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Grady Health Systems Linen Optimization

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TABLE OF CONTENTS

Table of Contents...........................................................................................................................................2

Table of Figures..................................................................................................................................................6

Table of Tables................................................................................................................................................7

Acknowledgements...........................................................................................................................................8

Executive Summary.........................................................................................................................................9

1.0 Linen Optimization in Grady Memorial Hospital..................................................................................10

1.1 Introduction...............................................................................................................................................10

1.2 System Overview......................................................................................................................................10

1.3 Objective..................................................................................................................................................11

1.4 Justification.............................................................................................................................................12

1.5 Project Background................................................................................................................................13

1.6 Problem Statement................................................................................................................................14

2.0 Literature Review....................................................................................................................................16

2.1 Quality Control in Linen and Laundry Service at A Tertiary Care Teaching Hospital in India..........................................................16

2.2 Manual for Implementation of 5s in Hospital Setting.........................................................................18

2.3 Applying lean Six Sigma to Reduce Linen Loss in an Acute Care Hospital....................................19

2.4 Infection Prevention and Control Ward/Department Laundry Guidelines........................................23

2.5 Tackling the Challenge of Linen Losses.................................................................................................25

2.6 Laundry and Linen Services in Hospitals.............................................................................................26
2.7 Implementation of 5S Management Method for Lean Healthcare at a Health Center in Senegal: A Qualitative Study of Staff Perception

2.8 Linen Utilization Reduction Program

3.0 Project Specifications

3.1 Design Requirements

3.2 Project Schedule

3.3 Project Management

3.4 Responsibilities

3.5 Budget and Resources

3.6 Design Concepts

3.7 Verification Report

3.8 Minimum Success Criteria

4.0 Problem Solving Approaches

4.1 Approach 1: Standardized Usage of alEx Machines

4.2 Approach 2: Industrial Machines & Contractor

4.3 Approach 3: Quality Control

5.0 Current Linen Management Process

5.1 Standard Linen Management Process

5.1.1 Linen Delivery

5.1.2 Linen Replenishment

5.1.3 Par Sheet

5.1.4 Collection of Soiled Linen
**TABLE OF FIGURES**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>System Overview of Linen Management</td>
<td>11</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Flow Chart: Linen and Laundry Service</td>
<td>17</td>
</tr>
<tr>
<td>Figure 3</td>
<td>SIPOC</td>
<td>21</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Order Linen Process Map</td>
<td>21</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Why-Why Diagram</td>
<td>21</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Control Plan</td>
<td>23</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Project Schedule</td>
<td>32</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Team Responsibilities</td>
<td>34</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Present Day Linen Process</td>
<td>47</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Soiled Linen Process</td>
<td>49</td>
</tr>
<tr>
<td>Figure 11</td>
<td>Emergency Unit Linen Replenishment</td>
<td>52</td>
</tr>
<tr>
<td>Figure 12</td>
<td>Clinical Decision Unit (CDU) Linen Replenishment</td>
<td>53</td>
</tr>
<tr>
<td>Figure 13</td>
<td>Emergency Unit Soiled Linen Collection</td>
<td>54</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Clinical Decision Unit (CDU) Soiled Linen Collection</td>
<td>55</td>
</tr>
<tr>
<td>Figure 15</td>
<td>scrubEx Display of aLex Machine Linen Status</td>
<td>59</td>
</tr>
<tr>
<td>Figure 16</td>
<td>Proposed Refill Process Chart</td>
<td>65</td>
</tr>
<tr>
<td>Figure 17</td>
<td>Quality Function Deployment</td>
<td>67</td>
</tr>
<tr>
<td>Figure 18</td>
<td>aLex Machine Insert and Medical Professional Outline of aLex Machine Insert</td>
<td>68</td>
</tr>
<tr>
<td>Figure 19</td>
<td>Emergency Unit Linen Replenishment Implementation Trial</td>
<td>72</td>
</tr>
<tr>
<td>Figure 20</td>
<td>Grady Health System Cost Benefit Analysis Summary</td>
<td>73</td>
</tr>
</tbody>
</table>
TABLE OF TABLES

Table 1: Linen Item per Bed.................................................................63
Table 2: Emergency Unit Linen Replenishment Times.................................84
Table 3: Clinical Decision Unit (CDU) Linen Replenishment Times..............85
Table 4: Emergency Unit Soiled Linen Collection Times............................86
Table 5: Clinical Decision Unit (CDU) Soiled Linen Collection Times...........87
Table 6: Emergency Unit Replenishment Implementation Times..................88
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EXECUTIVE SUMMARY

Grady Memorial Hospital, under Grady Health Systems (GHS), is the fifth largest public hospital systems in the United States of America. In the Southeast region, Grady Memorial Hospital is a premier level I trauma institution, that also provides other medical service specialties that accumulate a diverse, and knowledgeable set of medical professionals.

Within this report, there are various recommendations that our team has presented based on different scenarios that could be present within the interaction of the linen management department and other departments at Grady Health Systems. These recommendations will aid in determining the best decision that can be made in improving the linen management process.

The primarily approach our team focuses on is creating an improved, standardized linen process based on the current linen management process in place. This includes standardizing the usage of the alEx machines by medical professionals, and the communication held between medical professionals and the linen department. The final recommendation of the implementation of this approach will serve as an improvement in the efficiency of time, aiming to reduce the replenishment time by 10%, as well as serve as the best possible utilization of the process and medical machines, so that Grady Memorial Hospital will be receiving the best and optimal results in their linen process.

Our implementation trial of the primary approach reduced the linen replenishment process by 2.54 minutes, or 13%, surpassing our goal of reducing the time by 10%.
1.0 LINEN OPTIMIZATION IN GRADY MEMORIAL HOSPITAL

1.1 Introduction

As apart of the completion of our degrees in Industrial and Systems Engineering at Kennesaw State University, each student must complete a Senior Design project. The purpose of the project is for students to display their knowledge and use skills learned in previous Industrial and Systems Engineering classes to apply to a now real world problem. Projects are selected by the students, and will a project that is conducted over the course of one semester. Using the guidelines set by the Senior Design Advisor, will guide students in the final preparation and presentation to the Department of Systems and Industrial Engineering.

1.2 System Overview

In Grady Memorial Hospital, the linen that is in the facility is not the property of Grady Health Systems, but instead it is rented out by a linen contractor, Nova Medical Centers. This linen is received by the Linen Management department at Grady Memorial hospital, between the times of AM to PM. The Full-Time Equivalent (FTE) staff then move the linen to the linen distribution room, and build carts based on the various departments in the facility. The amount of linen needed is communicated by using Par sheets, that communicate the Par level, or the amount of broken down linen, per department.
1.3 Objective

The objective of the project was to optimize the linen appropriation process Grady Memorial Hospital by minimizing waste and enhancing the productivity of the procedure, with the main role of institutionalizing and improving the procedure while meeting quality objectives. As a team, we decided to set the main focus of the project to be linen department process inside Grady Memorial Hospital, concentrating on the EMS and nursing staff communication inside the procedure. The Laundry Service was considered out of the degree despite the fact that it can affect the linen conveyance process. This choice was made because the laundry service is located outside of the hospital at NOVA medical center. There is a shipment of linen that comes to Grady Memorial Hospital twice a day with fresh linen. However, we focused on the amount of linen usage in two specific areas which are the Emergency department and Clinical Decision Unit. A Lean critical thinking approach was utilized to achieve the task. First objective is to have a full
understanding of the current state of the linen process that is happening in the hospital. Second, we will come up with a future plan that will improve the hospitals linen process by pinpointing the main issues and what alterations would have the most effect on the system. Third, we will come up with an implemented future state that will help the outcome of a new process. This will include improvements accomplished, responses from the staff and nurses, as well as areas that essential need to be improved.

1.4 Justification

When looking at the 5s system, justification on a financial, efficiency, and qualitative standpoint can all be seen. To justify our solution we looked at the old process of linen from each input and output angle to improve efficiency. By keeping the cleaning and disposal process of unfit linen, the time and money saved is a key indicator to justify the solution. Also, by decreasing the soiled to clean linen ratio use by 16% and increasing efficiency, upwards of seventy thousand was saved to then re reallocated for a different fiber linen but should be used to implement more cleaning and sustaining technologies.

When testing solutions, it is important to justify and run tests in multiple environments. When examining departments, a major problem was keeping things clean and organized. A Lot of times no one is allocated a specific job so it does not get done or it takes a team and time is being wasted in another place. This speaks directly to efficiency which is the IPO or input, process, and output stages that the lined transitions through. In conclusion, by focusing on
efficiency, the cost and quality will both have positive effects, but also more linen orders can be filled if need be in an organized sanitary method.

1.5 Project Background

The vision of Grady Health Systems is that it will become the leading public academic healthcare system in the United States. Grady Health Systems is composed of several medical service components: Grady Memorial Hospital, Crestview Health and Rehabilitation Center, the Infectious Disease Center, the Loughlin Radiation Oncology Center, the Maloof Imaging Center, six community health centers, the Regional Perinatal Center, the State of Georgia Poison Control Center, the Georgia Cancer Center for Excellence, The Marcus Stroke and Neuroscience Center, Grady Emergency Medical System, Level I trauma center, and Emergency Medicine and Burn centers. We will be focusing on one component of this system, being the Linen Management department within Grady Memorial Hospital.

Grady Health Systems first opened its door to the city of Atlanta on June 2, 1892 to serve the medical needs of citizens in the city. Its opening was revolutionary for history, as its high quality services where provided for all residents of Atlanta, regardless of social status and race.

