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SPACE OPTIMIZATION IN WAREHOUSES

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for the Degree of

MASTER OF SCIENCE IN INTEGRATED SUPPLY CHAIN MANAGEMENT

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Abstract

Space is the key essential in any type of warehouse across the world. Trying to optimize the space that warehouses need is a task that everyone should take seriously. Looking outside the picture and knowing how to utilize and optimize warehouse space to the fullest potential is critical to realizing an efficient and well-balanced warehouse. Warehouses come in all different types and sizes around the world and to use them in a way to make them the most efficient is key to a successful business. However, sometimes change is a necessary adaptation for a business to better utilize their warehouse space which will allow them to be successful. Businesses should investigate the future and what they are looking for with the advancement of technology. Answering the questions of what is needed for growth and what type of warehouse space is necessary to support that growth? This is where today meets tomorrow… and how to fully optimize the space that is needed to go forward.

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Introduction

Warehousing space is a critical component for any business that wants to remain competitive and ensure adequate storage for their supply chain. Some might agree and some might disagree that warehouse space is not enough in today's work environment and that the supply chain is growing rapidly around the world. This boils down to public infrastructure, economy, services, and all international issues that might arise with the functions of warehouse space (Rabianski & Seagraves, 2011). Companies are faced with a daily dilemma of warehouse space utilization.

Through the analysis of VA Clinics and the warehouse space utilization, the need and ability for the clinic to maximize their optimization is paramount to the success of their supply chain ultimately leading to patient satisfaction. This is important to understand the issues of how to control inventory and making sure enough space is utilized to handle all the supplies and/ or materials on any given day. With all the tools and resources that are available for use, it is important to understand the need for space and how this can work in the favor of the VA Clinic. This will in end help with the movement of supplies as they come and go. It is also important to keep a close eye on the inventory and adjust as needed so there is never an overstock on items that might get purchased taking up space in clinics that could be better utilized. Companies might disagree that space utilization is limited in warehouses. However, companies are not looking at all the possible solutions to maximize their warehouse space. Looking into the future with the growth of the supply chain industry and the growing number of products that are being shipped every day, it is imperative to know how to tackle such issues on space. A successful company must be able to change their space utilization as the industry changes and not be afraid of change.

Companies must think outside the box and determine the best ways to maintain space in the warehouse as this is a critical point and juncture on how to manage your inventory levels.

It is important to understand the rational of warehouse space and how this could help or damage a company in the long run. So, this research paper will paint a clear and precise understanding of how to utilize and optimize space when space is needed in a warehouse.

Literature Review

This literature review will examine a total of 18 articles and books combined that look at the use of the space optimization in warehouses. This is an important topic that was chosen as the ongoing need for supply and space is always a factor in storing inventory at any given time. The presented research over the last few years will be useful in optimizing the best space in warehouses and at the VA Clinics.

The inefficiency of managing warehouse space has taken a toll with up to 3,000 hours lost per year (Rabianski & Seagraves, 2011; Richards, 2018). The works of Baran & Galka (2017), Hayes (2014), and Hiatt (2006) bring the importance of how to implement and use change in the workplace successfully to help further the development of the warehouse environment. Change is difficult and must be managed in a way to have positive results with employees. Identifying the change is the first objective, and to achieve the results of the change will need everyone's attention (Hayes, 2014). Also, by working with other customers, both old and new, change in an organization is beneficial because this can promote efficiency through resource acquisition allowing an organization to be successful in managing space in a warehouse. Baran & Galka states, "The culture is an intangible variable that has its own effects on the organization" (2017, 116). This is important to understand that corporate culture is not all the

same and to come to an understanding on what each organization wants. Lastly, it is imperative

to realize that not everyone will adapt to change the same way. So, what Hiatt states on

reinforcement is ideal, "The greatest risk associated with a lack of reinforcement is a person or

group that reverts to old habits" (2006, p. 40). It is imperative to come with an approach to that

person or group that what the outcome can look like in the end and have someone to champion

the change. So, treading lightly at first is the best option to have. Also looking at the demand of a

product is a very important factor for considering space in a warehouse. Rabianski & Seagraves

noted, "Demand decreases as firms get better at managing inventories with modern computer

systems and inventory handling equipment" (2011, p. 25). Advancement in today's world of

technology is amazing and companies can save lots of time and money utilizing technology

especially computer-based tracking systems. With built in software that tracks the supplies that

come and go, and the software can help manage the supplies to help maintain a steady balance

and flow. This also, will help with any stockout issues and to find alternative supplies if needed.

