

4-30-2018

EJM Chain Fall Tooling Optimization

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Final Design Review (FDR)

by

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April 30, 2018



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CHAPTER 1: EXECUTIVE SUMMARY

The following report describes the progress made by the EJM Chain Fall Tooling Optimization Team since the In-Progress Review. The team has finalized the facility layout design for the chain fall area including the concept of operations, functional requirements, and performance specifications. The scope of the project is completing the new procedures for reducing waste and completing the AutoCAD drawing of the final design. The team researched the objectives accomplished by the new layout design.

The goal of the project is to reduce the safety hazards and increase productivity. The team shifted the focus to the salvage, recycling, and waste policy for the chain fall area and the assessment time of the kits - kit turns, time needed to assess, amount of inventory. The team estimated the average cost of the missing kits in the chain fall area based on average tool costs. The team estimated the losses of the company for two years (2016 and 2017).

Although the team has not currently finished all the cost benefit analysis for each alternative, the team has finalized the outcome of the problem-solving approach for most of the problems found in the chain fall area. The reason for this is that the team is still waiting to receive data from Siemens. After finalizing the design area, the team makes recommendations for future studies based on the limited time to finalize all the proposals made in the report.

CHAPTER 2: FDR SUMMARY

2.1 INTRODUCTION

The team continues to find more issues in the Field Service Products (FPS) Atlanta facility regarding worker idleness, inadequate warehouse rack methods, and lack of data. The EJM Chain Fall Tooling Optimization team has evaluated alternatives and compared them to the current system. The team continues to define that the best alternative meets the key criteria and is the most cost beneficial. Furthermore, the team met to discuss challenges of the project and analyzing the data acquired from Siemens. The team decided to reduce the time finding potential issues within the chain fall area to make more time for changing more important issues. The team reduced the amount of problems to solve in this one project by narrowing down to specific, more impactful issues. Mr. Ernie Ayala, the project manager, provides the team with information related to the area, different methods applied in other Siemens facilities to use them as an example, and tools the team needs. In addition, Mr. Ayala schedules conference calls and meetings with management to support the team with additional information related to the general plant's productivity, current plans implemented, and any concerns or questions. Resident Expert Mr. Randall Weidner constantly provides information to the team answering questions regarding the area. The team spends most of the time observing the area in its entirety and shadowing the workers. These constant visits have helped the team to understand the chain fall area system and increase the data needed to brainstorm and discuss different alternatives to the facility's layout. The new layout is the team's solution for removing safety risks and minimizing delays the workers must face every day in this department.

2.2 OVERVIEW

The overview of this project is to redesign the layout of the chain fall area. The purpose of the redesign is to maximize productivity and minimize the safety hazards. Along with the current layout of the Chain Fall area, the team has discussed multiple areas that contribute to safety issues and less productivity. The stakeholders involved are Shipping & Receiving, Mechanical 1+2, internal and external customers, and other Siemens facilities, but the team has learned about Shipping & Receiving' correlation with the chain fall area's processes (the rack storage process being the principal area of concern). Other than the many tools the team will apply to improve the layout, a cost benefit analysis will be conducted to ensure that stakeholders will agree with making the job easier and more practical for the chain fall area workers. There are also non-monetary factors that affect safety and productivity. The factors are health, environment, reputation, worker morale, and quality. If the company fails to respond to accidents and concerns from the workers, they will be discouraged from performing at their optimal level. Furthermore, they will waste more time carefully moving and operating the equipment by not taking advantage of its mobility or efficient design. The team considers benefits including saving labor, time, input, and the dollar value of each change. There are similar studies that aided in obtaining dollar values for each change. Below is the current state of the cost benefit analysis.

Part of the chain fall area's redesign is to take care of the tool boxes that they use to store their tools for repairing. These boxes create a real safety hazard as explained earlier in this report.

Another part of the area redesign is to create a clear route for the forklift that matches the OSHA standard. The company can avoid incident caused by the movement of the forklift by having clear routes with stop signs and restriction areas.

The layout is discussed among the team, and the alternatives are monitored for approval and disapproval. Based on the cause & effect diagram, the team located several factors that inhibit safety in the area:

- a. Machine: maintenance, cleanliness
- b. Material: vendors, customers, storage, contamination, age
- c. Environment: lighting, room temp, air quality
- d. Methods: wait time, prep time
- e. Measurement: lighting
- f. Operator: training, skill

2.3 OBJECTIVES

The team's objective is to present the optimal layout for the Chain Fall area. To reach this goal, the layout will have to be improved and balanced between safety and productivity. The safety portion will incorporate occupational health and safety into the facility design by researching OSHA requirements for the area. On the productivity portion, the team will analyze the past production records to find solutions or methods for improving the current production. Facility layout design typically has multiple objectives. The following list shows the main objectives from the team's new design:

1. Reduce safety hazards
 - a. Assign important responsibilities to maintain 5S
 - b. Implement safety measures
 - c. Ensure safe, pleasant environment
 - d. Establish clear safety and recycling procedures

2. Increase the productivity of the area
 - a. Ensure effective communication
 - b. Improve visibility of the area's floor
 - c. Reduce unnecessary human movement in the area
 - d. Human Factors Design

2.4 LIST OF REQUIREMENTS

The following list is the requirements of the new system that the team established:

- Procedure of utilizing and obtaining objects shall be easily accessible and reduce fatigue.
- Area shall be organized to reduce clutter and accidents.
- Area shall sustain an environment of zero incidents.
- Design shall maximize all activities of 5S.

2.5 JUSTIFICATION

The current system of the chain fall area is not optimal in many areas including organization, safety, and productivity. The team studied the material handling of the chain fall area. The following list shows the justification for making changes to the material handling.

- Removing unnecessary equipment that are rarely used or not used at all
- Maximizing space
- Establishing clear routes for workers and forklift operators
- Storing unnecessary equipment for relevant future use
- Providing equipment to worker that needs it most

- Immediately reducing the time for recycling equipment that no longer must be in the area.

The amount of equipment and tools utilized for repairing in the Chain Fall area is not proportional to the number of technicians employed. Equipment, such as tables, can be improved or replaced completely to ensure safety and employee morale regarding the equipment. Furthermore, some items can be shared within two workers.

2.6 PROJECT BACKGROUND

The Chain Fall area department inspects and repairs heavy duty equipment from its own department and from the other departments inside Siemens. This department is usually working from Monday to Thursday between 7am to 4:30pm. This schedule varies since Saturday, and sometimes Sunday, are added to the work schedule during the high season (typically February to March and April to July) when tools are needed more.

The department's work area is 80.14 ft by 45.95 ft. This area is divided in five stations and each one has one assigned technician to handle the tool services every day. The tools are divided in Mechanical Pneumatic with David in charge of this station, Mechanical Jack with Cliff and Daniel as technicians in charge of this tools, and Mechanical Chain Hoist where Derek and Randall (Chain Fall area supervisor) take care of these tools. The stations come with a desk, a chair, a designated space to receive the tools from the other departments, and a heavy-duty tool box for the tools the technicians use every day during work. Depending on the tools to service, the stations are implemented with certain heavy-duty devices. For instance, two stations come with a JIB crane, two stations share two heavy duty hydraulic bench press, and three stations have hose for air tools. The area has 6 circular parts storages, two cabinet, two computers, one

printer, an additional heavy-duty table shared by everybody, a fireproof cabinet and a pallet jack hydraulic tester. Finally, the parts and tools are frequently brought in and out to the Chain Fall area by a forklift that has access to inside the area where the technicians are working.

2.7 PROBLEM STATEMENT

The current situation is that the layout of the chain fall area needs to be redesigned to increase productivity and safety. There are many safety risks and process errors that hinder FSP Atlanta's productivity. As a result, the team plans to identify efficient ways to utilize the space, time, and manpower of the area. Furthermore, the chain fall area lacks an easy access to data - cost of not assessing kits within the due date - that can be used for analysis and important decision-making. Assessing the kits in time for the technicians is problematic in the area because the process of placing the kits on the racks contributes to inconsistent assessment timing and quantity. The complaints from the chain fall area workers are directly related to the lack of clear priorities when choosing which kit to assess first. This adds unnecessary work and stress on the worker. Also, the redesign of the area must adhere to the organization of equipment and tools including the sorting process of the warehouse racks.

The concept of operation for this project is that the new layout will have a new sorting process for shelves, clear, standard procedures and processes for tool usage, and implementation of new safety measures.

The functional requirements for the redesign of the chain fall area layout will increase productivity and reduce safety hazards. Also, the chain falls area's throughput will be optimized,

the safety ratings of the area will increase, and the recycling time will be reduced. The logbooks and other documents within the area will have complete up-to-date information.

2.8 MINIMUM SUCCESS CRITERIAS:

The performance specifications for the redesign of the chain fall area layout will increase productivity by 10%., the safety ratings of the area will increase by at least 70%, and the throughput of the area will be optimized by eliminating 20% of the items that contribute to overloading or clutter in the workspace. The recycling time will be within 5 days. The kits shall be assessed within 90 days based on the control chart averages in Chapter 4. Finally, the minimum success criteria of picking up operation time in the storage area is 10%.

CHAPTER 3: LITERATURE REVIEW

The team researched databases with the KSU account to find studies of facility layout optimization. Kazerouni writes that the quality of the work of employees is strongly related to the level of concern for Occupational Health and Safety (4459). In other words, if the team designs a new layout based on OSHA requirements, the quality of the workers will increase. Afrooz Moatari Kazerouni's expertise lies in Industrial Engineering and Manufacturing Engineering, and she has redesigned the layout of hospitals and factories. While redesigning, Kazerouni considers Occupational Health and Safety to incorporate safety measures. She states that there are two performance measures that are important - lateness and higher quality (Kazerouni 3244). The team identified the objectives associated with the redesign of the chain fall area (Kazerouni 3244). She also mentions risk estimation as a mean to ensure that the layout model integrates safety (3249). Risk estimation is based on questionnaire surveys and previous accidents that occurred in the area. The risk value determines if the risk very high, very low, or in-between these factors. The team has rated the area with surveys of safety risk.

According to another article from Kazerouni entitled, *A proposed occupational health and safety risk estimation tool for manufacturing systems*, a physical arrangement, which minimizes the movement of personnel and material between departments, could decrease material handling costs, increase system effectiveness and productivity and enhance safety by reducing the risks associated with production activities (4459). The team plans to make changes to the layout based on the needs of the technicians. There are technicians with different needs. For instance, a technician may use a tool more often compared to other technicians in the same area. The materials needed should be at a reasonable distance in respect to the technician that

utilizes it the most. Kazerouni also writes that the severity of harm can be estimated by taking into account:

- The severity of injuries or damage to health; e.g. slight, serious or fatal
- the extent of harm; e.g. to one person or to several people

Based on this evidence, the author suggests metrics to calculate risk. The team is careful to notice safety hazards and their impact on the technician. The team checks the risks to see its range. The range would be the number of technicians that are exposed to the same potential risks.

Rick Pendrous writes that, "Forklift trucks are responsible for around a quarter of all injuries involving workplace transport and so it is vital companies have systems in place to keep them away from pedestrians. This can be as simple as painting a white line on the floor," said HSE inspector Stuart Parry after the hearing. Based on Parry's statement, the team recognizes the importance of the separating technicians and forklift drivers by establishing clear boundaries for each workstation. The team recognizes that the new system that the team proposes must reduce the likelihood of forklift related injuries. Nick Welch, senior technical development executive for forklift truck training accrediting body RTITB, formerly the Road Transport Industry Training Board says, "It's not just about driving carefully, it's about segregation of vehicles and pedestrians; it's about load safety both on the vehicle and on the racking; it's about good all-round awareness and guarding against the unexpected, not to mention how the machinery is maintained and checked." There must be standard for the maintenance of forklifts. It is not enough to provide training to the forklift drivers. If the forklift operator has a clear visual that lets them know where they cannot drive, the pedestrian's level of safety will increase.

Mike Bracko writes that ergonomic ideas such as how much a person can lift without mechanical, assistance, lifting and working in awkward positions, and high-frequency and long-

duration lifting and lifting objects with inadequate handholds (OSHA 2017). The team has examined the tools that the technicians use, as well as the process of using the tool. Based on this, the team has thought of practical alternatives that can reduce the awkward positions for lifting or handling equipment in general. This article describes ergonomic goals like designing workstations to be compatible with human limitations and preventing excessive fatigue and discomfort. The team spoke to the technicians in the chain fall area to check steps in the process that contribute to fatigue like using their back or using excessive force to lift or handle material in the area.

In the next article entitled, *How to Design a Warehouse Racking Layout: 10 Steps to Efficient Planning*, Reeves writes, “before you begin, talk to knowledgeable contractors (like your material handling company), your warehouse manager(s), and even your drivers: They have years of experience in warehouse facility operations and planning, not to mention experience in your specific warehouse.” Based on Reeves’s statement, the team recognized the value of the feedback from the experience and knowledge of management and the technicians that work in the chain fall area. The team spoke to management and the technicians about the redesign of the warehouse rack storage to determine solutions that both parties will accept and have considered in the past. For instance, having a clear indication of the kits due date and month of arrival was one of the concerns of the technicians and of management. A manager that walks in the area with this clear indication on the racks would be able to easily detect if anything is missing or placed incorrectly. Reeves also writes that an empty warehouse may look like a gaping maw, but the reality is that there are physical constraints on your storage space. Your job, when designing an efficient racking system, is to make the best use of finite space. Making the best use of the finite space in the chain fall area is a challenge the team noticed since the start of the project. The

team's redesign accounts for unused space in the warehouse rack storage by presenting a solution that will maximize the storage of the chain hoist equipment. For instance, there is chain hoist equipment that can roll off the pallet, so the pallets must be placed on the low shelves. The high shelves are not being used currently, so the finite space in the chain fall area is not maximized.

Azadeh writes that the Lingo software can be used for SDEA (Stochastic Data Envelopment Analysis). The purpose of SDEA is to find the optimum layout alternative among all feasible alternatives. The advantage of SDEA is accounting for multiple factors like safety and environment. Additionally, Simulation approach is integral for facility layout analysis. The article also discusses using questionnaires addressing safety and environment factors. The team has already begun surveys about safety and we will also work on new questionnaires regarding the chain fall area's safety and environment. Obtaining measurements for each equipment will be necessary based on this flowchart:

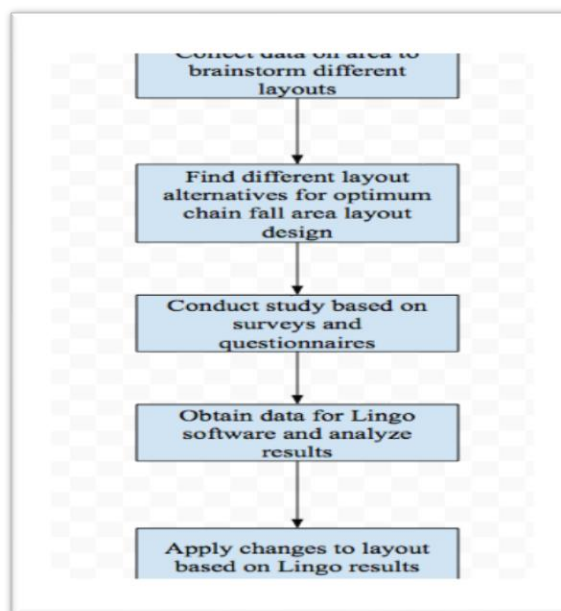


Figure 1: Flowchart for Lingo Software

The next article discusses redundancy in the facility layout. According to Zhao, accounting for redundancy can reduce material handling costs. The team will consider redundancy of the tools used in the chain fall area to complete the facility layout design of the chain fall area. The team can locate shorter flow routes for tool movement. The author encourages use of the myopic approach to determine redundancies.

