IMPLEMENTING LEAN IN HEALTHCARE'S WAREHOUSE OPERATIONS – EVALUATION OF 5S'S BEST PRACTICE

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Abstract

Lean strategies in healthcare aims to improve patient throughput, reducing medication errors, redesigning work flow, improving patient safety, and reducing cycle time but studies to improve healthcare's warehouse operation was not common. Managing medical supplies has always been a priority due to demand uncertainties and the risk of shortages which would greatly affect patient safety. This study showcases two implementation approaches for 5S (Hybrid and traditional) conducted in three different hospitals' central warehouses at Ochsner Health System. These warehouses store similar medical products with over 1000 supplies (e.g. syringes, gloves, primary IV) that supply different departments within hospitals and clinics. The participating warehouses faced similar problems due to over/under stocked inventories, space constraints, and poor layouts. The objective of this study was to compare the impact of implementing a Hybrid 5S (integrated with inventory management techniques and process improvement tools) along with two traditional 5S's to improve healthcare warehouse operations. Although, all the two approaches improved the baseline warehouse process, the warehouse that used the Hybrid 5S showed the greatest improvement with an increase of 59.5% in inventory turnover and 15.7% space saved. Lessons learned from this case study are discussed and used to propose guidelines to integrate inventory management techniques and 5S.

1. Overview of Lean in Healthcare

Currently, a rapid need for Lean in healthcare has been growing due to its systematic approach in improving quality, safety and efficiency (Kim et al, 2006). Applying Lean has always been challenging in healthcare, particularly in addressing patient needs and providing a safer environment to avoid errors. Emphasizing wastes in medical practices, Endsley et al (2006) considered output (wrong process, over-production, delay, large variation in output rate and demand) and flow (waiting, duplication of process, rework, work interruptions, and non- standardized work) as the two main categories for problems in medical practices. According to Koning et al (2006) one of the significant contributors to health care cost is operational inefficiencies in medical service delivery. Managing supplies efficiently and having proper levels of inventory is a major activity that supports high quality levels of health care delivery. Managing medical supplies has always been a priority due to demand uncertainties and the risk of shortages which would greatly affect patient safety. Even though uncertainties are impossible to be completely removed in any supply chain system, strategies could be developed to match supply and demand without accumulating unnecessary levels of inventory (Jones, 2006).

Ochsner Health System laid its Lean foundation in the year 2007 with a handful of Lean Leaders and five LSU interns. The team is involved in conducting Lean projects in nearly 200 departments across its 8 hospitals and 35 clinics in Louisiana. This research is concentrated in the warehouses of three hospitals holding similar supplies and operations. This research explores the effectiveness of a Hybrid 5S compared to two traditional 5S's in reducing overall inventory and streamlining supplies. The Hybrid 5S integrated traditional 5S with process improvement and inventory management tools within healthcare. The Hybrid 5S model uses the Kaizen event structure to establish the relationship between process improvement tools and inventory management techniques. In order to evaluate the impact of the Hybrid 5S model, the results of its implementation were compared with two traditional 5S's at Ochsner.

This study assesses the impact of a new strategy, the Hybrid 5S, in healthcare's warehouse operations starting with identifying critical items, reducing overall inventory, redesigning warehouse layout, optimizing space, and reducing distances travelled.

2. Inventory Management in Healthcare

Kilpatrick (2003) emphasized the need for Lean Production strategies for eliminating seven different types of wastes. In particular, excess inventory, which negatively impacts the hospital's cash flow, leads to inefficient use of warehouse space. For instance Kumar et.al, (2006) implemented Lean in Indian

Small Medium Enterprise's to eliminate defects, reduce variation and inventory. However according to Graban (2008), companies tend to wrongly think that the goal of implementing Lean strategies is to achieve low inventory, when in reality the goal should be to deliver high quality health care services while maintaining appropriate levels of inventory. But a study conducted by Nicholson et al (2004) showed that healthcare systems have not shown enough attention to proper inventory management strategies, and their current practices focus mainly on periodic review of inventory levels. However, in most cases managing inventory has been purely experience or politically driven rather than depending on historical data (Nicholson et al, 2004) or actual patient consumption data. Various tools and techniques have evolved in the past displaying the importance of addressing inventory. One such method, ABC classification, based on Pareto principle, has proved to be significant in classifying a large number of supplies (Ramanathan, 2006).