     The works of Heragu et al. (2011) and Yao & Chu (2008) propose that analytic data is

one of many key elements needed to determine the right number of supplies to keep in a

warehouse. Companies face a challenging task to make sure that the supplies are in a steady flow

and that the movement is fluid within and out of warehouses. To maximize the warehouse space

at its fullest potential, what requirements will have to be met to have this happen. To replenish

the supplies at the right time will have to have a schedule set in place. According to Yao & Chu

"To find an optimal replenishment schedule to minimize the Maximum Warehouse Space

Requirement (MWSR). Obviously, the lower the MWSR, the better the replenishment schedule"

(2008, p. 623). That is why data is going to help reduce any overstock items and make it where it

is a JIT (Just in Time) inventory concept helping to free up needed space. Once the data is

collected and can be applied, using the data to forecast future supplies when it is needed is a big step to take.

Shamaeva (2021), Shi et al. (2017) and Venkitasubramony & Adil (2016) discus that the collected data is necessary to plan on what type of warehouse is needed and how big of a structure to store the material in. Also, in the case of preexisting warehouse space, especially the VA Clinics as they are typically small and older, an evaluation is required to determine the best equipment and storage concepts needed to optimize the space. The works of Bartholdi & Hackman (2008), Derhami et al. (2016), Mix (1991) and Mentzer et al. (2007) propose that space utilization is dependent on space and throughput. Bartholdi & Hackman states that "one can layout stock to be more space efficient by storing similar sizes together" (2008, p. 8). The use of many different storage methods is discussed in detail by Bartholdi & Hackman. The authors also added different problems to help reduce the space issued associated with different styles of warehouses and the flow of the supplies, "Design conceptualization is a key step in the design of a warehouse" (Heragu et al.,2011, p. 6842). Coming up with designs of a warehouse via the computer will help map out the space that is needed maximize efficiency. Science and math are the main driving force that is involved in determining the space needed for a warehouse. It is important to point out that companies need to know what right verses what is wrong on determining what type of space is needed, as companies face a lot of different problems that warehouses face on a day-to-day basis.

Fumi et al. (2013) and Guo et al. (2015) discuss in detail the significance of the polices that are needed to set forth the type of storage for what is being stored. Management of this is an ongoing issue that is drastically changing due to supply and demand. Guo et al. states "required storage space (RSS) of items is important in warehouse management, particularly for warehouse

design, storage policy selection and one-way travel distance evaluation. Existing research on class-based storage assumes that the RSS of an item equals its average inventory level" (2015, p. 2405). Having a well laid out plan before implementing storing supplies is a huge step on where everything should be located and what is the most efficient way on where supplies are stored within the warehouse. The factor for having the RSS is to help eliminate any wasted space and to save money from the location of all the supplies. Fumi et al. states that " storage location assignment problem (SLAP) - concerning the storage location assignment policies of products within a warehouse - has embodied the critical issue in operations management and research, and over the last four decades many significant scientific contributions" (2013). This can include cold storage, temperature control and highly secured storage units. Making sure to have such dedicated polices on what kind of warehouse is needed will help the overall growth of the company.

Assaf et al. (2006) and Mansour & Chrisensen (2001) explains the general dynamics of warehouse space and how it has impacted today's global supply chain issues. With space considerations and how to implement the key to space is a critical measure that companies must face. "A supply chain should implement corrective action measures with key individuals who know how to provide the best guidance" (Assaf et al. 2006, p. 155). How can companies, especially the VA Clinics, can utilize the resources set forth to improve their space management during every logistical scenario. How much does employment factor into play as Mansour & Chrisensen states "employment accounts for the majority of the variation in industrial property construction and that shocks to output and interest rates affect the supply of industrial space only through its impact on employment" (2001, p. 79). This gives a strong case in which companies must look at the property and how they store their inventory efficiently. With supply chain

growing faster and faster, forecasting is a critical part of today's supply chain. Mansour &

Chrisensen also explain the importance of a different type of measurement related to space. They

state that "the volume of freight shipments as proxy for warehouse inventory to provide an

alternative measure of warehouse space demand" (2001, p. 87). So, more companies are facing

challenges to find warehouse space as the shipments from the freight liners can carry more

supplies per cargo ship.

Methodology

Multiple sources were used to help achieve the best outcome of the research. The first

initial method that was used for this research was that of visible observation of multiple

warehouses in a span of 3 years. The observation in the different warehouses included: 1) how

the inventory was being organized, 2) how much of it was being used and 3) what was the turn

rate of the supplies. The main purpose of this research is to see how much space was being

utilized for all the supplies that are coming and going. Observation of a product for a specific

period and to see why the item was being ordered more often than what it should be occurred.

Knowing that the product is available by the next day, reducing the stock level will make it more

efficient and save time, money, and space in the long run.

The next source was that of quantitative data. This type of data helped to determined

what supplies were not moving as fast and thus helped to determined what the reduction of stock

level helped to maximize the needed space in the end. The smaller number of products in the

warehouse at any given time was the ideal goal. The use of JIT (just in time) inventory method,

as it works very well once all the numbers are calculated correctly to achieve the results. Using

this type of method can eventually help with reducing the number of supplies that have been

sitting around for a while and to free up that needed space in warehouses.