Another report used as a guideline was “Application of decision support system to strategic warehousing decisions” based on the warehouse implementation these professionals made to the company Buckeye Cable Vision Incorporated (BCV). BCV had serious problems with warehousing, inventory tracking, low inventory turnover, and others. The Warehousing Decision Support System used had different, descriptive alternatives to solve the problems. One phrase the team finds knowledgeable in this article is “*A model is only as good as the quality of the data that support it*”. The team will rely heavily on relevant, good data and facts to make decisions.

Another article that illustrates the importance of upgrading the warehouse in modern companies is “Research”. This article mentions that warehousing process continues to include the same way of building for the last 50 years. That model is already obsolete because the actual companies deal with modern challenges including production, demand, personal and equipment.

CHAPTER 4: LAYOUT PLAN AND PROCESSES

This chapter discusses the layout plan and processes within the Chain Fall area by presenting two different types of methods. The methods describe how the team is working to reach an improved layout and process of the area. Within the first method, the team uses different engineering tools to find and analyze the possible types of problems that the area has. The second method includes the different problems that the team can see happening every day during work. The team has come up with different ideas or opinions about how to solve the problems from both methods, and they are presented after each problem that is listed. To have a better understanding of the Chain Fall area, the team has made a diagram of the area including all the objects. (Figure 2).

4.1 CURRENT LAYOUT PRESENTATION

Figure 2 shows the current layout of the Chain Fall made in AutoCAD. The graph shows the current division of the area by work area for each station with measurements. In addition, the figure shows the distribution of the tools, areas for review and service of parts, and other tools or equipment's used. The red area is the current path forklifts use to deliver or pick up parts for the Chain Fall area. As the figure 2 shows, every station and object inside the area have been numbered, listed, and described for easier recognition.

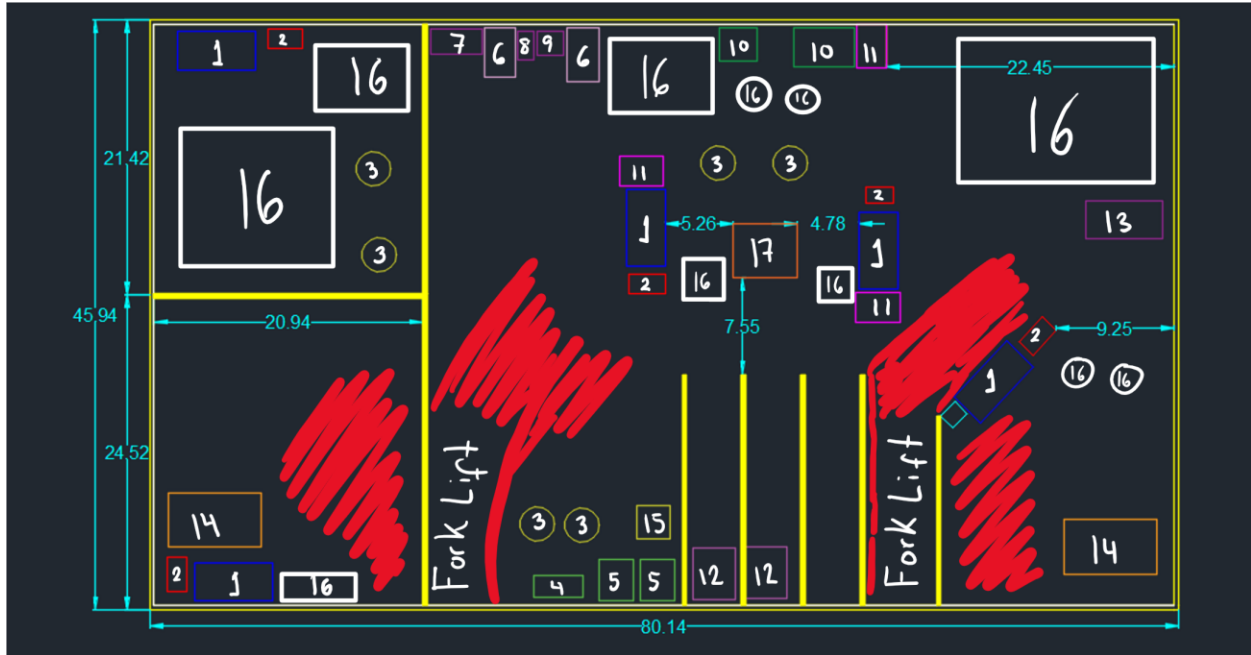


Figure 2: AutoCAD Drawing of Current Chain Fall Area Layout

The following is the legend of the layout above:

1. Tables: They are used for repairing tools.
2. Tool boxes: They are used to store the heavy-duty tools that the workers use for repairing.
3. Circular storage tool: They are used to store the small tools and parts that the workers use for repairing
4. Chain Fall equipment 25 tons: Small crane to work with up to 25 tons heavy duty tools.
5. Recycle cages: They are used to collect empty boxes.
6. Computers: The two computers are used for print documents, checking emails, and pull orders.
7. Cabinet Storage: This cabinet is used to collect labels, bottles, duct tape, towel paper and other products.

8. Cabinet Documents: This is used to collect documents as inspections, manuals, and certificates for the parts and hydraulic tools used.
9. Printer: It is used to print any needed documents.
10. High pressure machines: They are used to inspect the hydraulic tools.
11. Oil collector tools: These are used to collect the oil from certain air tools during their maintenance or repair.
12. Pallets with tools: The pallets contain the tools for maintenance.
13. Pallet jack tester: This tool tests the pallet jacks during their service.
14. Chain fall crane heavy duty: It is the machine that used for inspecting the chains.
15. Yellow Flammable cabinet: This cabinet is fireproof and works to storage different inflammable chemicals technicians use.
16. Unused tools or part waiting to be used: These spots are accumulating different parts and tools that could be recycled or reorganized.
17. Heavy duty table: A metal heavy duty tables used repairing purposes.

4.2 LIST OF SYSTEM ENGINEERING TOOLS

The following is a list of system engineering tools that helps the team to identify, categorize, and prioritize the safety and productivity issues in the Chain Fall Area. This helps the team to decide the final layout. A brief explanation of each tool is under problem solving approach section.

1. AutoCAD Software

The AutoCAD program is used by the team to design the current layout diagrams (Figure 2) to have a visual of the current area. Additionally, the program helps to create

different designs based on the results of the other tools the team is using. This way, the designs can be compared and analyzed to pick the best one.

From Cause and Effect Diagram below, the team highlighted the main factors for safety hazards and delays that will play a larger role in the overall redesign of the chain fall area.

2. Arena software:

Since the new design of the storage area will not be implemented during the project time because the management team must review and approve it, Arena software is used to simulate the operation time of picking up the kits from the storage area to the work area. Arena model shows the times of this operation with the new design of the storage area as shown in figures 43 & 44.

3. Cause & Effect Diagram:

After brainstorming, the team decided to construct a cause & effect diagram, two affinity diagrams and a Pugh matrix to identify the categories for each problem area, potential measures, and key criteria for the chain fall workers.

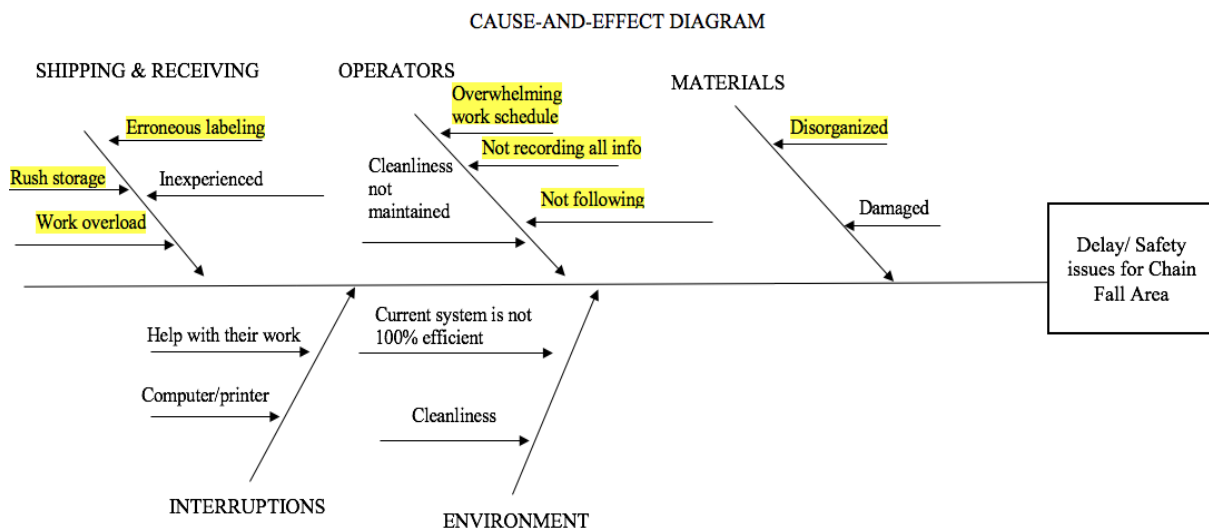


Figure 3: Cause-and-Effect Diagram

The team has learned that the Shipping and Receiving department has a work overload, and they rush to meet customer demands. The team’s solution for organizing warehouse racks can potentially put more burden on the Shipping and Receiving technicians that operate the forklifts and place the kits in the Chain fall area shelves. As a result, the potential burden on Shipping and Receiving was considered including the disorganization of the materials (kits), and lack of info (prioritization of delivery) into any potential solutions the team has for the area.

4. Affinity Diagram:

The team brainstormed the general issues with the chain fall area and categorized them for effective organization. This affinity diagram helped the team to decide what issues are more prominent based on the team’s consensus. The team’s alternatives will be geared to a few issues of each category including lack of safety features, missing kits, waste policy, and clear forklift paths.

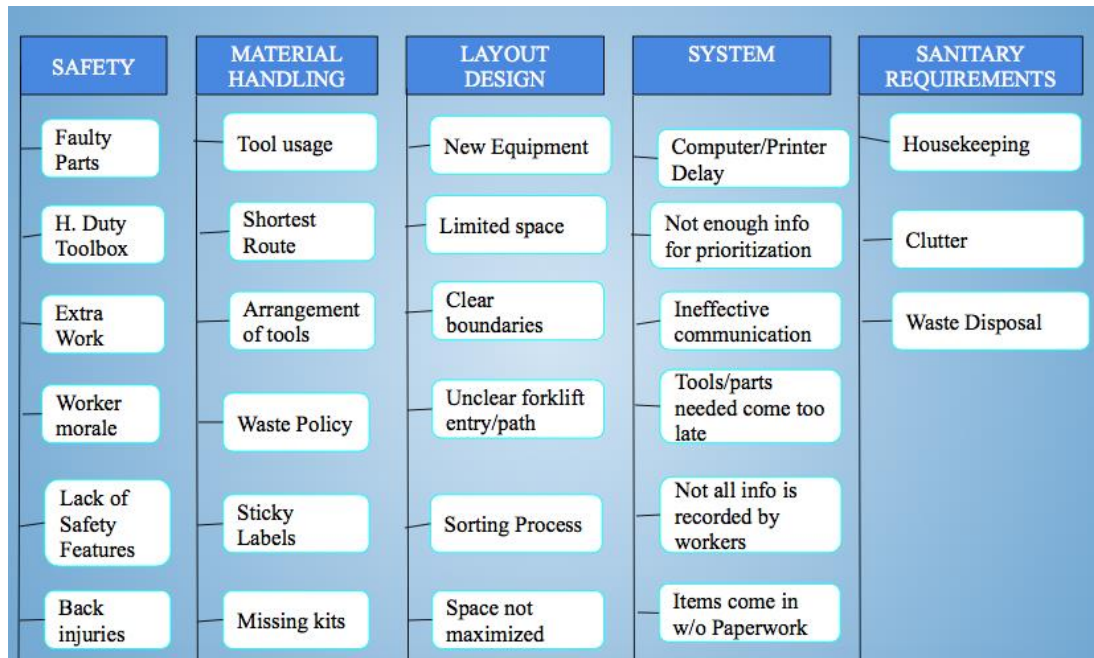


Figure 4: Affinity Diagram 1

The purpose of the second affinity diagram below is to identify the team’s main goals for the project and how the team will prove and measure the success of the alternatives implemented. The Critical to Quality (CTQ) refers to factors that are important for the quality of the process to ensure that the customer deliveries are satisfactory. The drivers are more general, and the potential measures are the team’s metrics for improving the productivity and safety of the area.

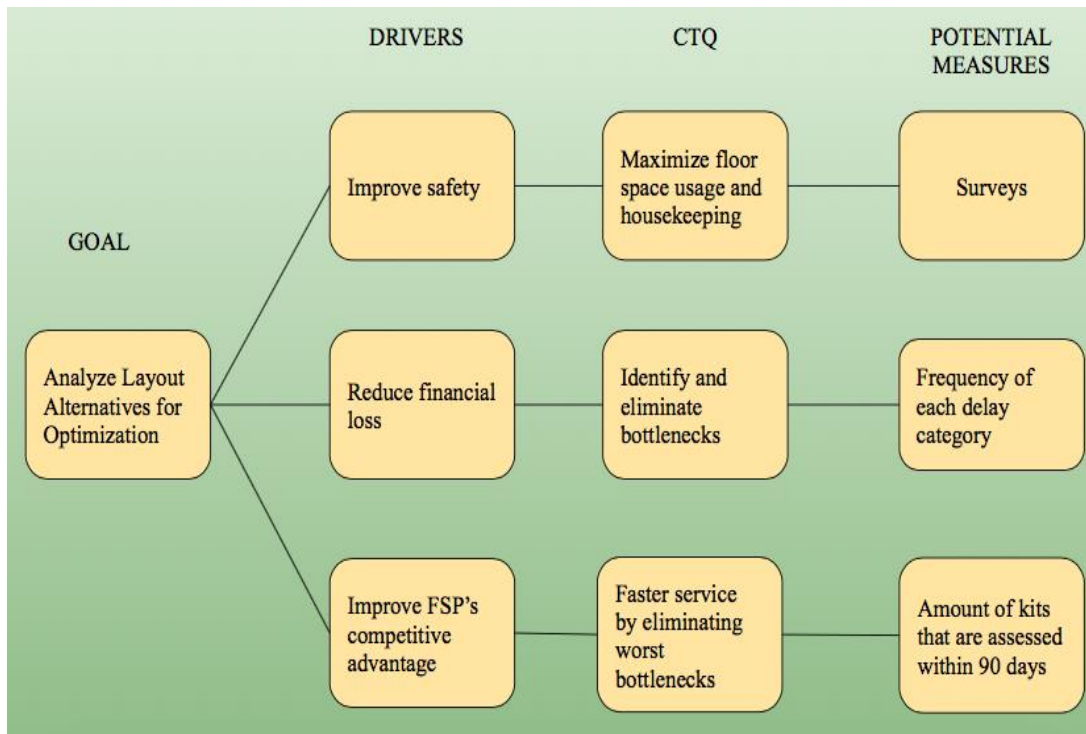


Figure 5: Affinity Diagram 2

5. Control Chart (XBar-R):

Mr. Ayala provides the team with gathered data from Siemens’ assessment time kits reports. The team decided to construct three control charts on Minitab with this data. The purpose of the control chart is to monitor the process of assessing kits to see if they are assessed within 90 days. The team recognize that the current design of the rack storage is not optimal because the time to assess kits can exceed 90 frequently. With the

purpose of reduce the assessment time, the team has decided to redesign the rack storage. The general analysis for the control chart is that if any point lies outside the upper control limit or lower control limit on either the x-bar and r chart, the process is out of control. The control chart helps the team to monitor the process of kit assessment rates. The rate is the number of days it takes the chain fall technicians to get the kit ready for the customers, and other departments inside the facility as mechanical 1 and 2, or other areas. The following control charts show the kit assessment times in days of each type of equipment.

