Designing A Sustainable And Transferable Inventory Management System For Small Healthcare Facilities

Shree Frazier

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FOR SMALL HEALTHCARE FACILITIES

For the degree of Master of Science in Industrial Engineering

Is approved by the final examining committee:

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Sara McComb

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______________________________

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DESIGNING A SUSTAINABLE AND TRANSFERABLE INVENTORY MANAGEMENT SYSTEM FOR SMALL HEALTHCARE FACILITIES

A Thesis
Submitted to the Faculty
of
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Shree Natasha Frazier

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of
Master of Science in Industrial Engineering

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ABSTRACT

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Managing the costs of supplies within healthcare facilities has been a task that has plagued the health industry for many years. Many facilities are accustomed to using a par system approach. This involves bringing an inventory item to an amount sufficient for daily operation. This method often requires daily inspection by a healthcare worker, which reduces his/her time spent performing value added tasks. Employees at small healthcare facilities have multiple responsibilities, therefore they cannot afford to spend much time on inventory management. A proposed approach is the Kanban method, which allows for strict monitoring of inventory items without the need of constant inspection. Items are organized according to the ABC classification system, with B and C items complying by a special case of the Kanban method, the two bin system. To implement such a system, healthcare employees must undergo training of inventory management principles. This educational training is a major component that allows employees to effectively sustain the inventory management system, as well as reproduce it across other residences on their campus. The purpose of this thesis was to develop an inventory management system for a small healthcare facility that is sustainable and transferrable.
CHAPTER 1. INTRODUCTION

As of 2010, healthcare costs in the United States have been estimated at 2.6 trillion dollars (Varghese 2012). An article published in February 2014 in the Forbes magazine states that costs have increased almost 50% to 3.8 trillion (Munro 2014, para. 1) and inventory accounts for approximately 30-35% of the total healthcare cost (Nicholson 2002; Chandra 2013). This means that roughly a billion dollars is spent each year managing the flow of items within healthcare facilities across the nation. According to the researchers at the Center for Innovation Healthcare Logistics at the University of Arkansas, high costs may be due to inefficient inventory best practices (Nachtmann & Pohl 2009).

Many healthcare facilities do not have an effective method to maintain organization within the storeroom. This lack of organization leads to inefficient inventory management. Items that are not given a designated location known to all employees and are shelved haphazardly will lead to over ordering and having items expire. In most healthcare facilities, the inventory manager(s) are generally healthcare workers, mainly nurses, who have many other pressing responsibilities, primarily patient care. Therefore they do not have the necessary time to effectively manage item flow (Ciambrone 2012). Lack of organization can also lead to an issue of an overstocked storeroom, which may be caused by having multiple employees placing orders for the same items and not designating one
employee to handle all inventory requests (Nicholson 2002). Not having an effective method to maintain organization within the storeroom has led to over ordering items and in turn has caused inventory costs to increase.

The high cost of inventory has led many stakeholders in healthcare to seek other ideologies to help reduce inventory costs (Gadenne 2011). Many have turned to the success the manufacturing industry has had with lean management techniques for solutions to the inventory management problems that exist within healthcare (Power 2005; Jarrett 2006). Lean management focuses on adding value and meeting customers’ needs by eliminating waste. In the case of inventory management in healthcare, lean would focus on issues of reducing over ordering, creating a clean storeroom for easier stocking and retrieval of items, and maintaining effective inventory practices to help reduce cost so that employees can focus on providing their patients with quality care.

Researchers believe that the percentage of inventory costs can be reduced to 6-13% with the implementation of an effective inventory management system. However, to work towards reducing inventory costs, healthcare facilities need an effective and efficient inventory management system that can be implemented (Caroly 2010). Some healthcare facilities, mainly large hospitals, throughout the United States have hired consultants specializing in supply chain to help develop these systems (Varghese 2012). Smaller healthcare facilities may not be able to afford hiring a consultant to implement a system and educate employees on how to maintain that system. Therefore, an inventory management system is needed that is easy to implement and manage in facilities with limited staff who have multiple responsibilities, without the aid of a consultant.
The purpose of this thesis is to define an implementation process for a transferrable and sustainable inventory management system for a small healthcare facility. Small healthcare facilities have little, if any, opportunity to employ a consultant to introduce inventory management techniques (Inman, 1990). Therefore healthcare personnel are given the responsibility of making sure items are ordered weekly, while complying with the other demands of their job. This presents a problem for many nurses, because they do not have the time to physically count items and provide quality care to patients. The implementation of a Kanban system may help reduce the amount of time healthcare personnel spend managing inventory.

With the many patient-centered responsibilities and the limited experience healthcare personnel have with inventory management systems, the proposed system must be easy to implement, simple to use, and cost effective. The focus is on taking complex inventory management concepts and presenting them in a universal language, so that they can be implemented throughout the various departments or floors in the facility inexpensively. The primary goal of healthcare personnel is to provide quality care to patients and in order for the system to align with this goal, it must be efficient and effective in a short time frame for operation.