When many people promoted the idea of opening up a public hospital in Atlanta, Grady Memorial Hospital came into fruition. Grady Health Systems is now one of the leading Level I Trauma institutes in the country, the largest hospital in the state of Georgia, the fifth largest public hospital in the country, the thirty-fifth largest hospital in the country, and a public hospital for the city of Atlanta.
Our focus will be working with the Emergency Management department at Grady Memorial Hospital on the linen management process throughout the various departments in the facility, and with their contractor, Nova Medical Centers. It is very critical that the management of linen process is working properly, as it is an important staple to Grady Memorial Hospital serving its clientele. The issue that the Linen Management department is having, has been not enough resources put into the analyzation of the process, which in turn has been hindering the productivity of the linen process, resulting in out of stock linen, late delivery of linen, or unnecessary movement of linen.

Nova Medical Centers is the contractor that provides not only the linen for Grady Memorial Hospital, but also responsible for the decontamination and sanitation process of the linen. The contract with this contractor is two-months-old, with a total contracting period of one year.

Environmental Management Services is responsible for cleaning the rooms in Grady Memorial hospital, as well as making the hospital beds.

1.6 Problem Statement

The problem statement defines the objectives to help diminish the costs, and the SIPOC (Supplier, Input, Process, Output, Customers) outline that is appeared above in the system overview. The fundamental issue for the situation is that standard ruined to clean material by 3.86%, contrasted with the objective 5%, within the first six week there was a loss of $18,101 in lost linen that is conceivably occurring by the partners disposing of linen inaccurately or ER
Grady Health Systems Linen Optimization

taking linen. The principle objective is to evaluate the linen/laundry conveyance activity and lessen the measure of lost linen, and accepting a similar measure of weight that was given to the department at the start of the shift.
2.0 LITERATURE REVIEW

With this project, we have conducted extensive research to aid us in how we should approach the project objective before starting our data collection. Below are our referenced articles, in which we summarized for the audience. These article summarizations will serve as an explanation of each individual article, and how these articles can assist us in data collection, process improvement, or an explanation of methodology we could have as an option.

2.1 Quality Control in Linen and Laundry Service at A Tertiary Care Teaching Hospital in India

In India often times the people do not trust hospitals due to the lack of equipment efficiency but also the lack of staff and process errors. The hospital morale can be raised making it a better work environment to potentially attract hires, but also to gain the trust of the community. Although the linen, which in India includes: bedding for cribs and trolleys, theatre and eating materials, bedding and bathroom items, as well as clothing, is the top performing sector, work still needs to be done. The support services for patient care is a huge platform for hospitals to perform in true perspective and facilitate the patient care process. As we know linen and laundry are considered to be support services, but also guarantees prevention and regulation of healing facility contamination by opening the eyes of the public.

However, the study was done by interviewers, observation, questionnaire and study records. The information examined included physical complex, labor, materials, types of gear...
and natural elements. The different components of labor considered comprised of number of staff working, their capability, preparing, advancement roads, inspiration and occupation fulfillment. Process was considered by doing perceptions in material and clothing administration through a predesigned flow chart (shown below), which was supplemented by interviews with various class of staff. Persistent fulfillment, staff fulfillment and microbial tally of washed linen (quality measurements) were contemplated in the result.

**Figure 2: Flow Chart: Linen and Laundry Service. Int J Health Sci (Qassim)**

According to the present study found that regardless of specific lacks in the equipment, labor and process, the material and clothing administration is giving a palatable support of its clients. Therefore, the administrations can be additionally enhanced by evacuating the present lacks both at structure and process level (Int J Health Sci (Qassim)).
2.2 Manual for Implementation of 5s in Hospital Setting

When implementing new systems and strategies it is important that a full grasp of the concept is achieved. According to this manual of implementation, it is best to have a structured guide as to how to properly follow the 5s process. Through cut and dry training to the front line of the hospital staff, the hospital overall process can be cleaner and smoother alongside cutting the budget and improving efficiency.

Training and planning are the most important phases. When training, be sure to have a lesson plan or a few guides to be sure that everyone is engaged. The 5s/Kaizen process ensures safety of guests, staff, and patients through various duties. By assigning stations to everyone specifically, the entire hospital will be clean because everyone is accountable. This method, as explained in the guide, is called the “shine” method. Prior to the shine method is the sort and set steps. First discard any unwanted or toxic articles away from useful inventory. Then set or organize all the materials and inventory after sorting. After everything is organized and make it a standard for it to be that way every time to instill a sort of company culture. Finally, sustain the hygienic levels by routine training and maintaining a discipline for the standard.

The 5s method, if worked properly and as a team, is set to improve the overall workplace as well as service delivered to clients. Each person has a responsibility so everyone on the team knows each role. If something comes up short in the chain, then another link is responsible for strengthening that area. This is similar in the 5s method because without teamwork if someone gets hurt then it is up to whoever saw it to report it to management, fix the problem, but also assess the situation and learn so that it won’t persist.
In a chain of command everyone needs a backup or support system. When solving problems in the workplace it is important that someone enforces the rules but does it respectfully and in a way that improves the problem. This is the job of the WIT or work improvement team formed by a small group of like minded motivated staff working to implement solutions and monitor the 5s process. The QIT or quality improvement team is the support to the WIT’s but are the managers and higher ups of the WIT. With these small focus groups everyone on each level can have a say but the job still gets done. This is a prime example of having a union within the hospital but also top down management where decisions are made from the top but middle managers and the front line still have a voice.

Financially, the 5s system cuts back on damaged items which will cost replacement, but also keeping things fresh and accurate for restock. Linen costs specially can be affected by the 5s method when linen is being unaccounted for or the delivery time of cleaned linen is not fast enough so new ones are ordered. By keeping organized the output of the sheets will speed up in turn making the delivery faster and at a set time with the new organization put into place.

2.3 Applying Lean Six Sigma to Reduce Linen Loss in an Acute Care Hospital

It is common misconception that Six Sigma can only be used in the manufacturing setting, too many resources are needed to implement six sigma, and that using the methodology of Six sigma causes employee cuts. These misconceptions of Six Sigma are untrue, and we believe that any company can benefit by using the methodology, techniques, and tools of Six Sigma to improve any type of process. Being that linen usage in hospitals are running low,
because patients are not returning baby blankets, sheets or the linen is completely damaged causes a huge loss to the linen department. This case study explains a similar process in Fort Lauderdale, Florida, where the current state and strategy development along with five different phases of the DMAIC (Define, Measure, Analyze, Improve, Control) and other key concepts.

The Define phase is when the problem statement is recognized, setting goals to help reduce the expenses, and the SIPOC (Supplier, Input, Process, Output, Customers) chart is shown. The main problem in the case study is that baseline soiled to clean linen 3.86%, compared to the goal 5%, the first 6 weeks there was a loss of $18,101 in lost linen that is possibly happening by the associates discarding linen incorrectly or ER taking linen. The main goal is to evaluate the laundry/linen distribution operation and reduce the amount of lost linen, and receiving the same amount of weight that was given to the department t the beginning of the shift. The SIPOC (Figure 3) express the levels of steps involved in handling the linen when it gets to the hospital and how it works.
The Measure phase is the current method that mapped and measures to determine the baseline metric, as well as validating the measurement system. The Measure Phase included the following activities: Define the current process, Define detailed Voice of Customer (VOC), Define the Voice of Process (VOP) and current performance, Validate measurement system (Furturer, 2011).

In the Analyze Phase, this is the step where the problem is acknowledged and solved in various ways of lost linen and low soil to clean linen ratio. In figure 5, the diagram displays where in the hospital the linen possibly goes too and gets lost. In this fourth stage, different improvements and plans were distinguished, a cost/advantage examination was done, a future
Grady Health Systems Linen Optimization

state was composed, execution targets and undertaking projects were set up, and pilot upgrades
were implemented.

![Why-Why Diagram](image)

**Figure 5: Why-Why Diagram**

In the Control Phase, the outcome of the implemented pilot activities were measured. A
control plan was developed to monitor the time it leaves the linen department and the process it
maintains to improve shown below in figure 6.
However, the hospital improved the reducing of linen loss and saved $77,480 and decreased the soil to clean linen that was being used by 16%. This case study shows how Six Sigma helps improve a process the right way. By having the right data, information, and causes of the problem made it easy for us to understand the problem, as well as gave us a great way to implement these ideas into our issues at Grady Hospital.

2.4 Infection Prevention and Control Ward/Department Laundry Guidelines

One approach that we were considering was possibly looking at dividing the amount of linen that is contracted and linen that could be processed by an in-house industrial washer or dryer, if the facility decides to invest in the equipment. In considering this approach, there would
have to be standards in place for employees to properly handle soiled linen that is maintained within the facility.

The purpose of the Control Ward Department Laundry Guidelines is to ensure that laundry and linen of the facility if not only correctly stored, but the linen and laundry is also processed and handled properly that limits and minimizes the amount of infection transmission that may occur in the materials. The only linen that is used in the facility is linen that is managed properly and meeting the standards for client usage.

For prevention of the risk of infection, there will always be compliance with the standards procedures while handling soiled linen will reduce the risk of exposure to blood and body fluids. With the storage of soiled linen, it has to be known to follow the standard precautions at all times. Contaminated linen is to avoid contact with your own personnel linen. Linen soiled with blood or body fluids or from infectious patients should be sent to the laundry in a water-soluble bag that has been placed inside the red linen bag. These items should be carefully rolled inside the drier dirty linen to help prevent any potential breakdown of the water-soluble bag during collection and transport. There are also procedures for linen bag usage, as no sharp items are to be placed in the bags, should not be filled more than ¾, and ensuring that the bags are properly sealed. Other regulations apply such as which linen going into which bag.