3. Traditional 5S Applied to Healthcare

5S is a systematic Lean tool and the simplest to implement for organizing and standardizing the workplace (Kilpatrick, 2003). Ho (1999) described 5S as a technique to establish and maintain a quality environment in an organization. Dulhai (2008) suggested that 5S rules have immediate and significant effects on the sequence of activities in the work environment, thus influencing the performance of processes in the company. Traditionally, 5S follows a sequence of activities (sort, set to order, shine, standardize, and sustain), that results in an effective tool for house-keeping or organizing supplies. As described by Kilpatrick (2003), 5S provides immediate returns on investment and is applicable to diverse organizations. However, research has not been performed to assess implementation strategies using Lean tools to a warehouse of a healthcare facility. Considering the amount of research on inventory control techniques, it would be interesting to find out the impact of integrating Lean and inventory management techniques. Frequent problems in handling supplies/equipment in healthcare that add to non-value added activity include; 1) delays in delivery of supplies due to improper ordering, 2) mix ups in getting supplies, 3) returns by departments due to defects, 4) difficulties in handling new type equipment, 5) effective utilization of space (Graban 2008). This research focuses on managing healthcare supplies and strives to address the problems stated in (1), (2), and (5).

The objective of this study is to implement, document and evaluate the impact of the Hybrid 5S strategy, compared to the results of implementing two traditional 5S in hospital warehouses. To compare the post-5Ss performance of the three hospitals' warehouses case studies, the performance metrics used for the comparison analysis includes inventory turnover and 5S audits.

4. Hybrid 5S Model

Based on current literature and industry practices, a conceptual model was developed for the Hybrid 5S which integrates process improvement tools along with inventory management techniques (Figure 1). This model is formulated in four phases, following the Kaizen event structure, which are based on the adoption of Deming's cycle or the PDCA cycle. Kaizen was built on the principle of continuous improvement focusing on low cost and low risk improvements (Jacobson et al, 2009).

Phases 1 and 2: Pre-work begins with observations and preparations to formulate a plan (Wilson, 2000). In most cases identifying a key process is primarily determined by mapping the process and specifying value from the customer's perspective (Womack et al, 2005). Value Stream Mapping is an effective tool to identify the opportunities for improvements and distinguish between the value added and non-value added activities (Kumar et al, 2006). Planning of Lean initiatives considers inventory management techniques such as ABC classification, estimating ordering and carrying cost, and layout re-design. According to King et al (2006) one application of Lean thinking is the redesigning strategy to improve the process flow in a health care perspective.

Phase 3: The implementation phase is the establishment of 5S, which involves the first three stages of 5S: Sort, Set to Order, and Shine.

Phase 4: The fourth phase adopts Standardize and Sustain of 5S which oversees variations in the overall process flow and constantly looks for solutions to counter any issues. Wilson (2000) emphasized that the final phase in any process improvement is to measure the improved process by evaluating effectiveness, efficiency, relevance and impact. Based on this study, a conceptual model was developed (*Figure* 1) with four phases of Kaizen events by integrating process improvement tools with the inventory management techniques.

5. 5S Implementation

This research had three main elements: 1) Data Collection, 2) Documentation of the case studies and 3) Analysis of performance metrics (inventory turnover and 5S audit) before and post-improvements.

Warehouse Characteristics: The case studies showcase the results of implementing the Hybrid 5S and the traditional 5S at three central warehouses at Ochsner Health System. The warehouses stored over 1000 medical supplies (e.g. syringes, gloves, primary IV) for different departments within the hospital and other clinics. The process of ordering supplies to central supply and vendors is carried out electronically by using an application called LAWSON. LAWSON contains a complete history of each item such as the demand of each month, item cost, current stock, and also the vendor supplying the item. LAWSON also has the provision to maintain the inventory of each item and has the ability to calculate the economic order quantity (EOQ) and re-order level (ROL) using pre-defined formulas. Despite these features in LAWSON, inventory control practice was purely based on the experience of employees in all the warehouses. All three warehouses used the LAWSON system, facilitating access to inventory turnover data before, during, and after implementing the Hybrid 5S and Ochsner's traditional 5S model.

5.1 Hybrid 5S implementation

The Hybrid 5S implementation was carried out for a period of 4 months with 15 warehouse workers including the director and a Lean leader. Their current practice for inventory management was driven by the experience of one single employee. Moreover, the warehouse was facing problems such as 1) Over/under stocked supplies, 2) Increase in time due to look-up of supplies, 3) Space constraints, 4) No standardized process in the arrangement of supplies. To address these problems the Hybrid 5S model was implemented (Figure 1) with the objective of standardizing supply chain processes and optimizing warehouse operations.

