Michigan Medicine

The Environmental Services Department

Analysis of Supply Closets Throughout Michigan Medicine

Final Report

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EXECUTIVE SUMMARY

The Environmental Services Department (EVS) at Michigan Medicine is responsible for the cleaning and sanitization of the entire hospital campus. EVS has experienced difficulty allocating supplies to the proper supply closets throughout the hospital in a timely fashion, resulting in high cases of supply stockouts. EVS asked an Industrial and Operations Engineering (IOE) 481 student team from the University of Michigan to develop a method for stocking the supply closets to improve the stocking efficiency. The team has completed a series of studies, observations, and analysis and presents key recommendations to improve the stocking process efficiency.

Background

The growing census in the hospital and lack of EVS staff has contributed to the high occurrences of inadequate supplies in the closets. Having inadequate amounts of product within a supply closet has caused housekeepers difficulty in performing their assigned cleaning tasks. Housekeepers defer to unassigned supply closets, and stash away supplies to avoid needing to call for supplies in the future. EVS does not have a good understanding of when and how much of each type of supplies exist in each closet, making it difficult to meet the demand accurately and stock efficiently. When a supply closet is low on product, the EVS department receives a notification on their pagers or phones from the team or department that discovers an inadequately stocked closet; these occurrences are not currently recorded in the system utilized by EVS.

The stocking process occurs only during the weekdays and closets are stocked primarily every other day; no stocking is conducted on Saturday or Sunday. The stocking process starts when the EVS team places a stock order with their suppliers, and it is filled and delivered the next business day, and ends when stock keepers complete stocking the closets. Typically, stock keepers need to return to the stockroom to refill their carts multiple times in order to finish stocking their closets.

Scope

The focus area of this project was the University Towers located on the main medical campus of Michigan Medicine. The University Towers include 66 supply closets dispersed over approximately one million square feet. The team examined products such as toilet paper, paper towel, hand sanitizer, soap, garbage bags, and sharp containers. The project did not include closets outside of University Towers or determining any PAR levels for the supply closets.

Methodology

The project was performed in the following phases: literature search, data collection, analysis, findings, conclusions, and recommendations.
**Literature Review**
The first phase was a literature review that consisted of reading and considering the ideas of previous studies to better understand how others have approached supplies-stocking optimization problems and benchmark best practices. The team reviewed several articles and identified three that relate to the stocking process of supplies in hospital settings. The first article looked at just-in-time methods, such as exchange carts. The just-in-time method works by having an entirely stocked cart ready, so that when one item runs out, the entire cart is replaced. The second article looks at a two-bin replenishment system using an e-kanban system. This system works by having a typical two-bin system, so that if one bin runs out the second bin is used while the empty bin is refilled. The difference here is that RFID tags are used to notify staff that a bin is empty. The third article looked into improvements regarding the project process to study stockage and usage processes within operating rooms. The team used these articles to develop a process for conducting studies, collecting data, and to help brainstorm recommendations.

**Data Collection**
Data collection was conducted through both qualitative and quantitative methods, including observations, interviews, and time studies.

The team observed and interviewed stock keepers who stock the supply closets and EVS management for a total of 60 man-hours and made note of inefficiencies. The team collected information on how EVS management orders supplies, coordinates with employees, trains employees, creates work schedules, and assist employees with their jobs.

To help determine the number of inadequate supply shortages, or stockouts, a recording system was set up to determine how frequently there were inadequate supplies in the closet for housekeepers. The team obtained the current work schedules for stock keepers and housekeepers from EVS management.

The amount of time it takes for each stock keeper to stock each floor of the University Tower was recorded for four consecutive weeks. The stock keepers recorded the time it took to stock each floor and each closet. In addition, the team conducted more detailed time studies corresponding with observation sessions of the elevator times. The team further analyzed the elevators times and elevator usage, spending over 60 man-hours riding and recording elevator times.

**Data Analysis**
The team analyzed results from the observations and interviews, data collection through time studies and recorded data, and benchmarking industry best practices by conducting a literature search. The team mapped out the current state of the closet stocking process, determined opportunities for improvement by identifying the wastes and bottlenecks in the process, and identified trends in stock keeping times by analyzing the recorded times from stock keepers and using Excel to derive key insight. From analysis of the information, the team developed recommendations to improve the efficiency of the stocking process of the supply closets at Michigan Medicine.
Findings, Conclusions, Recommendations, and Expected Impact

By following the above methodology, the team was able to derive conclusions and recommendations to improve the efficiency of the stocking process of closets. The findings, conclusions, recommendations, and expected impact for each recommendation are found in the table below:

