THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF SUPPLY CHAIN AND INFORMATION SYSTEMS

ESTABLISHING A MORE EFFICIENT INVENTORY WAREHOUSING OPERATION IN MEDICAL LOGISTICS FOR THE UNITED STATES MARINE CORPS

DANIEL JOHN ROSE
SPRING 2016

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Supply Chain and Information Systems
with honors in Supply Chain and Information Systems

Reviewed and approved* by the following:

Robert Novack
Associate Professor of Supply Chain Management
Thesis Supervisor

John Spychalski
Professor Emeritus of Supply Chain Management
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

ABSTRACT

With the needs and demands in supply chains increasing and growing quickly, organizations are looking for new ways to meet demand and to make their operations more responsive while staying efficient and effective.

This research studies the Medical Logistics Company for the United States Marine Corps at their base at Camp Lejeune in North Carolina. The Medical Logistics Company houses equipment and medications and prepares them for deployments and missions in areas all over the world. With sensitivity to expiration dates, strict lead times, and the importance of having supply on hand, some challenges arise that can lead to waste and high costs to the organization.

Through a background study, a review of medical and supply chain literature, and interviews with companies and executives in various health-related fields, some common challenges and supply chain solutions have presented themselves in this research.

Companies and organizations are often able to improve the operation of their facilities and processes by using organized electronic inventory systems, carefully monitoring and allocating inventory to minimize waste, and postponing movement of products until the products are ready to be used by the customer. Hopefully, through some of these ideas, the United States Marine Corps will be able to more effectively manage their inventory and operations as they continue to meet the demands of their customers.

TABLE OF CONTENTS

LIST OF FIGURES

ACKNOWLEDGEMENTS

I would first like to begin by thanking my thesis supervisor and one of my greatest mentors from my years at Penn State, Dr. Robert Novack. He has provided wonderful support, advice, and guidance during my years of study and throughout this process. Also, I would like to thank Dr. Charles Nicholson who has been a great teacher, mentor, and friend over the past few years. He has always pushed me to be the best student possible in the classroom and has never hesitated to assist me in any way possible. Last, but certainly not least, I would like to thank my parents for all of their support and guidance over the last twenty-two years. All the way through my upbringing, they have provided me with more than I could ever ask for, always offering their love and encouragement in my academics, athletics, and service activities. I would not be the person that I am today without their teachings of faith and values, and I will always be extremely grateful for all that they have done for me.

Chapter 1

Introduction

With the ever-increasing complexity of supply chains' demands and needs, organizations need to continue to work to be both responsive and efficient in their operations in order to meet customer demands. There is often a tradeoff between responsiveness and efficiency, as shown in Figure 1, and it more often than not costs more in order to maintain shorter lead times.

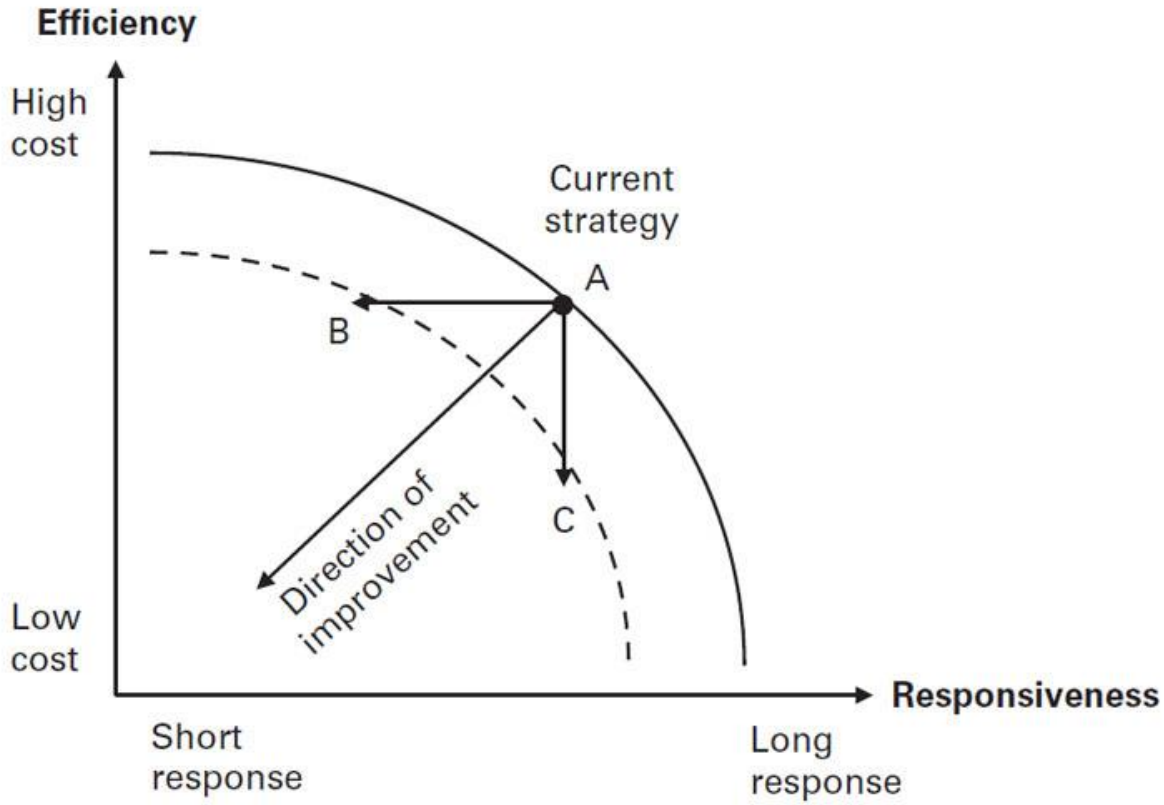

Figure 1. Efficiency vs. Responsiveness

Organizations work to strike a balance between these two options, and this becomes difficult when the products being considered are high priority or integral items to an operation.

Companies are looking for new ways to improve their operations in order to be more responsive to demand or to lower costs, and this can come in many forms throughout the supply chain.

Because every company, organization, and operation differ, supply chain and logistics strategies vary depending on resources and processes in place. Depending on the type of product that is being worked with, there are different needs that must be addressed. For example, with temperature sensitive or products with expiry concerns, inventory and movement strategies may need to be adjusted in order to accommodate those needs. For an order to be fulfilled, product needs to be picked from previously stocked shelves, prepared for shipment, and sent on its way in a timely fashion. All of this needs to take place in order to meet customer demand on time, and this can present many challenges.

The purpose of this thesis is to evaluate the medical logistics operations with the United States Marine Corps and to provide insight into areas that may be improved in order to be more responsive to demand while also keeping an efficient and effective operation in place.

From here, this thesis will discuss some of the background of the medical logistics operation at Camp Lejeune. After the background, a literature study will be completed to become more informed about the topic at hand and related areas in supply chain. The methodology of

this study will then be discussed, followed by the results that have been found. Based on the background, literature review, and results compiled during the study, recommendations and conclusions will be drawn along with future actions that can take place to further improve and expand upon the work that has been done in this paper.