Implementation of the inventory management system is an important aspect of the project, but the focus is also on sustainability. Many healthcare facilities have implemented lean principles and have been able to obtain initial success. By not focusing on continuous improvement, areas where lean has been implemented are not reporting positive results and deem the lean project a failure (Guimarães 2014). Practices such as
educating employees by training sessions about how the system operates will help to ensure sustainability.

The anticipated impact of this project is that it will provide small healthcare facilities a guide to help improve their inventory management. This project may empower healthcare personnel with simple inventory management and storeroom management skills that may help them effectively monitor the flow of items within their facility at a low cost and in less time.
CHAPTER 2. LITERATURE REVIEW

Lean Management

Lean management is the process of adding value and meeting customer’s needs by eliminating waste (De Souza 2009). The concept of lean management was made popular by the Toyota Production System. The founder of this system, Taiichi Ohno, focused on identifying and eliminating seven types of waste in the production system, which would help improve service to the customer. To determine what qualifies as waste within a company, there needs to be an understanding of which jobs/activities are non-value added. Non-value added activities can be detrimental to a company or organization because they do not make an impact on the service provided or product produced and/or they cost a substantial amount of time and money (Heinbuch 1995).

Lean management has had a profound impact on several industries including manufacturing and healthcare. Lean implementation in manufacturing has resulted in supply chain improvements. The development of a more effective material restocking process by adjusting batch size, has allowed for more space in the warehouse and a reduction of inventory costs (Bateman & David 2002). In healthcare, the implementation of lean principles at some facilities has been found to reduce length of stay. Length of stay is caused by errors due to poor communication among staff or poor planning and lean has improved the flow of these processes (Heinbuch 1995).
The concept of lean has already been transferred to many health facilities across the country. A 425-bed hospital in West Central Ohio improved their supply chain by implementing automation technologies that linked several departments within their facility. With this communication and data availability among departments, the hospital was able to streamline nurses’ workflow, improve inventory management, and maintain better control of supply costs (Barlow 2013). Another large hospital in Nevada was able to hire a consulting team to help implement an inventory management and educate their supply chain team. This allowed the team to reduce inventory as well as the number of expired items in their facility (Barlow 2013).

While there have been numerous examples of effective implementation of lean concepts at large healthcare facilities, limited literature focuses on lean management at small care facilities. This may be because many small care facilities do not possess the resources to implement extensive lean strategies or tools. Many large care facilities can designate a team of administrators and employees to work solely on implementing lean principles (Banaszak-Holl 1996). The limited staff available at small healthcare facilities prevents this from happening. Having a small staff means that healthcare personnel assume many responsibilities including caring for patients, managing a unit, and performing administrative duties. These responsibilities limit the amount of time healthcare personnel can devote to projects that do not directly affect patient care. Patient care is the number one priority, so anything that detracts from that may not receive the appropriate time to function properly.

Despite the limited resources available at small healthcare facilities there is a need to implement lean to help day to day operations, especially inventory management, run...
more efficiently and effectively. The positive impact that effective lean practices have in some large hospitals, shows that attempting to implement lean in small facilities has the potential to produce similar results. The challenge is to develop and implement an inventory management system that is cost effective and decreases the amount of time healthcare personnel currently spend on inventory management, which often includes counting items. This leads to the research question: How do you develop a process for sustainable and transferable implementation of an inventory management system for a small healthcare facility?

RE-AIM Framework

The RE-AIM framework serves as a guide to make the case for a quality improvement project that involves implementing simple inventory management techniques in small healthcare facilities. The RE-AIM framework (Glasgow, Vogt, & Boles 1999) was originally developed to evaluate the effectiveness of public health and community-based interventions. Since its development, the use of this framework has grown to many fields including sports injury prevention, environmental change, quality improvement, and improving children’s physical activity. The five dimensions that are used to assess the interventions are reach, effectiveness, adoption, implementation, and maintenance. Each dimension is defined below:

- **Reach**: The individuals willing to participate in an intervention or program.
- **Effectiveness**: The positive and negative effects on important outcomes.
- **Adoption**: The individuals who are willing to initiate an intervention or program.
- **Implementation**: The individual’s adherence to the intervention protocol(s) with regards to consistency, time, and cost.
• **Maintenance:** The degree to which an intervention or program becomes part of organizational practices.

This framework is applicable to the proposed inventory management system because it allows us to understand why the intervention is needed and helps to analyze the impact of the intervention at the individual and organizational level. With each dimension, there is a “how” question that should be asked of the researcher: “How do I reach those that need the intervention?”, “How do I know the intervention is effective?”, “How do I develop organizational support for the intervention?”, “How do I ensure the intervention is delivered properly?”, and “How do I sustain the intervention?” These questions are critical because they help researchers, employers, stakeholders, and others invested in improvement projects to evaluate the intervention before implementation takes place. In the following sections the RE-AIM framework is used to analyze the current state and justify the need for a simple inventory management system in small healthcare facilities.