Phase 1 entailed planning and preparation of the Lean initiatives to understand the current process which was carried out by conducting a brainstorming session with the materials management director, Lean leader, and a Lean intern. The outcome of this effort was a draft of the current state value stream map of warehouse operations. The planning included assessing their current inventory, space utilization, and the distance travelled by the employees (spaghetti maps) for picking various clinic and department orders. The pre-work revealed inaccuracies in determining re-order levels and order quantities resulting in excess inventory which led to occupying more space. Also, bottlenecks were observed during the daily routine of picking orders resulting in excess travel for the warehouse personnel, thus increasing the picking time of each order.

Phase 2 involved conducting the Lean initiatives by adopting the inventory management tool ABC, inventory model and re-designing the layout of the warehouse. ABC classification categorizes the most critical items as 'A' followed by moderate items as 'B' and finally least effective items as 'C'. ABC classification is based on the inventory value of each item which is a product of annualized sales and the unit cost. The items are arranged in descending order and the later classified as 'A', 'B', or 'C'. To develop a deterministic inventory model, the ordering cost and the holding cost are primarily estimated to establish the Economic Order Quantity (EOQ) and Re-Order Level (ROL) to update into the LAWSON. The basic inventory model for calculating EOQ and ROL are as follows.

$$\text{EOQ} = \sqrt{2AD/H} \qquad (1)$$

Where,
A = Ordering Cost,
D = Annualized Demand,
H = Holding Cost.

The Reorder Level (ROL) is expressed as;
ROL = Lead time (L) * Demand (D)/ 365 (2)

Equation (1) represents a deterministic inventory model which assumes that a uniform demand exists throughout the cycle. However, healthcare has more uncertain demand which questions the need for incorporating probabilistic models in the calculations of LAWSON. Currently, LAWSON supports the use of EOQ and ROL as expressed in equations (1) and (2). Ordering costs (costs incurred from ordering to receiving the goods) are determined through cost analysis. Benchmarking, which can act as a substitute for inaccessible information, was obtained from the Association for Healthcare Resource & Materials Management (www.ahrmm.org) to determine holding costs. Another important aspect of the implementation process of Hybrid 5S is the re-design strategy. Various sessions of brainstorming and interviews were conducted among 10 participants who were involved in redesigning the warehouse layout and allocating items to its designated shelf. The redesigned layout focused on reducing the distance travelled by the employees for picking up items. To do this, the supplies were classified based on the results of the ABC classification with the idea of restricting employee travel to 'A' and 'B' class items. The ABC classification showed that nearly 53% of the overall items (A-category) constituted 82% of the inventory value. The calculated EOQ and ROL revealed a decrease in order quantities and re-order levels in most cases. The layout redesign witnessed a straight line pattern of the arrangement of racks starting with the

'A' category items followed by 'B' and 'C' categories.

Phase 3 included implementation of the inventory model and the first three steps of 5S which are sort, set to order, and shine. The implementation of sort resulted in removal of obsolete items and a space reduction of 15.7%. Set to Order observed space allocation for each item based on 75% of the sum of its EOQ and ROL values. Shelf and rack heights were standardized considering the OSHA guidelines for healthcare warehouse operations.

Visual labels were introduced for each item with its LAWSON and vendor number followed by the EOQ and ROL values. Barcodes were included in the label for its transition to a new and effective system of managing inventory and delivery. Shine witnessed floors and passage ways free from oil or dust, cleaning the racks, providing sufficient lighting, assigning responsibilities to employees and maintain a cleaning mechanism.. Finally, the fourth phase is the measurement of performance of the hospital warehouse by evaluating its monthly inventory turnovers and determining the efficiency of 5S using an audit tool which rates each warehouse based on the number of non-conformities.

5.2 Traditional 5S Model

Two facilities were used to compare the impact of Ochsner's traditional 5S. The Ochsner's traditional 5S comprises of three phases which includes pre-work, implementation, and post analysis.

Pre-work addresses the inventory (manually adjusting on-hand quantities to reflect true demand), planning resources, tools and equipment required, and visual and ergonomic enhancement through various brainstorming and interview sessions. To assess the time spent and the distance travelled in searching for supplies, spaghetti maps were developed. However, measures were not taken in redesigning the overall layout of the warehouses. Supplies were grouped by function rather than frequency of use.

Implementation of sort, the first phase of 5S, included a plan to eliminate obsolete items based on usage reports. Set to Order witnessed grouping of similar items followed by visual enhancement techniques by adding labels to the items and aisles. Measures were taken to ensure each item had a single location. A cleaning mechanism was enforced between the employees to monitor the tidiness of the warehouse.