Linen bags are color coded to assist in indicating the risk of the linen and laundry, as well as guidance on disposal and other procedures. Internal transportation and storage of soiled linen consists of soiled linen being transported in identifiable carts or hampers, separately from clean linen, and other procedures and specifications.
Included in this guideline is also laundering of uniforms worn by clinical staff, which are laundered by a specific designated manufacturer. And if uniforms come into contact with infectious material or body fluids, the soiled garments are laundered by Canterbury Laundry Services. Clean linen should be properly protected during storage and kept separated during transport to prevent contamination. Disinfestation of the inside of washing machines includes using a hot wash cycle and adding 20 ml of sodium hypochlorite per litre to give 1000 ppm available chlorine while filling.

2.5 Tackling the Challenge of Linen Losses

One proposed solution we have been also thinking about is focusing on the loss of linen, as it is one of the main costs to the hospital when the linen and other laundry have to be returned back to the contractor upon being cleaned. This documents serves as some procedures that can be used in taking into consideration and approaching the problem of linen loss within hospitals, and what can possibly be done.

It is important to be very cognizant of the warning signs of linen loss such as product damage, late internal deliveries, poor inventory control, increase in linen costs, switching to disposable linen, and customer complaints. To tackle linen loss you must first recognize that there are problems going on, and many for different reasons. One way linen is loss, due to patients is due to the transferral of patients to different rooms or facilities, or taking the items home once they are discharged. It is important to development process that halts losses and abuse of the linen.
2.6 Laundry and Linen Services in Hospitals

This article serves as further research into our options of having the client having certain linen and laundry be carefully handled by an outside contractor, and certain linen being handled by the hospital facility if the machinery were in place. When cleaning laundry and linen in the hospital setting, it is important to make sure that it is being handled carefully and minimizing the risk of infection at all times as much as it possible can. There has to be regulations and rules put into place if there is a possibility that the hospital gains partial responsibility in regulation laundering of the linen and laundry.

In this article is describes the main purpose of the laundry department is to provide clean material to the patients and ensure that hygienic conditions are maintained in the process. The responsibilities of the department also include technical operation and decision making based on linen stock, daily transaction of the linen in distributed areas, how much linen to be purchased, establishment of linen quota in various departments, and different linen and laundry in different departments. The department should distribute fresh, clean linen to the correct departments, maintain different types of machines of linen, inspect and repair or replace damaged linen, sort and process the linen, and collect the soiled linen from the different departments.

It is ideal to have the location of the department in area that is isolated or connected to a water and power plant. It is important to have features such as: Space for heavy equipments like washing machine, supervision over the supply of water and power, storage area for cleaning materials, area for placing soiled linen, industrial washing and drying equipment, sorting area for cleaned linen, sewing room for mending linen with an iron and iron board, and a small office space area. Having a control area determines the smooth operation and effectiveness of the
Grady Health Systems Linen Optimization

department, as its focus is on communication and processing information to various departments within the hospital.

It is important to make sure that there are duties and responsibilities upheld by the housekeeping in charge. Their function would include making sure that every procedure that is supposed to be carried out by the linen department is being maintained and cared for. This includes, but not limited to, maintaining the area in which the cleaning material is stored, making sure that the linen is checked for the worn usage, maintenance of the washer and dryer kept in the department, as well as other equipment, and making sure proper cleaning and handling handling of the linen is being done by technicians.

2.7 Implementation of 5S Management Method for Lean Healthcare at a Health Center in Senegal: A Qualitative Study of Staff Perception

This article serves as further research of the Japanese lean methodology of 5S. This is a management method used in order to improve the organization of the workplace, and has be widely recognized in various organizations. We want to apply this methodology for quality improvement of the system of linen utilization for the facility.

The decision to use 5S methodology was based on the future expansion of the method to future medical facilities. Due to the ease of physical access of the stakeholders, it would not be as difficult on collection of data. The health center had 78 staff members consisting of outpatient consultation, maternity, dental, pediatric, immunization, laboratory, social counseling, health
education, and nutrition programs. The location of the health center was in a low-income, area of poverty with less access to healthcare services compared to other affluent areas.

The 5S implementation trial used consisted of three phrases. In the first phase, there was training and planning for the application of the 5S management method. For the second phase, there was a series of analysis of the 5S practices and purposes for each unit in the facility. In the third and final phase, it consisted of monitoring the process of the implementation. The objective was to standardize the health system's administrative process and all activities of the hospital.

In the study, 21 health center staff were interviewed after doing a pilot implementation which lasted for a year. The staff were asked questions regarding their views on the 5S program in the workplace and routines. This information was organized and used to gather narrative information by the usage of coding processes and thematic analysis.

Based on the gathered information, it showed that despite resource constraints and other demotivating factors present at the health center, the 5S program created changes in the work environment, including fewer unwanted items, improved orderliness, and improved labeling and directional indicators of service units. So the quality of services were made more efficient as it was more focused on the patients, and improved the morale of the hospital staff.

### 2.8 Linen Utilization Reduction Program

Because one the solutions we have in mind focuses on the loss of linen, we did further research of the cause of losses and how it can be prevented. Linen loss is the most common problem of hospitals and causes a loss in costs that accumulates the more material is lost or
Grady Health Systems Linen Optimization

stolen. In this article is gives us insight on some procedures that can be used in taking into
consideration and approaching the problem of linen loss and lowering the cost of linen and
laundry.

In this article, it states that a successful linen management has consistent fresh and clean
linen delivery and consistent soiled linen pickup. It is important that the fresh linen is
consistently delivered to the linen department, as well as the linen department delivering the
fresh linen to the various departments of the hospital, the linen department collecting the soiled
linen from the various departments, and then the linen department returning that soiled linen to
the contractor. It is important for this process to have in a 24 hour trend to be as effective as
possible. Correctly determining the par level builds the confidence and reduces hoarding of
linen, and the additional time for linen deliveries throughout the day.

It is necessary for the soiled collection to occur in a manner that will optimize the amount
of linen that is returned to the laundry prior to the sorting and washing of linen. When utilizing
an outside processor, it should determine when the maximum amount of soiled linen needs to be
ready for pick-up by the laundry. It is important if the linen can be tracked, and will reflect an
appropriate par level for each department. Daily par levels delivered to units should be adjusted
on a regular basis to match the supply and demand of a department.

Linen loss also occurs through ambulances as well, and patient care and security staff
should be educated so they are aware of the cost impact associated with the linen loss via the
transfer and emergency squads. This is can be done by observing the transfer and ambulance
admissions that occur. It would also be important to educate patient care staff on proper disposal
of linen. It would also be best to switch the patient belonging bags to clear bagss rather opaque,
because it would be able to easily see if a client was taking linen and other belongings from the hospital.
3.0 PROJECT SPECIFICATIONS

3.1 Design Requirements

Our primary goal for our project is to identify various opportunities for improvement in the usage and material handling of linen. We will focus on the type of linen usage per area, replenishment time, and the amount of linen of linen lost. Achieving this objective will raise the familiarity with the hospital facility staff on linen waste, as well as educate any potential institutional reserve funds that could be produced by enhancing the bed changing practices.

To accomplish this goal, the team observed and interviewed different departments throughout Grady Health Systems. This being done was to gain insight on how each department uses their linen differently, as well as .

Our main focus will be optimizing the linen distribution process in Grady Health Systems. We will create a system that is easily interpreted by all the medical professionals who interact with the linen management machine, alEx. We aim not to create costs for the hospital, due to the linen management department’s recent purchase of linen management machines, and other linen management resources. We will work with the current space used by the linen management department and the linen management machines located throughout Grady Health Systems.

By standardizing and simplifying the process, this will bring the elimination of waste and improvement on the efficiency of the process, and in turn will be meeting our quality goals. With quality goals being met, linen management process of Grady Health Systems will more time
Grady Health Systems Linen Optimization

efficient but also maintain the quality and prevent possibility of increasing health risk while handling linen.

The linen management department and supply chain department at Grady Health Systems can use this knowledge and research to make decisions on the future state of the process, as well as allocate money in areas the departments feel are necessary based on our suggestions.

3.2 Project Schedule

Shown below is the schedule of our Linen Optimization Project with Grady Health Systems. This schedule communicates on the work in which will we be performing, the timeframe in which it will be done, all of our activities as shown in the work breakdown structure, and the resources in which we will need and be using to perform that activity.

Figure 7: Project Schedule
3.3 Project Management

Our project manager, who will guide and oversee everything conducted in this project is Lori Woods. Lori is the Director of Emergency Management for Grady Memorial Hospital. She provides any information that we need, as well as assist us in coordinating with the staff of the linen department.

3.4 Responsibilities

Below, we have our planned individual responsibilities throughout the course of the project. We used the RACI Matrix to assist us in visually representing the identification of roles and the assigning of responsibilities towards our project.