**Reach**

The proposed simple inventory management system is geared towards small healthcare facilities including pharmacies, physicians’ offices, long-term care, and small clinics. These facilities have a limited staff that takes on many responsibilities within the organization. These duties include providing patients with quality care, managing a unit(s), and administrative work. Many facilities assign multiple staff members, primarily nurses, to monitor inventory levels due to the lack of time each employee has (Chee Tahir 2010). Oftentimes information is not effectively communicated amongst staff because there is no system in place that allows for items to be accounted for appropriately. Nurses
and other healthcare personnel lack the expertise to implement a functional inventory management system, so the issues that plague this operation continue to persist.

**Effectiveness**

Inventory management is the process of efficiently and effectively monitoring the flow of units so that stock is not too high or too low for operation. Inadequate levels of inventory can either be too costly for a company to maintain, or they can put the company at risk of not meeting production requirements. There are certain aspects of inventory management that need to be considered to keep operations running efficiently including time. Knowing how long it takes to receive an item from the supplier and how long it takes for an item to be used in production is crucial to understanding the number of items to order and when that order needs to be placed. Managers also need to be mindful of keeping accurate records of inventory items. This information provides insight on how often certain items are being used and allows managers to make adjustments on order quantities.

There are many concepts to help managers understand how to effectively and efficiently monitor their inventory. A well-known classification system that aids inventory management is the ABC analysis (MacKerron 2013). This system follows the Pareto concept that suggests 80% of the cost is consumed by 20% of all inventory items. The classification of stock is determined by multiplying the demand of an item for a specified period of time by its unit price. Once total usage cost is determined for all items, it should be sorted so that the largest contributors of inventory costs are grouped together. Stock that falls in the 80/20 category are labeled “A” items and are usually under strict inventory management. The “B” class of items accounts for about 30% of inventory, but
only incur 15% of the cost. The “C” class of items may represent 50%-60% of inventory items, but only incurs about 5% of the total cost and receive minimal attention. The reason for classifying items into these categories is so that it can be determined how much inventory management is needed for each item to keep costs low and ensure the appropriate amount of inventory is available.

Currently, many healthcare facilities employ an inventory management technique similar to the par system. This system works by establishing a quantity needed for each item based on average usage. When the inventory level of a particular item drops below the quantity (par) needed the item is replenished (Leone & Phillippe 2011).

The par system appears to be a straightforward approach for monitoring inventory levels, but bringing an item to “par” is a tedious and time consuming process. In order to determine if an item is at the appropriate quantity level, the inventory manager must physically count each item daily. This means that an inventory manager or others involved with inventory management may be counting up to 1,000 different products at a small health care facility and up to 10,000 different items at a hospital. Due to the amount of time spent counting items, some inventory managers have admitted to guessing whether or not the stock they monitor is at par levels. Items that are not at par levels must be resupplied or reordered. This requires the inventory manager or storeroom attendant to make frequent trips to and from the storeroom restocking items.

The inefficiency of the par system has led to many health care facilities looking to improve their inventory management system. The daily counting of each item to determine if they are at an adequate inventory level decreases the amount of time employees can spend performing other duties and causes fatigue (Martinez-Jurado 2013).
Healthcare facilities use thousands of items each day and many of these items are not interchangeable. Not having enough of a particular item can lead to unsafe practices. Having too much of an item is costly and crowds the storeroom. This approach would not be employed at manufacturing facilities, so it should not be employed in an industry where the service is solely focused on improving the quality of people’s lives (Jarrett 2006).

**Adoption**

In order to apply lean methodology, it must be understood that lean is a major cultural change within an organization and must be acknowledged at all levels to help ensure success. To help understand the change and guide personnel to eliminate wasteful activities, the five steps of lean thinking were created. The steps are to: specify the value of the service or product from the viewpoint of the customer; understand why it is important; map/identify all actions needed to complete the task in the system; create flow within the system by eliminating all functional barriers; allow employees to retrieve items when needed; and continue to eliminate waste by analyzing the system after improvements have been made (Potsinka 2010; Reijula 2012). The five steps of lean thinking are an iterative process that helps organizations continuously make changes in the system benefitting both employees and customers after initial implementation.

Another component of lean that assists with understanding lean thinking and lean implementation is the 5S methodology: sort, straighten, shine, standardize, and sustain. The aim of this concept is to develop and sustain a standard way of operating to ensure efficiency, reliable ways of working, and continuous improvement (Taylor 2013).
Incorporating lean management techniques may seem like an effective strategy to help improve work processes, eliminate waste, and provide better service to the customer. However, many organizations that attempt to implement lean are not successful. The most glaring reason may be lack of commitment and participation from the administration and staff (Potsinka 2010; Guimarães 2014). Change is not always welcome, especially when the work processes employees are accustomed to are being modified. Convincing employees at all levels that lean practices are beneficial to the organization as well as its customers will help ensure successful implementation. This starts when there is a strong commitment from top management (Thong 1996).

Management has the ability to help overcome resistance to change by providing its employees with the resources and a favorable environment to implement the intervention effectively (Shortell 1995).