Table ES-1: Findings, Conclusions, Recommendations, and Expected Impact

<table>
<thead>
<tr>
<th>Findings</th>
<th>Conclusions</th>
<th>Recommendations</th>
<th>Expected Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Housekeeping shifts overlap with stocking shifts</td>
<td>- Supplies simultaneously exits and enters the closets, making it difficult for EVS to track supplies</td>
<td>- Move the primary stocking shift from day (8:00 AM - 4:00 PM) to night (12:00 AM - 8:00 AM)</td>
<td>- The efficiency of the stocking process will increase by at least 50 minutes / shift (the difference between the elevator trips during day and night times number average of trips)</td>
</tr>
<tr>
<td>- During the daytime, the average elevator trip is 7 minutes. This occurs on average 4 times/shift</td>
<td>- Traveling between floors on elevators is the largest bottleneck</td>
<td></td>
<td>- EVS will gain a better understanding of how much of each supply the housekeepers used</td>
</tr>
<tr>
<td>Switch to Night Schedule</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standardize Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Trips down to the stockroom have elevator times that can be up to 40 minutes for a round trip, hence creating a large bottleneck in the efficiency of the current stocking process</td>
<td>- By enforcing and enacting new rules through training and best practices, EVS can create a standardized and more efficient stocking process</td>
<td>- Create a virtual map to show proximity of the elevators and closets</td>
<td>- The variation in stocking process will decrease</td>
</tr>
<tr>
<td>- Stock keepers follow no standardized procedure for decision making</td>
<td></td>
<td>- Train stock keepers how to stock the cart for maximum efficiency</td>
<td>- Stock keepers will be informed of best practices</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Enforce one trip down to the stockroom per shift</td>
<td>- The stock keepers can stock closets faster meaning they can finish their job earlier</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Increased efficiency in the stocking process</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Findings</th>
<th>Conclusions</th>
<th>Recommendations</th>
<th>Expected Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement Communication System</td>
<td>- Stock keepers are uncertain about how much supplies they will need when they load their carts</td>
<td>- Implement a paper or electronic communication system between housekeepers and stock keepers</td>
<td>- Better idea of what to stock the cart with</td>
</tr>
<tr>
<td>- There is no formalized communication system in place between housekeepers and stock keepers</td>
<td></td>
<td></td>
<td>- Less trips down to the stockroom</td>
</tr>
<tr>
<td>Create Runner Position</td>
<td>- Stock keepers make an average of 4 trips down to the stockroom per shift get supplies that they are low on or run out of. This round trip can be greater than 40 minutes</td>
<td>- Implement a “runner” position</td>
<td>- Better communication amongst housekeepers and stock keepers</td>
</tr>
<tr>
<td>- Stock keepers spend valuable time during their shift making trips down to the stockroom</td>
<td></td>
<td>- Runner would help the stock keepers in stocking the closets by running down to the stockroom to grab the supplies the stock keeper needs</td>
<td>- Stock keepers are more efficient by not having to take the elevator down to the stockroom</td>
</tr>
<tr>
<td>- Runner would be the only one taking the elevator up and down</td>
<td></td>
<td></td>
<td>- The runner would be the only one taking the elevator up and down</td>
</tr>
</tbody>
</table>
INTRODUCTION

The Environmental Services (EVS) department at Michigan Medicine is responsible for the cleaning and sanitization of the entire hospital campus. EVS has experienced difficulty allocating supplies to the proper supply closets throughout the hospital in a timely fashion. The stocking process includes loading the carts with supplies, transporting the supplies to the closets, and putting the items on the shelves. Through observation of stock keepers and interaction with EVS management, stock keepers are taking too many trips to the stockroom and EVS is receiving a high volume of calls for insufficient supply levels. EVS asked an IOE 481 student team from the University of Michigan to develop a method to improve the efficiency of stocking supply closets. To address the inefficiencies in the stocking process, the team conducted a series of studies and analysis to determine the underlying issues within the stocking process and identify wastes. From these key findings, the team has recommended changes to improve the efficiency of the supply stocking process and plans for future study methods to help EVS understand the incoming and outgoing supply rates of the closets. This final report presents the methods, findings, conclusions, and recommendations from the project.

BACKGROUND

The EVS department at Michigan Medicine has noticed that many supply closets are not being refilled with their paper products quickly enough to satisfy the rate of demand. The EVS department has attributed this problem to the growing census in the hospital, which has now consistently reached over 90% capacity. In addition, there is a lack of consistent EVS staff, resulting in slower rates of closet stocking. These occurrences of inadequate paper product stock in the closets have caused the housekeepers difficulties in performing their assigned cleaning tasks throughout the hospitals. Having inadequate amounts of paper product within a supply closet has caused departments, hospital teams, and individuals to defer to unassigned supply closets using different key access entries for their needed products. In addition, some paper products have been found stashed away in secret and unsanitary areas of the hospital in order to “save up” on the products in case a closet runs out. Lastly, occurrences of inadequate stock leads to stock keepers needing to refill closets, which have recently been stocked that takes time from the stock keepers primary task of stocking closets that have not yet been stocked.

The EVS team needs a way to record when and which closets become empty after the stock keepers have already filled them to reduce these occurrences. When a supply closet is low on product, the EVS department receives a notification on their pagers or phones from the team or department that discovers an inadequately stocked closet; these occurrences are not currently recorded in EVS’s system. For the 93 total closets throughout the hospitals that EVS is in charge of stocking, there is currently no system in place to electronically and instantly alert the EVS team of a supply closet low on product. There is also no way to know where all the product goes, who is using it, and when it is being used the most (during which shifts, emergencies, etc.).

The stocking process occurs only during the weekdays and closets are stocked roughly every other day. The stocking process starts when the EVS team places a stock order with their suppliers, and it is filled and delivered the next business day. The order is transported and
stocked in the main stockroom by the stock keepers. EVS has two stock keepers that work each day and three days of stock is kept as a requirement for any emergency situations. Next, the stock keepers choose which items to place on their cart that they think they will need to stock their closets for the day. Stock keepers stock the same floors in the same areas of the buildings they are stocking each time. The boxes of stock stacked on the cart must not exceed eye level for safety measures. The stock keepers then replenish their assigned closets going from the top floor down. The stock keepers record the amount of items in each closet, the amount of items stocked, and make note of any items they must bring up from the stockroom. Stock keepers return to the stockroom for products as needed. The stock keepers continue this process until all their closets are stocked. For a detailed visual of the process of stocking a closet, see Figure 1 below.

![Figure 1: Overview of the Current Process for Restocking Closets](n = 15 hours, observations conducted by Team 7, February 2017)

The EVS department has looked into the problem of paper products rapidly disappearing from the supply closets and believes that some of the stock might be taken for non-hospital uses and is disappearing with reasons unknown. The EVS team has expressed the need for an improved system in stocking the closets as well as a proposed plan on how to track all the paper stock being used in the closets. The proposed system aims to cut down on the occurrences in which the EVS team is notified that a closet needs a refill on stock.