Chapter 2

Background

Initial discussions were started with the representatives at Camp Lejeune, as the project was underway. Eventually, research was conducted during a two-day visit to Camp Lejeune in order to gain a more full understanding of the magnitude of the fulfillment operation and the main challenges and issues that are at hand.

Current Fulfillment Operations

At the beginning of the fulfillment operation at Camp Lejeune, material is acquired from vendors. Eighty percent of the material that is purchased comes from the prime vendor for the respective items. Typically, medications and equipment have separate prime vendors for supply of items in this specific operation. Contracts have been set up with those prime vendors, but this process happens higher up the chain of command. Additionally, fifteen percent of the materials are purchased from the Defense Logistics Agency (DLA) or smaller vendors in the system. Under this umbrella, smaller suppliers are often used for products that are very limited in availability or for items that are needed in a faster manner than the typical lead times. For the last five percent, a purchasing card is used to replenish the warehouse.

After the materials are ordered, there is a typical lead-time of forty-eight to ninety six hours. The prime vendor is the fastest in regards to lead-time. Along with this, a “fill or kill”

policy is in place. This means that if an order is placed and the supplier does not have the quantity in stock that is demanded, the order is cancelled. The Medical Logistics Company (Medlog) currently has to run a report manually to see that this has happened, and a new order needs to be generated with a new vendor. When the material that has been ordered is received, the pallets need to be signed in manually, unpacked, and checked over for any damage or issues with the shipment. Any disputes with the shipment must be submitted to the vendor within five business days of receiving the shipment. Once the shipment has been signed in, it is received into the Defense Medical Logistics Standard Support System (DMLSS) through manual entry by document number. It is received against a "location" that it was ordered from: either an assemblage/block or a physical location on a shelf.

From the point of receipt against the designated location, product is moved to the assigned location. The main warehouse location is in an assemblage or block. In this area, Expeditionary Shipping Containers (also referred to as "cans") are held that will contain supplies that are needed for a mission. Supplies that have shelf lives and can expire are not held in this location, rather they are held in the med cage. These kits are held within the cans that can be easily taken into a mission when it is time to deploy. Every four years, individuals at Medlog meet with the doctors to determine what needs to be included in the different kits. Although this is updated more often, this review process every four years determines main changes or transitions into new equipment and devices that have been developed. Other locations include the med cage, consumable cage, and non-expiry cage. The med cage contains medications and perishable items that are maintained for expiration dates and for storage purposes. The contract with vendors states that perishable items need to have a twelve-month shelf life as they come in.

Medlog prefers eighteen months, however. Product with a shorter shelf life is permissible, but it must be known that this product will be used very quickly once it is brought in. Because of this shelf life concern, a first in first out (FIFO) method is used when handling this inventory. The consumable cage contains items and supplies that do not have shelf lives and focuses more on equipment and supplies such as bandages, wraps, and devices. The non-expiry cage will house any extra supplies that may have come with an order. For example, larger quantities than needed are sometimes brought in because of bulk packaging. Those that are not needed or that cannot be stored in the assemblage or consumable cage can be stored in the non-expiry cage for the time being.

Within the warehouse, perishable items and medications are reordered with the goal of replenishing the med cage. These items are not placed in the assemblage or block when they are received in. Non-expiry items, however, are reordered to replenish the block and what has been used in that location. Before ordering, Medlog refills the blocks from the consumable cage. If an item is not housed in the block or the consumable cage, an order is placed to replenish the supply.

The next step in the process includes Medlog receiving an order for kits for a deployment to a mission. These orders come from customers that include different battalions within the Marine Corps. In order for this to happen, a Health Services Support Element (HSSE) letter needs to go through approvals before the mission. The HSSE letter must go up the chain of command through the unit Commanding Officer (CO), the Major Subordinate Command CO, and the II Marine Expeditionary Force Surgeon’s office for final approval with at least forty-five

days before the mission. Once these approvals happen up the chain of command, the letter comes to the Medlog ops division. Ops will inventory the items that are currently in stock and check in the system so that there is an understanding of what is due in with a shipment. If a material or piece of equipment is needed and it is not in stock or on order, the ops division will check in with the resources division to see what needs to happen in order to have material brought in. When it is time to begin to get kits ready for deployment, Medlog has a few steps that need to take place. First, the specific kit that has been ordered will be stocked with the correct medications and perishable items that had been housed in the med cage. Once the kit has been stocked with everything that it needs for deployment, Medlog will go through everything with the customer one by one. This is called the "pre" limited technical inspection. When the customer is ready to return to Medlog and go through this process again, they will return and individually look through the prepared shipment on a can by can basis to make sure that everything is in stock and ready to go. If the customer is satisfied and the kits are ready, the customer can then take the kits and proceed to the mission.

After the mission is completed, the kits are sent back to Medlog. When the kits arrive, each can is opened up and inventory is completed on all items. Anything that is labeled temperature sensitive gets counted as a used item and it is then disposed of. If any perishable items can be reused or re-shelved, Medlog will allow this to happen. If these items are expired or damaged, they are counted as used and are disposed of properly. In order to dispose of items after kits come back, Medlog has a few options. Any "sharps" such as syringes are disposed of in their own area. This is to prevent any accidents or injuries from occurring. There is also the Defense Reutilization Management Office (DRMO), which is a DoD disposition program office

that receives obsolete, replaced and no longer required material and equipment across all classes of supplies and either sources them to other DoD or government requirements, or attempts to liquidate them on the open market. Additionally, some items can be disposed of in the trash. For some medications, Medlog is able to use a med returns process to dispose of them properly and to recover a portion of the money spent. With the accepted medications, Medlog normally can see ten cents on the dollar in credit for returns. This method is used whenever possible. Once inventory is completed and all used materials are accounted for, this is when Medlog will charge their customers for the used products. If anything is unused and does not have a shelf life, it is kept in the kit to go back on the shelf. At this point, one fulfillment cycle has been completed and Medlog is then able to send a demand signal for the non-expiry material in the specific kits in order to replenish what was there. When the replenishment order is brought in, it is replaced into the kits, and any extra that came along with it is stored in the consumable or extra cage.

Below, in Figure 2, a more visual summary of the process described above is represented in the material flow chart.