Another barrier to successful lean implementation is the lack of understanding of lean concepts (Reijula 2012). Lean is an iterative process and one of the main goals is continuous improvement. Many organizations that have implemented lean may initially see reductions in waste, however failure to continuously evaluate the system to understand where more improvements can be made lead management to believe lean does not work for them. Contributing to unsuccessful lean implementation may be the lack of effective training if any at all (Potsinka 2010; Guimarães 2014). Seminars, training sessions, and workshops are tools to continue to educate employees on continuously improving lean in their work environment. This is especially helpful in an industry such as healthcare where a majority of employees do not possess experience working with lean management concepts.
Implementation

Before attempting to implement an inventory management system, it needs to be understood that health care facilities are complex environments, which further distinguishes it from other industries. The physical layout of each hospital, residential facility, private practice, etc. differs greatly. With hospitals, the physical layout often varies by floor since different departments (i.e. operating room, maternity ward, and trauma center) provide different services. This means that the inventory management system implemented must be adaptable to each environment. In manufacturing, the process to create a particular product is the same every time. A raw material(s) enters the process and goes through several manipulations to create the finished product oftentimes with minimal monitoring and operator interaction. It is also known how much of the raw materials are needed to create that product and average daily use normally does not vary by much. This is not necessarily true for a product in healthcare. When a syringe leaves the storeroom, it has the potential to be used in a variety of ways including administering medication or feeding patients. On any given day there can be an increase in syringe use due to a traumatic incident. The inventory management system must effectively communicate this information so when it is time to reorder, there will not be a shortage of syringes due to inaccurate counting and reporting.

The dynamics of patient care contributes significantly to the difficulty of properly managing inventory. This should cause administrators to rethink their approach to managing inventory. The par system is a time consuming process that small healthcare facilities cannot afford due to limited staff. A lean inventory management system technique that could be implemented is the Kanban system. With this system, there is no
need to physically count each item to determine what needs to be reordered. The Kanban is typically a card consisting of product information, acts as a signal and alerts the inventory manager when an item needs to be reordered (MacKerron 2013). The implementation of a change as simple as this can help decrease the amount of time healthcare personnel spend on inventory management.

**Maintenance**

Many lean systems fail after implementation, because of lack of commitment from staff and administration, no desire for continuous improvement, and/or little to no employee training (Taylor 2013). There are many frameworks geared towards maintaining lean practices within an organization, but sustainability needs to be looked at in the context of the healthcare industry. The healthcare environment is complex and dynamic, so a strong commitment from administration and staff, such as monthly updates on operation, is needed for continuous maintenance of a system. Employee training is also critical to sustaining a system. The case can be made that lack of training healthcare personnel about how to properly manage item flow is a glaring example of a system maintenance failure. Without adequate training, employees have no motivation to properly sustain a system, especially with the many responsibilities required of their job.
CHAPTER 3. METHODS

The Setting

The healthcare facility in which the inventory management system was implemented is located in Chicago, IL. It is comprised of eight individual residential facilities that are home to roughly 600 patients. The residence that was targeted for the quality improvement project is the largest on campus, housing approximately 120 patients. This residence will serve as a model for staff so that the inventory management system can be transferred to the other residences on campus.

The head administrator and four nurse managers at the targeted facility were involved with the design of the inventory management system. One of the nurse managers in attendance also served as the inventory manager and had been in the role for seven years. The storeroom manager was not involved with the development of the inventory management system, but was integral during the implementation process. Below is a list of all employees and their roles in the development and implementation of the inventory management system.

- **Head Administrator**: Approved final designs and any changes that occurred during implementation.
- **Inventory Manager**: Developed the categorization of items as well as the classification of items for the inventory management system.
• **Storeroom Manager**: Stocks items as delivered and retrieves items for each of the six units within the facility as requested. Does not retrieve specialized items because employees that use them will retrieve them as needed. Works with the inventory manager to ensure items are being ordered each week.

• **Nurse Manager 1**: Served as a backup to the inventory manager, but will assume the role permanently when the inventory manager retires.

• **Nurse Manager 2**: Will be in charge of the inventory management of the new facility that is currently being built. Needs to understand how the new system will operate so that it can be transferred to the new facility.

• **Nurse Manager 3**: Will serve as the new backup to the inventory manager.

**Intervention**

Designing and implementing the inventory management system was completed in two phases. The first phase, storeroom management, was completed within seven full working days. Storeroom management consists of organizing all items by similar attributes into categories and rearranging the storeroom so that items can be easily stocked and retrieved. After the first phase was completed, the inventory manager wanted to begin the second phase immediately so the system could be in operation for at least a month before her retirement. The second phase, inventory management system, was completed within two weeks. The purpose of this phase was to implement a Kanban system for items requiring strict monitoring and a two-bin/box system for items that do not need strict monitoring. Specific details about the design and an assessment of the implementation phases are provided in the Results chapter.
Data Collection and Consent

Approximately one month after the completion of the quality improvement project, a survey that was created using Purdue Qualtrics was sent to the head administrator who disseminated it to the four nurse managers. A list of the questions and how they align with the RE-AIM framework is shown in table 3.1. The survey questions focused on the functionality, sustainability, and transferability of the new inventory management system. These questions were designed to gather user perceptions about the inventory management system, opportunities for improvement, and sustainability.