**Key Issues**

The University of Michigan hospitals use many supplies to keep the hospital clean for their valued patients; however, the EVS team has experienced difficulty keeping each closet stocked with the supplies that the housekeepers and other employees need to fulfill their duties. With 93
closets spread over three million square feet, the EVS team reported that it is easy to lose track of the supplies and difficult to determine how often and how much to replenish supplies. The following key issues have led to the problem under investigation:

- Inadequate levels of the correct stock in the closets
- Inconvenience for housekeepers to obtain needed supplies
- Inconsistent rate of supply usage by housekeepers
- Unknown amount of stock in each closet
- Unnecessary amount of trips to the stockroom

**Goals and Objectives**

The main goal of this project was to improve the efficiency of the stocking process at Michigan Medicine. To accomplish this, the team conducted the following tasks:

- Conducted a series of studies on the stocking process
- Identified wastes in the process

With the information, the team developed recommendations to:

- Decrease the number of trips stock keepers take to the stockroom
- Decrease the number of instances in which closets have inadequate supplies
- Increase the efficiency of the stocking process
- Propose methods for studying high rates of supply usage

**PROJECT SCOPE**

The focus area of this project was the University Towers located on the main medical campus of Michigan Medicine. The University Towers include 66 closets dispersed over approximately one million square feet.

The scope of this project included the following:

- 21 of supply closets in University Towers on floors 4-9
- Supply stocking process analysis
- Stocking schedule to maintain PAR levels in closets
- Plans for future studies on PAR levels and supply usage

The project did not include the team completing the following:

- Replenishing and stocking the closets
- Placing orders for new materials
• Evaluating other supplies and other closets within Michigan Medicine
• Creating PAR levels for the closet

PROJECT APPROACH

The team approached the project in four phases: literature review, data collection, data analysis, and recommendations. This section does not include the recommendations as they will be presented further in the report.

Literature Review

The first phase was a literature review that consisted of reading and considering the ideas of previous studies to better understand how others have approached supplies-stocking optimization problems. The team reviewed several articles and identified three that relate to the stocking process of supplies in hospital settings.

The first article was from the Ontario Health Association, “Operating Room Inventory Optimization,” which focuses on the method to study the supply stocking and usage process. The first step is to determine which parties are involved and needed, and the timeframe for the analysis. Next, the current state is mapped. Finally, a solution is developed by conducting research; defining process requirements; drawing a future state process map; and conducting an inventory analysis, technical reviews, gap analyses, and a trial with the recommendations [1].

The second article by Bendavid, Boeck, and Philippe, brought the use of technology, specifically RFID tags, into the stocking process of medical supplies [2]. The approach uses both quantitative and qualitative data to support an E-kanban RFID system to stock the medical supplies. The system used a two-bin replenishment system for medical supplies with an attached RFID tag that is moved to a board when one bin is out of supplies to notify the stock keepers that another bin is needed. The article states that process ensures stock rotation, saves time, and minimizes the stock out occurrences.

A just-in-time (JIT) method or a stockless distribution to reduce costs for their supply stocking process is another method being used in healthcare. The article from Hospital Materiel Management Quarterly talks about using exchange carts as one way to implement JIT [3]. Exchange carts house all supplies in a central location and once a supply in the cart runs out, the entire cart is replaced with a fully stocked one. The exchange cart method is a similar methodology to a two-bin stocking process.

These papers discussed previous endeavors within hospital systems to increase stocking efficiency, which coincides with the project’s goals and objectives. The team used the papers to help structure how to conduct studies and brainstorm recommendations.
Data Collection

The team collected data through three different methods: observations and interviews, times studies, and recorded data.

Observations and Interviews
The team observed stock keepers who stock the closets within the University Towers during their shifts for a total of 15 hours and made note of inefficiencies. These inefficiencies were defined as actions or occurrences that create unnecessary movement, waste of material, or time.

The team scheduled formal interviews with EVS management to collect information on ordering supplies, coordinating and training employees, and creating work schedules.

The team also had informal interviews with stock keepers that focused on how the stock keepers stock their closets. These interviews included the decision process on how many supplies to stock, how often, how much, and when. These interviews also helped to determine how stock keepers load their carts and what concerned the stock keepers in relation to their responsibilities.

Time Studies
The amount of time it takes for each stock keeper to stock each floor of the University Tower was recorded for four consecutive weeks by the stock keepers writing down the time it takes to stock each floor and closet. Paper forms were provided to the stock keepers to track these times as seen in Appendix A.

In addition, the team conducted more detailed time studies corresponding with observation sessions, recorded the amount of time it takes stock keepers to stock each closet, the time spent walking from closet to closet, the amount of time traveling between floors, and the amount of time spent on the elevators.

Recorded Data
The stock keepers noted the current level of supplies in each closet and the team compared it to the PAR levels determined by EVS from a previous study from December, 2016. Stock keepers kept track of how much was in the closet and how much of each supply they stocked on the sheet from Appendix B; this data was be collected for four consecutive weeks. A recording system was setup to determine how frequently there were inadequate supplies in the closet for housekeepers during the data collection phase; this is a metric that was previously not being recorded. The EVS management created an excel sheet to record the information in as shown in Appendix C. EVS management kept track of the time of the occurrence, what closet it occurred at, and what supply was out over four consecutive weeks. The team obtained the work schedules for stock keepers and housekeepers.

Data Analysis
The next phase was data analysis, which consolidated the data collected in the previous step into key findings. The first step was to map out the current state of the closet stocking process, which
is shown in the SIPOC of Appendix D. The team also examined trends between the schedules of EVS management, housekeepers, and stock keepers. The team then determined opportunities for improvement by identifying the wastes and bottlenecks in the current process. From the recorded stock keeping times, trends, similarities, and/or significant differences among departments or closets were identified using statistical and graphical methods. The results of the analysis are outlined in the next section.