      Other data that was collected was qualitative data through casual conversations with

fellow coworkers. Through these conversations, ideas about space and changes that they felt

were necessary based on their perspectives would help with optimizing the space in the

warehouses. This was done to gain feedback and to see what changes they could see happening

with the space that we had to work with. Also, by reaching out to other individuals that worked

in the same environment to see if change would be in the best interests of the use of optimizing

the space in their warehouses helped to create buy in to possible changes in the future.

      The last part of the methodology utilized is the empirical review of resource materials

that are used to help with the overall determination of optimizing space in warehouses. This

research will help focus on the importance of warehousing and utilizing the best practices to use

space in any type of scenario. This is also important to understand what changes are needed to

have this happen and to have an opportunity to realize the potential of what space optimization

can bring to a company.

Discussion

Space in a Warehouse

What is space in a warehouse and how can one utilize it to its fullest potential? When determining different ways to utilized space, not one simple plan of action will help to determine this. When determining the best practices of optimizing space in a warehouse, lots of different factors will come in to play when figuring the scenario out. Rabianski & Seagraves points out that "Demand for warehouse space is a function of the labor force and the population of the economy, public infrastructure and services, and international issues such as currency exchange rates and trade barriers/restrictions" (2011, p. 25). The end goal is having adequate space for any company that stores supplies in warehouses. This must be done with a strategic mind set by looking outside the box. Problems with utilizing space can be a challenge. Are all the tools and data being used correctly to maximize the efficiency of space? The VA Clinics that were observed will benefit from knowing the proper use of inventory management if the analytic data is correct and that the VA would understand the importance of space allocations.

Management of Warehouse Space

Many types and sizes of warehouses are all around the world and to manage them correctly and efficiently is not an easy task for any company to take on. If it is a new or existing warehouse, it is essential to make sure that the correct tools and data are used to maximize the design of the space that is being utilized. First is the understanding and the collecting of the data for a certain period to obtain accurate data.

Companies, like the VA Clinic, should follow a few simple steps to ensure they receive the best results with inventory and the space that the warehouse needs to store the supplies at any given time. Mix mentions the first step is to "Compile as much detail about the inventory as

possible. Data must be for individual SKU's (Stock Keeping Units) and include the projected

average or maximum inventory levels and standard unit volumes" (1991, p. 100). Mix points out

the second step of this process is making sure that the warehouse is laid out in a way that the

space is best used and is efficient (1991, p. 100). The third and final step Mix states is that "to

develop estimates of how much space for each type of storage media (floor, racks, bins) will be

required for each item. This process is data intensive" (1991, p. 100). For the most part, having a

contractor come in to take measurements and what type of equipment is needed to fulfill the

requirements will determine what space is needed for supplies.

The Saw Tooth Method is used to help see the flow of the inventory at any given time.

Please see Figure 1 for example as it can represent any type of supply in the inventory system.

As the red line (Inventory Level) decreases with time, then take that area which is needed to

reorder the supplies before running out and the baseline. This reorder point is roughly at the 50%

range of the decline, which allows time for the supplies to be reordered and delivered. If this is

done correctly, then any stock outs of inventory will be avoided (Bartholdi & Hackman, 2019).

The Saw Tooth Method is usually based on a 2-week supply. If the supplies in the inventory that

are sitting for a while, then adjustments to the total quantity and reorder points must be done to

bring it to a 2-week turnaround. This is just an average without taking in the possibility of back-

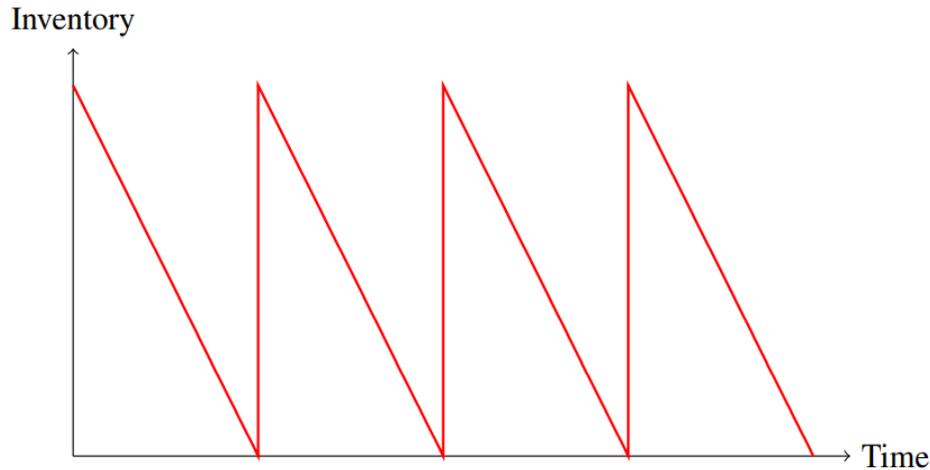order items, seasonal items or damage items that could alter the levels.