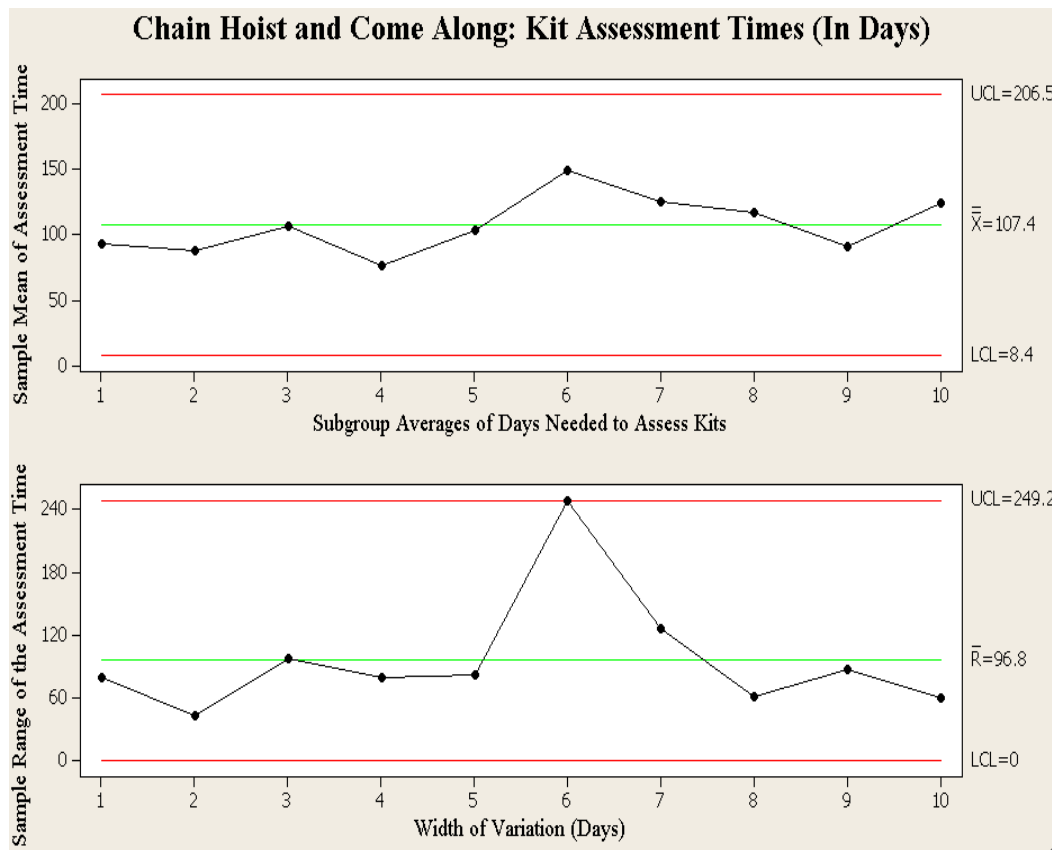


Figure 6: Control Chart 1

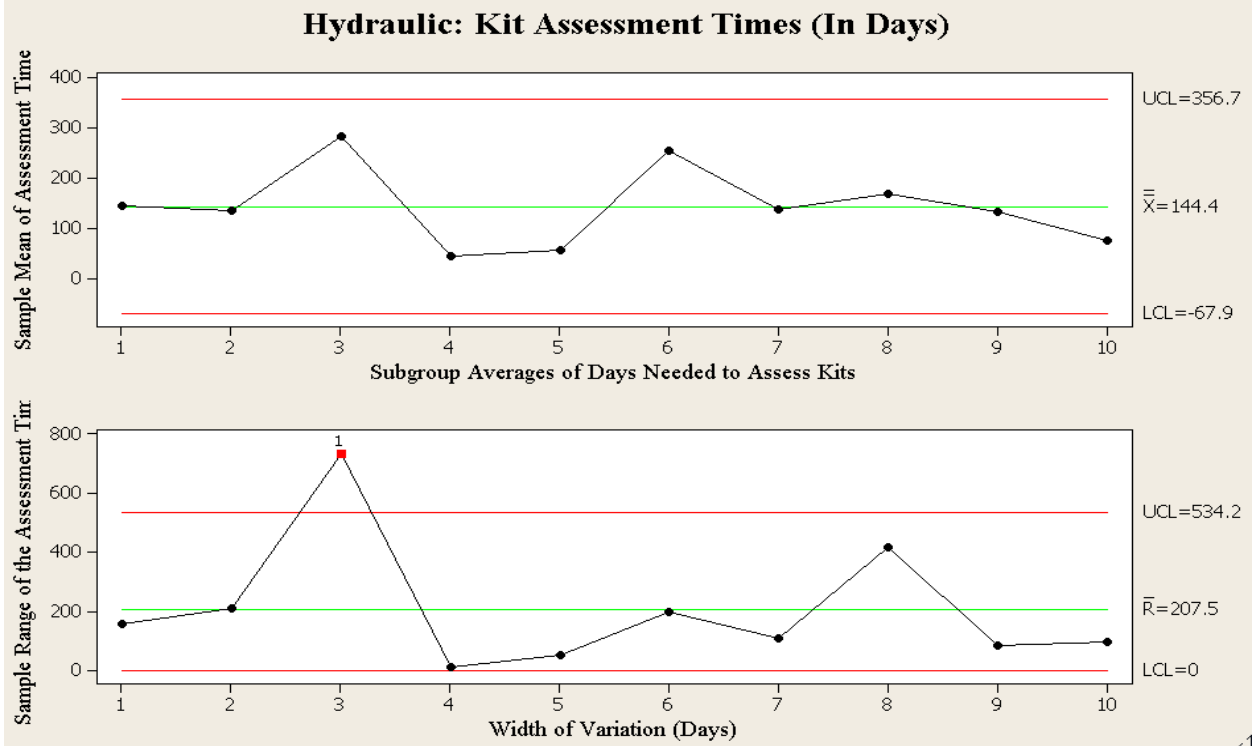


Figure 7: Control Chart 2

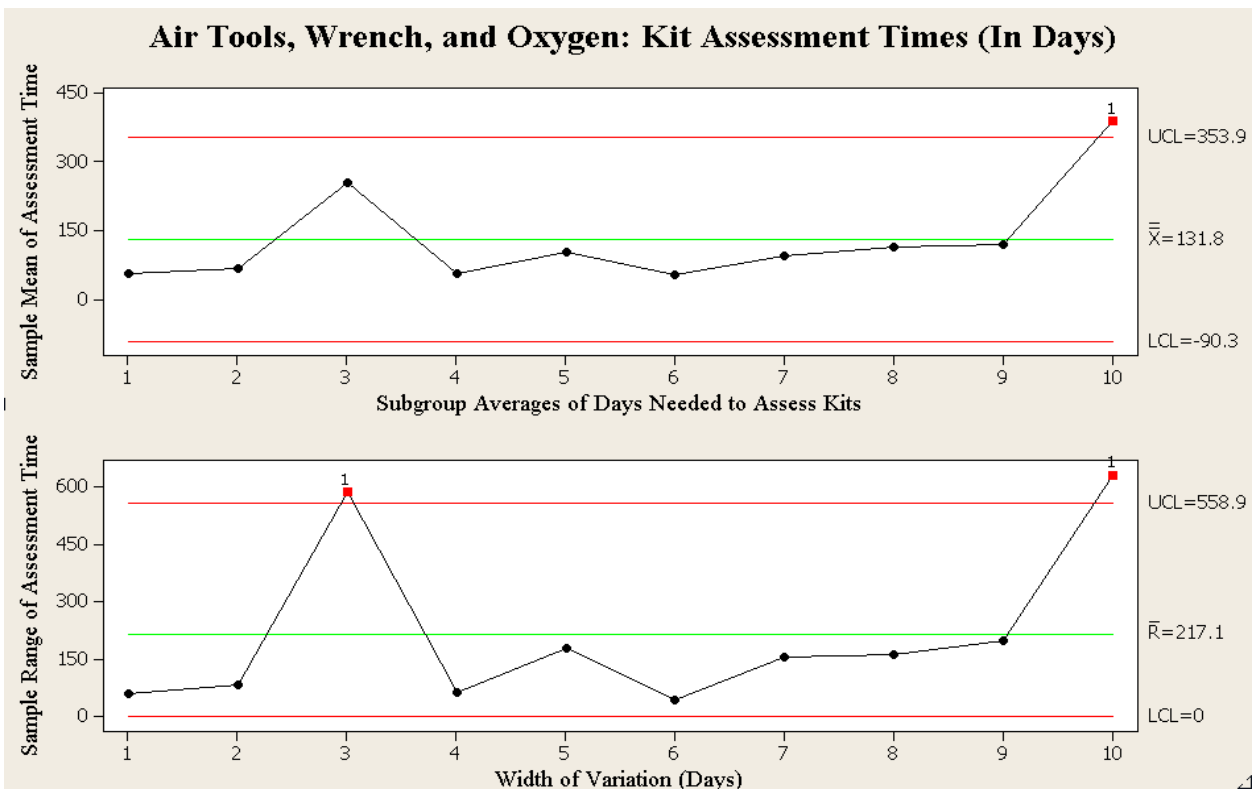


Figure 8: Control Chart 3

Both the hydraulic and air tool subgroups are out of control because both fail the test of being in statistical process control. One or more data points (kit assessment times) exceeds the upper control limit. This means that there are special cause variations that can be removed from the process. Management should investigate the points that lie outside the control limits and locate the cause. Once the cause is located, it should be removed.

6. Pareto Chart:

One of the tools that the team also uses is the Pareto chart which indicates that tools availability and lack of communication are the significant few among the trivial many. These help the team focus their time on issues that have a higher impact in the chain fall area. Lack of communication refers to lack of policy and procedures from management while tool availability and accessibility refers to locating kits, chain hoists, pallets, and other equipment in a quick, efficient manner. The chart below describes the categories that contribute the most to the delay of the area. The data was generated from previous reports' pareto charts.

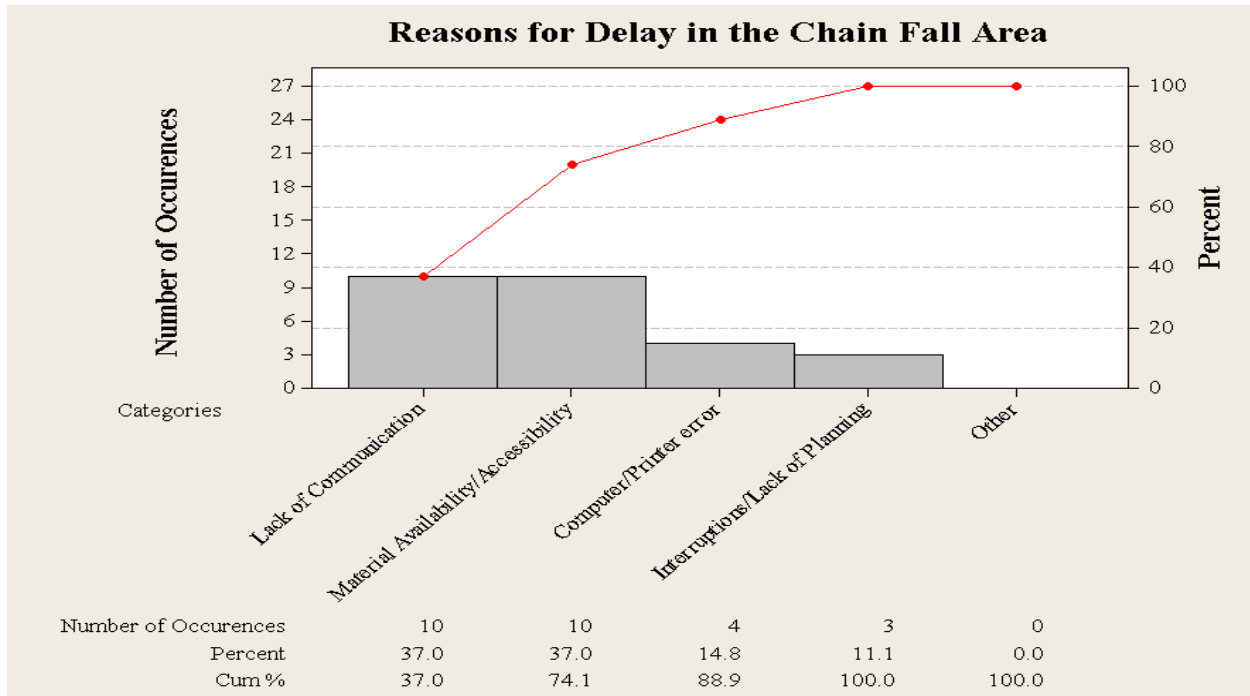


Figure 9: Pareto Chart 1

The lack of communication category deals with the lack of managerial policy and attention to the worker’s responsibilities for keeping the area safe and organized. Furthermore, computer error stems from the printer’s spool malfunction or inaction and the computer’s overall browsing and startup speed. Also, tool availability and accessibility refer to the lack and abundance of tools needed, or the quantity of items that serve little or no purpose in the chain fall area. The pareto charts show that the tool availability/accessibility and lack of communication contribute to 74.1% of the delays that occur in chain fall area.

7. Pugh Matrix:

The Pugh matrix is another tool that was constructed by the team to identify how each alternative impacts the criteria with ratings as shown below (table 1). The criteria in the Pugh matrix is based on the needs of the chain fall area and the desired level of achievement provided in the new system. The desired level of achievement is compared

against the extent to which the alternative meets the criteria. The scores in each column are added up to determine the most effective design in terms of cost and other criteria.

The alternatives are represented by the letters A, B, C, and D while the ratings are numbered from 1 to 5, 5 represents excellent, and 1 represents very poor. Alternative A is reorganizing the racks by dividing it by 12 parts where each division represents each month. The kits will be arranged from top to bottom and left to right. The purpose is to reduce the confusion of operators from all shops operating the forklift.

Table 1: Pugh Matrix

Key Criteria	Sub-criteria	A	B	C	D	Current Design	Target Design
Organization	Efficient Movement	4	4	3	5	1	5
	Manageable Sorting	4	4	3	5	1	5
	Bad Labeling	4	4	3	5	1	5
	Relocation + Remove	4	4	3	n/a	1	5
Safety	N/A	4	4	3	3	2	5
Costs	N/A	5	3	3	3	1	5
Benefit	Kit assess time	4	4	3	5	1	5
Delay	Other Shops Sorting Unclear Priority	4	4	3	5	1	5
					5	1	5
					5	1	5
Time constraint	N/A	3	4	3	4	1	5

TOTAL		36	35	27	45	12	55
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Alternative B requires that a new full-time technician be hired with the sole purpose of inspecting and organizing the warehouse racks. Alternative C combines the ideas from Alternative A and B. On the other hand, alternative D involves placing a screen in the chain fall area for clearly display the kits received in the area and their respective due date and priority.