FINDINGS AND CONCLUSIONS

From the data collection and analysis, the team came up with findings and conclusions broken up into the current state and time studies. These findings and conclusions bridge the gaps in knowledge to address the team’s primary goal of increasing the efficiency of the stocking process, and set the foundation for the team’s recommendations.

Current State: Findings

Analyzing the current state at a high level allowed the team to better understand the process, identify areas of waste, and determine where in the process to focus improvement efforts.

Current State Map

A current state map in the form of a swimlane diagram, as shown in Figure 2 below, was developed from interviews and observations with stock keepers and EVS. The process begins with EVS management placing an order for the supplies the day before stocking, and ends at the end of the stocking period when EVS determines the order quantity. The stock keepers make two key decisions within the stocking process. The first is estimating how much of each type of stock to place on their carts to most efficiently stock their floors. Currently, stock keepers do not actually know how much stock is needed in the closets. They estimate what to put on their carts using their past experience with the closets they stock. Occasionally, they happen to run into the housekeepers, and housekeepers let them know what items are needed. The second decision is determining when to gather more supplies from the stockroom; one model stock keepers use is to immediately return to the stockroom as soon as the stock keeper runs out of a certain supply. Another model is to complete a floor or two before returning down to the stockroom during a convenient time, such as lunch, while keeping track of what supplies are needed.
Current Schedule
The team also analyzed the current state from the perspective of the schedules of the three key stakeholders in the stock keeping process. EVS management, the stock keepers, and housekeeper’s shifts on a 24-hour schedule are shown in Appendix E. Figure 3 below points out two key relationships in the current schedule. One of these relationships is that primary housekeeping shifts directly overlap with the primary stocking shifts. The second is that the heaviest stocking shift overlaps with peak internal hospital traffic. Internal hospital traffic includes patients on beds being moved throughout the hospital, food service, maintenance, materials services, and other hospital operations.
Figure 3: Current Schedule of EVS Management, Stock Keepers, and Housekeepers

(Schedule provided by EVS Management)

**Current State: Conclusions**

From the team’s current state assessments, four main conclusions were identified. Based on the findings, stock keepers must make several decisions, combined with the variation of stocking methods, the team concludes that the stocking process needs standardization. Another conclusion is that EVS needs a more accurate system to determine how much stock to place on carts, since the current system of using the stock keeper’s intuition is not based on any real information regarding what is needed in the closets.

Based on findings from the current schedule, the shifts of the stock keepers and the housekeepers overlap towards the last half of the stocking shift, which makes it difficult to track the supplies that are leaving the closets, since supplies are simultaneously entering and exiting. Finally, the stock keeper’s efficiency is undermined due to the stock keepers’ main shift overlapping with the peak internal traffic, especially during the elevator travel component of the process. The overlap is largely due to elevator space constraints. Patients on beds take up more than half of the elevator space, and always receive priority on elevators. Stock keeping carts take up about half of the elevator space; it is therefore impossible to fit both a patient and a cart on the elevator. The team decided to further examine elevator travel times, as discussed in the next section.

**Time Studies: Findings**

The team conducted time studies to help determine bottlenecks and process inefficiencies. The time studies were broken into two categories: stocking process times and elevator times.
Stocking Process Times
The team first recorded different process times for the supply stocking process. Table 1 shows the process times analyzed for how long it takes to stock a closet and an entire floor, as well as the number of trips taken to the stockroom per shift.

Table 1: Process Times for Stocking Closets and Floors
(n=56 hours, times recorded by Team 7 & Stock Keepers, March 2017)

<table>
<thead>
<tr>
<th></th>
<th>Stock Closets</th>
<th>Stock Floor</th>
<th>Number of trips to the stockroom (per shift)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>7.28 mins</td>
<td>42.75 mins</td>
<td>4 trips</td>
</tr>
<tr>
<td><strong>St. Dev.</strong></td>
<td>3.59 mins</td>
<td>8.73 mins</td>
<td>1.63 trips</td>
</tr>
<tr>
<td><strong>Max</strong></td>
<td>16.8 mins</td>
<td>52 mins</td>
<td>7 trips</td>
</tr>
</tbody>
</table>

From these times the team found that it takes an average of just over 7 minutes to stock a closet. The standard deviation is 3.6 minutes, but the max time can be up to about 17 minutes. Each stock keeper stocks 4 closets per floor which takes an average of about 43 minutes with a standard deviation of almost 9 minutes. However, floors can take up to 52 minutes and each stock keeper stocks about three floors during a shift. Finally, the team analyzed the number of trips the stock keepers make down to the stockroom per shift. During each shift, the stock keepers take an average of 4 trips down to the stockroom with a standard deviation of almost 1.63 trips. The maximum amount of trips can be up to 7 times, which is a result of not stocking the closets for the two days over the weekend when supplies are very diminished.

Elevator Times
Next, the team looked at elevator times for travel to the stockroom and between floors. Stock keepers helped collect these times using the form found in Appendix F. First the team analyzed the elevator times down to the stockroom summarized in Table 2.

Table 2: Elevator Travel Times to and from Stockroom
(n=60 hours, Team 7, April 2017)

<table>
<thead>
<tr>
<th></th>
<th>Time to go down to Stockroom</th>
<th>Time to go up from Stockroom</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>26.51 mins</td>
<td>17.98 mins</td>
</tr>
<tr>
<td><strong>St. Dev.</strong></td>
<td>11.23 mins</td>
<td>11.06 mins</td>
</tr>
<tr>
<td><strong>Max</strong></td>
<td>37.74 mins</td>
<td>29.04 mins</td>
</tr>
</tbody>
</table>
From the table, the average time to go down to the stockroom is 26.5 minutes with a standard deviation of 11.23 minutes and the time to go up from the stockroom has an average of 18 minutes with a standard deviation of 11 minutes. The maximum for the trip down was about 38 minutes while to come back up was 39 minutes, which means that a total trip down and back to the stockroom to get supplies can take up to 70 minutes. With the average of 4 trips to the stockroom per shift, about 4.67 hours spent traveling to and from the stockroom.