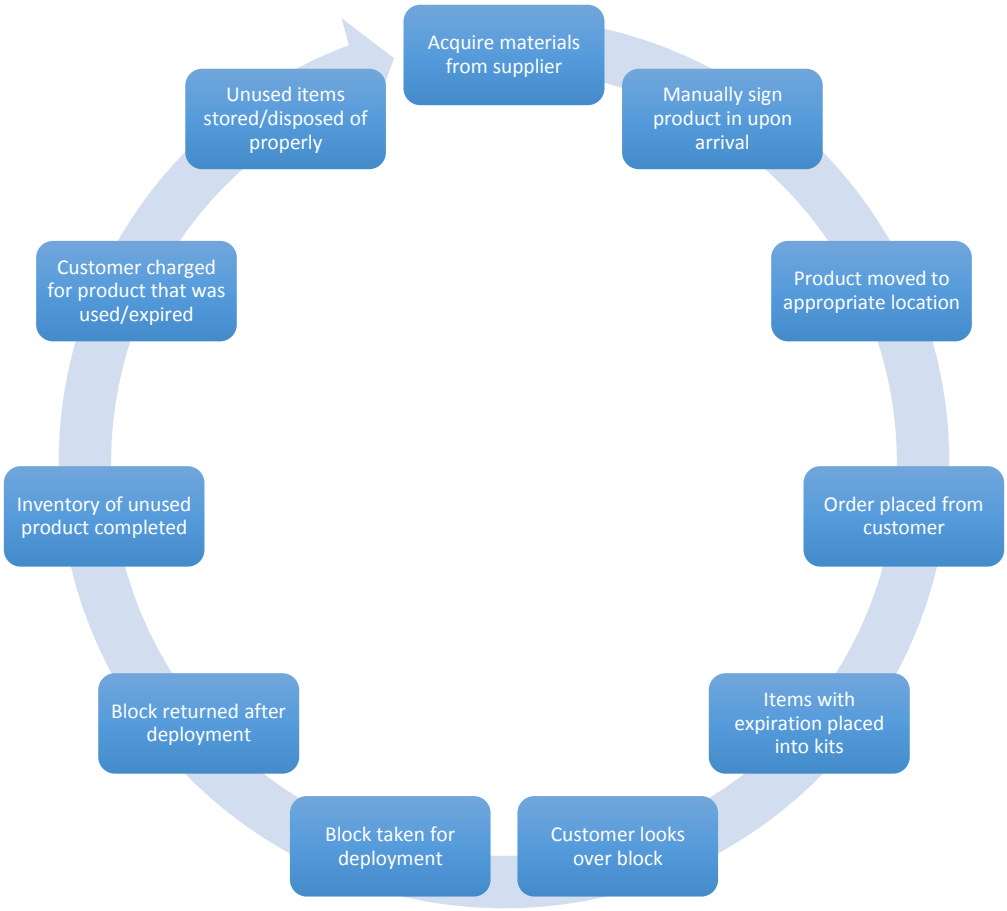

Figure 2. Flow of Material Summary at Camp Lejeune

Challenges Faced

Within the operation at Camp Lejeune that has been previously discussed, there are some key challenges that impede the efficiency of the medical logistics fulfillment. To begin with, there is a high level of expiration of medications that are in inventory. This has been difficult to manage because of shelf lives and of uncertainty in demand at times. In 2014 alone, Medlog lost approximately $800,000 through disposal of expired medications.

Additionally, the business systems that are used for the current operation are not linked to one another. The ordering, inventory, and equipment system, called DMLSS, is not linked in any fashion to the accounting system, called SABRS. Since these systems do not talk to one another, there is a reliance on manual entry for inventory updates and to address issues.

The HSSE letter process can also present challenges to the fulfillment operations. Since there is the extended list of approvals needed, it can be difficult to meet the forty-five-day deadline before a mission as explained previously. At the same time, there are instances in which inventory is not received in time for the missions even if the HSSE letter has gone through approvals. Much of this can be attributed to the limited number of suppliers that Medlog is permitted to use. In order to use a new supplier if a primary source is not available, Medlog must go through a waiver process to get a new vendor approved before ordering supplies.

In regards to receiving in inventory and moving inventory in the warehouse, Medlog has a manual operation. When a pallet comes in, it is manually accounted for and counted by hand. It can often be tough to submit a dispute to a supplier within the required seventy-two hours because of this manual process, leading to occasional damaged or missing product that cannot be sent back to the supplier. Also, employees have made mistakes in inventory counts with the manual process because of simple human error or illegible writing.

There can be challenges with following up with suppliers as well. When an order is placed by resources, it is assumed that the order will soon be completed and on its way. Sometimes, however, there will be issues with an order being fulfilled and Medlog will not know about it. This is due, in part, to a lack of communication with suppliers to ensure that the order is on its way. Both resources and the supplier could both be more proactive in this process in order to ensure that uncertainty in the supply chain is mitigated.

When bulk packs of items are brought in, there can be difficulty translating these broken down packs into the DMLSS system. This difficulty is due to confusing nomenclature in the system and it is tough to give an accurate representation of the inventory that is actually in the warehouse.

As a whole, the Medlog operation at Camp Lejeune works to do the best job that it can to fulfill demand in a timely manner for battalion missions and deployments. Much like any organization, however, there are some important challenges that hinder their ability to streamline their processes and take big steps forward.

Focus Areas for Improvement

Although there are various areas that can be studied and improved upon, the main focus here will be on the expirations of materials. This topic contains the most concern, as Medlog has seen between $600,000 and $1,000,000 in costs of expired materials annually in the past. There are some limitations here in that a “war reserve” needs to be on the shelves at all times. This is emergency stock that needs to be quickly accessible and there is not a lot that can be done to change this.

With the main focus on expirations, some of the other areas that have been discussed can still be adjusted and see improvements. This will be shown in more detail in the coming sections.

Chapter 3

Literature Review

Stockless Inventory

Today, organizations are using a wide variety of inventory stocking and holding methods as seen in Figure 3. One of these methods is the stockless inventory method. Stockless inventory boils down to orders being fulfilled "…in exact, sometimes small, quantities and delivered directly to departments…" (Freudenheim, 1991). In other words, the distributor acts as the warehouse and holds inventory, replenishing used product on a predetermined schedule based upon use and agreements between the user and distributor. This is becoming very popular in medical settings such as hospitals. When the distributor representative comes to the hospital, the individual knows the exact quantities that should be held in each location such as examination rooms and emergency rooms. That representative will either deliver the exact amount to replenish the original amount of a product, or they will even enter each room and observe what needs to be replenished and replenish only what is needed.