8. LogBook Tools Repairs:

As previously stated, the Chain Fall area is a department that works with different other departments inside the Siemens Facility. These different departments bring tools from their kits to be inspected, maintenance, repaired, or replaced based on the Chain Fall area’s technicians’ review and decision. The tools are coming every day and in different quantities. (figure 10) This is when the program Microsoft Excel becomes useful.

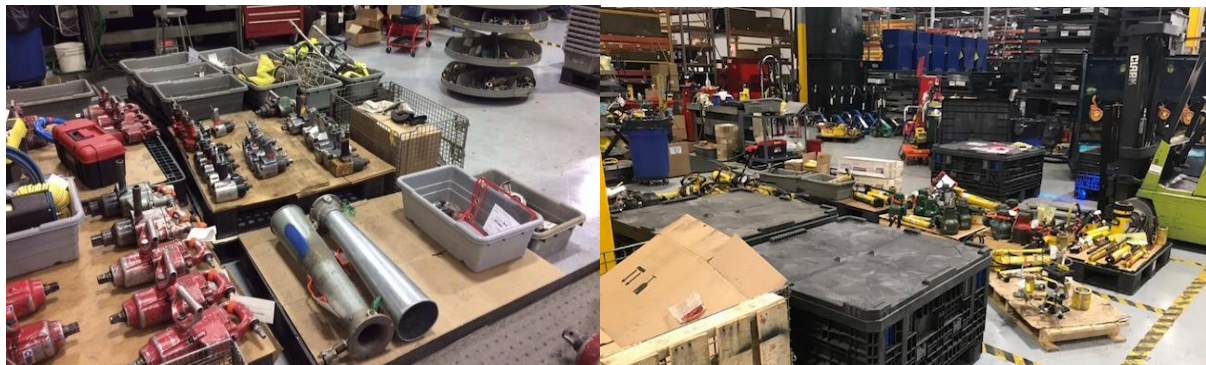


Figure 10: Incoming tools From Other Departments

The only method every department must record these parts is a log book located at every department. The log book records the name of the part, kit number, part serial number, the date when the tool is delivered to the Chain Fall area and the

date when the tool is taken back to the department where was coming from. However, the records are inconsistent respect to the dates when the tools are returned to their actual locations, and some other data related to the actual number of tools received in the Chain Fall area. This happens sometimes because of human mistake or lack of interest. Even with this problem, the team finds these records with a high value because entering these information in Excel they will help the team to understand how the flow of the tools inside the chain is fall area and build a better layout.

9. Tool Usage Survey

- a. The team want to apply the idea of reducing equipment to gain space for productivity inside the work area. However, the constant traffic of tools coming in and out from the work area, the different type of kits Siemens has, the different and many type of tools the Chain Fall area has complicates the process of removing equipment. In addition, the team cannot record every technician and every time through every day. Therefore, the team came up with the idea to number the equipment in pink (figure 11) and provide the technicians with logs (figure 12). The goal to figure out which tools are more used than others. Every technician will have to report on his own log what equipment and how many times he has used it during the day.



Figure 11: Labeling Tools



Figure 12: Tools Usage Survey

- b. Safety risk survey that measures the potency of the safety hazard in the chain fall area. This survey includes different categories of different types of safety risks. This survey has 1-10 ranking system (1 is safe and 10 is very dangerous). The overall safety hazard rating is the average of the other survey categories rates as shown below:

Survey of Safety Risks										
Type Of Risk	Rank									
	1	2	3	4	5	6	7	8	9	10
Forklift Safety Risk										X
Tools Box									X	
5s								X		
Lifting Pallet									X	
Over all Risk									X	

1 = safe

10 = Very Risky

Figure 13: Safety Risk Survey

4.3 PROBLEM SOLVING APPROACHES

In this part the team will present the issues found inside the work area that have high priority to be attended. These issues will be presented separately with a brief explanation of their current situation. In addition, the team will state different method of how to resolve them.

1. Pallet Jack equipment:

The pallet jacks take up the most space in the chain fall area compared to the other types of tools (figure 14). Each pallet jack dimension is 48” by 21”. The space inside the area is reduced, especially when this tool is grouped with many other pallet jacks. As a solution to save space, the technicians are stacking the pallet jacks on top of one another. This solution is effective, but these tools keep accumulate to the point of taking a large space in the area. The team came up with two different methods to solve this problem.

The first method is to prioritize the work for this type of tool once they arrive to the Chain Fall area to prevent them from accumulating. However, the second method is to reassign the pallet jacks to another place where they can be stored until is time to repair them.



Figure 14: Pallet Jack Storage

2. Heavy Duty Tool Box:

The technicians work with heavy duty tools to fix different types of equipment. These tools are always put away. They are kept in a red heavy-duty tool box and retrieved every time they are needed again. Each technician has his own heavy-duty tool box in his work station. However, these tool boxes have become one of the area's problems because the red tool boxes create a real safety hazard. Based on a survey and questionnaire the team conducted for each technician, the tool box has tipped over more than once. This is a safety risk for the technicians. The risk occurs when the technicians open more than two tool box compartments at the same time. Unfortunately, the company believes that these heavy-duty tool boxes come with a safety feature that prevents the user from opening more than one compartment at the time. As the team tested in the Chain Fall area, all the heavy tool boxes used by the technicians can open all the compartments at the same time (figure 15).



Figure 15: Heavy Duty Tool Boxes

The team proposes three different changes that might occur simultaneously or individually at the final design draft of this project. The first suggestion is to replace these boxes with another type of heavy duty box for \$500 price cost per box. The second option is to remove the wheels of the boxes which it will give them more stability. This change will cost \$0 because the removal will be done by the same technicians. The third option is to try to tie the tool boxes to the tables with hooks to make them more safe and stable. These hooks will cost \$15.08. All these changes could benefit the company by preventing the accidents that could cost the company \$362,493. The costs of injury correspond to one employee having an accident. Below is the cost- benefit analysis table that explains the cost and benefit of each alternative to help the team to choose the best alternative for the project final design. All costs of injury were obtained from the OSHA website.

Table 2: Heavy Duty Tool Box Cost Benefit Analysis

Heavy Duty Tool Box	Benefit	Cost (Indirect + Direct)
Option 1: Replace Tool Cabinet with a new one.	Time saved, labor saved, higher morale for workers, reduced safety risk, more confidence on equipment usage. Save from \$55,855 - \$256,160	About \$500 each Five heavy duty tool boxes \$500 (5 boxes) = \$2500.00
Option 2: Remove Wheels underneath Tool Cabinet	Time saved, labor saved, higher morale for workers, confidence using tools.	\$0
Option 3: Tie it with hook strap (900lbs)	Save on the fracture and multiple injuries cost, reduce the safety risks.	\$3.77 for each hook strap: Will need for all tool cabinets. There are 4 of them: \$18.08

Option 4: Do nothing	Save \$15.08 or save \$1200	Fracture: \$55,855 + \$50,778 = \$106,333 Multiple Injuries Including Both Physical and Psychological: \$ 121,981 + \$ 134,179 = \$ 256,160 \$ 256,160 + \$106,333 = \$362,493.
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3. Chain Drums:

Another problem of the chain fall area is the safety hazard of the green drums. The technicians work with different types of chain hoist that can lift from 1/2 tons to 40 tons. Therefore, the review of the chain, an essential part of a chain hoist to lift, has to be done for every chain hoist. If the chain shows even a little crack or cut at some point, it needs to be removed completely and replaced. The green drums seen in the figure 10, contain the chains needed for the certain type of chain hoist. Therefore, the risks for the technician to suffer any injury is based on the excessive strength he puts in his arms and his back during the process of reaching the chain and removing it from the drum. Because of these risks, the technician could decide to avoid replacing the chain hoist even when this chain presents damages. This bad decision from the technician would lead to a deadly risk when this damaged chain hoist is operated again back on the field.



Figure 16: Green Drums

The team came up with three ideas to solve the problem. The first solution is finding a tool at a low cost to solve the problem quick. The figure 17 below shows the OSHA approved equipment that minimizes the excessive work required by the technician.



Figure 17: Mobile drum carrier and positioner

The second solution is to put a winch on the side of the drum for an easier chain removal. (Figure 18).



Figure 18: Hand Trailer Winch

The third idea is to build a tool according to the technician to solve his problems or needs. The cost is unknown at this moment because the team does not know how long the tool would take to build it and how many people, as engineers and mechanics, would need to be involved. Even after this tool is finished, the product will have to pass the OSHA requirements to be implemented.

Below is the cost and benefit analysis tables for all alternatives above.

Table 3: Green Drums Cost Benefit Analysis

Green Drums	Benefit	Cost
Option 1: Purchase the tool	Reduce fatigue / avoid injures / saves time	\$559.00 - \$1500.00
Option 2: Replace a winch	Reduce fatigue / avoid injures / saves time	\$22.99

Option 3: Build a Tool	Reduce fatigue / avoid injures / saves time	Siemens Cost

4. Relocation of Equipment:

Furthermore, the team finds inside the Chain Fall work area different type of equipment that need to be relocated, changed, or redesigned. In order to take the right decision respect to all these equipment, the team is running a Tool Usage Survey. The team presumes to gain at least 10% in space after all these modifications. Other type of tools will have to be improved based on safety implementations. In this chapter the team will present these equipment’ problems and methods how to solve them. However, the final decisions will be explained in chapter five.

- a. **Hoses:** The technicians in the Chain Fall area use hoses often to clean up the jacks and some other tools with air. Unfortunately, they are left on the floor after being used (figure 19), and any technician could trip over the hose. This would cause serious injuries to any person.



Figure 19: Hoses

- b. **Heavy Duty Tables:** There are two tables inside the work area that need to be relocated. Table A (figure 20) is positioned in a different angle compared to all the other tables. This current desk position is an obstacle for everyone’s work. Besides the safety risk when the forklift operates inside the area, and when the operator cuts the chain because some pieces tend to fly off at any direction where the other workers are located. Also, the current position of the table wastes space. Same as table A, table B (figure 21) is not positioned in the most convenient way and it is causing waste of space. In addition, table B in figure 21 is a stronger table compared to the other five tables in the work area because of the material is built. This type of table does not shake and can handle well heavy-duty tools work on top of it. In the past, all the tables were the same as this one, but they all were replaced. Just one was left and relocated in the center of the work area for everybody usage. The problem occurs when more than two technicians want to use it at the same time causing delays.

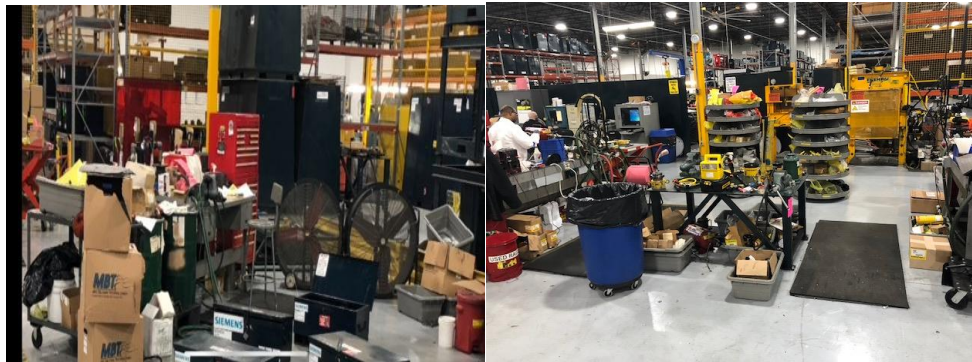


Figure 20: Desk Placed on an Angle Figure 21: Middle table

- c. **Chain Hoist door:** Redesign of the safety chain hoist door (wider door slit, curvature for natural pulling down of the chain) or new chain hoist door (account for Randall’s insight in notes). The team decide to remove this door since it is not a part of the safety standard of the machine nor OSHA standard.



Figure 22: Inspection Machine Safety Door

- d. **Yellow Cabinet:** The yellow cabinet for flammable products has been in the middle of the working area for safety reasons as shown in the figure 23 below. This cabinet is used by every technician to collect the different products they need to fix the tools. However, this cabinet has become an obstacle for daily work. The plan is to measure how often is use and depending on that information, relocate the cabinet at some other place inside or outside the work area.

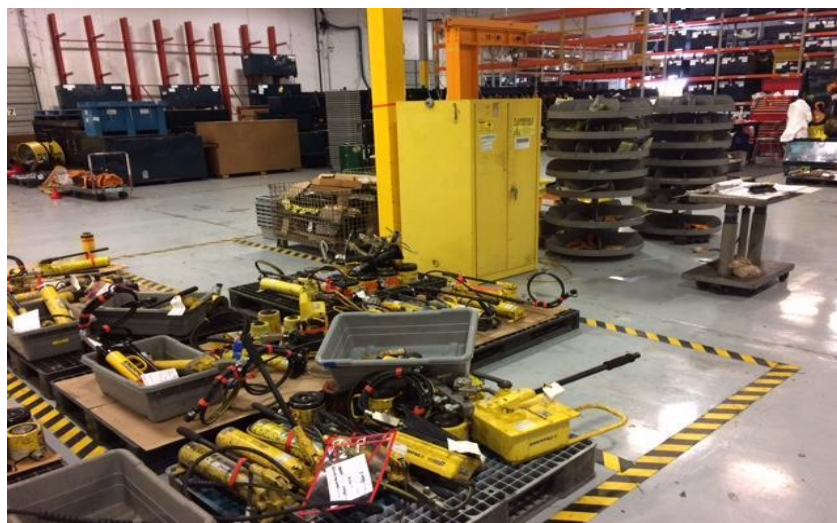


Figure 23: Yellow Cabinet/Tape

- e. **Cabinet Storage and Cabinet Document:** The cabinet storage and the cabinet for documents are not efficiency used. The cabinet storage collects different type of products needed by the technicians for daily work; and the cabinet document store different type of documentation related to inspections, manuals, and equipment information (figure 24). However, these two types of cabinets have been used poorly and incorrectly. This is because the cabinet storage has an inorganization of products, while the cabinet documents has outdated documentation (manuals, tools certifications, and logs) older than six months required to keep at the floor. The team suggest organization and combination of both for better daily work and to generate more space.



Figure 24: Cabinet Storage and The Cabinet for Documents

- f. **Circular Storage tools:** There are six of these circular storage tools inside the Chain Fall area (figure 25). These tools have been assigned two for the Mechanical Pneumatic (MPN), two for Mechanical Jack (MJ) and two for Mechanical Chain Hoist (MCH). These storages contain different spare parts for many type of tools. However, the team observes some parts are over stored, some other have corrosion, and there are some other spaces empty. The team want to reduce the number of these tools by combining them.



Figure 25: Circle Storage Tools

- g. **The Chain fall 25 tons:** This is a type of crane is used by the technicians to tests chain hoist tools putting as maximum pressure up to 25 tons weight. Any other type of chain hoist above 25 tons weight, this equipment is not going to be useful. Besides, this equipment is located around the tools receiving area coming from other departments (#14 figure 2). This generates a safety risk related to the path of the forklift a lot of space. The team considers removing the tool to improve space and reduce the risk of an accident.
- h. **Open Areas:** The areas (#16 figure 2) in the Chain Fall area are presented in an unorganized way. These areas have parts everywhere including recycled tools, equipment waiting to be taken at some other areas outside the work area, spare parts for different tools, and cleaning products. All these parts need to be reorganized according to their use.
- i. **Chain Measurement:** Mr. Randall daily work requires to change the chains that present damages from the chain hoist tools. This works requires that Mr. Randall cuts the chain at the specific size needed for the specific tool. Although, he uses his arms to calculate the size he needs; this method is not the best because if he gets the wrong size, he will have

to cut another piece of chain, again. This will generate a waste of resources. The team considers a method to calculate the correct size without apply much effort.

