Standardizing and improving the efficiency of Michigan Medicine’s supply chain management of hospital supplies

Final Report

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EXECUTIVE SUMMARY

The supply chain system for medical supplies at Michigan Medicine organizes, submits orders, and distributes medical supply items throughout the hospital. This service is important because it allows the nurses and physicians to provide quality care to patients. The Supply Chain Manager is concerned that the system is inefficient and ineffective because it takes a long time to distribute items, leading to stock outs and use of expired goods. Therefore, Michigan Medicine is in the process of launching a two-bin supply chain system to improve the supply chain system. The Supply Chain Manager requested that IOE 481 Team 1 from Michigan Medicine evaluate the two-bin system and identify critical problems in the supply chain management. This will allow Michigan Medicine to better balance the workload of stock keepers, reduce supply chain distribution time, and manage variables and distribution times. The scope of this project included analyzing time study data, evaluating the two-bin system, and providing system implementation recommendations.

Background
Michigan Medicine distributes medical supplies by utilizing stock keepers to manage inventory in each hospital unit. The stock keepers are responsible for collecting supplies, managing inventory levels, and reordering in correct quantities. The stock keepers begin their shift by collecting supplies from the warehouse and stocking their distribution cart. This is based on quantities of supplies ordered the previous shift. Then the stock keepers go to their assigned unit to distribute the supplies. Once the supply is replenished, the stock keepers check to see if there is more supplies that needs to be reordered. The stock keepers know to reorder supplies when there are empty bins on the top shelf in the supply room. These bins represent a “kanban” which in Lean Manufacturing is a signal that notifies the system to do something. With the two-bin system, an empty bin indicates that it is time for the stock keeper to order more supplies. In each supply room, the kanban signals the stock keeper to order more of that item.

Methodology
The team performed the following tasks to address the Supply Chain Managers’ concerns:

● **Literature Search** - The team conducted a literature search on lean supply chain management and healthcare operations research to gather information on data collection techniques, statistical analysis, and simulation modeling used with similar processes. The papers obtained during the literature search helped the team investigate input modeling techniques as well as simulation modeling input analysis that established methods of data analysis to perform on the time study data collected.

● **Historical Data Analysis** - The team received time study data on the supply chain system prior to the two-bin system implementation from the project coordinator. This data was collected by the stock keeper, tracking relevant information about the process of the supply chain system. This information included the date the stock keeper worked and the
time for each event the stock keeper completed during his or her shift. Each event was also given a description and category that it was grouped under. The team had information from 37 stock keepers during the week of January 19 to January 25, 2017.

- **Two-Bin System Time Study** - The team received time study data for the unit 5C stock keeper during the month of February and March. This time study data centered on categorizing the time that the stock keeper spent carrying out certain activities. These activities included travel time, wait time, sub-stocking, stocking, unit interaction, inventory, and stock outs. This information would later be used to analyze the percentage of time that the stock keeper spends performing each task as it relates to Unit 5C.

**Findings and Conclusions**

The team made the following conclusions from the information gathered and analyzed:

- **Literature Search** - The first document, *Prioritizing Lean Supply Chain Management Initiatives in Healthcare Service Operations*, discussed the implementation of technological solutions to improve supply chain operations provided background information on the importance of simulation modeling for hospitals representation. The second document, *Design and Analysis of a Health Care Supply Chain Management*, was helpful when developing input parameters for the simulation model. The team looked at measures necessary for conducting the time study and analyzing the collected data.

- **Historical Data Analysis** - The team requested historical data to create a baseline to compare the two-bin system time study data. The hospital team had divided the typical stock keeper activities into three categories: Reactive Inventory Practices, Strong Inventory Practices, and Required Non-Inventory Time. The hospital team found that 27% of stock keeper’s time was spent completing Reactive Inventory Practices, 61% Strong Inventory Practices, and 13% Required Non-Inventory Time.

- **Two-Bin System Time Study Data Analysis** - Based on shadowing data provided by the coordinator, the project team was able to create graphical comparison of the two different supply chain replenishment processes. It was found that the average process times of several of the regular stock keeping activities decreased. However, the amount of interaction that had to occur with the nurses within unit 5C decreased dramatically. This could be attributed to the adjustment period that accompanied the implementation of the two-bin supply room replenishment process. Additionally, the team found that the percentage of time spent stocking the unit itself actually decreased. Although the team had limited data, the overall conclusions indicates the hospital is working in the right direction. Ideally, as more data is collected the average process times will continue to decrease as will interaction with employees within the unit.