**RACI:** R - Responsibility, A - Accountable, C - Consulted, and I - Informed
### Figure 8: Team Responsibilities

#### RACI Matrix

<table>
<thead>
<tr>
<th>Project Deliverable</th>
<th>Role</th>
<th>Project Manager</th>
<th>Process Designer/Data Analyst (Kylea Hutton)</th>
<th>Research Analyst/Optimizer (Samira Abdi)</th>
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</thead>
<tbody>
<tr>
<td>Initiate Phase Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Submit Project Request</td>
<td>C/I</td>
<td>R/A</td>
<td>R/A</td>
<td></td>
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<tr>
<td>- Discuss Team Responsibilities &amp; Roles</td>
<td>I</td>
<td>R/A</td>
<td>R/A</td>
<td></td>
</tr>
<tr>
<td>- Research Solution</td>
<td>I</td>
<td>R/A</td>
<td>R/A</td>
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<tr>
<td>- Develop Research Background</td>
<td>I</td>
<td>R/A</td>
<td>R/A</td>
<td></td>
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<tr>
<td>Plan Phase Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Create Project Objective</td>
<td>C/I</td>
<td>R/A</td>
<td>R/A</td>
<td></td>
</tr>
<tr>
<td>- Create Schedule</td>
<td>I</td>
<td>R/A</td>
<td>I/A</td>
<td></td>
</tr>
<tr>
<td>- Create Additional Plans as Required</td>
<td>I</td>
<td>R/A</td>
<td>R/A</td>
<td></td>
</tr>
<tr>
<td>Execute Phase Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Build Deliverables</td>
<td>C/I</td>
<td>R/A</td>
<td>R/A</td>
<td></td>
</tr>
<tr>
<td>- Create Status Report</td>
<td>C/I</td>
<td>R/A</td>
<td>R/A</td>
<td></td>
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<tr>
<td>Control Phase Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Data Collection</td>
<td>I</td>
<td>R/A</td>
<td>R/A</td>
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<tr>
<td>Close Phase Activities</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>- Analyze Final Data and Remanider Activities</td>
<td>I</td>
<td>R/A</td>
<td>R/A</td>
<td></td>
</tr>
<tr>
<td>- Finalize Report, PowerPoint, Video, Poster</td>
<td>I</td>
<td>R/A</td>
<td>R/A</td>
<td></td>
</tr>
</tbody>
</table>

3.5 Budget and Resources

Grady Health Systems has provided us with full usage of their facility during their operational hours. We will also be frequently communicating with their contractor that provides their linen, Nova Medical Centers, to gain more insight and information regarding the life cycle
Grady Health Systems Linen Optimization

of the linen. Grady Health Systems will provide us with the software that their company uses, such as, visio, as well as their company computer machines, conference areas, and more.

Due to recent justifications in gaining new medical equipment in the facility, including linen weight carts that convert linen weight to the contractors accepted value before the turnover of soiled linen is received by the contractor, as well as alEx, linen management machines placed that are placed throughout the facility, at this time Grady Health Systems sees that all of the infrastructure is in place in the facility to perform the current and future state of linen management processes. With this information, we will not have a budget for this project, but will be working with the infrastructure already in place.

Other tools that we will be using are Excel, Visio, Microsoft Project, Arena, and conducting time studies, to record and analyse our collected data.

3.6 Design Concepts

To analyze and demonstrate the understanding of what we have learned with our studies of Industrial and Systems Engineering, we decided to focus on linen optimization in Supply Chain in the field of Health Care. This process involves used linen that must be received by contracted laundry services for cleaning and decontaminating the linen for future usage.

With the usage of quality control, bedsheets and other hospital linen can be separated, preventing the spread of potential infected or contaminated linen articles. According to National Library of Medicine and Health Institute, ninety percent of linen is not used for its full useful life. By using quality control, we are able to pinpoint that quantity trumps quality so linen is
Grady Health Systems Linen Optimization

...easily destroyable and replacement fees come into play. Because there will be a recommendation that requires it, we will also want to focus on the importance of quality of the linen, one goal of ours is to focus on the type of material that is being used in the hospital. We want to find more durable sheets, that are resistant to tearing or easily stained due to various liquids it will come in contact with.

Also, looking into the material of the linen assists in keeping down allergies or reactions to the material. Silk, wool, and cotton are the top three fabrics that are hypoallergenic. By focusing on quality the worry of dust mites, bed bugs, or other germs and bacteria lodged into the material is slimmed. Sweat and stains also ruin quality of the linen, so we will analyze the absorbent rating of the linen. Bamboo sheets and moisture wicking sheets are the studied top two coolest sheets.

Another recommendation that we want further investigate, is looking at the return of cleaned sheets and a possible investment in the future for Grady Memorial Hospital, in which there is a purchase of industrial-sized washing machines to have in-house. This new equipment could be in a dedicated sector, made specifically for sanitation of linen. This can possibly lead to Grady Health Systems not having to outsource resources for the sanitation of linen, or certain types of linen. There could also be industrial sanitation equipment companies that are willing to partner with Grady Health Systems to supply the sanitation equipment.

If in the future, Grady Health Systems were to purse the route of in-house sanitation of linen, steam cleaning the linen could be an optimal method of the could reduce the amount of electricity produced. Also, using steam the linen could be heated at the highest temperature to ensure proper disinfecting.
3.7 Verification Report

In order to verify that our recommendations is effective and that our results are ones that show improvement, we will analyze our design by comparing three key components: the type of linen usage per area, replenishment time, and the amount of linen of linen lost.

As apart of our design, we will measure data based on the type of linen usage per area, replenishment time, and the amount of linen of linen lost, as well as using the software of the Linen Management department. We will evaluate our results by conducting time studies done throughout various departments, and analyze that data. We will interview various medical professional staff located in different areas in the facility to gather data. We will also look at the historical data provided by Grady Health Systems, to compare the results.

3.8 Minimum Success Criteria

By the end of our project, we expect to properly understand the linen distribution process that happens in Grady Memorial Hospital, in which we can give our best proposed recommendation. This includes having a better understanding of the guidelines and figuring out how closely the hospital is following those policies. We hope to accomplish any improvement in regarding the type of linen usage per area, replenishment time, and the amount of linen of linen lost. We hope to decrease any of these three metrics by 10%.
Successfully accomplishing the proposed design concepts will result in us having a full grasp of the process design and factoring components, such as cost and effectiveness.

To personally deem ourselves successful, our research and proposed recommendations, all together or singularly, should cut costs as well as make the linen as eco and people friendly as possible, as well as reducing the costs of the replacement of linen and outsourcing of linen.
4.0 PROBLEM SOLVING APPROACHES

4.1 Approach 1: Standardized Usage of alEx Machines

Our first approach consists of standardizing the usage of the alEx machines. Upon an initial brief shadowing the linen technicians and medical professional staff at Grady Memorial Hospital, we initially noticed that all of the departments we visited had different ways of contacting the linen department to begin the replenishment of the linen in their department. Some of the medical professional staff would get the clerk of that department to directly call the linen department and request for the entirety of the alEx machines to be restocked, without stating if there was a certain type that needed to be replenished, or if the entirety of the machine needed to be replenished. Due to this, the linen technicians would prepare a cart full of different types of linen, and replenish the needed linen in that department based on the par sheet, or the guidance of the alEx machine displaying which linen types were stored in that particular machine.

Another thing that we noticed was medical professional staff waiting until linen was almost completely empty, or at a dangerously low amount of linen remaining. This caused a delay in the linen to be received, and for medical professional staff to attend to patients. This also lead to another problem as that trash and other miscellaneous items were being stored in alEx machine, as some of the departments had a limit on how much linen they could retrieve. In order to receive more credits, medical professionals in these departments could deposit linen in exchange for retrieving more linen. Because the alEx machine cannot physically identify linen, but only an object’s weight, the alEx machine would register the weight of the item, thinking it was linen being deposited, and credit that staff member for depositing linen.
Based on the problems we initially saw, we thought it would be best to standardize the usage of the machines. This is so that everyone is following the same protocol, and few issues shall arise. Implementing standardization would include determining a safety stock for the linen, so medical professional staff are familiar that that amount of linen is the lowest amount of linen they need to function, and upon reaching that amount of linen, the replenishment process needs to occur before running out of linen. A way of indicating this is by having color indications inside of the alEx machines, as this gives a simple easy visual for the medical professional staff, so that they immediately know what to do when the machine reaches certain colors as they retrieve linen from the machines. A final good method of standardization for the alEx machines, would be for the machines to indicate which linen can be held in that particular machine depending on the department.

4.2 Approach 2: Industrial Machines & Contractor

Our second approach involves Grady Memorial Hospital investing into their own in-house washing machines, as well as continuing to have contractors as well. Currently, all of the linen that Grady Memorial Hospital uses in the hospital is owned by a Nova Medical Center, which is a contractor that provides other linen services to Grady Memorial Hospital as well, such as delivering clean linen and retrieving soiled linen, washing soiled, provided linen treatment, and other services. The linen that the contractor delivers daily is not delivered at a set time, and arrives during an interval period without indicating to the linen department exactly their arrival. Even though the contractor delivers linen daily, not all types of linen are delivered daily. This is
due to some department being open during regular business hours, Mondays through Fridays from 8 AM to 5 PM, and closed during the weekends. Because of this the linen department can expect not to retrieve all types of linen every day.

The shipments delivered by the contractor are also varying, as the linen department can expect 8 large bins of linen in one shipment, or sixteen large bins of linen in one shipment. It varies based on the way the contractor assembles the orientation within the trailer. Upon retrieving the clean linen, the linen being used by a patient, and the linen returned to the linen department in preparation to return back to the contractor for washing, there are linen losses. Linen loss occurs for different reasons, some of the biggest reasons being theft, medical professional staff hoarding the linen due to the AlEx machine running low, and the linen becoming lost during any transit within the hospital. All linen is weighed when it is retrieved, before being given to the linen department, and weighed before it is returned back to the contractor. For any linen that the contractor delivers, but does not return upon delivery pickup, that is considered a ‘loss’ for the department, and Grady Memorial Hospital has to pay for the total amount of linen lost at the end of the year, or upon the expiry of the contract with the contractor.