- j. **Forklift Path:** There is a continuous access of the forklifts inside the Chain Fall area. This happens because of the demand of tools to be inspected and repaired by the technicians of this area. However, there is not a current path described in the actual layout because the forklift operators make up their own routes while they drive. This is considered high risk for technicians’ safety (figure 2). The team wants to keep the technicians away from the forklift paths to reduce the risks. Based on OSHA standard, red and white tapes need to be added to the area. This will show clear pathways and stop signs for forklifts to prevent work interruption and accidents to the technicians as shown in Figure 33 in chapter 5. The cost and benefit of the red table are shown Table 4.

Table 4: Forklift Routes Cost Benefit Analysis

Forklift Routes	Benefit	Cost (Indirect + Direct)
Option 1: Create two routes (Marked with red tape)	Save of \$38k - \$105k	\$20
Option 3: Do nothing	\$0	Loss \$38k - 105k

The team suggests creating these routes and stop signs with red tape which will cost \$20. If this situation does not get solved, incidents might occur, and these will cost the company many times more than the attempt to solve it later. Since the company has zero such incidents, the team has made a research about the cost of these kinds of incidents which is \$38k - \$105k. The cost benefit cost analysis of the forklift safety risks is as shown above.

5. Work Instructions:

for hydraulic jack (with pictures). Work instructions are done for inspection the hydraulic jacks. The company has work instructions, but it is not well developed. They are wordy statements and pictures are not included in them. According to human factors design, work instructions need to be simple to read and have visual instructions as much as possible because humans attempt to follow the visual instructions more than written ones. There are other different processes in the area other than inspection, but the work instructions are made only for the hydraulic jacks. If the company's management team finds these instructions are valuable to them, work instructions for other processes can be created by the team members. **Refer to Appendix X.**

6. Computers:

Team lead is responsible for contacting IT for any computer related problems. The problems that occur are having an old version of software that negatively impacts the speed in which workers use the computer. The internet browser closes tabs unexpectedly. Ms. Blanche, the plant Director, suggests that the team speak to IT to tell them our ideas of updating the computer with ease. The issue is also the workers tend to either keep the computer shut off or on. Not sure which one interferes with the update process. The computer can restart, and it can take up to 5 minutes to restart and 2 minutes to log in. However, the team has suggested the auto updating system which will make it easier to maintain the weekly updates.



Figure 26: Computer Workstations

7. List all violations of OSHA.

- a. OSHA require “that permanent aisles and passageways must be marked appropriately and in a consistent manner plant-wide” (OSHA Standard 1910.22)

Red and white – red and white tape are used to identify an area to be kept clear for safety reasons such as electrical panels, fire extinguishers and all others that may be dangerous, etc.

Red – is commonly used to identify areas of scrap/waste in the facility. Each area should be separately marked. The purpose of red tape is to be compliant for 5S and safer workflows.

- b. OSHA requires “In the area of materials handling and storing, ergonomic principles may require controls such as reducing the size or weight of the objects lifted, installing a mechanical lifting aid, or changing the height of a pallet or shelf.” (OSHA Standard 2236.16)

- c. OSHA requires the safety hazard of fractures and bruises caused by being struck by materials or by being caught in pinch points

8. Purchase two digital clocks for hydraulic jack:

The inspection process of the hydraulic jack requires the worker to time the process while using the hydraulic machine. These clocks need to be placed on the top of the machines where it will be easier for the worker to keep track with the required process time. Those two clocks will cost \$9.88. The clock is shown in figure below:



Figure 27: Digital Clock

9. Designing and Redesigning:

- a. New staging area: the staging area is the waiting area that the finished product or the incomplete product is sitting. The chain fall area needs some staging areas such ready kits staging area and received kits from receiving department that need to be ready in short time (less than one week) staging area. Also, each machine needs to have its own staging area next to it. For instance, a staging area is needed for the finished product of the hydraulic jacks until it gets moved to the responsible department.
- b. Redesign the storage area:

The storage areas that includes six different racks, and each rack has different numbers of shelves as shown in figure 28 below. They store the returned tools that come back from the customers till they reopen and inspect them. They have 90 days after the day they receive the tools to open and inspect them. If this period passed without opening the boxes of those tools, the company will be responsible for any missing and damages tools. The problem is that the workers cannot locate the boxes that come first because this area does not have a flow chart of incoming and outgoing boxes which make the company loses good amount of money yearly when they open the boxes and find some missing tools after the 90 days period of time. The team compared the current system with the new redesigned system to implement in terms of how each impact the key criteria. The current sorting process of warehouse racks does not achieve the goal of never missing a deadline, and the process heavily contributes to the number of kits missing, resulting in financial loss for FSP. Also, the team has timed the workers while locating the earliest kits to open and inspect them, and it took them an average of 30 minutes to do the whole process of locating the kit and bring it into the work area.



Figure 28: Warehouse racks

The team has come up with three alternatives to solve the problems of the storage area. The first alternative is to divide the storage rack into 12 different parts, each part refers to each month of the year. In this solution, workers can never miss any due date because they will know the due date of each part of the rack. This design has a labor cost of \$1,800. Same area’s workers could do the work of redesigning with over time payment. For example, three workers will do the job of redesigning for 16 hours in total. The breakout of the payment will be as the following:

$$\begin{aligned} \text{Overtime payment per hour} &= 1.5 \times \text{Current payment per hour} \\ &= 1.5 \times \$25 \text{ per hour} \\ &= \$37.5 \text{ per hour} \end{aligned}$$

$$\begin{aligned} \text{Overtime payment per worker for 16 hours} &= \text{Overtime payment per hour} \times 16 \\ &= \$37.5 \text{ per hour} \times 16 \\ &= \$600 \text{ per worker for 16 hours} \end{aligned}$$

Overtime payment for 3 workers = overtime payment per worker for 16 hours x 3
 = \$600 per worker for 16 hours x 3
 = \$1800 for 3 workers in 16 hours

The second alternative is hiring a new worker that acts as an organizer and makes sure that the kits are sorted correctly to not put more burden on the shipping & receiving team. This person will work 40 hours during the busy season and 20 hours a week during the slow season. This worker will work all his/her hours for organizing the storage area and be responsible for checking all kits' due dates to force applying the 90 days policy.

The team also compares three alternatives for the sorting process to remove unnecessary, time-consuming steps for the processes of the chain fall workers. The following table is the cost benefit analysis for each alternative.

Table 5: Warehouse Rack Organization Cost Benefit Analysis

Warehouse Rack	Benefit	Cost (Indirect + Direct)
Option 1: Organize the warehouse rack by months.	Time saved, labor saved, higher morale for workers, reduced safety risk	\$1800 (Labor cost for reorganization)
Option 2: Hire a full-time worker to ensure that the kits are organized.	Time saved, labor saved, higher morale for workers.	\$52,000 annually plus benefits for employee based on the company's payment policy
Option 3: Option 1 and 2 combined	Increase productivity and reduce likelihood of losing a kit and missing the 90-day deadline.	\$53,800 + time to implement process and train the workers
Option 4: Do nothing	-\$Will be updated next week	-\$will be updated next week. Times to assess kits remain unstable and missing the deadline for 90 days continues to occur frequently.

c. Redesign of the A-set and B-set pallet:

The pallets are unsecured which means it is dangerous for the technician to lift the tools on this pallet because it does not have walls to keep the tools inside the pallet as shown below. The workers attempt to leave the three top shelves in the storage area empty because they do not want to risk lifting these pallets. The team's suggestion is to replace them with pallets that have 2 inches walls to increase their safety. This can be an internal operation where a Siemens technician produces a custom-built pallet with the walls. Another option is buying the custom-built pallet from another manufacturing shop or company. The cost of changing these pallets is \$72.68 per pallet.

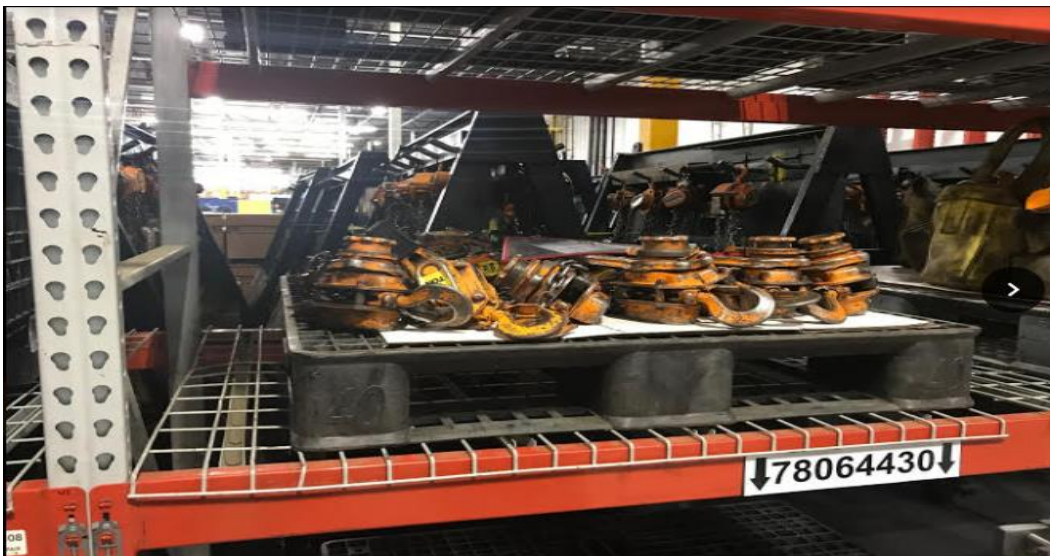


Figure 29: A-Set Pallet

10. Create 5S task responsibilities for each area: Since the cleaning employee of the company does not have the responsibility of cleaning inside the areas, each worker will be responsible for their area. Each part of the chain fall area will be a responsibility of one employee and there will be a 5S responsibility card which will include the name of the employee and the picture if it is possible as shown below:

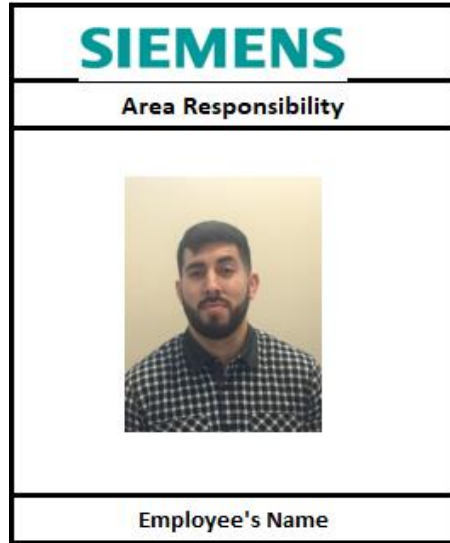


Figure 30: 5S Standard

11. Adding orders screen to the area:

This screen will include the orders numbers and details based on their priorities. The current system of posting the orders to the chain fall area is delaying the work process because the shipping/receiving department does not require that the worker inform the chain fall workers about the new orders each time they are received. Because of the shortcoming, the team proposes to add the screen. The screen will turn the method of posting the orders to be electronic, and it will have a software that is pulling the orders details straightly from the shipping/receiving department software. This screen will cost \$350. An example of this screen could be in the figure below:

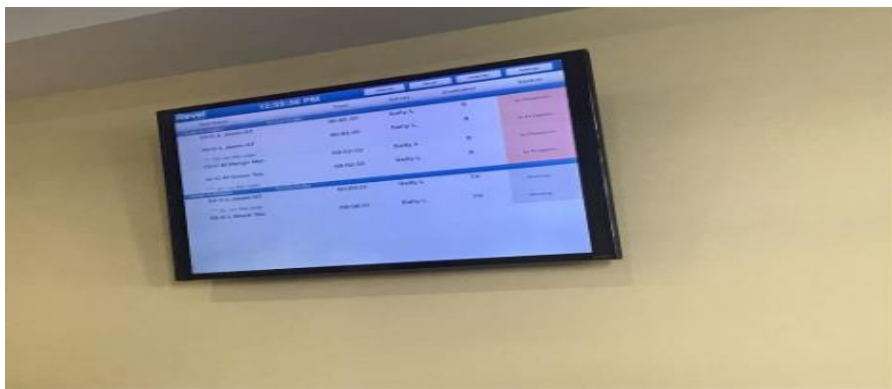


Figure 31: Orders Screen

Meanwhile, the team has been following the Gantt Chart for completing the project activities. The Gantt Chart below indicates that the team has completed Final Design Review and the final part of the design phase.

WBS	Tasks	Task Lead	Start	End	Duration (Days)	% Complete	Working Days	Days Complete	Days Remaining
1	Planning	Algarin	1/6/18	1/28/18	23	100%	15	23	0
1.1	Submit Team Topic	Algarin	1/6/18	1/6/18	1	100%	0	1	0
1.2	Completed Plant Tour	Medina	1/10/18	1/10/18	1	100%	1	1	0
1.2.1	Collect Data	Abdulmahdi	1/21/18	1/21/18	1	100%	0	1	0
1.2.2	Measurement of the Area	Abdulmahdi	1/22/18	1/21/18	0	100%	-1	0	0
1.3	Initial Design Review	Algarin	1/22/18	1/22/18	1	100%	1	1	0
1.4	Brainstorm layout of facility	Medina	1/25/18	1/28/18	4	100%	2	4	0
2	Design	Medina	2/15/18	3/17/18	31	100%	22	31	0
2.1	Preliminary Review	Medina	2/15/18	2/19/18	5	100%	3	5	0
2.2	Survey	Abdulmahdi	2/20/18	2/27/18	8	100%	6	8	0
2.3	Pareto Chart and Ishikawa	Algarin	2/28/18	3/7/18	8	100%	6	8	0
2.4	In Progress Review	Algarin	3/8/18	3/17/18	10	100%	7	10	0
3	Analysis	Abdulmahdi	3/14/18	4/9/18	27	100%	19	27	0
3.1	Critical Design Review	Abdulmahdi	4/4/18	4/9/18	6	100%	4	6	0
3.2	AutoCad Drawings	Abdulmahdi	3/14/18	3/17/18	4	100%	3	4	0
3.3	More Data for System Tools	Algarin	3/21/18	3/24/18	4	100%	3	4	0
3.4	New Policy on Recycling	Medina	3/28/18	3/31/18	4	100%	3	4	0
4	Review	Abdulmahdi	4/1/16	4/29/18	759	100%	541	759	0
4.1	Finalize Design	Abdulmahdi	4/1/16	4/4/16	4	100%	2	4	0
4.2	Concept of Operation	Algarin	4/1/16	4/4/16	4	100%	2	4	0
4.3	Complete Literature Review	Medina	4/8/16	4/9/16	2	100%	1	2	0
4.4	Final Design Review	Algarin	4/26/18	4/29/18	4	100%	2	4	0

Figure 32: Gantt Chart

This project was based on a specific budget that was provided by the company which is \$4000, but the goal is to get the project done within \$2000 to implement solutions. The breakdown of the total cost is shown in the table below:

Table 6: Project’s Total Cost.

Task	Cost
Redesigning the storage area	\$1,800
Red cabinet hooks	\$60.32
Red tape for the forklift's route	\$20.00
Orders Screen	\$350.00
Green Drums	\$1,500
Hoses	\$37.98
Digital Clock	\$19.76
Total	\$3,788.06

CHAPTER 5: RESULTS ANALYSES AND DISCUSSION

This chapter will explain in detail the results and decisions the team has come with, after analyzing all the problems found and mentioned in Chapter 4. In addition, Chapter 5 will present the final Chain Fall area layout based on these results. Team finds this layout will improve safety and productivity of the Chain Fall area.