**Recommendations**

The team recommends the following work to improve supply chain management of medical supplies at Michigan Medicine:
- **Staffing Model** - The team recommends that Michigan Medicine Supply Chain team implement a lean staffing model because it will be a useful tool in determining how many stock keepers are required to manage the two-bin supply room replenishment process. The staffing model will work with the inputs and outputs of the simulation model to generate simple staffing numbers immediately after a simulate take place. All that is required of the graduate team building the model is that they ensure that the simulation model reports out the average process time at each station in the simulation and that the amount of item lines that were replenished is counted. Those metrics along with total stock keeper availability can be used to have a better idea of what is the necessary amount of stock keepers needed so that the process keeps pace.

- **Improved Communication** - The team recommends that Michigan Medicine implement an onboarding plan for the two-bin system because the nurses and hospital staff aren’t following the two-bin protocol as they should be. An onboarding system will be crucial to the two-bin system’s effectiveness because the system cannot function as intended unless the hospital staff understands the process. The team recommends that Michigan Medicine increase its communication to the nurses by posting flyers in the staff bathrooms on each floor. The bathrooms are an important place to communicate to nurses because they are frequently used and nurses have the time to read flyers while there. The team also recommends that communication of the two-bin system continue through nurse meetings and email communication.

- **Dashboard** - Michigan Medicine needs to utilize a dashboard to maintain a high level view of all metrics associated with the two-bin supply room replenishment process. The dashboard groups all the metrics into a single table and allows the changes in the metrics to be seen over time. For the dashboard to be more compatible with the simulation, the project team determined which metrics were most critical to the evaluation of the two-bin replenishment process and if the simulation could generate them as an output. From there the team worked with making slight changes to the design and inputs of the simulation so that the desired metrics could be easily outputted and recorded.

- **Barcode Scanners** - Michigan Medicine should consider implementing barcode scanning technology into the two-bin supply process. This technology would allow stock keepers to complete their work more accurately and efficiently. The Barcode scanners would allow stock keepers to scan the empty bin barcodes for reorder, automatically send the information to the computer system, and then mark the supply for reorder. This technological improvement has the capability to decrease the overall lead time for orders and increase the accuracy of inventory taken by stock keepers.
INTRODUCTION

Michigan Medicine is a health care system that focuses on being the leaders and best in healthcare, innovation, and education. In order to provide the best quality of patient care possible, it is important that physicians and nurses have access to quality medical supplies. The Supply Chain Manager of Michigan Medicine wants to improve the current supply chain system because she believes that the current medical supplies distribution throughout the hospital is inefficient and creates waste.

Michigan Medicine has developed a two-bin supply chain system that will increase the efficiency and effectiveness of the medical supply distribution by stock keepers. The two-bin supply chain system has been launched in Unit 5C, the primary unit of study for this project. Ultimately, the goal is to launch this two-bin system throughout the entire hospital. Before launching the program, Michigan Medicine wants to determine how long the old system took, how long the two-bin system will take, and how many stock keepers are required for the two-bin system.

The team developed a simulation model that compares the old supply chain process to the two-bin supply chain process. This required utilizing time study data, provided by Michigan Medicine, on the old supply chain system. The team determined necessary input parameters, conduct time studies on the two-bin supply chain system by studying Unit 5C. The team used this information as input data for the simulation model and extrapolate the data to be applied to the entire hospital system. The results for the simulation model for medical supply distribution by stock keepers can be applied to the entire hospital. This proposal discusses the plan for the project including an action plan, proposed approach, and timeline.