The team then looked at the average elevator times traveling in between floors within the University Towers. Figure 4 shows the elevator times over different times during the day.

![Average Elevator Travel Times](image)

**Figure 4: Elevator Travel Times for Different Shifts**  
(n=60 hours, times recorded by Team 7, February-April 2017)

The figure shows that during the current stocking shift from 7am to 4pm the average travel times are the elevator times are almost 7 minutes per trip between 7am and 12pm and just over 4 minutes between 12pm and 4pm. Theses times are much greater than times later in the evening and night. Between 5pm and 10pm the elevator times drop to just less than 2 minutes and from 10pm to 5am it drops even further to just around a minute. Table 3 shows the mean and standard deviation of the four time periods.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Mean Time</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning (7am-12pm)</td>
<td>7 mins</td>
<td>6 mins</td>
</tr>
<tr>
<td>Afternoon (12pm-5pm)</td>
<td>4.5 mins</td>
<td>3 mins</td>
</tr>
<tr>
<td>Evening (5pm-10pm)</td>
<td>2 mins</td>
<td>1 mins</td>
</tr>
<tr>
<td>Night (10pm-5am)</td>
<td>1 min</td>
<td>0.5 mins</td>
</tr>
</tbody>
</table>
The team broke the times into four shifts: morning (7am-12pm), afternoon (12pm-5pm), evening (5pm-10pm), and night (10pm-5am). In the morning the peak total trip time can take up to 13 minutes, while at night the peak total trip time is only 1.5 minutes.

Finally the team looked at the usage rate of the elevators during the peak hospital and elevators time from 8am to 5pm. Figure 5 shows the occurrences of elevator usage.

![Figure 5: Elevator Usage During Main Stocking Shift](n=56 hours, times recorded by Team 7 & Stock Keepers, March 2017)

From the figure it is determined that the elevators are used the most from 8am to 9am and 11am to 1pm. These are the times that the stock keepers use the elevators the most and internal hospital traffic is also high.

**Time Studies: Conclusions**

The time studies provided the team with a variety of conclusions. First, the time to the stockroom can take up to 40 minutes one way. There is room here to decrease the time and frequency of trips to the stockroom. Second, the peak elevator usage times are from 8am to 9am and 11am and 1pm, which is during the peak time of internal hospital traffic. Third, stock keepers take a large number of trips to the stockroom per shift and there is room to decrease the frequency of trips to get supplies. Finally, the process times have a large standard deviation due to the lack of standardization in the stocking process. The team interviewed and observed stock keepers and EVS management to help determine the standard process.
RECOMMENDATIONS

From these key findings and conclusions, the team brainstormed solutions to address the primary goal of increasing the efficiency of the stocking process. The four main recommendations the team developed are 1) Switch Stocking Shift to Night Schedule, 2) Standardize Training, 3) Implement Communication System, 4) Create Runner Position. These recommendations are discussed in depth below.

Recommendation 1: Switch Stocking Shift to Night Schedule

Two key findings drive this recommendation: the high elevator travel times during the day, and the significant overlap of housekeeper and stock keeper shifts. The team developed an alternate schedule, which has the stock keepers perform the majority of stocking at night. The team recommends moving the primary stocking shift from day (8:00 AM - 4:00 PM) to night (12:00 AM - 8:00 AM). See Appendix G for a detailed rendering.

By moving the primary stocking shift to night, the team expects the following outcomes. The probability of low supply levels for housekeepers will be reduced, since closets will be full at the beginning of each shift. Stock keepers will gain a better understanding of how much of each supply the housekeepers used, since supplies are not leaving and entering simultaneously. The efficiency of the stocking process will increase, due to cutting down on the largest bottleneck, long elevator wait times. At least 50 minutes of productivity will be added, by taking the difference between the average elevator ride time during the day and the average elevator ride time during the night, and multiplying this by the average number of trips per shift.

It should be noted that the new schedule primarily addresses the efficiency of the process. It may not directly address the problem of supplies beginning to run out towards the end of the second day’s housekeeping shift, given that every closet is currently stocked every other day. For example, a closet stocked on Monday will begin to run out of supplies on Tuesday. One foreseen issue is that the new schedule may simply move the problem a few hours earlier, such that supplies will run out during the afternoon instead of later in the day.

It may be feasible, however, for EVS to stock every closet in University Towers patient floors every night, with the increased efficiency of the stocking process at night coupled with the lower amounts of supplies put in each closet, given that stocking would occur twice as frequently. To stock the closets each night, EVS would most likely need to hire one more person to stock, and additional stock keeping training of the “floater” pool of employees to account for imperfect staff attendance. If EVS stocks the closets every night, then it is expected that the number of stockouts will decrease.

Another option to consider regarding the stocking shift would be to move the shift a few hours earlier than current, to 4 or 5 AM. Moving the schedule may avoid having to completely retrain night staff, and may simultaneously still provide the benefit of quicker stocking and traveling between floors. However, it should be noted that nurses typically start their rounds around 6:30am to 7am, so the hospital will still be busier than at night.
Recommendation 2: Standardize Training

Two key findings drive this recommendation: the high elevator travel times during the day, and the lack of training regarding when to return to the stockroom to restock a depleted item on the stocking cart. For example, the stock keepers currently do not have a set procedure on how to stock their carts and how to troubleshoot in the situation where they run out of supplies on their carts. Some stock keepers stop stocking closets and return to the stockroom to restock their carts with the depleted supplies. On the contrary, some stock keepers continue making their rounds and keep a note of (1) the supplies they ran out of and (2) how many supplies are needed in the closets thus making only one trip to the stockroom, often during lunch or another time they have to return downstairs.