Post Analysis: A 30 day action plan was developed for sustaining the improvements of the warehouse which reflects any issues encountered, action taken, and the status of completion.

6. Comparison Analysis

After collecting data and documenting the case studies, results were evaluated to assess the impact of the two 5S methods on warehouse operations. Inventory turnover for a year was considered and compared 6 months before and after the implementation of the two 5S. For the Hybrid 5S the inventory turns were taken for eleven months before and eleven months after the 5S initiative. Inventory turnover is the ratio of the cost of the goods sold to the average inventory. ANOVA ($\alpha = 0.05$) was used to test the hypothesis that 5S increased inventory turnover. Significant difference in the inventory turnovers was determined using ANOVA in Statistical Analysis Software (SAS 9.2).

5S Audit: In order to assess the efficiency of the warehouse after the implementation of both 5S models, a survey was conducted among the directors of three warehouses who actively participated in the process improvement initiatives for the three warehouses. The 5S audit is based on Ho (1999) who identified non-conformities as a setback for auditing a 5S implementation. The 5S audit was modified to suit hospital warehouses where 0-5 of non-conformities were depicted as 'excellent', 6-10 as 'good', 11-15 as 'average', 16-20 as 'marginal, and non-conformities greater than 20 depicted as 'poor'. Finally, the scores were compared to each hospital and a 5S scorecard comparison matrix displayed overall scores.

7. Results

Results from the hypothesis test showed no significance difference at $p = 0.8320$ for one facility before and after the implementation of Ochsner's traditional 5S model, but the second facility showed significant improvement at p=0.0008. SAS output showed a statistically significant difference for the Hybrid 5S at p=0.0021. Inventory turnover of the facilities showed a greater level of improvement immediately after the implementation with Hybrid 5S increasing 59.5% compared to the traditional 5S at 15% and -4.1%. The Hybrid 5S improved inventory by saving 15.7% space by reducing the number of steel racks from 171 to 149. Warehouse space reduction was not observed for either traditional 5S. The results from 5S comparison matrix reflected a marginal rating for Ochsner's traditional 5S with scores of 16 and 18. The Hybrid 5S produced 9 non-conformities making it a 'good' rating.

8. Discussion

The results of the study clearly show that Hybrid 5S had the greatest impact compared to traditional 5S. Even though one traditional 5S witnessed an increase in inventory turnover (15%), space in the warehouse was not reduced. Hybrid 5S showed a positive influence on the warehouse after the implementation with an increase in inventory turnover of 59.5% and nearly 15.7% space saved. This may be due to the incorporation of Kaizen, which provided insight to identify the root causes and provided a systematic procedure. In contrast, traditional 5S neglected the actual problem, and the procedures were suited for monetary benefits rather than sustaining for the long term. Moreover, the traditional 5S ignored the use of inventory techniques and other Lean process improvement tools best suited for the facility. Several other factors could have influenced the Hybrid 5S such as more efficient team work and employee and management's commitment However, an effective method needs to be addressed for sustaining the improvements in the future. This was well observed after the implementation, where inventory turnover showed non-uniform distribution rather than a steady increase for all the three warehouses (Figure. 2). Employee training and top-management involvement needs to be exercised constantly in order to sustain the improvements for long term. From the success of Hybrid 5S future studies can include a set of guidelines to serve as a template to replicate Hybrid 5S in other hospital warehouses. Moreover, probabilistic models can be adopted for inventory management which can satisfy uncertain or seasonal demand in healthcare. Process improvement tools and procedures can be studied for the development of an effective approach or model that is best suited for an organization.