Based on these problems faced, we thought it would be best that instead of all of the linen being completely owned by the contractors that Grady Memorial Hospital are partnering with at the time, that Grady Memorial Hospital owns certain linen types, and that the other linen types are owned by a contractor. In determining which linen types should be owned by the hospital, and others being contracted would be based on categorization of the linen. This categorization can range from the dirtiness of the linen, to which linen are in the highest demand for the
hospital. This would be beneficial as this way Grady Memorial still does not have to be completely over the entirety of owning the linen, but they can always have the linen they need the most on hand in the hospital. This approach would require the acquiring of an industrial washer and industrial dryer for the linen department, and a department facility redesign to make room for the pieces of equipment, as well as the storage area for dirty and clean linen. An economic analysis can be performed to determine when the cost of the equipment will breakeven, as well as water and electricity bill costs for the hospital. Because Grady Memorial Hospital is a government facility, it may also be able to save costs on their bills as well depending on if they are able to receiving a discount on such bills.

### 4.3 Approach 3: Quality Control

Our third approach is quality control of the linen that is being used, and maintaining that quality level of the linen. When the linen is being delivered, and upon the linen going upon the beds for different patients, the linen should be clean, spotless, and of high quality. The quality of the linen is every department is the same, which is great and something to be proud of. Ironically, not all departments should have the same needs of the same quality as other departments. For example in departments where mothers are delivering children, the sheets tend to get very soiled easily by the bodily fluids, thus ruining the sheets. In other departments, such as the Emergency Unit, some linen is put on patients, and when they have to undergo surgery the linen is immediately cut to be removed from their body.
Based on this, there should be categories for linen based on departments and typical usage of that linen. This type of division will help in identifying which types of quality of linen should be placed in all departments. After determining which quality types of linen belong in each department, there should be an array of different linen types that can be used as well. This includes options such as washed cloth linen, chemically treated dyed cloth linen, or disposable linen, as examples. A cost analysis can be performed to determine if this would prove effective in saving the hospital money, or what can be fixed to have the hospital benefit from these decisions.
5.0 CURRENT LINEN MANAGEMENT PROCESS

In our first conversations with the Director of Emergency Management and the staff of Linen Management, we discussed the linen management process. It is important to fully understand the process in order to know what we were trying to implement improvements on. We were not sure of the scope in the beginning of the project, as seen in our three separate solutions on different aspects of the linen management process system.

We decided to focus on the improvement of the interaction between the linen management department and other departments as this was an issue and convenient as for the ease of access of all stakeholders involved. Below we explain the best case scenario of the standard linen management process, which is if the process was running without the imperfections that occur in the facility throughout the day.

5.1 Standard Linen Management Process

In the standard linen management process, we can expect for the contractor to deliver clean and fresh linen to the Linen department, and the linen department collects the clean linen and returns weighed soiled linen to the contractor. The linen department will then sort the fresh linen by the amount in its respective department, and the linen department replenishes the linen in the other departments, while also collecting soiled linen that needs to be returned to the contractor.
5.1.1 Linen Delivery

As stated previously, linen is not owned nor cleaned by Grady Memorial Hospital. The linen is owned by NOVA medical, and is also cleaned and processed by the contractor. Fresh linen is received daily by the linen department from the contractor, as the soiled linen is received from the linen department to be processed by the contractor. This process occurs at least twice a day, which the contractor arrives between the hours of 10 AM EST to 6 PM EST.

5.1.2 Linen Replenishment

There are three shifts that the linen department currently has: 6:30 AM EST to 2:30 PM EST, 2:30 PM EST to 11:00 PM EST, and 11:00 PM to 6:30 AM EST. Replenishment of linen occurs immediately once a shift begins based on the PAR level of the department. After the initial replenishment, the linen department tracks which departments need replenish by using scrubEX, an inventory linen management software paired with the aLex machines to track the linen usage in real-time.

5.1.3 PAR Sheet

The Periodic Automatic Replacement sheet, or PAR sheet, assists the Linen department in knowing how much linen to give to a department. The PAR sheet is further broken down into the type of linen, and the specific amount of that individual linen. The PAR level determines
the absolute minimum amount of inventory that is needed to be in stock for a specific period of
time. When the inventory amount falls below that PAR level, it needs to be replenished as
quickly as possible. Each department has a different PAR level for different types of linen, so not
all departments have the same type of linen or even the same amount of PAR levels. This is due
to the different demands of the various departments.

5.1.4 Collection of Soiled Linen

Once the linen department completes the replenishment of linen in the departments, they
return back to the linen room, and retrieve the bins to collect soiled linen from the other
departments in the hospital. The soiled linen is placed into the bins, and is returned to the
basement, where the bins are then weighed to make sure that the amount of the bin is the same as
the amount originally issued by the the contractor, as well as a little added weight due to dead
skin cells, sweat, and other bacteria. The bins are placed near the receiving docking area to await
being picked up by the contractor to be washed.

5.2 Present Day Linen Management Process

While a standard linen management process exists, when talking to professional medical
staff and observing the linen management process, we noticed that there is a deviation between
the established process, and the actual process. In order for each bed at the hospital to be
arranged with a fresh set of linen, three different departments work collectively to make it
happen. These three areas are the Laundry Service, the Environmental Management Service (EMS), and the nursing staff.

The laundry service one of the important part during this process, since Grady hospital do not have a laundry department. All of their linen is sent to NOVA Medical Center to get washed. The EMS would request a daily order of all the linen that is needed to the laundry service for the following day. Between the hours of 4pm and 6pm, a truck will arrive to the hospital with the clean linen that was requested the day before. The linen staff is also obligated to collect all the dirty linen throughout the day from each department before the truck comes, so it will be ready for them to take back to NOVA Medical Center.

During a normal day, there are 3 shifts: first shift is 6:30am-2:30pm, second shift is 2:30pm-11pm, third shift is from 11pm-6:30am. During the shift, the linen is staff is required to make sure each of their assigned department aLex machine is full at all times. The lead time from when the linen is ordered until the time it gets to the nurses takes about a couple hours depending on the department. However, the nurses would call the EMS to request a refill or the linen staff will look at the chart that tells them when a department is running low. Finally, when the linen is used and becomes soiled, it is disposed of and sent back to NOVA for washing, and accomplishing the linen cycle. The general outline is shown below in Figure 9 explains the daily process.

![Figure 9: Present Day Linen Process](image)
5.2.1 Linen Delivery

Linen is normally brought to Grady hospital between the hours of 4pm-6pm everyday. Once the linen arrives it is unloaded at the dock and taken straight to the scale to weigh the cart. When the cart is weighed the linen staff takes it to the linen room where all the linen is kept and they separate all the bath towels, flat sheets, pillow cases, gowns etc into each department. The staff gathers all the linen that is needed for each department that they are assigned and once the cart runs low the staff is required to refill it.

5.2.2 Linen Replenishment

The EMS uses a software that is connected to the aLex machine that notifies the linen staff when each department is running low on linen. The nurses are also able to request certain linen that is running low. The EMS would automatically see that a department is low through the device and refill it within hour. The staff normally walks through each department when they first come in to see what is running low and then go back down to the basement and gather all the linen that was needed. The linen staff normally goes back to every department to refill every hour or so depending on the traffic of the department.

5.2.3 PAR Sheet

The PAR sheet as we mentioned above helps the Linen department know how much linen to give to a department. The last couple times we attended on site, we realized the staff was not
Grady Health Systems Linen Optimization

using the PAR sheet. When the staff comes in during their shift they would make a quick walk through seeing what their assigned department is running low on for the time being until the evening truck comes in from NOVA medical. The staff normally tries their best to even the linen throughout the department until the truck arrive in the evening. However, the staff would mainly fill up the the aLex machines until its full. This will make the PAR sheet useless even though it would of been a great tool to use to stay organized.

5.2.4 Collection of Soiled Linen

Once the linen is utilized, it is placed in the linen closet by housekeeping, then the linen staff will collect it in between and at the end of their shift. The soiled linen bags are supposed to be placed in tubs, so it can be easy for the linen staff to collect it, but instead housekeeping throws it in there and it pills up. When the linen staff collects all the linen they bring it down to the basement and waits for the evening truck from NOVA medical to arrive. When the truck arrives with the clean linen carts, these are exchanged with the soiled linen carts and taken back to NOVA Medical to get washed. In Figure 10 below, it shows the process of the soiled linen.

![Soiled Linen Process Diagram](image)

**Figure 10: Soiled linen Process**
6.0 DATA COLLECTION AND ANALYSIS

After initially speaking with the staff of the linen department to gain more insight about how the linen management process works, and how their department interacts with other departments, we decided to do some initial data collection of the process. We gathered data by surveying and speaking with multiple medical professional staff, conducting time studies of the process of replenishing clean linen to certain departments, as well as conducting time studies of the process of the collection of soiled linen from these same departments. Below, we have included the data that we have collected, and interpretations of the data.

6.1 Professional Medical Staff Surveys

We decided that one of the best ways to know how we can improve the linen management process is to speak with stakeholders involved in the process. It is important that we have the voice of users in the process, so we spoke to various medical professional staff, including nurses, nurse practitioners, and department secretaries about their end of the linen management process. There was a survey made that was composed of questions regarding any known procedures that they knew about requesting linen, when linen was typically replenished and delivered to their department, along with other detailed inquiries about the linen management process on their end of the process. This survey was given to medical professionals in these different departments: .
We also had the opportunity to discuss with medical professionals outside of the survey to receive even more detailed information. Based on the survey, we discovered that for most departments did not have a known procedure for requesting linen unbeknownst to the the medical professionals such as the nurses and doctors, but the department secretaries were very knowledgeable in what procedures to take in requesting linen due to their experience in working for the hospital.

The information we gathered from the medical professionals was very insightful, as we were informed about other information, such as the linen department would sometimes replenish the linen in their department, and accidentally forget to collect the soiled linen from the department. This information help us in deciding that it would be very reasonable to do a time study with purpose. It also guided us to some possible solutions that we thought could both assist the linen department, as well as the medical professional staff.