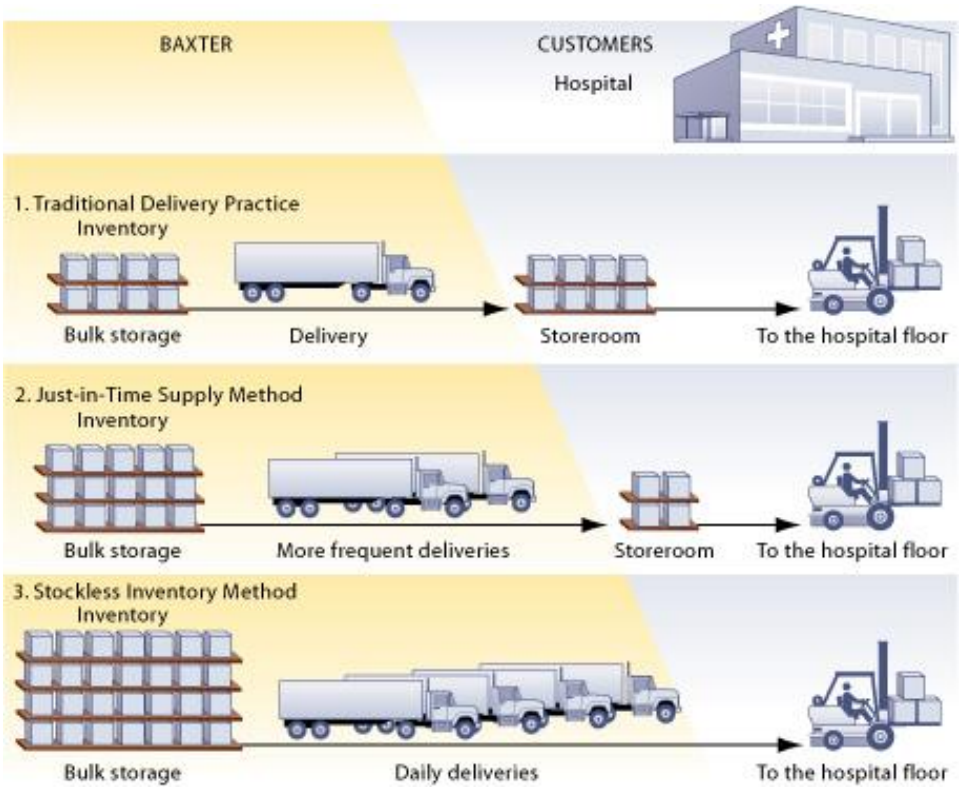

Figure 3. Traditional vs. Just In Time vs. Stockless Inventory Methods

This can result very low quantities being delivered, but there are many benefits to this system as well. Alex Caldwell, with The Claflin Company, states, "…Stockless is perceived as putting people out of jobs, but in reality it allows healthcare facilities to redeploy staff to care-focused tasks." (Stockless, 2015). With deliveries taking place more often and usually in lower quantities, the current staff has more time to work on other projects and has more flexibility instead of constantly having to replenish large amounts of inventory and worry about unboxing large shipments.

Secondly, Caldwell discusses that customers often receive cases or large quantities of product, which can allow for more expiration, damage, lost items, or obsolescence. This simply

comes from holding inventories with the potential not to use them for long periods of time. With stockless inventory, however, units are usually distributed in “eaches” and are only replenished in the amounts that were used (Stockless, 2015). This allows for smaller quantities and less handling and damage resulting from handling and holding inventory.

A third benefit that is common to stockless inventory systems is the reduction in waste that can result from implementation. Caldwell claims that there will be less waste in inventory from damaged or expired products as discussed previously. Additionally, though, packaging is often reduced or eliminated because of the individual units being delivered and stocked rather than cases packed in cardboard and shrink-wrap. In many cases, a reduction in waste can result in high cost savings for organizations and supply chains (Stockless, 2015).

With all of these benefits, Alex Caldwell still advises that no organization completely switch over to 100 percent stockless inventory all at one time. It is suggested that the system be implemented by department or division in order for the staff to become more accustomed to the new processes in place.

From a more detailed cost savings perspective, both suppliers and customers can see benefits in the appropriate environments. In an article from the New York Times, David Cassak was interviewed claiming that hospitals spent $15 billion on routine supplies such as disposable gloves, sutures, and gowns in 1990 when the article was published. Although this was years ago, the potential cost savings is still very visible. Cassak is quoted stating, “For every dollar spent to buy a product, hospitals spend another dollar to move that product through the system,”

(Freudenheim, 1991). With such high handling and holding expenses in typical inventory systems, stockless can greatly reduce this.

According to Freudenheim in the New York Times, in a stockless system distributors are able to increase costs more often and become more of a sole supplier for customers. With three to five percent service fees, the cost of the goods to the customer is higher, but shipping, handling, and holding costs are reduced (Freudenheim, 1991). There are often total cost savings in the supply chain, but a thorough evaluation should take place in order to truly see where cost drivers are located among the different options.

As explained, both suppliers and customers can benefit with a stockless inventory system from a financial standpoint, however other variables are considered when making a decision about the appropriate inventory system needed within an organization.

Common Challenges in Health Care Supply Chains

In health care, it is of the utmost importance to have supplies on hand when they are needed. In order to ensure supply, significant manpower and resources are often directed towards the supply chain. These are just a few challenges in health care supply chains as stated by Tefen Management Consulting in Quality Digest in 2012. Tefen states that many health care entities do not often have the most state-of-the-art inventory management systems, forcing them to rely heavily on a lot of human intensive labor.

Along the same lines, the lack of inventory management systems leads to manually driven processes such as inventory counts that are a "best guess" and require significant time from the labor force (Tefen, 2012). Often in industry, people and experience are relied upon heavily to provide a "rule of thumb" idea when it comes to quantities ordered of different products. Although this can sometimes suffice, relying on people rather than processes and data for forecasting can cause major issues if those people are no longer employed or involved in the operation. Because of the lack of tools, many departments tend to create their own policies when inventory is needed quickly, causing disconnects across organizations and standard operating procedures either being ignored or nonexistent all together (Tefen, 2012).

Importance of Accurate Forecasting

When it comes to fulfilling demand in any supply chain or industry, it is always extremely important to have accurate forecasting in order to be effective. This is basic supply chain knowledge, but it becomes even more important when lives depend on product being available and ready for use at all times. In retail, inaccurate demand predictions leads to lost sales or overstocking of goods, both of which are costly. In health care, inaccurate demand may lead to insufficient care for patients because of the lack of stock of certain supplies on the shelves. This is obviously more concerning than in a retail industry.

In health care, however, there are many opportunities to be successful in forecasting. For example, a hospital is one of the only places that a manager can look up the number of "customers" and then the potential demand for certain products every single day. This can be very predictable, allowing for more accurate forecasts of goods being used (Callahan, 2004). The health care industry is beginning to become more automated with information sharing and sophistication in their supply chains, but this is still new. For example, they are now using methods such as activity-based costing, Internet-based analysis of purchasing, and outsourcing the management of supply and purchasing (Callahan, 2004).

With the aforementioned information sharing in supply chains, the information systems being used are integrated together to show trends based on the surgeon doing work, hospital scheduling, patient demographics, and even seasonal demand patterns. All of this helps the hospital and medical agencies to better forecast their demand and retrieve as accurate of information as possible. With all of this information, hospitals are now seeing lower inventory levels, lower costs, and improved service levels. This leads to higher satisfaction at the clinic, high productivity, and improved patient safety (Callahan, 2004).

Continuing with this idea of information sharing, health care entities can begin to use their integrated systems to flow information upstream to suppliers and manufacturers. This becomes more of a "demand chain" as Callahan writes. Through this information sharing, hospitals are beginning the process of automated replenishment from the supplier while using real-time data. As a whole, this automated replenishment is a great strategy as long as demand

data is accurately logged and product is accounted for with certainty and is organized in the appropriate locations.