5.1 FINAL LAYOUT PRESENTATION

This is the final layout the team has built based on the results and decisions the team has made after using the two methods that involves all the tools described and used in Chapter 4.



Figure 33: Final Design of The Area's Layout

The following is the legend of the layout above:

1. Tables: They are used for repairing tools.

2. Tool boxes: They are used to store the heavy-duty tools that the workers use for repairing.
3. Circular storage tool: They are used to store the small tools and parts that the workers use for repairing. They have been reduced from 6 to 3 based on their low use.
4. Chain Fall equipment 25 tons: It has been removed because of low use.
5. Recycle Cages: Relocated to another place to continue collecting empty boxes.
6. Computers: The two computers are used for print documents, checking emails, and pull orders.
7. Cabinet Storage: This cabinet is used to collect labels, bottles, duct tape, towel paper and other products. It will be used now to collect documentations from the cabinet documents.
8. Cabinet Documents: Removed since it was not really used.
9. Printer: It is used to print any needed documents.
10. High pressure machines: They are used to inspect the hydraulic tools.
11. Oil collector tools: These are used to collect the oil from certain air tools during their maintenance or repair.
12. Pallets with tools: The pallets contain the tools for maintenance.
13. Pallet jack tester: These tools tests the pallet jacks during their service. Relocated to obtain more space.
14. Chain fall crane heavy duty: It is the machine that used for inspecting the chains.
15. Yellow Flammable cabinet: This cabinet is fireproof and works to storage different inflammable chemicals technicians use. Relocated next to the Cabinet Storage (7)

16. Unused tools or part waiting to be used: These areas are now organized and serve as parts storage for tools repairs (the square location), and helps now to put the drum for recycle products (the circular location)
17. Heavy duty table: A metal heavy duty table has been removed. Now the #17 is assigned for the pallet jacks to be reviewed and repair.
18. Location for the tool to be used to operate the drums with chains or recycle products.
19. Measures marked on the floor for easier work with the replacement with the chain for the chain hoist.

5.2 RESULTS AND DISCUSSION

Logbook Tools Repairs

Although, the logbook already mentioned in chapter 4 contains 100% of data about the check-in dates for the tools that were brought in at the Chain Fall area, there is only 35.04% of data related to the check-out dates of these tools. However, the team can still obtain a substantial amount of information needed to build a better layout. The team understands that the more data collected and analyzed, the results will be more precise even when there is some missing data. Therefore, the team collected two years of data from the log book and analyzed it using Microsoft Excel. There were 1347 total number of entries between 2016 and 2017 and these includes all the information found in the log book mentioned in Chapter 4.



Figure 34: LogBook

Firstly, the team realized that each tool spent an average of 9.42 days inside the area. This information is important because the implementations will have to reduce this number. The information from the table 8 shows 97 kits where the tools were coming from, and the total number of times these tools were in the Chain Fall area. For example, the number of tools from the “B-Set” kit # 78010797 were presented 381 times which is 28.29%.

Table 7: Number of Kits Assessed per Station

Number of Kits Assessed per Station 2016/2017		
Kits	Count per Station	% per Station
78010797	381	28.29%
7800198	208	15.44%
78046516	51	3.79%
7800233	49	3.64%
78050994	49	3.64%

78040570	45	3.34%
7800389	45	3.34%
7800200	40	2.97%
7800197	38	2.82%
7800417	33	2.45%
7800305	23	1.71%
7800077	23	1.71%
78029516	22	1.63%
7800443	21	1.56%
78030378	15	1.11%
78034927	14	1.04%
78035179	14	1.04%
7800349	13	0.97%
7800151	12	0.89%
7800385	11	0.82%
7800367	10	0.74%
7800230	10	0.74%
7800437	9	0.67%
78027864	8	0.59%
7800244	8	0.59%
7800306	7	0.52%
7800253	7	0.52%
78044402	7	0.52%
7800161	6	0.45%
7800171	6	0.45%
78044408	6	0.45%
7800260	6	0.45%

The next chart (figure 35) gives the team the information about the yearly flow of parts by month, quarter and year. This is important because the chart explains graphically how busy the Chain Fall area gets comparing one year to another. This information can be classified as high, normal, and low season.

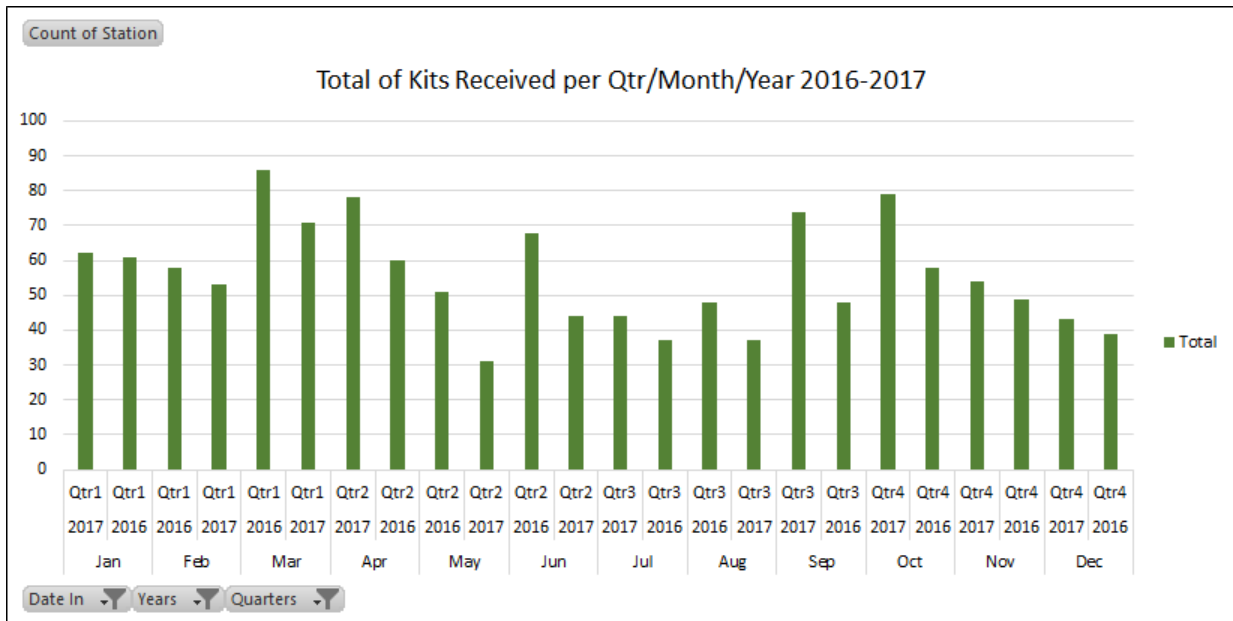


Figure 35: Total Kits Received per Time Periods

The third chart (figure 36) gives the information related to the different station located in the Chain Fall area and how busy they get with the parts that must be repaired. Mechanical Pneumatic (MPN) which is the busiest compared with the 539 tools against the Mechanical Jack (MJ) and compared with the 472 and Mechanical Chain Hoist (MCH) with 334 tools.

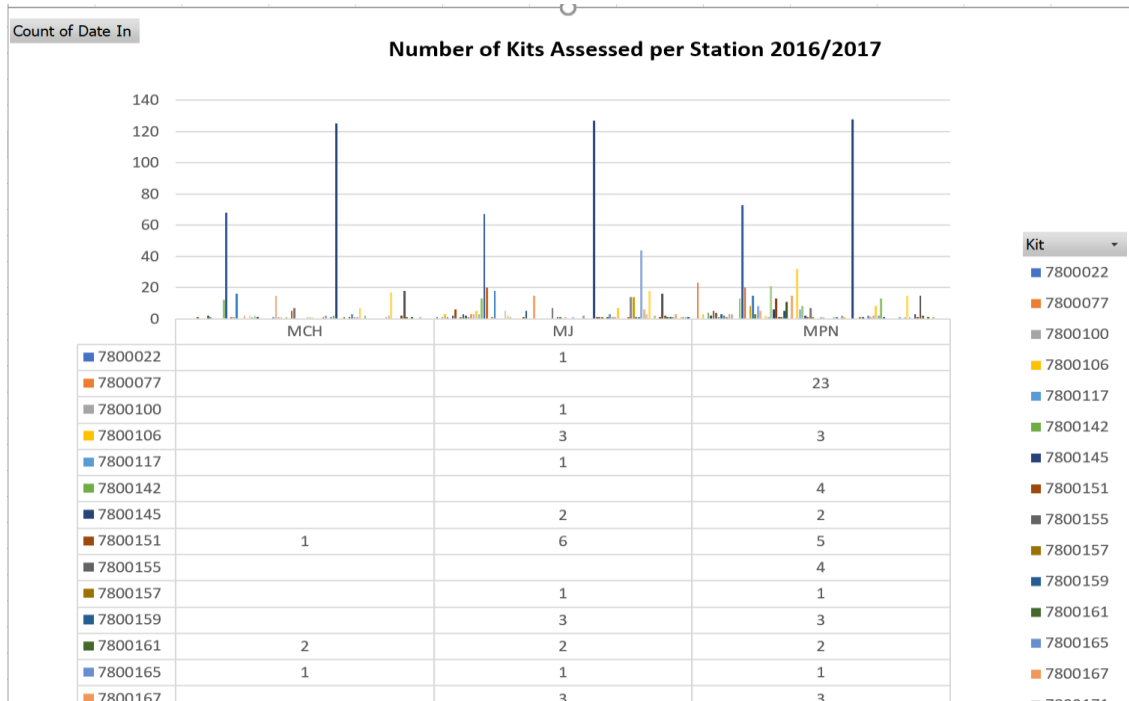


Figure 36: Number of Kits Assessed per Station

These three graphs are part of the plan that helped the team to create an improved layout. This new layout has the space to receive and distribute throughout the area the most frequently tools brought in for service during the three type of seasons Siemens has per year.

Tool Usage Survey

Although the goal to keep records of the daily equipment usage was intended to last for a month, the technicians were able to record their daily equipment usage for the period of one week because of the high season demand. However, the team assumes that equipment not used during high season it going to be less likely used during low season demand. The results were ran through Excel and this graph (figure 37) was generated.



Figure 37: Equipment used in Chain Fall Area

The numbers in red (0-6) mean to be removed from the work area, yellow (7-12) mean to be combined with some other equipment and green (>13) mean to be relocated inside the work area according to the technician usage. The team still did an additional visual supervision related to the equipment to be removed during different days and for the period of two week. At the end, it was concluded those tools in red were corrected to be removed from the work area.

Also, some other results analyses and discussions are as following:

1. Pallet Jack equipment:

The team came up with two different ideas presented in Chapter 4. However, neither of them is applicable. The idea to prioritize these tools would be hard, especially during the high season. The second idea would cause the technicians to find more space (which is not available) and most likely the technicians will forget about these tools with the pass of the days. The best

solution is to keep them located where they are already. But according to the new policy document the team will implement, these types of tools will be marked with a tag (figure 32) indicating the date they were accepted in the Chain Fall area. If the tools are not repaired within 10 business days, the tool will have to be recycled.



Figure 38: Repair Tag

2. Heavy duty tool boxes

As it was already reviewed in chapter 4, the less cost-effective solution is to tie the technicians' heavy-duty tool boxes with hooks (figure 39) attached to their heavy-duty tables, which are already bolted to the floor, to improve the boxes stability when they are used (figure 40). Using this method, the risk of a technician to get injured will be reduced considerably at the time to open the drawers. In addition, the company will prevent any legal claim in the future by any employee involved in an accident because of this tool. The other options the team discussed were not applicable because



Figure 39: Attaching Hooks



Figure 40: Tie Tools Box with Hooks Example.

the current tool boxes are brand new and do not need to be replaced. Besides, there are currently five boxes inside the area and they all would need to be replaced. Finally, the idea to remove the wheels from the tool boxes will stop completely the mobility of these ones and reduce their productivity.

3. Chain Drums

The team final decision about the drums was to purchase the actual device needed to do the job as shown in figure 41. The team found two types of tool that can do the job. One is a hydraulic tool as figure 17 in chapter 4. The cost of this one is around \$1500.00. The problem

with this tool is that its enormous frame will take more space than what is actually needed inside the work area. As a result, the team chooses the second tool which is manual, easy to use, and cheaper. The tool costs around \$600.00 and will take 25% less space than the hydraulic one. In addition, this tool will assist the technicians to remove the drums with recycle products (#16 in figure 33) instead of using the forklift. The wrench tool idea is not safe, and it would take more time and work to install it at each drum. The third idea was to build a tool, but it will take a lot of time and effort. First, it needs a design made by an engineer. This design would take many hours or days because it will have to be under OSHA safety regulations to be lifting around 1000 pounds. Later, this design will have to be built and go through different tests to prove its reliability. In case it fails, the tool will have to be brought back to the design stage for changes and start over the process again. Since it is very complex, the team finds this solution as not worth it.



Figure 41: Mobile Drum Carrier

4. Relocation of equipment:

The decision of these tools to be removed, combined or relocated is based on the graph (figure 37). Surprisingly, the team finds that after all these equipment modifications done in the Chain Fall work area, the technicians will gain 22.86% space. This is definitely more than what it was expecting. It is going to be gain 5.58% by equipment reduction and 17.28% based on relocation and organization.

- a. **Hoses:** Retractable hoses (Figure 42) will be implemented to reduce the space usage and safety hazards. This would eliminate the chances of incidents which leads to continue maintaining the Zero incident. In fact, having Zero incident means the company is not losing any money for covering any incident. In addition, those retractable hoses will save a lot of time because they will be placed next to the inspection machines for quicker use. The stations will need to have one retractable hose as shown in the figure below which costs \$18.99 for each.



Figure 42: Steel Air Hose Reel

- b. **Heavy Duty Tables:** Reorganizing the tables of the area is one of the most important issue that is needed to be solved to satisfy safety standard by OSHA and maintain 5S. The table A is currently placed on angle of 45° from the area's side as shown in Figure 20 which is wasting space very much. However, this table will have to be moved parallel to the side of the work area as Figure 33 represents. This will solve the area related to space, organization and safety. About the table B, the team suggest replacing all the current tables from the technicians with the same type of table B. This will provide the technicians the facility to work better and comfortable, no delay their work because of waiting, and gain space removing the table B no needed any more. In addition, the team suggests to start replacing the tables with Daniel's table. According to the Tool Usage Survey (figure 37), Daniel is the technician that is most currently using this table besides everybody else.
- c. **Chain Hoist Door:** The safety chain hoist doors are the doors that Siemens company has added to the chain fall inspection machines to add more safety value to those machines while inspecting the chain hoist. The team has decided to remove those doors because they have bad designs which makes them useless and disruptive. This design as shown in figure 15 includes a little rectangle hole that was supposed to be fit to the human regular height, but it is much higher than that. From research, the team has figured out that the average height for human male is 176.4 cm (5 ft 9.5 inches), and for female is 162.9 cm (5 ft 4 inches), but the height of this whole is 200 inches (6 ft 5 inches) which makes it not suitable for

human usage. In addition, the machines safety manuals that were made based on OSHA regulation do not include those doors. Removing those doors will reduce the disrupting that they have.