Written consent for the quality improvement project was received by the healthcare facility as well as Purdue University’s Institutional Review Board. Participants’ identities were kept confidential and their responses were collected without identifiers.

Theoretical Framework

To help guide an assessment of implementation process, the Consolidated Framework for Implementation Research (CFIR) was used as a resource. CFIR is a combination of many implementation theories and is structured to gather information about what works in an intervention and why. This framework has five domains, explained below: the intervention, inner setting, outer setting, characteristics of the individuals involved, and the process of how the implementation is achieved (Damschroeder 2009).

- **Inner Setting**: The features of the structural, political, and cultural contexts through which the implementation process will proceed.

- **Outer Setting**: The economic, political, and social context within which an organization resides.
• **Characteristics of Individuals**: The cultural, organizational, professional and individual mindsets, norms, interests, and affiliations.

• **The Intervention**: The characteristics (adaptability, complexity, cost) of the intervention being implemented.

• **Implementation Process**: The interrelated formally planned or spontaneous sub-processes that work towards effective implementation.

While the RE-AIM framework justifies why this intervention is necessary, the CFIR framework highlights the critical components needed for effective implementation.
### Table 3.1: Post Implementation Questions and RE-AIM Framework Alignment

<table>
<thead>
<tr>
<th>Question</th>
<th>Reach</th>
<th>Effectiveness</th>
<th>Adoption</th>
<th>Implementation</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Were there any modifications to the new inventory system prior to it being put into effect?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2. How has the organization benefitted from the new inventory system?</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. How sustainable do you think the new inventory system will be within the organization?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>4. Do you believe this inventory system approach can be easily translated to different neighborhoods and residential facilities across the campus? Why or why not?</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Did the inventory system achieve the goals expressed by the organization (decreased costs, inventory in storeroom kept at a minimum)?</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>6. How easily was this improvement approach learned by those that interact with the system?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>7. How well received was this inventory system improvement by users in the organization?</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>8. Since this inventory system approach may be translated to other facilities on campus, what advice would you give for a more successful transition?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>9. What improvements would you make to the inventory system so that it better aligns with the organization’s capabilities?</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>10. How has your role within the inventory management system been impacted by the changes?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
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CHAPTER 4. RESULTS

Characteristics of the Intervention

Phase I: Storeroom Management

Storeroom Organization

The first step towards implementing the new inventory management system was to categorize all items with similar attributes, which can reduce the amount of time spent searching for them. While performing this task, waste was discovered in the form of expired and no longer used items. The expired items were discarded and items no longer used were gathered for donation to other healthcare facilities. After the waste was removed, the remaining items were arranged in seven categories: medical, diapers, formula, respiratory, hygiene, office supplies, and miscellaneous. Miscellaneous items include disaster kits, emergency care kits, pillows, and other items not essential to daily care. Each category of items was given a designated location in the storeroom based upon frequency of retrieval and weight of item. Items that were used daily such as formula and diapers were located near the entrance of the storeroom, so that time spent stocking and retrieving them could be reduced. Formula, which is packaged and transported to the units in cases of 12-24 cans depending on the brand, is a heavy item. Restricting placement of formula to the middle and lower shelves may reduce the storeroom manager’s potential risk of injury.
In addition to categorizing items by product type, color codes were assigned. The purpose of the color codes is to simplify inventory stocking and retrieval by associating a color with a particular group of items. The healthcare facility does not have a specialized color coding system in place for any other function, which will not create confusion for healthcare personnel designated to retrieve items. A color code chart was developed by the inventory manager and is displayed below. When assigning colors, the inventory manager matched color with category function. For example, respiratory items concern the patient’s ability to breathe. Nurses associate a patient breathing properly as having a pinkish color. Therefore when an employee needs to retrieve a respiratory item, they will go to the pink section of the storeroom because this color is associated with breathing/life.

- Medical = Red
- Diapers = Orange
- Formula = Blue
- Respiratory = Pink
- Hygiene = Yellow
- Office supplies = Green
- Miscellaneous = Black

_**Storeroom Design**_

The storeroom’s purpose is to house materials in a secure, clean, and organized setting. In order for the storeroom to fulfill its purpose, the placement of items must be designed so that the storeroom manager can efficiently and effectively retrieve and stock
items without confusion. With the input from the inventory manager, improvements to the current storeroom included:

1. All items were classified by the ABC classification method.
   a. Helps determine which items require strict monitoring
   b. Drives the location of more expensive items so that a visual check of inventory levels can be performed.
2. Less frequently used items and non-heavy items are located on the top shelves if space is limited elsewhere.
   a. Reduces the risk of potential injury to healthcare personnel, by eliminating the need of a step ladder to retrieve commonly used items.
3. ID labels for all items contains: product name, supplier name, order quantity, reorder point, location in storeroom, color code (label can represent color or a dot can indicate the color)
   a. Identifies items for easier completion of weekly orders
   b. Easier to locate items by category with color code present
4. Location of items was designated by aisle letter, shelf number, and row number.
   This concept is similar to that of a grocery store. Eight aisles consisting of 3-5 shelves were created for the item categories (Sketch located in Appendix A). Each aisle was labeled with a placard that provided item category and color code. An example of an item location would be men’s deodorant: Aisle C, Shelf 4, Row 4.
   a. Relates to a concept (grocery shopping) that is familiar to everyone.
   b. Ensures every inventory item has storage space in the storeroom that is logical and easy to locate.
5. Items that are retrieved and stocked often, as well as items that are of high value, (diapers and formula) are stocked near the entrance of the storeroom.
   a. Helps reduce the amount of time the storeroom manager spends retrieving and stocking those items.
   b. Hoarding is an issue, so having the more costly items near the entrance allows the inventory manager to perform a quick visual check of their levels.

**Phase II: Inventory Management**

**Kanban System**

After organizing the storeroom for easier retrieval and stocking of items, the next phase was to implement the Kanban system. Kanban, which means card or signal, contains information about the item including name, supplier name, quantity per container, and location in storeroom. The Kanban system’s goal is to maintain inventory at a minimum by supplying items only when needed. This system is used primarily for A classified items because it allows for strict monitoring. The healthcare facility documents weekly item purchase orders and has a record of this information dating back to at least five years.

After examining purchase orders for the previous year, it was determined that the A items would include diapers, formula, and gravity pump bags. It was also determined that all diaper and formula associated items would be classified as A items as well because nurses were over using them. There was an issue with nurses using aloe touch wipes, a B item, on all patients after a diaper change even though the item is designated
for patients with sensitive skin. The inventory manager decided to keep the stock in her office for strict monitoring, which eventually overcrowded her space. Classifying items such as aloe wipes as A allows for strict monitoring and free up office space.

The A items account for approximately 70%-75% of the total weekly order budget. When the quantity of an item reaches its reorder point, the Kanban acts as a signal and alerts the storeroom manager that the item needs to be ordered. This card is replaced in the “Kanban reorder bin,” located in the storeroom, so that the inventory manager will know that item needs to be ordered that week. After the order has been placed, the cards will be placed “Kanban re-file bin”. When the shipment arrives, the storeroom manager will return the card to the appropriate reorder point position.

Two-bin/box System

The two-bin system is a special case of the Kanban method. It is primarily used for C classified items, as well as B items not requiring strict monitoring. Inventory for an item is separated into two bins. The first bin contains the order quantity minus the reorder point. The order quantity is the number of items that minimizes ordering and holding costs. The reorder point is the number of items that will last until the new order arrives. When the first bin is emptied, the storeroom manager retrieves the Kanban card for that item and places it in the reorder bin, which informs the inventory manager to order that item. The second bin contains the reorder point quantity, which will last until the new shipment arrives.

Two modifications of the two-bin system were adapted because of limited spacing in the storeroom. First, instead of using two bins, each item was given one bin that measured two feet long. The Kanban card divided the reorder point quantity from the rest
of the items. For example, the order quantity for deodorant is twelve and the reorder point is three, then the Kanban card would be placed in front of three remaining deodorants. Slack is accounted for in the reorder point. This change to one bin allowed items to fit comfortably in the storeroom and created a considerable amount of space.

The second modification was to keep in compliance with health regulations. Some items cannot be removed from their original packaging, so the two-bin system now becomes the two-box system. Identifying the reorder point for these items requires a visual check. Items need to be reordered either when the box is half empty or three-quarters empty. The storeroom manager indicates the level for reordering on the box and it is also indicated on the item label.

**Inner/Outer Setting**

The healthcare facility identified the need for an easier approach to manage inventory after their inventory manager fell ill and no other nurse manager understood how to properly place orders for the week. The system that was in place at the time was similar to the PAR method. The inventory manager would physical count each item and order the necessary stock needed for the following week. The other nurse managers did not know the quantity needed for each item, which led to extensive time spent compiling purchase orders and over ordering.

During a meeting with the team, they expressed being open to any changes that would allow them to control over ordering and decrease the amount of time compiling purchase orders as long as the solution was cost effective. The healthcare facility annually receives about 60% of its funds from the government, 25% from donations, and 15% from other sources such as fees. All money received is used to keep the program
running, pay staff, and hold fundraising events, so there is not much funding left to invest in quality improvement projects. Therefore the inventory management system must be of minimal cost and use resources that are readily available. This facility has a budget for office supplies, so creating color coded item labels, Kanban cards, and signs providing information on item location was not a burdensome expense. The only required purchase was placards that designated the aisles where items were placed.

**Characteristics of the Individuals**

The healthcare personnel at this facility, especially those in managerial positions, are devoted to providing quality care to the patients and ensuring that the organization is recognized as one of the top residential care facilities in the country. Many of the nurse managers have been employed at the facility for 20-40 years, so they have a familial connection they have with the organization. Caring for patients has always been the employees’ priority, but growing with the organization means added responsibilities. The nurse manager involved with the intervention assumed the role of inventory manager seven years prior. Having that much experience managing inventory provided a smooth transition from the PAR-like method to the Kanban system. After implementation was completed, the manager had no issues operating the system.