Michigan Medicine distributes medical supplies by utilizing stock keepers to collect supplies from the warehouse and deliver them to each hospital unit. The current system operates inefficiently and leads to staff running out or using expired supplies. In response, Michigan Medicine has developed a two-bin supply chain system that will increase the effectiveness of stock keeper medical supply distribution and improve the quality of patient care. Before launching the program throughout the entire hospital, the team has evaluated the proposed changes by creating a current state SIPOC and future SIPOC. To quantify the two-bin system, the team determined necessary input parameters, conduct time studies, and analyze data by studying Unit 5C. The team used this information and collaborated with a graduate level team that are experts on simulation modeling. The team analyzed data and develop an input model for the graduate team to utilize while developing a simulation model for the entire hospital. Currently, the team has conducted staff interviews and observed stock keeper work. The next steps involve designing the current state map and developing time study parameters. This report discusses project goals and objectives, the engineering approach, and recommendations.
BACKGROUND

The supply chain system at Michigan Medicine involves various steps. As a general overview, the supplies arrive at the warehouse and are placed in corresponding inventory locations. This inventory is then stored in the warehouse until needed elsewhere in the hospital. Stock keepers access the supplies, collect the correct quantity, and distribute the supplies to the correct unit in the hospital. Stock keepers are assigned to specific units where the stock keepers are responsible for monitoring and managing inventory levels of medical supplies. Currently, the stock keepers check the quantity of supplies available in each unit’s supply room, med room, and nurse servers and order more supplies if needed. Due to time constraints, stock keepers usually spot check the medical supply levels and record these values. Based on the stock keeper’s experience with each unit and knowledge of each unit’s daily supply requirements, the stock keeper re-orders the supplies.

Despite the established process, the current medical supply system is out of date and inefficient for stocking units throughout the hospital. The current process requires stock keepers to count the remaining amount of supplies, know the usage tendencies of nurses, and be incredibly familiar with how each individual supply room works. The current system is unorganized and places more workload than necessary on all stock keepers and nurses. Furthermore, the current inefficient system has been in place for 10 years without any change or modification. This process needed to change as the unstandardized process places excessive and unnecessary stress on nurses and stock keepers, and may lead to shortage or oversupply of certain crucial medical supplies. Not only does this waste time and money, it also can create an environment that may not provide optimal care for patients.

A much needed change, the new medical supply process distribution employs a two-bin system that is far more efficient, lessens workload on stock keepers, and standardizes the distribution process. A two-bin style system enforces first-in-first-out which is especially needed for medical supplies. Essentially, for each specific medical supply there will be two bins, each with a predetermined optimal holding quantity. When one of these two bins is completely empty, it will be placed on top of the supply shelf. This empty bin serves as a kanban, or visual indicator, as to which supplies need to be restocked. The two-bin system is projected to lessen the time it takes for stock keepers to take inventory, and reduce over-ordering tendencies. The goal of the project is to design the best ways to implement the two-bin system throughout the hospital.

**Key Issues**

The following key issues were the focus for this project:
- Michigan Medicine has poor inventory control and supply distribution
- Current system leads to expired supplies, inaccurate reorder quantities, and stock outs
- There is an excessive workload for stock keepers
Goals and Objectives
The goal of the project was to determine the output and staffing needs of the two-bin supply chain system. The team aimed to do this by completing the following tasks:

- Create a SIPOC for the current state
- Develop a SIPOC for the future state
- Determine input parameters for a simulation model
- Provide metric monitoring system and track parameters on a dashboard
- Analyze time study data of the two-bin system

With this information, the team developed recommendations to:

- Create a staffing model to assist schedulers in determining how to staff stock keepers to accommodate workloads
- Implement an onboarding plan for the two-bin system and increase communication with the nursing staff

Project Scope
This project only included the replenishment process and its implementation for the supply room in Unit 5C of the Michigan Medicine hospital. The stock keeper and nurses in Unit 5C were the only employees whose processes were monitored. This project followed the process for the stock keeper determining when it was time for a bin in the supply room to be replenished.

This project did not include the replenishment process in other units in the hospital or specialized units. This project did not take into account the cost of additional workers to meet staffing requirements.

METHODS
The team focused largely on the process of stocking hospital supply rooms. Members of the team shadowed a stock keeper using the old medical supply system, synthesized historical data containing information about the current two-bin system, and distributed a time form to the stock keepers who were the first to implement the two-bin system. The team quantified several different methods of data evaluation.