The source for inconsistencies with the stocking process can be attributed to the training and onboarding that a new stock keeper goes through when joining the EVS team. The stock keeper shadows a current stock keeper for two weeks, consisting of full shifts throughout the week. After a two week period, the new stock keeper is considered experienced and is expected to know the best way of restocking the closets and loading the cart from their shadowing experience and intuition.

By enacting and enforcing new rules through training and best practices, EVS can create a standardized and more efficient stocking process, which would reduce the non-value added time in form of less trips down to the stockroom which consequently is increasing the efficiency of the stocking process. As a result, the team recommends standardization of the stocking process and of PAR levels when replenishing the closets.

Process Standardization
The team recommends creating new training procedures and emphasizing the need for standardization in the stocking process. Reinforcing the best practices by implementing the following can complete this:

- Create a virtual map to show new stock keepers the proximity of the elevators and closets
- Emphasize the rule to stock carts once and keep note of what to bring when a trip down to the stockroom is made to restock the supply cart
- Create a list for best practices and display it in the stockroom
- Train stock keepers how to best stock the cart to maximize efficiency
- Pair up trainees with stock keepers that stocks similar floors/products
- Record the supplies that are used for metrics and better inventory planning and resource allocation
- Create a video and brochure about following OSHA standards and cart stacking height limit

PAR Level Standardization
The team recommends incorporating visual management to make sure that the closets have the correct PAR level achieved with the least mental workload. In the past, EVS has printed sheets on the door to the supply closets with the PAR level for that closet. Frequently the sheets get
taken down or stock keepers do not complete the form. A way to make sure that the closets have the correct PAR level filled would be adding dividers onto the shelves. By taping off sections of the shelves stock keepers can easily see how much of each product to fill based on where the tape is located. For example, EVS management would tape off a section that can hold 3 rows, 3 columns, and 3 stacked toilet paper rolls. The area would correspond to a PAR level of 27 rolls for that closet. Stock keepers would then just need to fill up the area to the taped line. Visual management could improve the efficiency of maintaining PAR levels by eliminating the counting or math involved in determining how many items to add and taking off that mental workload and decisions the stock keepers must make.

Implementing the above recommendations should result in the following improvements:

- Stock keepers will be informed of best practices
- Stock keepers will stock closets faster
- Stocking process efficiency will be increased
- Wait time for elevators will be decreased
- Stock keepers will better utilize cart stocking
- Stock keepers will take less trips to the stockroom
- Stock keepers will not have to rely on finding trends within each closet to estimate how much stock will be needed to fill the closets

**Recommendation 3: Implement Communication System**

The team recommends implementing a communication system within the stocking procedure that would establish a network between the housekeepers who use the supplies from the supply closets, and the stock keepers who fill the closets within the towers at Michigan Medicine. The recommendation was driven based on the findings in the current state that conclude the following:

- Stock keepers currently rely on their own knowledge of closet trends in regards to stock levels to help them decide what to fill their carts with at the beginning of each shifts
- Stock keepers rely on informally speaking housekeepers in order to be informed on which stock items the housekeepers are low on, and or which items are in higher demand than the rest.

A formal communication system between the housekeepers and stock keepers would alleviate stock keepers filling their carts at the beginning of their shift with levels of each item based off their own observations and informal meetings with housekeepers during previous shifts. Having a better understanding of what stock supplies are needed and thus stocking the carts more efficiently would allow the stock keepers to fully stock more closets before running out of stock on their carts. By stocking the carts more efficiently, the number of trips stock keepers take to the stockroom and time wasted in the elevators would be decreased.
**Paper Communication**

One way to incorporate a paper communication system within the stocking process would be to post stock supply record sheets to the inside of each door to all supply closets. These sheets would keep a manual tally by the housekeepers of what supplies and how many of each are leaving the closet. Before each shift, stock keepers would make rounds to all their assigned closets to pick up these sheets and replace with new stock record sheets, and use the notes on the sheets to know what supplies are needed in their closets and thus what to stock their cart with. See Table 4 below for a sample stock record sheet for a single closet to use for a paper communication system.

*Table 4: Sample Stock Record Sheet for an Individual Closet*

<table>
<thead>
<tr>
<th>Product</th>
<th>PAR Level</th>
<th>Amount of Product Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>30x48 Liner</td>
<td>1000</td>
<td>Ex: 5, 10, 6, 3</td>
</tr>
<tr>
<td>40x46 Liner</td>
<td>200</td>
<td>Ex: 12, 4, 18, 9</td>
</tr>
<tr>
<td>24x33 Liner</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>White Roll Towel</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>9-in Toilet Paper</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>12-in Toilet Paper</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Single Roll</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Multifold Towel</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Purell Sanitizer</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>3 Gallon Sharp</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Another way EVS can incorporate a paper communication system within the stocking process would be to assign a stock keeper or another EVS worker to make rounds to each closet at the end of the midnight shift (if schedule stays the same) or at the end of the daytime shift (if schedule changes to having the primary stocking shift be midnights) and record how much of each specific stock supply has left the closet based on the PAR levels. The paper record for each closet would be dropped off at the community room where the stock keepers sign in before their shift begins. Here, the stock keepers will be able to pick up their associated closet records for the floors they need to stock for the day, and use the data to properly stock their carts.
Electronic Communication
The team would also highly recommend incorporating an electronic communication system that would utilize tablets in each of the supply closets and another in the main stockroom. On these tablets, a programmed Google data sheet could take inputted data from either the housekeepers or an assigned stock keeper/EVS worker on what supplies have left each closet, and subtract this amount from the PAR levels to give a summary of what is needed in each closet. The housekeepers would then be able to check the tablet in the main stockroom and see exactly how much stock is needed in each of their assigned closets. The electronic system would eliminate all paper trails but would have an associated cost for the tablets and secured mounting apparatuses for each tablet in the closets and stockroom. The team recommends using a Microsoft NuVision TM800W610L Signature Edition Tablet for housing the electronic system, which has an associated cost of $150 per tablet [4]. The team chose this tablet because it is fully capable of running the online data sheet when connected to the hospital’s internet and for economic reasons. Since EVS would be purchasing a high volume of tablets, going for a cheaper option is ideal for financial responsibility.