Figure 1: Saw Tooth Method example

Also, a Warehouse Management System in place is another great tool to make sure that the inventory is managed efficiently. If a warehouse is not managed correctly and efficiently then issues can arise with space and levels of inventories. According to Shi et al.,

"Poor warehouse size planning can have a significant impact on the efficiency of the operation. An excess of storage space results in a higher storage cost caused by empty warehouse space. On the other hand, lack of storage space can lead to extra cost of using overflow warehouse and longer response time" (2018, p. 1313).

If not utilizing the data correctly and having out of date software, companies are setting themselves up for costly mistakes.

Maximum Efficiency in Warehouse Space

Space requirements for some companies is a difficult task to handle and the warehouse layout will not be in the favor for that company. This is important, especially when a company might be growing faster than they first realize. There is room for improving the maximum efficiency of a warehouse and this might take a while for some companies to get to that point.

Shamaeva points out that "Warehousing areas are not very diverse in terms of their location, structure, and storing methods. About 95% of the warehouse units have only one story." (2021 p. 3). Being creative and using the best tools available will help reduce the implications and to help maximize the space that is needed.

If the company is facing expansion and/or they have more space available, then the first step is to network and brainstorm ideas to make the space efficient enough to last. The VA Clinic is always expanding or renovating. The location of supply storage is always on the back burner of any discussion until it is too late to consider where the supplies will be stored. According to Richards,

"When (re-)designing a warehouse there are a number of factors that need to be considered. These include the company's likely growth over the next 5 to 10 years, the possible change in product and customer profiles, total sales during this period and the likely sales channels such as online B2B, B2C and retailer sales" (2018, p. 252-253).

If measurements are off when dealing with a reconstructed warehouse or a newly built warehouse, then it will have drastic outcomes down the road. Fumi et al. illustrates the importance of "The design of a warehouse, ensuring its optimum layout configuration and effective material handling system, is strictly related to an accurate and structured allocation of products" (2013, p. 5). This is where a company fails. They do not do excessive planning on what space is needed before any new or renovation is constructed and complete. So, the company is then faced with questions on how to fix any space issues that might have occurred during the process of construction or renovation.

When dealing with space restrictions, the question to ask, is what type of equipment is needed to help with maintaining the space that is already in place? Also, Shamaeva suggests

"What planning principles should be used in designing new types of trade and warehousing buildings? What functions do these facilities have and what purposes do they serve?" (2021, p. 2). So, companies must know what product they are storing and figure out what products are moving faster than others. This way companies can adjust the location in the warehouse that the products are kept and to adjust their location, if needed, without changing the space on the floor.

With all the warehouses that are in operation, there are a wide variety of tools to move supplies such as pallet jacks to forklifts to help better utilize space. With the different types of racking/shelving units that will fit most pallets, the materials that are stored in warehouses must fit the racking or shelving. For example, if pallet storage is needed the size of the raw materials should fit into the racking or shelving units. The best results are storing the similar size products next to each other as this will save on space and time that is spent moving products back and forth. Also, companies must consider other areas in the warehouse that is needed to maintain their operation. So, having a well laid out plan to store other equipment and the need to move around is something that should not be forgotten.

Conclusion

There is always going to be room for improvement in warehouses, as todays Supply Chain is growing faster than expected. When a company is expanding their operations, they must make sure that the space is going to be efficient enough for the new warehouse or expansion of the preexisting one needing today and tomorrow's demand. Forecasting is a critical component of what space is needed down the road. Usually, 5 to 10 years is a goal for most companies to look at. By forecasting, this will help with determining the space needed due to the growth of the company. Also, by forecasting the amount of volume that the company might be getting will help in the determination on the size of warehouse so that they can accommodate the supplies. By utilizing the analytic data that can be obtain via computer software, this will help pull the most current inventory numbers to make and future adjustments. The VA Clinic has been trying to get the Supply Chain more involved in the planning of their future growth so that they can handle the volume of supplies on any given day. Also, that is there is no 2 VA Clinic that are the same in size. This makes it difficult for a one size fits all approach. So, with all the resources that are available in the public sector, it is imperative that VA Clinics do their homework in finding the best fit for the space that is needed. There must always be room for improvement with space and to do so will require change and understanding of what is best for the company. It is important to look outside the box and look at the different perspectives prior for any change to occur to optimize the space that is needed. Every day is a new day, and the VA Clinics must continue to look out for the best opportunities to expand on in a fast-growing environment.

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