- d. **Yellow Cabinet:** According to the Tool Usage Survey, the yellow cabinet for flammable products is often used by the technicians. This is the reason why it is going to be relocated inside the work area and next to the cabinet storage (#7 figure 33). This replacement will generate more space to receive tools and for the forklift path (figure 33). In addition, this will reduce the risk for the technicians to be hit by the forklift when they approach to the yellow cabinet.
- e. **Cabinet Storage and Cabinet Document:** The team has decided to remove the cabinet document because is not needed. The documents collected inside this cabinet pass the last 12 months. According to the new policy document the team will implement, there is going to be a large reduction of documentation inside the work area. According to the Tools Used Survey, the technicians use the cabinet storage many times during the day. This cabinet will have to be organized and prepared to keep assisting the technicians with the current daily work and in addition with the storing of documentation from the cabinet document.
- f. **Circular Storage tools:** Based on the Tool Usage Survey, the team confirms the current use of these storage tools. Just one storage will be removed from each group leaving only three in total. The spare parts in high number will have to be reduced, the one that present corrosion will have to be recycled, and the empty spaces will have to be occupied by the new parts coming from the recycled circular storage tools.

- g. **The Chain fall 25 tons:** The Tools Used Survey (figure 37) indicates that during the high season week for a period of seven days, this tool was used only 4 times. This means this tool would need to be removed and later (any time soon) replaced for the other two cranes used in the Chain Fall area. In the meantime, the team has designed this space gained for the tools receiving area. This space will be used (as it is mark on figure 37 during the High Season only. The goal is to keep the work area with the less tools as needed to reduce the risks of accidents. But it is necessary to count with space during the high season for better productivity.
- h. **Open Areas:** These areas have been organized to leave space for the tools received every day for maintenance and inspection, for the spare parts needed for the tools, and for cleaning purposes. This area will be relocated (#16 figure 33) and organized according to the new policy document that shown in Appendix. This way the area will keep clean and safe for the technicians.
- i. **Chain Measurement:** The team thought a method how to help Mr. Randall to solve the problem of how to measure the correct size of chain needed for the chain hoists. The team decided to make a straight line of 10 feet long marked on the floor (#19 figure 33) with two more lines (1 feet away from each other) to help Mr. Randall to get the precise size of the chain before he cuts it.
- j. **Forklift Path:** Red and white tape for forklift routes: based on OSHA regulation standard, the forklift routes must be clear and visible in the area. Red and white tape need to be added to the area where the forklift routes because the area doesn't have any clear pathways for the forklifts. This issue is a really important factor of the OSHA regulation since this safety hazard could cause a lot of incidents.

Currently, the forklift does not have an access limitation, and the forklift can go into any part inside the area which is against OSHA standard because this creates a serious safety hazards. Although it is an important and serious matter, the solution is in very low cost and will not cost the company more than \$20. The team has designed two different forklift routes that will be designed with red and white tape with red stop signs. Again, those stop signs will apply restriction on keep going inside the area. To get perfect results of this new design, all employees who can drive the forklifts need to be trained on the new policy of the forklift routes. The has decided not to come up with more alternatives because OSHA required the red and white tape that will be used for the forklift routes.

5. Work Instructions:

The team has done the work instruction for hydraulic jack inspection process which is one of the process that occurs in the chain fall area. This work instructions, as mentioned earlier in the previous chapter, will reduce the amount of confusion while training since they have more pictures than words. Also, these instructions are easier to understand, follow, and remember. The main resources were considered of doing this work instructions are the human factors design and safety (OSHA) standard. As shown in work instruction, each step has the consideration for one or more of the four important factors of all process which are quality, safety, environment, and stop (the end of the process).

6. Computers:

The team was planning to meet with the IT team to talk about one of the issues that can delay the work in the area which is the computers updating, but unfortunately, IT

team doesn't work in Suwanee, GA location. Thus, the team ended up talking to Ms. Blanche, the plant Director, to explain the idea of auto updating. The problem is they are doing the weekly updates during the work hours or choose not to do the updates which makes the computers to run slow. The team suggested the auto updating that can allow the update to be scheduled on weekends or after work hours. In results, the workers will not be interrupted by the computers updates. Based on the outputs of the tool usage survey as shown in figure 37, one of the computer must be either replaced with new computer or try to repair it because during the period of time of the survey, the area workers did not use that computer due to its slow processing.

7. List all violations of OSHA:

- a. OSHA requires “that permanent aisles and passageways must be marked appropriately and in a consistent manner plant-wide” (OSHA Standard 1910.22.)
Red and white – red and white tape are used to identify an area to be kept clear for safety reasons such as electrical panels, fire extinguishers and all others that may be dangerous, etc.
- b. OSHA requires “In the area of materials handling and storing, ergonomic principles may require controls such as reducing the size or weight of the objects lifted, installing a mechanical lifting aid, or changing the height of a pallet or shelf.” (OSHA Standard 2236.16)
- c. OSHA requires the safety hazard of fractures and bruises caused by being struck by materials or by being caught in pinch points

8. Purchase two digital clocks:

the results of having those two-digital clocks will be eliminating the error of timing the inspecting process of the hydraulic tools which results to increase the productivity.

9. Designing and Redesigning:

a. New staging area:

The team has redesigned a new staging area next to each machine in the area. These staging areas are going to help in increasing the productivity because these areas will make the area much more organized. Also, these areas will save the time of moving around locating for a staging area to use. Those staging areas are showing in the final design layout.

b. Redesign the storage area:

The team comes up with the final decision of redesigning this area by dividing the shelves into 12 parts, each part will be for each month. This design will make the workers to be able to locate the earliest arrived boxes which leads to all the boxes will be opened and inspected within 90 days. The kits in each part of the rack will have due date in 90 days which makes it easier for the workers to keep up with all due dates. For instance, the kits January part of the rack must be opened and inspected by the end of March and so on. Plus, this new design will reduce the time of collecting the earliest kit from 30 to 12.57 minutes. A model was created by using Arena to calculate the total time that will be required to get the kit from the shelves to the work area as shown in figure 21. The policy of the new system will be introduced to the area's workers and receiving/ shipping

department to insure of implementing it. Training session will be needed before implementing the new design. The team chooses to use the first alternative in redesigning the racks because it is much cheaper than the second one as shown in table 6. Redesigning the storage area costs \$1800 which is much cheaper than the other options since hiring a new worker costs the company about \$52,000 annually plus benefits for employee based on the company's payment policy. Moreover, the third alternative is the most expensive since it is a combination of the first two alternatives.

All three alternatives' purpose is to reduce the time of picking a kit from the shelves. By the final design of this area, the workers will need 12.566 minutes to complete the process of getting the earliest kit from the shelves of the storage racks to the work area while they need 30 minutes with the current design. Since the new design has not been implemented by the company yet, the team has made a model by Arena to simulate the new design time as shown two figures below. The Arena report shows that the new design of the storage area reduces the process time by 42% which makes it easier to the workers to manage their time for opening and inspecting the kits and never miss the due dates. In result, this reduction of time will increase the productivity of the area which means also reduction of money lost.

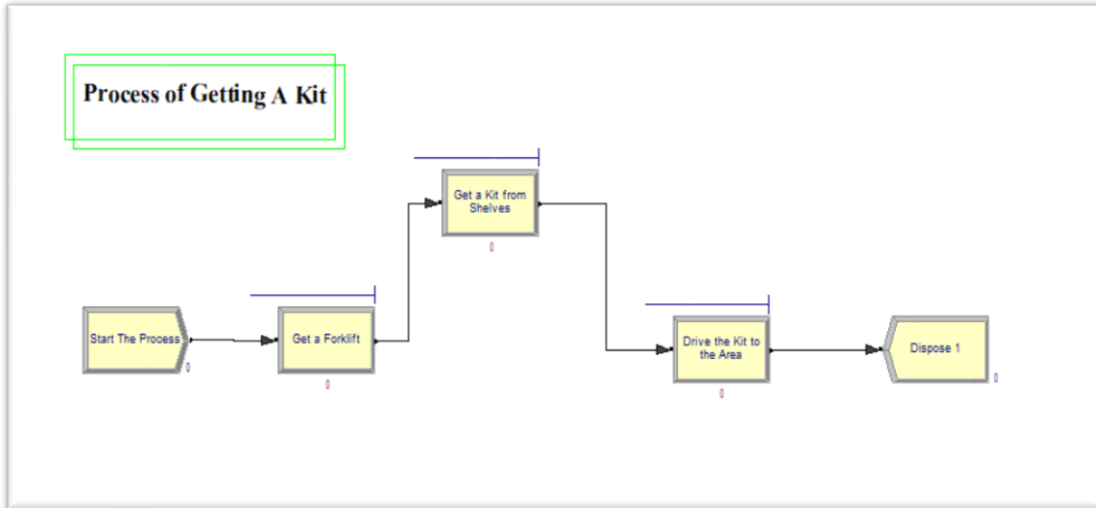


Figure 43: Arena Model of The Storage Area

Analyst: Esraa
 Model revision date: 4/ 5/2018
 Application ended at time : 480.0 Minutes
 Use Time Units: Minutes

TALLY VARIABLES

Identifier	Average	Half Width	Minimum	Maximum	Observations
Drive the Kit to the Area.WaitTimePerEntity	1.2321	(Insuf)	.00000	6.7859	24
Drive the Kit to the Area.TotalTimePerEntity	3.2214	(Insuf)	1.6863	8.6862	24
Get a Kit from Shelves.TotalTimePerEntity	5.2611	(Insuf)	3.8015	8.4103	24
Get a Forklift.WaitTimePerEntity	1.0580	(Insuf)	.00000	7.4315	24
Get a Kit from Shelves.VATimePerEntity	4.0627	(Insuf)	3.4603	4.5579	24
Get a Forklift.TotalTimePerEntity	4.0842	(Insuf)	2.7589	10.290	24
Get a Kit from Shelves.WaitTimePerEntity	1.1983	(Insuf)	.00000	4.2101	24
Get a Forklift.VATimePerEntity	3.0262	(Insuf)	2.6983	3.3447	24
Drive the Kit to the Area.VATimePerEntity	1.9892	(Insuf)	1.6863	2.3889	24
Entity 1.VATime	9.0782	(Insuf)	8.2792	10.001	24
Entity 1.NVATime	.00000	(Insuf)	.00000	.00000	24
Entity 1.WaitTime	3.4885	(Insuf)	.00000	11.381	24
Entity 1.TranTime	.00000	(Insuf)	.00000	.00000	24
Entity 1.OtherTime	.00000	(Insuf)	.00000	.00000	24
Entity 1.TotalTime	12.566	(Insuf)	8.4709	20.079	24
Get a Forklift.Queue.WaitingTime	1.0580	(Insuf)	.00000	7.4315	24
Drive the Kit to the Area.Queue.WaitingTime	1.2321	(Insuf)	.00000	6.7859	24
Get a Kit from Shelves.Queue.WaitingTime	1.1983	(Insuf)	.00000	4.2101	24

DISCRETE-CHANGE VARIABLES

Identifier	Average	Half Width	Minimum	Maximum	Final Value
Entity 1.WIP	.62834	(Insuf)	.00000	3.0000	.00000
Worker.NumberBusy	.45391	(Insuf)	.00000	1.0000	.00000

Figure 44: Arena Model Report

The data from Siemens confirms that the kits are not assessed in a timely manner for the most part as shown by the control charts and the figure below.

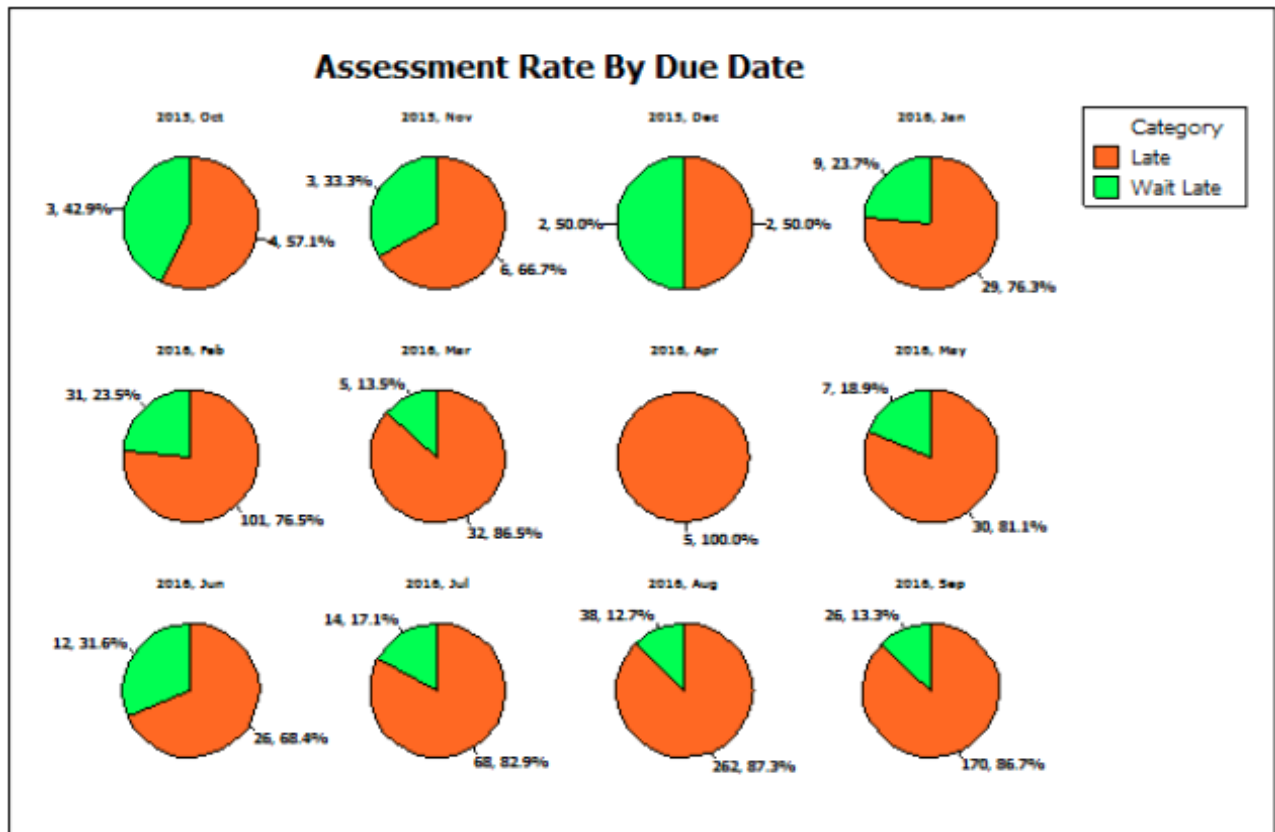


Figure 45: Assessment Rate by Due Date

The green area in the pie chart represents the proximity regarding the kit’s upcoming due date. The orange area shows that the kits were not turned in within their respective due date. The pie charts help the team understand that the kit assessment process needs careful supervision and changes to be more efficient.