6.2 Linen Replenishment Time Studies

In addition to conducting surveys and speaking with medical professionals in different departments, we conducted a series of 15 replenishment time studies for the Emergency Unit and the Clinical Decision Unit (CDU). The reason behind conducting these time studies were to grasp how long it took for a linen technician to replenish linen, as well as see if there was any activity that was occurring in the process that could be reduced, slightly altered, or even removed if uncontrollable for time efficiency.
Below, there is a stacked bar graph representing the amount of time percentages spent doing an activity within the linen replenishment process for the Emergency Unit.

**Figure 11: Emergency Unit Linen Replenishment**

Based on the information above, we found that the most time was spent in the replenishment of the linen in the Emergency Unit, the average percentage being 53% of the time of the process, with an average replenishment time of 10.21 minutes. Department travel time took 19% of the process, giving an average of 3.65 minutes. Linen Return time took 17% with an average of 3.55 minutes. Lastly, the average amount of time it took for cart preparation was 2.07 minutes, making up 11% of the process. The amount of time spent to travel back and forth from
the linen department took a good amount of time as well, as things such as the wait time for an elevator, or hospital patient traffic slowed down the process.

Below, there is a stacked bar graph representing the amount of time percentages spent doing an activity within the linen replenishment process for the Emergency Unit.

![Clinical Decision Unit (CDU) Linen Replenishment](image)

**Figure 12: Clinical Decision Unit (CDU) Linen Replenishment**

Based on the information above, we found that the most time was spent in the department travel time of the linen in the Emergency Unit, the average percentage being 40.73% of the time of the process, with an average replenishment time of 7.33 minutes. The amount of time spent to travel back to the linen department took a good amount of time as well, averaging 4.5 minutes, and 24.65% of the process. Again, as things such as the wait time for an elevator, or hospital patient traffic slowed down the process.
6.3 Soiled Linen Collection Time Studies

Conducting time studies on how long the process of collecting soiled, shows us the process the linen technicians go through as well as continuing to observe if there are any activities in the process that can be slightly altered or completely removed for efficiencies in time. We conducted 15 time studies in the same areas as the linen replenishment time studies: Emergency Unit, and Clinical Decision Unit (CDU).

Below, there is a stacked bar graph representing the amount of time percentages spent doing an activity within the soiled linen collection process for the Emergency Unit.

Figure 13: Emergency Unit Soiled Linen Collection
Based on the information above, we found that the most time was spent in the department travel time with a total percentage of 46%, giving an average of 5.25 minutes. The next amount of time spent in the process was the time to return back to the linen room, giving 40%, with an average of 4.77 minutes. This is understandable due to the amount of traffic that is faced in the hospital, as well as the limited amount of elevators for staff. The soiled collection was the shortest percentage of the process with 14%, with an average of 1.77 minutes.

Below, there is a stacked bar graph representing the amount of time percentages spent doing an activity within the soiled linen collection process for the Clinical Decision Unit (CDU).

![Clinical Decision Unit (CDU) Soiled Linen Collection](image)

**Figure 14: Clinical Decision Unit (CDU) Soiled Linen Collection**

Based on the information above, we found that the most time was spent was the department travel time making up 54% of the process, with an average time of 7.13 minutes.
Closely behind it, was the soiled collection, with an average of 1.58 minutes, making up 52% of the process. Lastly, the linen room return time was the lowest percentage of the process, making up 34%, with an average time of 4.61 minutes.
7.0 FUTURE STANDARDIZED LINEN MANAGEMENT PROCESS

When we first began our project, we had come up with different possible solutions that dealt with different aspects of the linen management process. In working with the staff of the linen department, as well as other departmental staff, we decided to limit our scope of the project to focusing on the improvement and communication between the linen department and other departments.

7.1 Professional Medical Staff Procedures for Linen Replenishment Request

In our initial and continuous observations and interactions with different departments in the hospital, we observed how the professional medical staff used the aLex machines to retrieve linen for patients. Most of the professional staff informed us that currently there are no procedures in the work area of the aLex machine that provides information on how to use the aLex machine or requesting linen. We want to create an informational sheet that is in the work area with the aLex machine that informs the professional medical staff on what the color indicators represent, when and how to request linen, and other information regarding frequent inquiries.

The information on the informational sheet will contain information gathered from the professional staff, as well as what the linen department thinks is the best way to assist in the relaying of information between departments.
7.2 alEx Machine Color Coding System

The alEx machine is a secure linen storage cart that is customized to reflect the quota for each department. Each linen item has a separate, labeled compartment that covers enough space to store the assigned amount based on the PAR level for that department. The aLex machine is normally filled with specific linen the department requests, but there is room to add different types of linen if absolutely necessary. To open the machine the nurses scan their cards, allowing access to the linen in the aLex machine. Once the nurses are finished collecting the linen, the door automatically closes. In order to refill the aLex machine the nurse would have to request it through the machine, which will signal the linen department on the specific linen the department needs.

However, the linen department is constantly watching all the different departments that have aLex machines with a color-coded signal system. The color-coded signal system can turn blue, green, yellow, or red. Blue represents that it is overstocked, whereas there is no more room for anymore linen. Green represents that it is full and no need to refill it. Yellow represents that its running low and that the linen staff should refill the cart. Red represents that it is empty and the linen staff needs to refill it right away. Figure 10 is the chart that the linen staff uses to keep up with each department and the amount linen usage. This system eliminates having several refills every couple of hours, and this also give the nurses a relief knowing that the linen department is able to see that the department is running low, or that the linen is on the way up.
Figure 15: scrubEx Display of aLex Machine Linen Status

Above in Figure 1, is the linen department using scrubEx, the linen management software that acts alongside the aLex machines indicates the floor (department) in which the machine is on the bottom margin, for example, the machine “014” is located in the Emergency Unit. The left margin displays the weight of the machine.

Based on the surveys and communication with professional medical staff, it would be beneficial to have color indicators within the aLex machine that indicate when the medical staff need to begin notifying the secretary clerk, who is the main person of contact with the linen department, to replenish the linen in their department. Having colors in the machine that possibly mirror the indicators being displayed by the scrubEx for the linen department, would also be
good to have for the medical staff as well, as the medical staff typically wait to notify the
secretary clerk that linen needs to be replenished when they are already out of linen. In having
the indicators reflect a red color, it would be indicating that the linen has reached the point in
which it is the safety stock, and that it is ideal that the linen department begins replenishment to
that department.

7.3 Replenishment/Soiled Linen Checklist

Apart of our proposed solution that we developed based on the interviews and time
studies, were to also have a replenishment checklist, as well as soiled linen checklist for the linen
technicians when they replenish departments. This would be a checklist that is not like the PAR
sheet, but instead a reminded check to make sure they have completed everything in the area
before leaving that area. Having a replenishment and soiled linen checklist would be very
beneficial as the linen technicians can not miss any task when conducting their replenishment
rounds, ensures standardization and consistency in the system, and sets good standards and
preparation for new linen technicians who will be going the crew in the near future.
8.0 TESTING AND IMPLEMENTATION TRIAL

After acquiring a clear understanding of the current process and constructing a more efficient and strong future state, we focused on testing and implementing proposed solutions from the future state. In Section 5 (Current Process), the trial implementation was focused only in the CDU and the Emergency Unit. The area we did our study on had a lot of linen being used every hour of the day. The linen department would constantly replenish each alEx machine every hour and a half, since the units were always busy. Due to time and capacity constraints, we unfortunately could not test all projected solutions. In order to make an important impact on the system, we implemented the most influential solutions with the fewest obstacles.

8.1 Implementation Trial goals

Before conducting our implementation trial, we have set the following goals for our trial as listed:

1. Revision or improvement and implementation approaches and systems for bed change and make-up, and scrub control.

2. Reduction of linen misfortune by concentrating on enhanced practices with linen utilized by emergency staff and during patient transfers.

3. Developed ceaseless linen instruction programs by making a material mindfulness process through cloth mindfulness days, in-administrations, cloth adjusts by cloth
administration staff, and a tip of the month program strengthening great material administration hones.

4. Distribution of monthly linen use reports conveyed to Department manager, which incorporated the Distribution Point Usage Summary Report, the Monthly Summary Report and the Par Level Report via Cart/Closet.

5. Consistent par level alterations based on departmental needs.

The trail implementation is judged against these goals in a final subsection to evaluate its success.

8.2 Updated Par sheet

As discussed in section 5.1 of the Future State, we decided to collect further detailed information about the daily usage for the CDU and the Emergency unit. Such data is shared information of the whole nursing staff in both areas. We interviewed and discussed with the nurse’s possible developments for linen usage in their consigned areas. With that information, we recorded the daily usage of each linen item per bed. This information can be found in Table 1.
<table>
<thead>
<tr>
<th>Linen Type</th>
<th>Clinical Decision Unit Usage per Bed</th>
<th>Emergency Unit Usage per Bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blankets</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Flat Sheets</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Pillow cases</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Towels</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Facial Towels</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Fitted Sheets</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gowns</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1: Linen Item per Bed

The par sheet usage for CDU is much higher than the Emergency unit. This is because the emergency unit the patients are not kept for very long. At the most the patients would be there for 4-6 hour depending on how severe the patient’s condition is standing and if they need
immediate attention. Also, the CDU has about 27 patient beds whereas the Emergency room has 16 beds.

On an average day, a patient gets their bed switched out twice a day in the CDU, unless they request to change it more. In the emergency unit, it is changed after each patient leaves unless its mandatory to change. The nursing staff and EMS agreed to meet once a month to review the par level together.