Recommendation 4: Create Runner Position
The team recommends creating a “runner” position to help maximize the efficiency of the stocking process. The runner would help the stock keepers in stocking the closets by running down to the stockroom to grab the supplies the stock keeper needs. Normally the stock keepers run out of some supplies that they need after the first floor. They then continue to keep stocking the floors marking down what supplies they need to bring back from the stockroom. Instead of having to make the trip down, the stock keeper would radio to the runner on walkie talkies what supplies they ran out of and the runner would bring them up what supplies were need. The process would continue every time a stock keeper runs out or is low on an item until all closets are stocked. Having a runner allows for the stock keepers to be more efficient by not having to take the elevator down to the stockroom. Instead the runner would be the only one taking the elevator up and down.

From adding the runner position the team expects that the stock keepers will be able to stock closets in a shorter amount of time since stock keepers are not making trips down to the stockroom. Consequences of the runner would be hiring and training a new employee, purchasing walkie talkies, as well as the stock keepers may have to wait on the runner to bring up their supplies in order to complete their closets.

Benefits and Risks
With each recommendation come assumed benefits and risks involved. The team developed the benefits using knowledge from observations, interviews, and data analysis. The team developed the risks from knowledge regarding the current process and interviews with EVS management. Table 5 summarizes the benefits and risks the team determined for each of the four recommendations.
<table>
<thead>
<tr>
<th>Benefits</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switch Stocking Shift to Night Schedule</strong></td>
<td></td>
</tr>
<tr>
<td>- Closets full at start of housekeeping shifts</td>
<td>- Make sure to follow noise rules, carts can be noisy</td>
</tr>
<tr>
<td>- Better insight and tracking of housekeeping use of supplies (PAR levels)</td>
<td>- Re-hiring and re-training may be required</td>
</tr>
<tr>
<td>- Decreased time of closet stocking process</td>
<td>- Management has less direct oversight over stock keepers</td>
</tr>
<tr>
<td></td>
<td>- Does not directly fix issue of low levels of supplies on second day</td>
</tr>
<tr>
<td><strong>Standardize Training</strong></td>
<td></td>
</tr>
<tr>
<td>- Stock keepers will be informed of best practices</td>
<td>- Need a method/enforcement plan to make sure best practices are followed</td>
</tr>
<tr>
<td>- Stock keepers can stock closets faster meaning they can finish their job earlier</td>
<td>- Need to develop brochure/videos/M-Learning assessments</td>
</tr>
<tr>
<td>- Increased efficiency in the stocking process</td>
<td></td>
</tr>
<tr>
<td>- Less time waiting in and for elevators</td>
<td></td>
</tr>
<tr>
<td><strong>Implement Communication System</strong></td>
<td></td>
</tr>
<tr>
<td>- Stock keepers have a better understanding of what to stock their carts with and how much of each supply item to place on cart</td>
<td>- The housekeepers might take advantage of this system and tell the stock keepers what they want in the closets and not base it off the PAR levels</td>
</tr>
<tr>
<td>- Stock keepers will be able to fully stock more closets before having to reload their carts</td>
<td>- Increased work for a stock keeper to go to each closet and record what is missing at the end of shift</td>
</tr>
<tr>
<td>- This process will minimize the amount of trips needed to take down to the stockroom and back up to the appropriate floor</td>
<td>- Might have to hire a new employee to take on this responsibility, or pay overtime for a stock keeper to record the used supplies in the closets</td>
</tr>
</tbody>
</table>


Table 5: Summary of Benefits and Risks of the Recommendations Continued

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create Runner Position</td>
<td></td>
</tr>
<tr>
<td>- Stock keepers do not need to make a trip down to stockroom</td>
<td>- Stock keeper ends up waiting on supplies from runner</td>
</tr>
<tr>
<td>- Runner absorbs elevator wait time</td>
<td>- Re-train current stock keeper/hire new runner</td>
</tr>
</tbody>
</table>

**PROPOSED RECOMMENDATIONS TO IMPLEMENT**

From the four main recommendations, the team identified which recommendations were most feasible and impactful by developing an impact-effort matrix, as shown in Figure 6. It should be noted that the two recommendations, which were not proposed to implement, may still be impactful, but are not as immediately needed as the other two. Once the chosen recommendations are implemented, EVS may reevaluate its needs and may still find the other two recommendations helpful.

![Impact-Effort Matrix](image)

**Figure 6: The Ream Recommends Implementing Training and the Night Schedule**

(Team 7, April 2017)

**Proposed Recommendations Methodology**

The team rated each recommendation based on how much effort it would require from EVS, and how much it will positively affect the stock keeping process. The first recommendation, switching the stock keeper’s shift to night schedule, was rated as high effort, but also very high impact. The night schedule would involve significant time to pilot the schedule, develop new
methods of managing the stock keepers, and retraining and rehiring. However, the impact would be very large, resulting in a very efficient stocking process, which is the project’s primary goal. The second recommendation, standardizing training, was rated as low effort and high impact. Training would require some time from EVS to develop training modules, but EVS would not have to implement any significant changes. The impact would be large due to the large decreases in variation within the process. The team chose these two recommendations for EVS’s ideal state because of the high impact to effort ratios.

The third recommendation, implementing a communication system between the stock keepers and the housekeepers, was rated as a high effort and high impact solution, although the impact is not as high as the night schedule. The communication system recommendation would require purchasing equipment and training housekeepers and stock keepers on how to use the system. In addition, it would require housekeepers to be diligent and consistent in filling out the forms, which may require additional supervision. The impact will be high in terms of giving the stock keepers an accurate count of what to put on their carts, as well as developing baseline usage levels of supply usage for EVS. Due to the lower impact of this recommendation, the team did not choose the communication system as a recommendation to implement.