Best Practices in Warehousing and Distribution

"In today's environment, speed through the distribution center is critical," says Don Derewecki who is an executive vice president at Gross & Associates (Harps, 2005). This has never been truer than what we are working with today. Although there are endless possibilities for best practices and operational efficiencies in a distribution center, many of them are very common and can be standardized regardless of the type of industry being discussed.

There are many best practices that can be applied to the situation that is being addressed by this research. However, for these purposes the list will be focused on only the very applicable best practices.

First, the use of automatic data collection is extremely beneficial. When people are using a pad and pencil, the potential for errors and accuracy issues is much higher. By using RFID or scanners, the operation and process will be much more efficient and accurate. Additionally, it is a best practice to minimize touches on inventory and product. If a strong enough warehouse management system is in place, touches can be minimized and packed into a shipping container rather than into a tote or having to use dedicated packing stations.

It is also a best practice to conduct an ongoing cycle count in a warehouse operation. By conducting ongoing counts, time and resources are saved by eliminating the need to go through the entire warehouse to conduct cycle counts every so often (Harps, 2005).

The returns process is a very important one to manage as well. When product is sent back, especially in medical settings, many products can have shelf lives and may need to be managed differently. In addition to this, there are sometimes options to return different medications with the benefit of recovering some of the money that was spent to acquire them.

With the warehouse as a whole, it is very important to constantly be evaluating warehouse requirements from a space and efficiency standpoint. As Harps writes, it does not make sense to design a warehouse and walk away, never to evaluate it again. Processes, customer requirements, regulations, and improvements may need to be made and these can be helped if the warehouse design is evaluated periodically and compared to needs and demands.

Amazon Dash

As supply systems become more efficient and customer-friendly, services are being offered to make the ordering process much easier and pain free. For example, Amazon has come out with a new service called Amazon Dash. Basically, the customer can buy a button for a desired product that is then connected to their Amazon account and to their Wi-Fi. The button is small and can be placed anywhere, such as stuck to a refrigerator or washing machine depending

on the product that the button has been purchased for. This is seen in Figure 4. When the user is running low on the product, say Tide detergent for example, they will press the button and their pre-selected detergent is immediately purchased through Amazon and will be delivered within a few days through their Amazon Prime account.

Figure 4. Amazon Dash Button

To eliminate errors, Amazon does not allow for double clicks on the button to count for two orders unless the user specifies ahead of time that they would like to allow that (Amazon, 2016).

The Amazon Dash service is allowing for a new way of ordering that is innovative in the industry and may be able to be applied to other markets and types of products. In the medical

industry, since many medications are at risk of expiration, a quick and easy ordering system such as this one could be beneficial at relatively low costs. As a general idea, these buttons could be placed at each stocking location of a product, and the responsible individual could simply press the button when product is used or needed. This allows for a very fast order that is all integrated without having much of a manual process. Although many organizations have highly advanced systems in place, this approach may be a step in the right direction for those that use highly manual processes or those that are looking for low-cost improvements in their operation.

Chapter 4

Methodology

The research contained in this thesis will be completed in a few different sections. These consist of a site visit for background information, a literature review, and a series of interviews with various companies in the private sector. Every part of this research will assist in providing assistance and improvements to the United States Marine Corps and their goal of minimizing waste and gaining efficiency in their medical logistics operation.

The first step in this research is to gain an understanding of the initial problem. It is important to become familiar with the background of the case at hand. Initially, phone conversations will be conducted with representatives from the United States Marine Corps to learn more about the reasoning for the study. Once there is an understanding of the goals of the study, a site visit to Camp Lejeune will be scheduled. The visit will consist of two days at Camp Lejeune in North Carolina. Upon arrival at the base, there will be a tour of the medical logistics warehouse. In each part of the warehouse and operation, different processes will be explained and discussed. Discussions will consist of methods in the warehouse that work well and those that do not work well. It will be important to ask questions not only of the supervisors of the different areas, but also of the individual Marines who work in each of the areas since they see challenges in the operation every day. Once the entire facility is seen, meetings will be held with those overseeing the operation for questioning along with next steps discussed. This visit will be extremely important and beneficial to be able to see the medical logistics operation being run in person so as to gain a visual understanding of the issues.

After this, a review of related literature will be completed to gain broader knowledge of this topic and how other organizations operate their supply chains. Since medical supply chains can have their own challenges and complexities, it is important to understand more fully the issues that are common in industry and how organizations have worked to address those and ensure efficiency.

From here, interviews with supply chain executives in industry will be conducted based upon a questionnaire and phone conversation. The questionnaire is provided in Appendix A of this paper for further review. These interviews will discuss best practices by large leading corporations in the medical field. The companies will provide valuable information that inspires possible improvement methods for the Marine Corps with their medical logistics.

After these interviews and discussions, results will be compiled for the study. With these results and with the previously mentioned research, suggestions for improvements will be made and future actions will be recommended. The hope is that these recommendations provide insight and ideas that the Marine Corps will be able to adopt into parts of their operation to continue to improve and see more success.

Chapter 5

Results

Through the interview process, as well as with the review of literature and background information, some common themes and results have arisen that should be noted. Phone interviews were conducted with five companies that have been kept anonymous in this thesis. These companies, labeled as Company A through Company E, consisted of supply chain consulting companies, chemical suppliers, and pharmaceutical manufacturers and suppliers. The representatives from these companies all had a vast amount of knowledge about the industries that they work in and also provided some examples of challenges that they have seen throughout their careers. Write-ups have been completed on each individual company and can be found in Appendix C of this paper.

One of the first key pieces of information from these interviews is the existence of the Defense Logistics Agency having the ability to work with suppliers to label product as having a longer shelf life. When the order of materials with expiration dates is placed, the DLA can use a specific project code to require that the product be labeled with a longer shelf life. With this, the supplier can then label the product with a longer shelf life according to what has been previously approved by the FDA. Typically, suppliers label a product as having a shorter shelf life to promote inventory turnover and reorders. With the DLA, though, the supplier will extend this shelf life because of the needs of the military. There is no difference in the actual product; it is simply packaged differently.

Another way that companies work to mitigate shelf life risk is through the rotation of inventory to outlets that can use it faster. One company shared that they have rotated some medical inventory with hospitals located in close proximity that could use the same products faster. Another brings in suppliers of blood inventory in hospitals and the supplier will work to allocate this needed blood to different locations that will use the blood quickly before it expires. This sharing and rotating of inventory seems to be very common across multiple industries to help with waste and costs for multiple parties.

Additionally, companies are using more and more electronic inventory receiving and monitoring devices. Although there is not an industry standard for barcoding, each company has their own internal barcoding or RFID systems in place to track and monitor their own inventory. This has improved inventory accuracy and traceability with internal systems at each of these companies.

Next, there is an agreement that postponement of delivery of medical products can provide benefits to customers. With the supplier holding stocks of inventory for their customers, the expiration dates are able to be better managed, especially when customers do not have the latest inventory management systems. Suppliers are able to allocate product more efficiently and many offer this as a value-added service for their customers.