8.3 Refill Process

In the recent composed framework, the objective is having the EMS linen staff to be able to have a consistent delivery convey when asked for materials within a specific time span. Keeping in mind the end goal to comprehend what that time period may be, we recognized every one of the means that are associated with the refill procedure. These means are as per the following:

- When the linen levels hit red either a call is put to the EMS Help Desk (from 8:00 am to 2:30 pm weekdays) or the texting EMS manager (evenings, evenings, and ends of the week).
- The linen staff is reached from the EMS Help Desk
- Linen is recovered from the linen storage space, lastly
- Linen is transported at the territory that asked for it
It is critical to comprehend what the lead time of the refill procedure is keeping in mind the end goal to set up the security stock level set apart by the red level markers shown on the screen in the EMS department and to educate the nursing staff with the goal that they know when to expect the conveyance.

The refill framework relies upon data move so as to tell the staff to exchange the linen from the Linen Storage Room to the department it is requested. The group built up three control focuses to quantify the execution of the framework. These focuses were situated at the EMS Help Desk, the EMS Storage Room, and the linen closet in every department. The data gathered at every one of these three areas would show the time required for the EMS Help Desk to contact the linen staff after the demand was made and for EMS to convey the linen after they were reached by the EMS Help Desk. The data that would be gotten from every one of the control focuses is the accompanying:

Figure 16: Proposed Refill Process Chart
The Program Support Assistant and the Linen staff were advised about the undertaking objectives and destinations and were asked to record the data delineate. The arrangement was to gather the information from the last two weeks with a specific end goal to get a general comprehension of the procedure lead time before actualizing the entire refill process. The gathered data would furnish the group with a gauge of the standard lead time for a refill, which would be imparted to the medical attendants. At that point, when the refill procedure was completely actualized, information would be gathered for an extra week to pick up a more precise measure of the framework lead time.

Lamentably, the information was not gathered by the EMS Help Desk or the EMS staff. Hence, the group was not ready to evaluate a pattern for the procedure lead time, and prescribes this is an essential early advance as execution continues.

8.4 aiEx Machine Insert Creation

Initially designing the procedures for the medical staff was first done by first hearing their voices, and that gave us a lot of insight, so we decided it would be best to also include them in the process for developing the procedures for them.

We choose to use the quality function deployment as a way to transform the voice of the medical staff into engineering requirements in the development of our procedures and inserts. We have listed the top requirements by medical staff, as well as their rating of the requirement. On
the top we have the technical requirements of the upper management of the linen department, emergency management.

By doing this, we can have a proper comparison of both parties’ requirements. On the top we have the correlation of the requirements as listed in the key below, as in the inside of the chart the relationship between the requirements illustrated. The Quality Function Development is seen below in Figure 17.

Figure 17: Quality Function Deployment
To illustrate the visual being used in the aLex machines for the medical professional staff to know when they are beginning the new process, we have inserts shown above in Figure 18. On the left-hand side, we have the insert that will be used in the inside of the aLex machines. When choosing the colors we wanted to mimic universal colors, so the color green being of good status, or 55% of the linen being stored in the machine, the color yellow being of cautionary status to begin the linen replenishment process, or 35% of the linen being stored in the machine, and finally red meaning immediately contact the linen department if already not done so, or 10% of the linen being stored in the machine. The right-hand side represents the visual for the medical professional.
Grady Health Systems Linen Optimization

professional staff to see outside of the alEx machine, and in an area that is beside the machine such as the wall. The purpose of these inserts are to be visual, short, and straight to the point as the medical professional staff have no time to waste in the hospital environment.
9.0 CONCLUSION

The main idea of the project was to improve the linen distribution system at Grady Memorial Hospital by reducing waste and enlightening the efficiency of the process, systematizing, and shortening the process while meeting quality targets. In concluding the possible approaches that could have been conducted, and us choosing to work on, as a team in order to accomplish our goals we had to come up with a lean method that was consistent throughout the project. We decided to interview nurses as well as clerks and observed the daily routine system with the linen staff. Based on the evaluation we received from the interview question, we were able to conclude that there was inconstancy and lack of communication throughout each department. However, we decided to create a flowchart that showed an easy process of what the linen process should look. Lastly, we passed out a trial implementation in pilot area to test the most significant parts of the projected solutions and detect obstacles on behalf of the implantation.

After finishing implementation, the anticipated Future State results can be measured and evaluated using three metrics, as described in our current and future state. The consistency of the framework can be trailed by the linen order/delivery proportion to ensure that the material being conveyed precisely reflects what is being requested. The material use per region can represent the genuine use of the framework and can be utilized to all the more precisely comprehend the linen request in the hospital. The linen refill lead time can be utilized to show the responsiveness of the refill procedure to help comprehend the proficiency of the refills. The proposed arrangement and proposals have been made to enhance the framework's execution as far as
solidness, genuine utilization and responsiveness which can be estimated with the characterized measurements.

The planned Future State effectively tended to the undesirable impacts recognized in the Current State, at last helping the two EMS and nursing staffs interfacing with the linen conveyance system. The EMS profits by the framework by having a more responsive, dependable and institutionalized process. With the association of all the linen related areas, EMS will check with a more noteworthy stock of linen in the EMS Storage Room enhancing the adequacy of their linen administration. This framework will likewise give them a superior comprehension of the interest in linen in all aspects of the facility. The nursing staff will likewise profit by a more solid, responsive, and easy to understand linencirculations process. The standard practices of the partners, alongside the refill appeal process, will guarantee the unwavering quality of the material conveyance.

9.1 Results

Based on the implementation of communication between the departments, the amount of time it takes to deliver linen to the Emergency Unit department from the linen department are 2.54 minutes which is over the 10% or minutes we were aiming for. This suggestion well exceed our expectations and we would suggest to the linen department at Grady Memorial Hospital implementing these procedures to reduce the amount of time in the linen process by 13%, or 2.54 minutes. Our implemented time study results are shown below in Figure.
Figure 19: Emergency Unit Linen Replenishment Implementation Trial

Unfortunately, due to unforeseen events and a time crunch, we were only able to perform an implementation trial on the Emergency Unit, originally planned were implementation trials on both the Emergency Unit and the Clinical Decision Unit. But with our focus on the implementation trial, what we mainly noticed was that while the actual action of replenishment in the unit was fairly taking the same amount of time as our first time study, the amount of time for cart preparation decreased. Due to the proposed process protocol, there was a better sense of communication between the linen department and other departments, as staff now effective communicate what type of linen they needed to be replenished and other specific details. This differs from the unstandardized methods of departments previously contacting the linen department with unspecific information.
Below we took into account information provided to us and the best case scenario of using this method to see what savings Grady Memorial Hospital could expect to receive over the span of five years.

9.2 Cost Benefit Analysis

We conducted a cost analysis following our information presented in our Initial Design Report Presentation on our time studies. The reason for the cost analysis is to show the estimate of strengths and weakness based on what would happen if medical staff had sheets in place compared to currently having no set protocol or procedural sheets in place. We considered information such as the salary of the linen technicians, cost of maintenance of the alex machine, software maintenance, training of the linen technicians, as well as how money would be saved if implementation of the proposed procedures. This Cost Benefit Analysis is shown below in Figure 20.

<table>
<thead>
<tr>
<th>QUANTITATIVE ANALYSIS</th>
<th>FIRST YEAR</th>
<th>SECOND YEAR</th>
<th>THIRD YEAR</th>
<th>FOURTH YEAR</th>
<th>FIFTH YEAR</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BENEFITS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COST SAVINGS</td>
<td>$167,690.00</td>
<td>$272,072.80</td>
<td>$375,684.90</td>
<td>$480,053.90</td>
<td>$584,122.90</td>
<td>$1,394,924.50</td>
</tr>
<tr>
<td>TOTAL BENEFITS</td>
<td>$167,690.00</td>
<td>$272,072.80</td>
<td>$375,684.90</td>
<td>$480,053.90</td>
<td>$584,122.90</td>
<td>$1,394,924.50</td>
</tr>
<tr>
<td><strong>COSTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NON-RECURRING</td>
<td>$1,594,180.00</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
<td>$1,594,180.00</td>
</tr>
<tr>
<td>RECURRING</td>
<td>$305,000.00</td>
<td>$246,000.00</td>
<td>$175,800.00</td>
<td>$110,340.00</td>
<td>$61,002.00</td>
<td>$81,902.00</td>
</tr>
<tr>
<td>TOTAL COSTS</td>
<td>$1,899,180.00</td>
<td>$246,000.00</td>
<td>$175,800.00</td>
<td>$110,340.00</td>
<td>$61,002.00</td>
<td>$1,676,082.00</td>
</tr>
</tbody>
</table>
| NET BENEFIT OR COST    | $(1,731,490.00)| $26,672.80 | $200,184.90 | $369,713.90 | $523,120.90 | $(281,157.50)
The cost analysis takes into account crucial information provided to us and the best case scenario of using this new linen process method to see what savings Grady Memorial Hospital could expect to receive over the span of five years.
10.0 RECOMMENDATION

With our project we focused primarily on one recommendation, in which we improved communication between the Emergency Unit and Clinical Decision Unit medical professional staff and the linen department. We briefly mentioned earlier in our report that there are other ways to improve different types of efficiency - unlike focusing solely on our improvement of efficient communication between the departments - of the the linen management system. Based on our results from the proposal we decided to focus on, we would suggest that Grady Health Systems implement these methods within the linen department, Emergency Unit for an overall reduction of 2.54 minutes of linen replenishment time.

We also recommend upon completion of the installation and implementation of these new procedures, that the proper retraining is done for each linen technician, and a training for the medical professional staff as well. This would be ideal as it holds the necessary standardization of the process in place, and would be good to have this training take place for every new staff, and twice a year for current staff.
REFERENCES


APPENDIX A: CONTACT INFORMATION

For any inquiries pertaining to any aspect of our project and how we conducted our approaches, please feel free to contact us with the following information below.