Observations
The team conducted observations by shadowing the Unit 5C stock keeper during his daily tasks. This included watching him break down his pallet in the warehouse, transfer all supplies to a cart, travel to Unit 5C, and replenish the supply room and nurse stations. After this was completed, the stock keeper walked the team through the process he used to reorder supplies. Initial observations were conducted before the two-bin system was in place.
After the two-bin system was implemented, the team conducted more observations with the stock keeper along with other stock keepers in different areas of the hospital. The team was introduced to the various two-bin systems that were in place, including a system that utilized pulling down a tab to signal that a supply needed to be ordered and a system that involved flipping the bin to signal reordering. While the team conducted these observations, the team also talked to additional stock keepers to learn more about the problems they saw in order to identify areas for improvement.

**Data Collection Methods**

The essential first steps of this project focused on familiarity with the system and positive change. The following methods were used to collect data about the medical supply distribution supply chain at the hospital:

- The team received historical data about the stock keeper system. The hospital’s own project team collected data from 37 stock keepers during the week of January 19 to January 25. After tracking the events of the stock keepers, the hospital team divided typical stock keeper activities into three categories: Reactive Inventory Practices, Strong Inventory Practices, and Required Non-Inventory Time. The hospital team found that 27% of stock keeper’s time was spent completing Reactive Inventory Practices, 61% Strong Inventory Practices, and 13% Required Non-Inventory Time. The purpose of this work done by the hospital team was to better understand how stock keepers utilize their time during the work day. The project team compared the activity data of the old system to data from the two-bin system.

- Time Studies collected by the hospital team, consisting of the day to day activities of stock keepers, were curated from the old medical supply system. The hospital team shadowed the stock keeper for one day while using the old inefficient medical supply system. The Unit 5C stock keeper was the first to utilize the two-bin system.

- Time Studies conducted by the project team for the newly implemented two-bin system were collected. The team shadowed the stock keeper for one day while he was utilizing the newly implemented two-bin system. This data was essential for comparing and contrasting time for specific activities already classified in previous time studies.

**Data Analysis Methods**

The team’s data analysis methodology centered on Value Margin Improvement (VMI). The mechanism of VMI observes the current ways in which the system functions, and points out possible system improvements. As the team was not tasked with the actual simulation of the medical supply chain system the team has placed emphasis on assessing other parts of the
system. Through utilization of a SIPOC, a future SIPOC, observations, input modeling, and data analysis the team will accurately evaluate the realistic benefits of the two-bin supply system.

Both the SIPOC and future SIPOC are lean manufacturing techniques utilized to assess the current situation. Each approach to a system focuses on five specific areas: the supplier, the inputs, the process, the output, and the customer. A SIPOC details all significant factors in any of these five parts of the system. Furthermore, a SIPOC addresses the current system while a Future SIPOC analyzes the future system. These two methodologies are crucial tools to evaluate the changes in the state of the medical system.

In addition to two SIPOCs, the team synthesized all observations, effectively analyzed the data, and accurately analyzed the simulation inputs. Though the project team was not directly tasked with simulating the current or future state of the medical supply chain, the hospital was yet to analyze the significant simulation inputs. An important first step to any simulation, input modeling supplemented and improves data analysis. Through gauging the significant factors based on trends in the observational data, the most effective inputs were modeled.

**FINDINGS AND CONCLUSIONS**

Using the methods described previously, the team developed findings and conclusions to achieve the goal of determining the output and staffing needs of the two-bin supply chain system. The team’s findings came from a literature search, time study analysis, and development of a SIPOC and Future SIPOC.

**Literature Search Findings on Input Modeling and Simulation Methods**

The team investigated the relationship between lean supply chain management and healthcare operations by researching literature. This is important and relevant to the project because the two-bin system developed for Michigan Medicine need to integrate into the healthcare system and need to parallel with health care protocol. The first article focuses on prioritizing lean supply chain management initiatives by utilizing technology, while the second article defines parameters for inventory management in healthcare systems.

The first paper introduces technological solutions that vastly improves supply chain operations. One application of technology is simulation modeling to allow hospitals to represent the entire healthcare system and examine that supply chain system by changing various conditions. Simulation modeling can be implemented in Michigan Medicine’s plan to improve the supply chain management of hospital supplies by modeling the potential of the two-bin system throughout the entire hospital. The article discusses challenges when creating a successful simulation model in healthcare such as collecting a sufficient amount of related input data. The team worked with Michigan Medicine to ensure that there is enough relevant data to be applied
to a simulation model. Another issue is actually implementing the model throughout the healthcare system. According to the paper, often simulation model studies in health care demonstrate a conceptual level, but fail to implement the actual model. The team developed a plan and steps for implementation.