Essentially most of the employees seemed comfortable with the changes to the storeroom and inventory management system after training was completed. There was an eagerness to use the new system because they bought into the idea that any improvements providing a potential reduction of workload and helping the organization save money would benefit both employees and the organization. The dedication the employees have to the organization contributed greatly to the success of this quality improvement project.
Some employees believed no intervention was needed. They were comfortable with the current setup of the storeroom, because they knew the location of the items they needed to care for patients and felt the addition of Kanban cards would be another responsibility. In fact one of the survey respondents noticed the drawback of some employees and said, “The advice I would give would be to approach the change with an open mind. I think there was concern that the new system would be "more work" but it isn't.”

**Process**

Learning that some healthcare personnel do not have a basic understanding of lean concepts is an example of why managing inventory is such a problem for healthcare facilities across the country. During the planning stage of the intervention, a proposal that explained an inventory management system using basic lean principles (see characteristics of the intervention) was submitted to the inventory management team. Unknown at the time was that the inventory management team was unclear on the content of the proposal. The content was not understood until the presentation of the proposal. One respondent stated, “We found at the beginning it seemed a little mind boggling, but when Shree met with the ordering team and explained the process. It made sense.” After the presentation was given, the team was able to provide helpful feedback such as color code designation and eliminating the use of the top shelves for employee safety.

Implementing the proposal was not executed by any formal plans. Storeroom management tasks such as moving items to their designated location, assigning color codes and developing labels was performed first, so that the inventory management system could be implemented next. Implementing both phases went smoothly except for
the development of item labels and Kanban cards, which proved to be the most time-consuming tasks of the intervention. The healthcare facility has hundreds of items in their storeroom, so there were many instances of items not having a label or Kanban card. The labelling process took approximately two weeks to complete working six hours a day, whereas all other tasks were finished in a few days. Reflecting on this part of the intervention, the inventory manager stated, “It was very tedious at the beginning, when making labels and Kanban Cards. That process took up a lot of time. Even after we thought everything was completed, we found some products unlabeled and without Kanban cards. This was adjusted and everything fell into place.”

When a new system has been implemented or any new changes are introduced into an environment, it is often difficult to accept change immediately. In fact one respondent noted that “…there was some skepticism at first (change is hard)”. After the inventory management system was implemented, employees were able to benefit from the storeroom organizational component immediately, which allowed them to believe that the change would be good for them and the healthcare facility. Seeing that the storeroom organization proved to be beneficial, employees did not mind buying into the inventory management component of the system. Convincing employees that one change can be beneficial, makes it simpler to introduce other components of the system.
CHAPTER 5. DISCUSSION

The aim of this thesis is to provide a guide for designing and developing an inventory management system for a small healthcare facility. This was achieved by focusing on the issues of lack of time healthcare personnel have due to multiple responsibilities, limited experience healthcare personnel have with lean principles, and sustaining the system after implementation. To address these issues, organizing the storeroom for easier stocking and retrieval of items was performed first. All items were categorized into seven item groups and were given a color code for identification purposes. Items in the storeroom were rearranged so that more frequently used items were located near the entrance and heavy items were removed from the top shelves to reduce the risk of injury. Labels containing product name, supplier name, location in the storeroom, color code, quantity order, and reorder point were provided for each item.

The next phase of the project was to implement the inventory management system. Before this could occur, the ABC classification method was used to determine the appropriate level of monitoring for each item. Based on these classifications, a Kanban or two-bin/two-box protocol was developed for each item. The Kanban system provided the inventory manager with more time for other responsibilities because there was no need to physically count each item to determine if it needed to be ordered. Employees that
retrieve items were trained on how the Kanban method works so that the system can be sustained. Further methods of sustaining the system are explained in the next section.

**Sustainability**

One of the biggest issues after implementing lean in an organization is maintaining the system. Many facilities struggle with system maintenance because proper measures have not been put into place. The first step to ensure sustainability is to train all healthcare personnel who interact with the system about proper storeroom and inventory management procedures. After implementation was complete, the inventory manager held an in-service in the storeroom to explain how the new system functions. Detailed explanations were given on why items in the storeroom were rearranged and given a color code. Preventing injury was a selling point to personnel because many discussed not wanting to use a ladder to retrieve items in fear of falling. Demonstrations were given on how to operate the Kanban system, so that all employees were informed on how it operates.

Another step to ensure sustainability is to create signage outside and throughout the storeroom. Creating signs to indicate where items are located in the storeroom as well as a grid displaying the storeroom layout was placed on the entry door so that employees know where to go to retrieve a particular item. In the storeroom, each aisle has been labeled by category and color coded accordingly. Signs that explain the color coding system have been added as well. The purpose of these signs is to reinforce storeroom management by constant reminder as well as reduce the amount of time employees spend searching for items. Employees do not have much time to spare, so having signs to direct
them to the item needed will allow them to continue to provide quality care for their patients.