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Samira Abdi: 404-933-8800 or samira.y.abdi@gmail.com

Advisor Contact

Adeel Khalid: or akhalid2@kennesaw.edu
APPENDIX B: INDIVIDUAL MEMBER CONTRIBUTIONS

Samira Abdi

My main contributions to the project include solely constructing the entirety of the project and every detail to its core.

The following list provides an overview of my key contributions:

1) The Three Different Approaches.
2) 7 out of the 9 Literature Review Articles and Summaries.
3) Development of the Project Schedule and Responsibilities.
4) Formatting the Report and Writing the report
5) Establishing project setup details (Verification, Background, Design Requirements, etc).
6) Generating Interview questions and conducting interview with medical staff.
7) Communication between medical professional staff and linen department.
8) Conducting time studies.
9) All data analysis.

Kyleia Hutton

My main contributions to the project include solely constructing the entirety of the project and every detail to its core.

The following list provides an overview of my key contributions:

1) The Three Different Approaches.
2) 7 out of the 9 Literature Review Articles and Summaries.
3) Development of the Project Schedule and Responsibilities.
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5) Establishing project setup details (Verification, Background, Design Requirements, etc).
6) Generating Interview questions and conducting interview with medical staff.
7) Communication between medical professional staff and linen department.
8) Conducting time studies.
9) All data analysis.
10) All presentations and reports statuses due.


12) Final Presentation.

13) Video.

14) Poster Board.

15) All methodology/data collection and execution of the methodology/data collection.
APPENDIX C: REFLECTIONS

In this section, we focus on post project reflections, regarding our experience with using our educational background and skills learned in our curriculum, challenges that we faced when working on our project, as well as resolutions we came up with to tackle these challenges.

The Educational Experience

Both of our backgrounds are Industrial and Systems Engineering students. Our classes here at KSU have aided us in using different Industrial and Systems Engineering methodologies, analyses, and software to approach and solve the problem we were faced with.

Challenges Faced

Since the very beginning, we have faced a lot of problems with our project, most being non-technical problems. Regarding our technical problems, we were very optimistic and ambitious, which lead us to various approaches to solve the linen management issues that Grady Memorial Hospital were facing. Our solutions were very unlike each other, and tackle different aspects of the linen management system. Which was good as we had different solutions to approach the problem, but not necessarily focusing on one solution, and going forward with that solution.
Grady Health Systems Linen Optimization

Another issue we face was how the initial process of the linen management process was explained to us, versus how the process was conducted. There was a lot of variation between what was initially explained to us by the linen technicians, then when we watched and experienced the in-time process of it. There were a lot of unnecessary steps added into the process such as going back and forth, the truck that dropped off new, fresh linen, and collected soiled linen not arriving at a standard time period. Also, some of the steps explained in the process were not done, such as checking of the par sheet, and making sure that the linen bin that was being taken had the suitable linen for the department that was being replenished.

**Resolutions**

To assist us in making our decision, we spoke with various departments at Grady to gather their opinions in where we could improve the most on, in which led us to making the decision of focusing on the improvement of communication between the linen department and two units, the Clinical Decision Unit, and the Emergency Unit. Also upon talking to medical professional staff, we conducted a survey to also quicken this process and get a diverse input of opinions and information.

Once gaining which solution we wanted to focus on, we began conducting time studies on the Emergency Unit and Clinical Decision Unit. We wanted to see how the process worked first hand, as well as if there were any steps in the process that we could remove to reduce the amount of time that was spent replenishing in those areas.
APPENDIX D: SUPPORTING DETAILS AND DOCUMENTATION

In this section, we include all supporting documentation in which we used to gather our data and information to assist us in carrying out the project, but also in making decisions.

Professional Medical Staff Survey

Below are the questions that we asked various medical professional staff in determining which proposed approach we wanted to tackle for our project.

1. Is there a known procedure for requesting linen for your department?
2. When is linen usually requested? Is there a designated time for the delivery of linen?
3. Are there any issues you have experienced with linen replenishment?
4. What are some common problems, if there are any, that may happen with the alEx machines?
5. Is there a stream map placed in the surrounding areas where the alEx machines are located, that explains the process of clean linen, the steps in replenishing that linen, as well as the collection of the soiled linen?
6. How long does it usually take to go through the amount of provided linen (when the linen is completely replenished)?
7. Are there some linen that is in more demand than others, but is not properly represented by the alEx machine? If so, which linen?
8. How long does it take for linen to be replenished?

9. If there are any things that you would improve about the aiEx machine or the linen replenishment process, what would it be? Are there any suggestions you have that could be done better with the system?

Linen Distribution Time Studies

Below are the time studies we conducted with the Clinical Decision Unit (CDU), and the Emergency Unit.
Table 2: Emergency Unit Linen Replenishment Times

<table>
<thead>
<tr>
<th>Trial</th>
<th>Cart Preparation</th>
<th>Department Travel Time</th>
<th>Replenishment</th>
<th>Linen Room Return Time</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
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<td>3.0333333</td>
<td>10.0166667</td>
<td>2.3833333</td>
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<tr>
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<td>10.3333333</td>
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</tr>
<tr>
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<td>1.25</td>
<td>2.5</td>
<td>9.3</td>
<td>5.032</td>
<td>18.082</td>
</tr>
<tr>
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<td>4.5</td>
<td>8.921</td>
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<td>20.8753333</td>
</tr>
<tr>
<td>Trial 5</td>
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<td>2.951</td>
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<td>2.932</td>
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<tr>
<td>Trial 6</td>
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<td>4.012</td>
<td>8.5</td>
<td>4.012</td>
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</tr>
<tr>
<td>Trial 7</td>
<td>3.097</td>
<td>3.938</td>
<td>7.589</td>
<td>4.031</td>
<td>18.655</td>
</tr>
<tr>
<td>Trial 8</td>
<td>2.321</td>
<td>5.037</td>
<td>11.23</td>
<td>2.943</td>
<td>21.531</td>
</tr>
<tr>
<td>Trial 9</td>
<td>1.867</td>
<td>3.962</td>
<td>11</td>
<td>3.531</td>
<td>20.36</td>
</tr>
<tr>
<td>Trial 10</td>
<td>1.954</td>
<td>4.0163</td>
<td>12.953</td>
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</tr>
<tr>
<td>Trial 11</td>
<td>1.231</td>
<td>3.128</td>
<td>10.531</td>
<td>2.127</td>
<td>17.017</td>
</tr>
<tr>
<td>Trial 12</td>
<td>2.45</td>
<td>2.762</td>
<td>11.023</td>
<td>2.041</td>
<td>18.276</td>
</tr>
<tr>
<td>Trial 13</td>
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<td>9.592</td>
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Hutton & Abdi 85
### Table 3: Clinical Decision Unit (CDU) Linen Replenishment Times

<table>
<thead>
<tr>
<th>Trial</th>
<th>Cart Preparation</th>
<th>Department Travel Time</th>
<th>Linen Replenishment</th>
<th>Linen Room Return Time</th>
<th>Total Time</th>
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</thead>
<tbody>
<tr>
<td>Trial 1</td>
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<td>7.41666667</td>
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<td>4.567</td>
<td>18.017</td>
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<td>4.589</td>
<td>4.031</td>
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</tr>
<tr>
<td>Trial 8</td>
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<tr>
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<td>6.762</td>
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<td>7.637</td>
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<td>20.8271</td>
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<td>7.321</td>
<td>4.923</td>
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</table>

![Emergency Unit Soiled Linen Collection](chart.png)

Hutton & Abdi 86
Table 4: Emergency Unit Soiled Linen Collection Times

<table>
<thead>
<tr>
<th>Trial</th>
<th>Soiled Collection</th>
<th>Department Travel Time</th>
<th>Linen Room Return Time</th>
<th>Total Time</th>
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<td>------------------------</td>
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Table 5: Clinical Decision Unit (CDU) Soiled Linen Collection Times
Table 6: Emergency Unit Replenishment Implementation Times

<table>
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<tr>
<th>Trial</th>
<th>Cart Preparation</th>
<th>Department Travel Time</th>
<th>Replenishment</th>
<th>Linen Room Return Time</th>
<th>Total Time</th>
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Table 6: Emergency Unit Replenishment Implementation Times
Grady Health Systems Linen Optimization

Medical Staff Priority

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<tr>
<th>Requirement</th>
<th>Importance Rating</th>
<th>Technical Assessment</th>
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<td>Quick Response</td>
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<tr>
<td>Easy to Interpret</td>
<td>7</td>
<td>+</td>
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<tr>
<td>Time Efficient</td>
<td>8</td>
<td>+</td>
</tr>
<tr>
<td>Designated Support</td>
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<tr>
<td>No extra time added</td>
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<tr>
<td>Less Responsibility</td>
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<tr>
<td>Quick Replenishment</td>
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<tr>
<td>Communication</td>
<td>6</td>
<td>+</td>
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<tr>
<td>Enough Linen</td>
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<td>-</td>
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<tr>
<td>Reliable</td>
<td>4</td>
<td>+</td>
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</table>

Hospital Technical Requirements

- Cost Effective
- Time Efficient
- Smooth Operation
- No Additional Cost
- Linen Loss Reduced
- Team Morale
- Support
- Productivity
- Fast Replenishment
- Quality Linen

Correlations:
- Strong Positive
- Positive
- Strong Negative
- Negative

Relationships:
- Strongest = 10
- Strong = 7
- Fair = 4
- Weak = 1

Hutton & Abdi 90