The second article gave the team insight to the parameters involved in inventory management. This is specifically relevant to this project because the team was identifying the measures necessary for conducting the time study and evaluating the collected data. The article emphasizes the importance of a successful supply chain management system and the effects in a healthcare system. These effects include safety for the patient, more economical system for the organization and a more efficient method of using hospital resources.

**Time Study Data Analysis**

The team investigated the effects of the two-bin system on the medical supply chain in the hospital through data analysis and forming conclusions about specific activities in the process. Stock keeper time study data was synthesized to show the percentage of daily activity spent completing work specifically relevant to unit 5C. These activities were: Taking Inventory, MSR (paperwork), Stocking, Travel Time, and Unit Interaction. The “Pre Two-Bin” and “Post Two-Bin” systems are depicted in the double-bar graph, shown in Figure 1.

![Figure 1. Percent of 5C Activity](image)

The team found that the time spent interacting with the unit and taking inventory increased with the two-bin system. However, percentage of time spent stocking the unit itself actually decreased. This is due to the fact that the metrics including the time to take inventory, complete MSR paperwork, stock supply rooms, travel, and interact with the unit have increased after the implementation of the two-bin system based on the time study data collected. Additionally, the team found that the stock outs decreased over time, as shown in Figure 2.
Although the sample size of time study data is not large enough to generalize these findings to overall conclusions, this data provides information indicating that the hospital in the right direction. In the long term, the two-bin system will be more effective with preventing stock outs and expired product, but there have been some issues with the implementation thus far. The team developed a set of recommendations assisted in improving the two-bin system process to reduce the time metrics and make it a more efficient supply system.

**SIPOC and Future SIPOC**

The SIPOC and the Future SIPOC, Appendices A and B respectively, show various customers and inputs to the system that were not previously considered. Customers to the medical supply system were listed as patients, nurses, and families. Suppliers were listed as stock keepers and medical supply orders. Inputs were the supplies themselves and the replenishment technique, whereas the outputs were empty supply bins, medical supply orders, and medically supply availability. The process details a high level overview of the supply unit replenishment process.

The SIPOC directly explains why the stock keeper had increased unit interaction post two-bin implementation. Since nurses are included as a customer of the process, the communication between stock keepers and nurses is essential for a smooth transition into using the two-bin process. A portion of the time study data was collected during the beginning stages of two-bin, when much of the process had not been communicated to the nurses utilizing the two-bin system. Therefore, more unit interaction was needed in order to inform nurses about the newly implemented system. Furthermore, this all ties back to the idea that nurses are customers to the process.
RECOMMENDATIONS

Staffing Model
The project team has developed a Microsoft Excel based staffing model using lean principles. The model is meant to take in values generated by the simulation and shadowing data to determine what is the optimal staffing for the two-bin supply room replenishment process. The team has also developed recommendations for changes to the simulation currently being developed by the graduate student simulation team so that it may better fit with the excel model. The simulation must account for the time availability of the stock keepers, the required amount of items for the supply room, and the amount of time it takes to complete certain activities in the replenishment process. The staffing model, shown in Appendix D, was created with the capability to be fit along with the simulation in order to have up to date information on what the ideal staffing is for the two-bin supply room replenishment process.

Improved Communication
The team recommends that the hospital increase its communication between the stock keepers and nursing staff to further improve the implementation of the two-bin system protocol. This can be done through direct communication and team meetings with hospital staff, nurses, and stock keepers. As a collaborative group, a training program can be developed so all users of the system can fully understand the two-bin system.

Written material is another way to distribute information on two-bin protocol. Flyers can be placed throughout the unit, particularly in the bathrooms, so that the nursing staff is made more aware of how to work with the new system. The team recommends placing flyers in the bathroom because it is a place frequently used by nurses where they have free time to read material posted on the walls or on the back of bathroom stalls. Flyers and other communication with hospital staff is crucial to the success of the two-bin system because the process design will not succeed unless protocol is followed. The hospital staff needs to be able to understand the system and the reasons for the implementation of two-bin in order to follow protocol and have the system succeed.