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Appendix – Figures

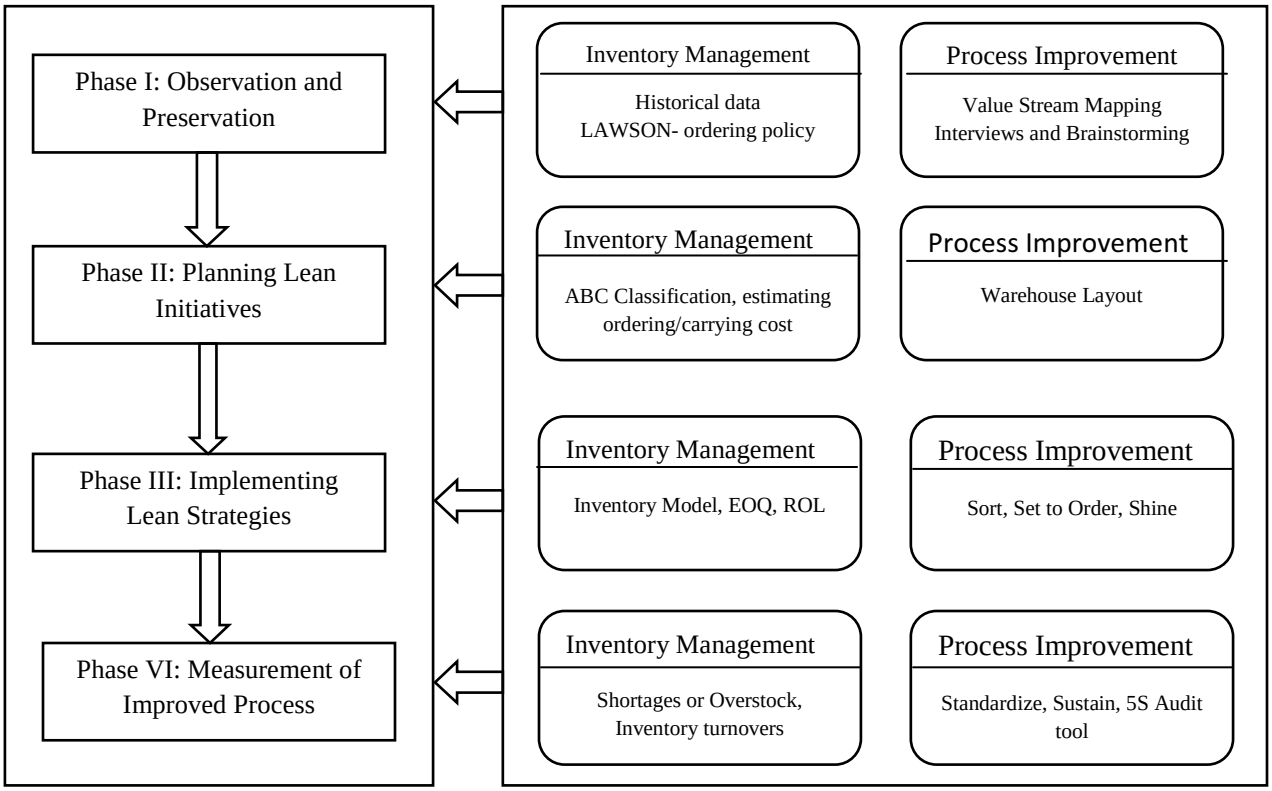

Figure 1. Hybrid 5S model

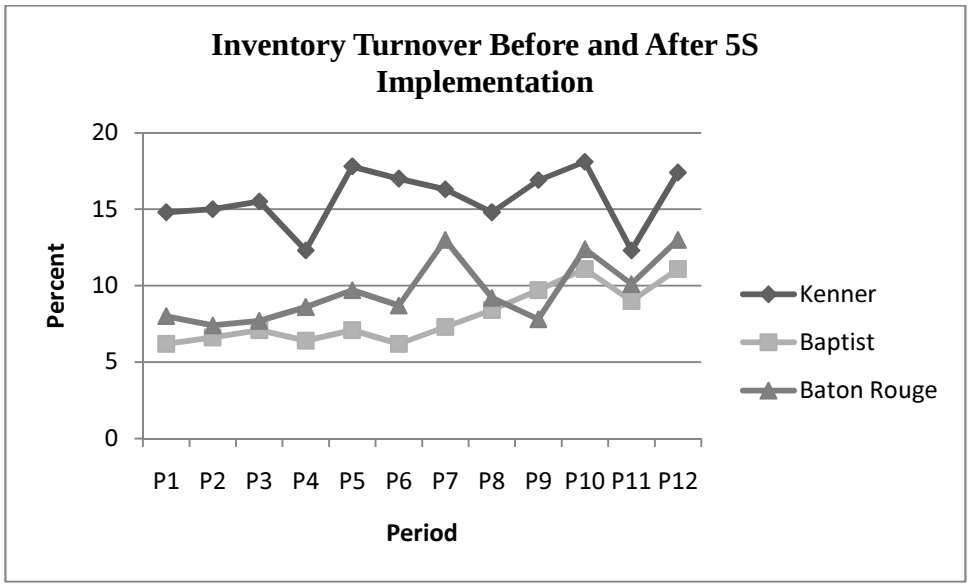

Figure 2. Comparison of inventory turnovers