In addition to creating signage to help reduce time spent searching for items, the Kanban system reduces the amount of time the inventory manager spends counting inventory. Previously, the inventory manager spent a day counting and ordering items for the next delivery, which forced her to cram her other responsibilities into the other four days barring an emergency. With the implementation of the Kanban cards to signal that an item needs to be ordered, the inventory manager does not have to physically count items each week.

The inventory manager is in charge of making sure that storeroom and inventory management are being properly maintained. The development of a monthly checklist for sustainability (Appendix B) will ensure that this is happening. The checklist loosely follows the five steps of lean implementation. The four main points of the checklist are to reduce waste, improve quality, implement better systems, and maintenance. The checklist serves as a reminder on how to properly maintain the new system as well as focus on continuous improvement. The five steps of lean implementation are an iterative process that focuses on continuously improving the system.

Lessons Learned

One of the lessons learned was that every issue a healthcare facility will have pertaining to managing item flow will not get solved just by implementing an inventory management system. Hoarding is an example of that. During the initial meeting with the inventory management team, hoarding was one of their main concerns. Unfortunately no inventory management techniques can solve that issue, but the new system provides a
better way to track sudden increases of item flow. An increase in item flow can be caused by many things including hoarding and an emergency event, however knowing that there is an increase in item flow alerts the inventory manager of a potential issue. Further investigation will be needed to determine the problem.

When implementing an inventory management system in a small healthcare facility, make sure at least three people are involved in that process. One person should have knowledge of how the storeroom operates. Another person should have extensive knowledge on managing inventory. The final person should serve as a backup when the inventory manager is unavailable. The issue at this facility was that the current inventory manager was retiring and the nurse assuming that role was not involved with the implementation, primarily due to other obligations. Serving as the inventory manager’s backup before, she was familiar with the previous system, however after the assuming the role inventory manager, she had to be brought up to speed about the new process. It also takes time for the nurse to adjust because he/she is adding another responsibility to an already dense workload. Having this person present during the implementation process may reduce any setbacks and anxiety that come along with a new role.

Having expert knowledge of inventory practices makes it easier to take control of the intervention and develop it accordingly. Healthcare personnel feel compelled to relinquish control since they have minimal knowledge of inventory management. It must be remembered that the employees will be the individuals operating the system, so they must be aware of what occurs at each phase of the process. Keeping employees involved may encourage sustainability of the system.
Lastly, make sure that the inventory and storeroom managers provide input. When developing the color codes for the item categories, the inventory manager immediately took charge of that task because of how nurses associate colors with patient-centered tasks. The color red was designated for medical items. Red is the color of blood and medical items include gauze, bandages, syringes with needles, and cotton balls. These items are used to either stop the flow of blood or to draw blood from the patient. The connections of colors to patients to devices needed for a task is one example of how valuable input from employees is when implementing the system.

**Future Steps**

The quality improvement project primarily focused on designing and implementing a sustainable inventory management system in a small healthcare facility. The next step is to understand how to tailor the system when it is transferred throughout the facility as well as other small healthcare facilities across the country. One solution to this issue may be in the development of storeroom management and inventory management flowcharts.

The flowcharts can serve as an assessment of the current state of the storeroom and inventory management process and determine which areas need to be improved. The flowcharts could be guided by the five steps of lean thinking and the five steps of lean implementation. The five steps of lean thinking can help healthcare facilities understand the need for an inventory management system by evaluating current item flow management to determine the issues causing inefficiencies. If the issue is increased cost, following the steps may help facilities determine the cause of the problem and begin to make changes. The five steps of lean implementation serve as a guide to facilitate
changes within the system. This process focuses on removing non-essential items/activities, ensuring all items have a proper location, implementing a system that continuously removes waste and defines item location, and sustaining that system. Flowcharts detailing these two processes may help improve healthcare facilities understanding of proper item flow management.

Another step that can be taken is the creation of a manual detailing the process to implement the storeroom and inventory management system explained in this thesis. During the planning stage of the intervention, the inventory management team did not fully grasp the system as it was explained in the proposal. There needs to be a manual and audio tutorial that can guide healthcare personnel to implement a similar system.
REFERENCES
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APPENDICES
Monthly Checklist for Sustainability

1. Reduce wastefulness
   - Eliminate over ordering items
   - Develop plan for no longer used items
     - Donate them
     - Recycle them if possible
   - Eliminate no longer used items on inventory ordering sheet
   - Downsize bin containers for item storage

2. Improve quality
   - All items should have their own label
   - Check unit’s request sheet to help keep track of items

3. Implement better systems
   - Storeroom management organization
     - Items categorized properly
     - Items are properly color coded
     - Most used and expensive items are located near front of storeroom
   - All signs are visible and intact
   - Items are off the ground
   - Inventory management system
     - Kanban bins are being properly used
     - Two-bin/box system is being maintained
     - Kanban cards are still intact

4. Sustaining the system
   - All healthcare personnel have been trained on the system
   - The inventory manager has a backup for when he/she is unavailable