Finally, the fourth recommendation of creating a runner position was rated as high effort and low impact. It would require EVS to hire and train another employee, which requires both time and capital. The impact is not as high as other recommendations, since the elevator bottleneck would now be moved to the runner position. Therefore, the team did not choose the runner solution as a recommendation to implement.

To implement the recommendations discussed above, the team, in parallel with considerations and feedback from the client and coordinator, has formulated prioritized steps of action.

**Action Plan**

The action plan for the proposed recommendations was created to facilitate the implementation. The plan has been broken down into tasks to be performed in a series of steps. The details of the plan are below.

**Step 1:** The EVS management team should hold a focus group with the stock keepers to determine best practices for the stocking process. From here, the EVS team can create a standardized workflow that describes in higher detail the decision making for a stock keeper, such as how to stock the cart and when to return to the stockroom.

**Step 2:** The EVS management team should conduct a pilot study of the midnight schedule on one floor for one week. In addition, the EVS management team should begin to create or outsource
training videos and best practices sheets to be passed and discussed at the end of the month. EVS management should also begin to create a virtual map.

**Step 3:** If the pilot study is successful, the EVS management team should communicate with the current stock keepers and inform them of proposed change and evaluate hiring needs.

**Step 4:** The EVS team should create and enact an enforcement plan to ensure stock keepers are following the new training practices in place. It is crucial to ensure that all stock keepers are well trained in the new standardized procedure before night schedule roll out.

**Step 5:** Rehire (if necessary) and retrain the stock keepers to follow new training practices. The stock keepers should be stocking the carts to maximize efficiency and recording the supplies that are used in the closets. The client should delegate responsibility of enforcing the standard cart stocking to EVS management personnel.

**Step 6:** The EVS team should officially rollout the switch to the midnight schedule. The EVS management team can formulate sheets comparing the efficiency of the new stocking process with the old stocking process. Also, the EVS management team can ensure the trips to the stockroom are minimized per shift.

**Step 7:** Further studies are recommended for determining PAR levels for each unique closet and improving the communication between the stock keepers and housekeepers when restocking the closets.

**OVERALL EXPECTED IMPACT**

In conducting the studies, the team used a current state map to identify trends in the stocking process as well as any wastes. The team then developed recommendations that improve the efficiency of the stocking process, and proposed two key recommendations to implement. The overall expected impact of the implementation of the recommendations made by the team are as follows:

- Increased efficiency of stocking process by at least 50 minutes
- Decreased number of calls from housekeepers for more supplies
- Decreased number of trips stock keepers take to the stockroom
- Improved working environment for housekeepers
- Improved patient experience
REFERENCES


APPENDIX

APPENDIX A: Time Recording Sheet for Stock Keepers

<table>
<thead>
<tr>
<th>Closet #</th>
<th>Time to Stock Closet</th>
<th>Time Walking to Next Closet</th>
<th>Time to Restock Cart (if needed)</th>
<th>Time to Stock Floor</th>
<th>Time Spent in the Elevator</th>
<th>Start Floor</th>
<th>End Floor</th>
<th>Additional Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use for initial trip</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
APPENDIX B: Stock Keeper Inventory Sheet Per Closet

Building: ______________________
Closet: ____________

<table>
<thead>
<tr>
<th>Item</th>
<th>Product #</th>
<th>PAR Level (max # in closet)</th>
<th>Amount in Closet</th>
<th>Amount Stocked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liners</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30x48 Liner</td>
<td>ELK7F3048</td>
<td>4cs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40x46 Liner</td>
<td>HE-H8046SC</td>
<td>2cs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24x33 Liner</td>
<td>HE-Z4833RNH</td>
<td>2cs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper Products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Roll Towel</td>
<td>KC 07040</td>
<td>12(ea)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9in Toilet Paper</td>
<td>KC 08422</td>
<td>12(ea)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12in Toilet Paper</td>
<td>KC 08433</td>
<td>6(ea)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single Roll</td>
<td>KC 04460</td>
<td>25(ea)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multi-Fold Towel</td>
<td>KC 01805</td>
<td>16(ea)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soap</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purell Sanitizer</td>
<td>GOJ324J-1</td>
<td>24(ea)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharp Boxes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Gallon Sharp</td>
<td>RS003</td>
<td>15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C: Stockout Collection Sheet

<table>
<thead>
<tr>
<th>Closet #</th>
<th>Item(s) Missing</th>
<th>Time Recorded</th>
<th>Floor</th>
<th>Additional Info</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
APPENDIX D: SIPOC Diagram of Current Stocking Process

Start: Supplies are ordered

Suppliers
1. Stock Keeper
2. EVS
3. House Keepers

Process

Inputs
1. Stocked Closet
2. Supply Order
3. Outage Complaint

Outputs
1. Money
2. Stocked Closet
3. EVS

Customers
Finished: EVS determines amount for next order

Carts are brought upstairs to closets
Carts are stocked
Supplies are organized
Supplies transferred to supply room
Supplies delivered to loading dock
Supply order is placed

EVS determines amount to order

House keepers use supplies
If outage, go and restock
If need more supplies go back to stock room
Head to next floor
APPENDIX E: 24-hour Current Schedule Timeline
## APPENDIX F: Elevator Time Collection Sheet for Stock Keepers

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Building</th>
<th>Elevator #</th>
<th>Floors Traveled (a to b)</th>
<th>Travel Time (from floor a to b)</th>
<th># of Times Kicked Out of Elevator</th>
<th>Stock Keeper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex (3/20 – 10:45a)</td>
<td>UH</td>
<td>45</td>
<td>2-6</td>
<td>30 min</td>
<td>2</td>
<td>Mike A</td>
</tr>
</tbody>
</table>
APPENDIX G: 24-hour Night Schedule Timeline