As previously stated, more detailed findings can be found in Appendix C of this paper. For these purposes, however, the results above discuss the most common themes across the medical and pharmaceutical industries that have been discussed with company representatives.

Chapter 6

Recommendations

As a result of this research and study, there are some recommendations that should be explained. In this section, the main recommended points will be listed and discussed in an order that will allow any improvements to flow into each other as they are put into practice.

The first recommendation is to use a barcoding system in the Medical Logistics Company operation. Through this system, inventory being received can be stocked more efficiently, allowing for more accurate inventory levels and eliminating manual entry of receipts. Without a more efficient inventory system like barcoding, challenges might arise in implementing the next recommendations that require accuracy and organization of inventory.

After a barcoding system is in place for tracking and stocking purposes, Medlog should continue to review inventory constantly while moving away from a "FIFO" policy. While the items that were received in the warehouse should theoretically be the first to expire, a "FEFO" (first expired, first out) approach should take more priority. By deploying inventory that is the first to expire, there should be less product that is left on the shelf to go to waste over time.

With expired products, Medlog should continue to work to increase acceptances in the medication returns program. With this, the Medical Logistics Company can cut portions of their losses by receiving small payments for medication disposal.

From this point, the Medical Logistics Company can begin to share helpful demand and inventory information with their key suppliers. This requires a level of trust and a relationship between the parties, but with information sharing and collaboration benefits can be seen that may not happen otherwise.

Moving in line with information sharing between the Medical Logistics Company and their suppliers, there are a few actions that can be taken once information is being shared. First, as stated before, the DLA can work with suppliers to obtain medications that are labeled with extended shelf lives. This is a value that DLA adds that other suppliers cannot, and it may prove extremely cost effective in the long run. Although some of these other suppliers may be less expensive from an ordering standpoint, the extended shelf lives would eliminate some of the costs associated with expired inventory. With this being said, it is recommended that larger volumes of product be ordered through the DLA in order to take advantage of what they have to offer.

Furthermore, Medlog should work with their suppliers to postpone shipments of products with sensitive expiration dates. By keeping inventory at the supplier for a longer period of time, these suppliers can use value-added processes to manage inventory for as long as possible until Medlog needs it in their warehouse. This keeps inventory levels in the warehouse low and also provides more visibility to both the customer and supplier.

Still in line with information sharing, Medlog has an opportunity to work with its' suppliers on the war reserve requirement that is kept in the warehouse. Since this is stock that needs to be held at all times, some of the inventory management may be able to be shifted upstream to the supplier. If inventory and expiration data is shared with the supplier, these suppliers may be able to find alternative sources in the area for supply that is near expiration. If this near-expiration material were moved to a hospital close by, for example, the hospital may be able to use it within days and Medlog would be able to rotate in product that now has more time until expiration. By working closely on turning this war reserve over and finding alternative outlets, expiration costs may be able to be reduced.

All of these recommendations discussed are dependent on accurate and efficient inventory tracking and inventory counts. Hopefully, these recommendations that are based on background research and trends seen in interviews can improve some of the challenge areas for the Medical Logistics Company in the United States Marine Corps. There are other areas for improvement and ideas that could be implemented, but this has highlighted some of the more visible improvements that could be made initially.

Chapter 7

Conclusions

As a whole, the Medical Logistics Company for the United States Marine Corps at Camp Lejeune in North Carolina has an extremely important function in providing equipment and medications to the Marine Corps for missions and deployments. In order to be prepared for any mission or emergency that may arise, Medlog must house inventories that can be allocated as quickly as possible. With this, however, there are challenges associated with expiration of material, waste, and space restrictions.

It can be challenging to balance efficiency and responsiveness in any supply chain, let alone one that has such an important role in taking care of human health and safety. With the background study that has been completed at Camp Lejeune, review of literature that has already been published, and interviews with executives in various healthcare fields, some results and suggestions have been formulated that can be explored by those involved at Camp Lejeune in their Medical Logistics Company.

There are a few limitations that have been in play during this study. The researcher does not have extensive experience or knowledge in the healthcare fields, and therefore relied on reading and conversations with professionals more than providing first-hand experience. From a time perspective, more interviews and questioning could have been conducted with a broader

spectrum of individuals, however feedback was not provided by every company that was contacted.

In the future, follow up studies could be conducted on a few different focus areas. First, heavy data analysis on individual products could be completed in order to see any trends in stockouts, overstocking, expiration, turnover, and other similar analytical categories. This may provide insight into the individual materials that need special attention while in inventory and on shelves. Additional research could be completed that studies the use of the business systems in place and how to maximize the computing potential and capabilities. For these purposes, however, the handful of provided suggestions should prove to be useful and beneficial to the Medical Logistics Company at Camp Lejeune as they continue to move forward and further improve their operations to better serve their customers.

Appendix A

Definitions and Acronyms

Can - individual container held on shelf at Medical Logistics warehouse at Camp Lejeun**e**

Block – combination of cans prepared for a deployment by the United States Marine Corps

SLEP Test – the federal Shelf Life Extension Program that extends the expiration dates on qualifying materials and drugs

DLA – Defense Logistics Agency

FIFO – First In, First Out

DMLSS – ordering, inventory, and equipment system for Medlog

SABRS – accounting system for Medlog

HSSE – Health Services Support Element letter needing approval before orders are fulfilled

NSN – National Stock Number

DRMO – Defense Reutilization Management Office

NDC – National Drug Code

GCSS – supply system used by the United States Marine Corps

Appendix B

Interview Guide

How do you receive inventory in?

Who makes the inventory decisions?

How does your ordering process work?

- What?
- When?
- How much?
- What drives the orders?

Is there a policy on shipping or is it more rule of thumb?

What type of inventory system do you use?

How do you deal with any expired or very close to expiration materials?

Do you accept med returns from customers for credit or disposal?

What supply chain/inventory metrics do you track for performance?

How do you forecast? How do you determine your safety stocks?

What type of MRP or business systems do you use? Are they all connected?

Do you use scanners or RFID for inventory?

Do you work with suppliers to keep downstream demand visible for order accuracy?

Appendix C

Interview Summaries

Company A

The first interview took place with Company A, a consulting company that assists state and federal government with improvements in business practices and supply chain. The company has just over one thousand employees. The representative that was contacted has been with the company for ten years and before that had twenty-five years of active duty military experience with time as a medical supply officer. This representative had a lot of familiarity with the Defense Logistics Agency (DLA) and their role in assisting with military medical logistics.