Based on the data in the two tables below, the team could calculate the loss of money in the previous two years. Table 8 include the average days to assets which is the average days the kits sit on the shelves until it gets opened and inspected. Also, it has the kit SKU and the quantity of tools inside those kits. On the other hand, Table 10 has the summary of the average cost for

the area’s tools which has been used to calculate the how much the company loses due to the current design of the storage area using the formula below:

$$\text{Amount of money wasted} = \text{Number of tools in the kits that passed due 90 days} \times \text{Average cost per tool}$$

Table 8: Money Waste Analysis

Inventory	Kit SKU	Price / kit	Fiscal Year	Avg Days to Assess '17	Fiscal Year2	Avg Days to Assess '16
4	7.8E+07	\$ 1,256.70	2017	19	2016	2
29	7800366	\$ 1,288.24	2017	100	2016	149
20	7800095	\$ 1,417.48	2017	90	2016	106
27	7.8E+07	\$ 1,831.41			2016	75
55	7800104	\$ 1,894.28	2017	97	2016	75
78	7.8E+07	\$ 2,098.94	2017	27	2016	84
28	7.8E+07	\$ 2,306.06	2017	152	2016	140
8	7.8E+07	\$ 2,321.10	2017	408	2016	88
41	7800073	\$ 2,416.75	2017	174	2016	60
32	7800309	\$ 2,488.63	2017	37	2016	79
8	7800103	\$ 2,650.56			2016	168
26	7800139	\$ 2,689.54	2017	112	2016	71
16	7.8E+07	\$ 2,756.52	2017	264	2016	142
42	7800086	\$ 3,085.79	2017	108	2016	63
18	7800136	\$ 3,201.96	2017	427	2016	304
32	7800111	\$ 3,415.72	2017	97	2016	70
33	7800125	\$ 3,694.34	2017	119	2016	60
13	7800132	\$ 3,789.86	2017	152	2016	55
91	7800087	\$ 3,824.58	2017	131	2016	95
22	7800441	\$ 4,052.36	2017	29	2016	42
34	7.8E+07	\$ 4,507.50	2017	62	2016	37
6	7800131	\$ 5,888.86	2017	100	2016	108
3	7.8E+07	\$ 8,075.95			2016	83
8	7800428	\$ 8,187.11	2017	534	2016	344
7	7.8E+07	\$ 9,088.30	2017	42	2016	73
9	7800080	\$ 9,432.26	2017	39	2016	53
7	7.8E+07	\$ 10,276.18	2017	87	2016	28
16	7.8E+07	\$ 10,939.78	2017	28	2016	13

Table 9: Money Waste of Storage Area Summary

Chain Fall Area	Amount
Cost of most expensive kit	\$ 10,939.78
Average kit cost	\$ 4,245.60
Cost of most inexpensive kit	\$ 1,256.70
Total of potential waste in 2016	\$ (38,210.39)
Total of potential waste in 2017	\$ (67,929.58)

The team wanted to know the number of kits currently assessed after 90 days. Recall that every kit that has been assessed after 90 days and is found that is missing any part, damaged or missing tool in its totality, will have to be completely covered by the Tool Depot (Siemens Facility). The chart compares the number of kits assessed during 2016 and 2017. The Team highlighted the kits that have been assessed after 90 days or more. Surprisingly, it can be seen the number of kits for late assessment have been increased from 9 kits in 2016 to 16 kits in 2017 just in the Chain Fall area.

The second table provides the team an idea how much was the potential loss from 2016 to 2017 because of late assessment. The average price was calculated based on the actual Siemens kits cost. The average amount per kit is \$4,245.60. Then, the team assumes just one kit is considered

as total loss based on “after 90 days” policy. The assumed total cost loss from 2016 is (\$38,210.39) and from 2017 is (\$67,929.58).

These amounts reflect the urgency for a new implementation related to the racks organization and kits assessment.

c. Pallet redesign of the A-set and B-set:

Since the current type of pallet is considered as safety hazard as mentioned in chapter 4, the team has solved this problem with suggestion replacing this type of pallet with a pallet with 2 inches wall. This pallet will be safer when the technicians lift it up into the topper shelf of the rack. Also, using this pallet will increase the space usage of the rack in to 50% since the rack contains 6 racks, and they are using only 3 of them.



Figure 46: Custom-built Pallet (48" x 48" x 5" with 1/2" Plywood Top, 2" x 4"

Edge)

13. Maintain 5S:

Since the company does not have a janitor who cleans inside the areas, the team has come up with clear design and policy that would make the workers to be responsible for maintaining 5S in their areas. In fact, the chain fall area has five workers, each worker is going to be responsible for to maintaining the 5S in his parts. The team used Excel to create a responsibility card that includes the worker's name and picture and will be in each part inside the area as shown in Figure 23. This method of solution will save the company the money of hiring a new cleaning employee, and it will keep sustaining the company 5S.

14. Adding orders screen:

The purpose of this screen is to reduce the time of updating the orders into the area. As stated in the previous chapter, this screen will increase the productivity of the area since the workers will be notified immediately once the Shipping and Receiving Department receives the orders.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSIONS

In conclusion, the KSU Chain Fall team is certain to be on the right path to reach the improved layout for the Chain Fall area. The team's idea of an improved layout combines productivity and safety for the technicians that work there every day. On the productivity side, the team has used different surveys and asked for documents or records related to the Chain Fall area's production. Later, to run all this data through different programs and understand what are the problems that need to be implemented, corrected or changed. On the safety side, the team has been looking for the implementation of the area to reduce in every aspect any risk that can put the technicians in danger. This idea takes the team to the implementation of new tools and the development of safety features. The team's redesign of the layout of the chain fall area adheres to the satisfaction of the workers and management, safety, and higher productivity. The team will continue to collect data for the cost benefit analysis (OSHA) to determine the final decision for the pallet redesign and the surveillance cameras to install in the area.

6.2 RECOMMENDATIONS

There are a few future recommendations that could be done for more improvement such as adding signing in/out machine into the company's system. This machine will help to keep the record of workers' numbers of working hours. Also, it will save time for the management team since they must do data entry of the workers' hours into excel sheet every Friday for about 4-5 hours.

Another recommendation is to remove or exchange the chain hoist inspection machine (the third inspection machine) which is used to inspect only the small chain hoist while the other



two inspection machines are used to inspect both big and small chain hoists. Therefore, the third machine can be removed since it is rarely used or exchanged with a machine that is similar to the other two.

Also, strong communication is needed in the form of “walkie-talkies” between departments for quick and easy information sharing since the departments are constantly working together.

Finally, cameras could be installed in the chain fall area to prove that there are zero incidents in the workplace, and to maintain the safety and security of the area.

CHAPTER 7: REFERENCES

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APPENDIX A

Acknowledgements: Everyone that helped you

A.1 Blanche Singleton

A.2 Ernie Ayala (Project Manager)

A.3 Darin Bland (Operation Manager)

A. 4 Larry Holsey (Shipping and Receiving Manger)

A.4 Randall Weidner (Resident Expert)

A.5 Daniel Manzy (Material Logistic Specialist)

A.6 Chain Fall Area Technicians.

APPENDIX B

Contact Information (Student and Advisor Contacts)

B.1 Dr. Adeel Khalid

B.2 Dr. George Wiles

B.3 Dr. Christina Scherrer

B.4 Dr. Robert Keyser

B.5 Dr. Awatef Ergai

APPENDIX C

Reflections (The Educational Experience, Challenges Faced, Resolutions)

C.1 CHALLENGES FACED

The team faced many challenges during the time of working on the project. A summary of the challenges and the team's responses are shown in the table below:

Project Challenges for Layout and Process Improvement

Challenges	Description	Team's Response
<p>Limited space in the chain fall area</p>	<p>The team has limited options for moving the equipment. For instance, the yellow cabinet is flammable and cannot be close to the computers. The team must carefully decide the best, new location for the tools.</p>	<p>Make sure changes to layout do not restrict access to the chain fall workers and disturb their normal work flow.</p> <p>Take forklift routes into consideration.</p>
<p>Time constraints</p>	<p>There is not enough time to assess all the problems that the team learned of the area. There is also not enough time to monitor the process at Siemens, especially since it is the busiest time for them.</p>	<p>The team agreed on the problems that most contributed to area's inefficiency by specializing on fewer, more important areas. Two affinity diagrams and an Ishikawa diagram were used to focus on key areas and make recommendations for any possible future studies.</p>
<p>Lack of data</p>	<p>There is data that Siemens cannot provide for the team. For example, the team needs to find out the cost of each kit if it is not delivered in time or if it is not delivered at all.</p> <p>The chain fall area is opposed to helping us with data due to the stress of their work. Their willingness to help us and talk to us has deteriorated as time has passed.</p>	<p>The team called Ernie to ensure data collection. He can assign someone to review our data/observations.</p> <p>The team will generate data based on previous data and analyze expected results if data is retrieved.</p> <p>The team also decided to analyze the data collected so far to make the best, possible decision for the layout.</p>

APPENDIX X

(Supporting details and documentation)

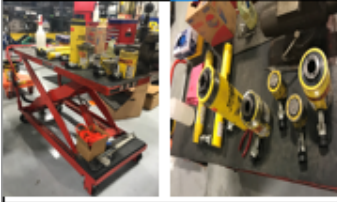



X.1 TECHNICAL CONTRIBUTION DETAILS.








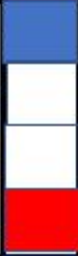




Task	Contributor(s)	Details	Completion Status
AutoCAD	Miguel Medina	Produces the current and the new final layout of the fall chain area.	100%
Arena	Esraa Abdulmahdi	Creates and runs Arena model to simulate the operation time of the storage area.	100%
Minitab	James Algarin	Creates different types of charts and diagrams to support and analyze the problem-solving approaches. Examples: Pareto Chart, and Control Charts.	100%
Excel	Miguel Medina	Creates different types of histograms to calculate different types of wastes.	100%
Work Instructions	Esraa Abdulmahdi	Creates Work Instructions for processes in the area to clarify them.	100%
Google Docs	James Algarin	Creates Affinity Diagram to classify the area's problems	100%
Surveys	Miguel Medina - Esraa Abdulmahdhi	Create two different type of surveys to collect data	100%
5S Responsibility Card	Esraa Abdulmahdi	Create a card with a name and a picture of each employee in the area to maintain 5S.	100%
Gantt Chart	James Algarin	Project's Schedule	100%

X.2 CHAPTER CONTRIBUTION DETAILS.

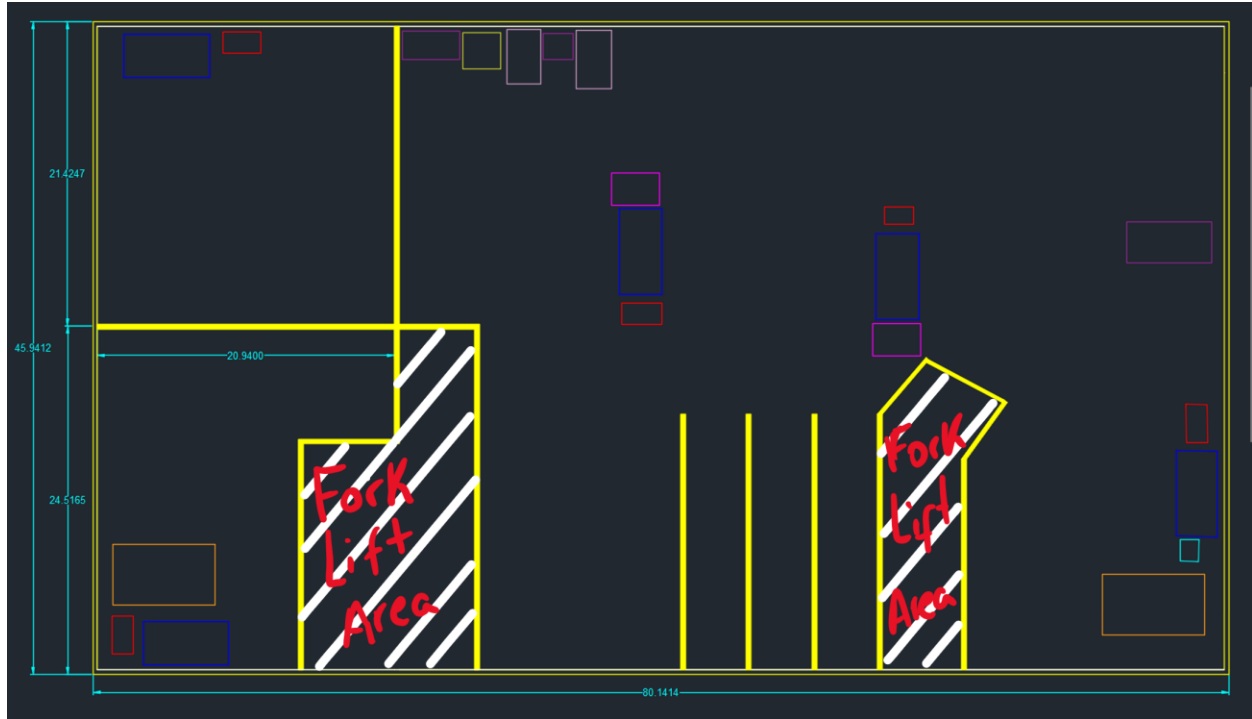
Chapter	Contributor	Completion Status
1	James Algarin	100%
2	James Algarin	100%
3	Miguel Medina - James Algarin	100%
4	Esraa Abdulmahdi	100%
5	Miguel Medina	100%
6	Esraa Abdulmahdi	100%
7	Miguel Medina	100%
Appendix A-B-C-X	Esraa Abdulmahdi	100%

X.3 HYDRAULIC TOOLS INSPECTION WORK INSTRUCTIONS:

SIEMENS		Work Instruction		Quality	Environment	Step	Safety
Hydraulic Jacks Inspection Process							
Picture	Action	Process	Why				
		Gather the required hydraulic jacks and put them on the moving cart.	To get all required tools closed by the inspection machine				
		Physical Inspection	To make sure that there is no cracks, required painting, or cleaning				
		Check the oil level	Open the tap at the top and check for the oil level and add some oil if it is required				
		Adjust the highest of the inspection machine	To have the correct height based on the size and dimensions of the jack				

		<p>Placing the Jack inside the machine</p>	<p>to start the inspection process</p>
		<p>Bring down the upper cylinder by</p>	<p>To test the machine</p>
		<p>Lift the cylinder inside the jack</p>	<p>To zero the jack in order to start the process</p>
		<p>Again, Bring the upper cylinder down and let attach the jack's cylinder</p>	<p>To start the inspection Process</p>
		<p>Close the security door of the machine</p>	<p>To ensure the worker and environment safety.</p>
		<p>Controlling and watching out the process</p>	<p>To test the pressure inside the jack. Up to 2% is the acceptable error percentage</p>

X.4 FIRST DRAFT OF THE LAYOUT DESIGN



X.5 POLICIES FOR THE CHAAIN FALL AREA:

1. In order to maintain the safety and productivity of the Chain Fall area, every technician is responsible for the cleanliness and organization for his/her own workstation.
2. The Chain Fall technician is in charge to re-enforce the safety and organization of the Chain Fall area to any other Siemens technician that is not part of the Chain Fall team.
3. Siemens technician will have to follow the Chain Fall area's boundaries to prevent any type of accidents or injuries. E.g. Forklift driving area.
4. Documents (inspections, log books, manuals) will be stored inside the Chain Fall area on the Cabinet storage for a period of six months. Any document older than six months, will have to be collected and stored in a different storage area assigned by Siemens and outside the Chain Fall area.
5. The Chain Fall technicians are responsible to review and demand that the other technicians record the correct information on the Log book for tools to be inspected. In addition, the Chain Fall technicians have the obligation to record correctly the tools they review and return to other departments.
6. Technicians are responsible to clean and retrieve any tool or equipment that they finished using back to its correct location.
7. The equipment used to recycle products will have to be taken to the salvage area as soon the equipment is full or not used anymore.
8. Technician will have to salvage the tool brought for repairing as soon as he/she notices the tool is not fixable.

9. If a tool is inspected and put on the side for waiting while the spare parts are not available at the moment, the tool will have to be tagged and dated. At this point, tools waiting for spare parts longer than 10 business days, will have to be recycled or salvaged.
10. The space highlighted as “High Season” at the tool receiving area will have to be used only during the high season or high demand of tools to be inspected. The less tools on the floor, the less risks of injuries the Chain Fall team will face.