Dashboard
A tool to evaluate continuous improvement of the two-bin process is a dashboard, shown in Appendix C. This tool will maintain a high-level view of all metrics associated with the two-bin system. A dashboard will enable the supply chain team to closely monitor how the hospital staff is adjusting to the two-bin system through the performance of key metrics. These key metrics are segmented into categories including quality, time, employee engagement, and finances. It will also demonstrate the quality of fit for the two-bin system and where the system makes major productivity gains. Furthermore, the dashboard is meant to enable the client to communicate the progress of the two-bin supply replenishment process throughout the hospital.
Barcode Scanners
The team’s Future SIPOC, shown in Appendix B, describes how to implement barcode scanning technology in a lean medical supply process. This is technology that Michigan Medicine can launch once the two-bin system is fully implemented. Barcode scanners would allow stock keepers to scan the empty bin barcodes for reorder, automatically send the information to the computer system, and then mark the supply for reorder. Implementation of a barcode scanner has the potential to decrease the overall lead time for orders and increase the accuracy of inventory taken by stock keepers. Additionally, this allows for stock keepers’ pick plans to be assigned as needed, minimizing waste of medical supplies.

EXPECTED IMPACT

In completing this project, the team hopes that their recommendations will assist in improving the communication between the stock keepers and nurses to ensure that the nurses are following the two-bin protocol. The team also hopes that the dashboard will assist in maintaining the metrics of the two-bin process to eliminate poor practices in stock replenishment and identify areas for process improvement.

In developing simulation inputs and giving them to the graduate student simulation team, the graduate team will continue working on a simulation model to develop recommendations for a stock keeper stocking model. The goal is that the developed staffing model will increase stock keeper efficiency during each shift and allow stock keepers to accomplish more work in a shorter amount of time.
References

Appendix A: SIPOC

**Process**

- Stock Keeper
- Medical Supplies
- End Supply

**Suppliers**

- Stock Keeper
- NURSE
- Medical Supplies

**Inputs**

- Stock Keeper
- Nurse

**Outputs**

- Stock Keeper
- NURSE

**Customers**

- Stock Keeper
- Patient

**Future S**

- Stock Keeper
- Medical Supplies

**NOTE:** The changes in SIPOC are an indication of improved accuracy and increased efficiency.
### Appendix C: Dashboard Template

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<thead>
<tr>
<th>Category</th>
<th>Metrics</th>
<th>Description</th>
<th>Data Source</th>
<th>Reporting Frequency</th>
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<td>Unit Supply Chain Time</td>
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<td>Monthly</td>
</tr>
<tr>
<td></td>
<td>Stocked Rate</td>
<td>The ratio of items that were stocked to those that were ordered</td>
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<td>Monthly</td>
</tr>
<tr>
<td></td>
<td># of Lines/SC's</td>
<td>Represents the number of lines/SC's in the system</td>
<td>Monthly</td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td>Quality</td>
<td>Represents the quality of the supply chain</td>
<td>Monthly</td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td>Sup. Order Rate-Not Stocked</td>
<td>Represents the rate at which suppliers are ordering items not in stock</td>
<td>Monthly</td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td>Sup. Order Rate-Stocked</td>
<td>Represents the rate at which suppliers are ordering items in stock</td>
<td>Monthly</td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td>Emn Turnover Rate</td>
<td>Represents the rate at which items are being turned over</td>
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<td>Monthly</td>
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### Appendix D: Staffing Model

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</tr>
<tr>
<td></td>
<td>Stocking</td>
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</tr>
<tr>
<td></td>
<td>Stock-Outs</td>
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<tr>
<td></td>
<td>Travel</td>
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<tr>
<td></td>
<td>Unit Interaction</td>
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</tr>
<tr>
<td>Total Stockkeeper Availability (Min)</td>
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<td>66</td>
</tr>
<tr>
<td>Amount of Orders</td>
<td>78</td>
<td>390</td>
</tr>
<tr>
<td>Simple Staffing (People)</td>
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<td>1.477</td>
</tr>
</tbody>
</table>