The DLA is the Department of Defense's logistics support agency. They assist all branches of the military in the logistics of their operations. In this case, they are meant to assist in bringing in medical supplies and devices. According to this representative from Company A, DLA will work with their suppliers to have special runs of medications and fluids that have extended shelf lives. Typically, with JIT, suppliers will mark the shelf life on their packaging based on the product's FDA approval. Assume, for example, a product has an FDA approved shelf life of three years. Suppliers may choose to label this product, however, as having a one-year shelf life. This is done because it causes more inventory turns and increased revenues for those manufacturers. With the military and the significance of missions, it is possible for DLA to work with those manufacturers to extend those shelf lives by applying a special project code to

the ordering system. For this to happen, it demands that the ordering representative be in contact with the DLA. While there is no difference in the actual makeup of the product, the manufacturer will display the maximum shelf life on the packaging for the military so that these products are usable for longer periods of time.

In addition, this representative discussed metrics that should be monitored in this field. Those metrics concerning lead-time and time of items on order took high priority. Any items that are on order for more than a month should be monitored carefully for any issues that may have arisen with the supply. The DLA can work to help order individual items and negotiate lead-time with suppliers to more efficiently meet demand. Also, in this individual's experience, it used to be possible to work with local hospitals to rotate inventory. The medical logistics unit would provide some of their inventory with little time left on their shelf lives to hospitals that would be using the product soon, in exchange for the same product that hospitals had in inventory with a longer time to expiration. This allowed for a quick and easy way to keep inventory from expiring and to minimize waste.

In regards to the DMLSS system, there is an option to tie barcode scanners into the inventory system. This would eliminate the use of pencil and paper inventory tracking and create a more automated operation in the process.

Company B

Company B is a leader globally in providing laboratory supplies and medical equipment. They have been in business for one hundred fifty years and have pharmaceuticals as one of their biggest business segments. The individual that was contacted has held various supply chain leadership roles with the company and was able to provide insightful information about experiences in pharmaceutical and medical supply chains. As with the other interviews, the questionnaire was the guide for this discussion.

From an inventory receiving standpoint, Company B has a specific process that has been effective for them. Once the purchase order is placed and the shipment has been sent from the supplier, Company B receives an advanced shipping notice (ASN) from the supplier via electronic data interchange (EDI). This allows Company B to see exactly what they will be receiving from the supplier so that they can prepare for receipt. When the order arrives from the supplier, Company B has generated "putaway cards" that are based on each individual pallet that is arriving. When these pallets arrive, the receivers know exactly where to place each individual pallet and can scan the product into the correct location using barcode scanners.

From a stocking perspective, Company B uses SAP to monitor all of their inventory and transactional data. The forecasting and inventory planning group meets four times per year to review product velocity and to analyze the movement of product. If each product has enough demand and movement to meet a predetermined hurdle rate set by the group, this product will be

moved into stock in Company B's warehouse. At the same time, those products that do not move enough to meet these hurdle rates are not held in stock. With very short-dated products, Company B tries to avoid bringing them into their warehouse for stocking. They would much rather have those sent from the supplier to the customer at the exact time that they are needed in order to provide the longest usable time to the customer. To monitor this, Company B prefers to have the ASN with product expiration dates specified very clearly. With some of these products, there is very erratic demand. It is always a possibility to lose a customer based on dating and expiration issues, so this is tracked very carefully. With some of these sensitive products, Company B takes precautions by shipping directly from the manufacturer using temperature and environmentally controlled units, while also providing a large amount of product traceability, which is integral in this industry. The use of drop shipments of time sensitive product in many cases can also mitigate these risks.

With this type of inventory and product sensitivity, it is extremely important to track related metrics. The individual at Company B named some of the main metrics that are tracked closely. These include inventory dollars, excess inventory, inventory with no demand, and inventory turns. Also related to these metrics, Company B has implemented a supplier scorecard over the last two years. The scorecard, which is centered on EDI, contains seventeen very quantitative metrics that provide detailed information on supplier performance. This scorecard has proven to be very valuable and helpful to Company B over the time that is has been rolled out.

Company B does not do any forecasting within their business. Rather, they provide their suppliers with a consumption report from previous months as well as new business wins. Although many of the suppliers would prefer a forecast, this is not something that Company B is doing at this point in time for various reasons including erratic demand. As stated previously, Company B uses SAP as their business system, and they have looked into adding modules that would provide the ability to create forecasts, but they have not yet put this into practice.

Company C

Company C is a global healthcare company that works to research and develop products in the areas of pharmaceuticals, vaccines, and consumer healthcare. The individual that was contacted works out of the research and development division and oversees quality and risk.

Also within R&D, there is a dedicated distribution and shipping team that prepares drugs for clinical use. This group, called cross-border shipping, often can see much variability in the products and volumes that they are shipping. Primarily, this results from the demand coming from clinical use and testing rather than in bulk like many larger customers may order. To place orders, clinicians either call Company C and request product or they go through an online portal that has been set up for product requests.

When discussing expiration of product and ways to mitigate that risk, the representative from Company C brought up a product called TempTale. Company C places a TempTale in with shipments of product that are temperature sensitive and that can be considered unusable if the shipment dipped below or went above a certain temperature. When the shipment arrives at the customer, the TempTale can be read and the customer can see the temperatures that the product was exposed to during shipment. If the TempTale shows that the product was outside of its temperature limits, then the product is not accepted and is then disposed of appropriately. This technology has helped Company C to be able to gather data and more certainty around their shipping environments and has reduced risk and saved money in some cases. In conducting more research on the TempTale product, information was found on the website of Sensitech, the

manufacturer of the TempTale. Sensitech is owned by United Technologies Corporation and holds a variety of supply chain visibility, monitoring, and tracking products for situations like the above and many more.

Additionally, Company C had much more extreme amounts of waste just a few years ago. In order to improve this, more demand planners and demand management professionals have been brought into the company to strengthen this part of the operation. From there, they now have increased planning capabilities and have been able to create more accurate forecasts and have a more efficient approach to planning. Specifically in the R&D area, many of the required studies that are done by clinicians drive the forecasts and demand that is seen. This is not exactly the case for the consumer healthcare division, however.

Company D

Company D is a consulting firm that is based on logistics and supply chain solutions. Their work primarily consists of assistance to manufacturing distributors and providers in distribution operations and inventory planning and management. The representative that was contacted is currently a practice director for healthcare for Company D.

In the hospital setting, hospitals often order directly from the distributors but the distributors will manage the inventory of materials. In larger hospital systems, the hospital will often have an integrated delivery network that acts as a distribution center to the different locations of that hospital.

In discussions about the expiration and management of inventory, some valuable information was learned about common processes. With larger distributors, many of them will add value to their customers by managing inventory for a longer period of time. This allows for a postponement of deployment of the inventory for as long as possible in order to manage expiration dates for the customer.

In addition, this representative suggested the possibility of having a distributor turn the inventory that is being held in the war reserve at the warehouse. This is similar to a situation of holding blood in inventory at hospitals. With blood, there are multiple types of blood that need to be held. These come with a forty-two to forty-five day shelf life and need to be managed efficiently. Because of the sensitivity of the material and the need for blood to be on hand, the

distributors of the blood will go to the hospital and work to manage the expiration dates in ways that minimize waste by allocating the blood to locations that will use it quickly. The representative from Company D also mentioned the idea that FIFO does not work well in a setting in which expiration dates are sensitive. Rather, a "first expired, first out" method should be used in order to better manage expiration dates.

This representative also discussed that there is a not a lot of "good" information sharing that takes place between customers and suppliers in the medical industry. Without this transparency, it is difficult to be able to plan effectively. Part of this issue is that there is not a standard for barcoding infrastructure or the capturing of data. There are, however, industry initiatives that are beginning around product barcoding and tracking. These are in their infancy stages.

Company E

Company E is a large biotech and pharmaceutical organization that has seen a high amount of growth recently. The representative that was contacted heads the business intelligence group for the company. In the past, this representative has worked in manufacturing and supply chain for multiple medical and pharmaceutical companies.

One of the challenges that Company E has faced is that every market and industry has their own regulatory requirements. With this, Company E does not have as much of an issue around the expiration of products. Rather, the packaging and labeling that is displayed has strict regulation around the length of time that it can be displayed before it needs to be changed or updated.

In regards to systems, Company E had challenges in the past, but was able to bring in the right people to work through them. Company E brought in representatives from another firm that made modifications to their business system in order to better fit their supply chain needs. These representatives were very tactically oriented and were able to improve Company E and their business system as they moved forward and grew their company.

The representative from Company E did explain that vendor managed inventory is very big in the medical and pharmaceutical industries. With postponement of the ordering process, the vendors and suppliers are able to manage expiration dates on products and provide their customers with materials that have longer times until expiration. This happens both in customer

facilities as well as in the vendor's warehouses, depending on the situation and needs of the specific customer.

Company E shares business systems with a few of their largest suppliers. This is only done with their most trusted and highest volume suppliers, as they partner to show demand and inventory levels.

The representative had a suggestion for supplier-customer relationships. In situations in which there are only a few vendors that supply the bulk of products to a customer, improvements in cross docking can effectively help to mitigate supply chain risk.

BIBLIOGRAPHY

Amazon.com. N.p., n.d. Web. 13 Mar. 2016. <https://www.amazon.com/b/?node=10667898011&sort=date-desc-rank&lo=digital-text>.

Cardinal Health Canada - Stockless. N.p., n.d. Web. 18 Feb. 2016.

Callahan, Timothy J., David R. Guzman, and Mark A. VanSumeren. "Effective Demand Forecasting In the Health Care Supply Chain." *MThink*. Owens & Minor, Inc., 16 July 2004. Web. 04 Mar. 2016.

Federal Shelf Life Extension Program Fact Sheet. N.p., n.d. Web. 06 Apr. 2016. <http://www.astho.org/Programs/Preparedness/Public-Health-Emergency-Law/Emergency-Use-Authorization-Toolkit/Federal-Shelf-Life-Extension-Program-Fact-Sheet/>.

"Focus: Supply Chain Trends/Issues." *Supply Chain News: Understanding the Operations Rules (Con't)*. N.p., 16 Feb. 2011. Web. 20 Mar. 2016. <http://www.scdigest.com/ontarget/11-02-16-1A.php?cid=4212&ctype=content>.

Freudenheim, Milt. "All About/Medical Supplies; Removing the Warehouse from Cost-Conscious Hospitals." *The New York Times*. The New York Times, 02 Mar. 1991. Web. 02 Mar. 2016.

Harps, Leslie Hansen. "Best Practices in Today's Distribution Center." *Inbound Logistics*. N.p., May 2005. Web. 20 Feb. 2016.

Hill, W. John, M. B. A. *Alternative Inventory Control Methods For Use In Managing Medical Supply Inventory*. Thesis. Air Force Institute of Technology, 1988. N.p.: n.p., 1988. Web. 21 Feb. 2016.

Rossetti, Manuel D., Ph. D. "Inventory Management Issues in Health Care Supply Chains." Thesis. University of Arkansas, 2008. June 2008. Web. 1 Mar. 2016.

SensiTech. N.p., n.d. Web. 06 Apr. 2016. <http://www.sensitech.com/products>.

"Stockless Inventory: Getting More with Less." *The Journal of Healthcare Contracting*. N.p., Oct. 2015. Web. 20 Feb. 2016.

Tefen Management Consulting. "Optimizing Healthcare Supply Management." *Quality Digest*. Tefen Management Consulting, 16 Oct. 2012. Web. 17 Feb. 2016.

Traditional vs. JIT vs. Stockless Inventory Image. Digital image. N.p., n.d. Web. 20 Mar. 2016. <http://paginas.fe.up.pt/~acbrito/laudon/ch3/chpt3-4fulltext.htm>.

Wroclawski, Daniel. "Your Next Washer Will Order Detergent for You."*Reviewed.com Laundry*. N.p., 09 Oct. 2015. Web. 20 Mar. 2016. <http://laundry.reviewed.com/news/your-next-washer-will-order-detergent-for-you-amazon-dash-whirlpool-ge>.

ACADEMIC VITA

Daniel John Rose

Education:

The Pennsylvania State University University Park, PA
Schreyer Honors College Class of May 2016
Bachelor of Science in Supply Chain and Information Systems
Minor in Engineering Leadership Development

Work Experience:

LORD Corporation *Erie, PA*
Oil and Gas NPI Sourcing Intern *May-Aug. 2015*

- Composed snubber major metals quote package, leading to 20-40% cost and 50% lead time savings
- Overhauled existing supply chain diagrams, detailing materials specifications, sources, and assembly flows
- Traveled to machining, plating, and heat treat suppliers for source inspection and product quality review
- Developed tooling supply chain capabilities information package detailing gaps for strategy discussion

LORD Corporation *Saegertown, PA*
Chemical Operations Intern *May-Aug. 2014*

- Created a Sustainability and Social Responsibility Supply Chain survey to send to all suppliers
- Compiled results from survey and reported to Global Sourcing teams
- Directed project to test a new type of sensor on bulk chemical tanks throughout plant
- Updated and formed over 85 manufacturing procedures to assist in improving product quality
- Produced a plant-wide policy detailing hose types, processes, specifications, and safety

LORD Corporation *Saegertown, PA*
Chemical Materials Intern *May-Aug. 2013*

- Documented multiple plant hazardous waste process flows
- Constructed a climate/conditions report for export shipments of goods
- Led two international presentations via web and audio conferencing
- Upgraded plant emergency evacuation process with team of individuals

Omega Plastics, LLC. *Erie, PA*
Maintenance/Assembly *June 2008-Dec. 2012*

- Performed mold assembly, disassembly, cleaning, and preventative maintenance
- Pulled and set molds in plastic injection molding machines
- Conducted inventory cycle counts for components and raw materials
- Inspected and cleaned finished product prior to shipment

Involvement:

Penn State SAP Student Interest Group *University Park, PA*
President *Sept. 2013-Sept. 2015*

- Conduct executive board meetings and direct organization and club decision making
- Coach others at SAP Student Interest Group workshops