DESIGNING WAREHOUSE FOR A MOTOR MANUFACTURING COMPANY

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งานวิจัยนี้ได้ทำการออกแบบคลังสินค้าของ บริษัทผลิตมอเตอร์ ในกรุงเทพมหานคร เพื่อให้สามารถรองรับกับการเจริญเติบโตของบริษัทในด้านปริมาณในการจัดเก็บและประสิทธิภาพในการดำเนินงาน งานวิจัยนี้เริ่มจากการศึกษาถึงปัญหาของคลังสินค้าในปัจจุบันและสร้างแนวทางการแก้ไขปัญหานั้นๆ ปัญหาหลักๆของคลังสินค้า คือ อุปกรณ์ในการจัดเก็บไม่เหมาะสม การจัดวางแปลนของคลังสินค้าไม่มีประสิทธิภาพ และการดำเนินการในคลังสินค้าที่ไม่เป็นระบบ ขั้นตอนในการออกแบบคลังสินค้าเริ่มต้นจากการสร้างแนวคิดในการออกแบบโดยคำนึงถึงปัญหาที่เกิดขึ้นและความต้องการของบริษัท หลังจากนั้นก็ตามมาด้วยรายละเอียดในการออกแบบซึ่งคำนึงถึง การแยกประเภทสินค้า แปลนของคลังสินค้า การเลือกใช้อุปกรณ์จัดเก็บและอุปกรณ์ขนย้ายในคลังสินค้า แปลนของคลังสินค้าโดยคำนึงถึงความถี่ในการขายสินค้า การดำเนินงานใหม่ๆ ภายในคลังสินค้า การใส่รหัสสินค้า สัญลักษณ์และป้ายชั้นวางของ ความปลอดภัยในคลังสินค้า นโยบายเรื่องสินค้าเก่าเก็บ และ5ส เครื่องมือวัดผลการดำเนินงาน 6 ชนิด จะถูกนำมาใช้เพื่อเป็นตัววัดประสิทธิภาพของการออกแบบคลังสินค้า

มีการพัฒนาในหลายๆด้านหลังจากนำเอาการออกแบบคลังสินค้าใหม่ไปใช้ ปริมาณในการจัดเก็บของคลังสินค้าเพิ่มขึ้นถึงร้อยละ 48.42 เวลาที่ใช้ในกระบวนการต่างๆในคลังสินค้าลดลงถึงร้อยละ 33.33 ความแม่นยำในการหยิบสินค้าเพิ่มขึ้นร้อยละ 2 มีการลดลงอย่างชัดเจนในจำนวนพนักงานที่บาดเจ็บในแต่ละเดือนจาก 3 คน กลายเป็น 0 คน ภายในสามเดือนแรก จำนวนสินค้าที่สูญหายและเสียหายลดลงร้อยละ 87.5 และการวัดระดับความพึงพอใจของลูกค้าโดยวัดจากการกลับมาซื้ออีกของลูกค้าใหม่เพิ่มขึ้นร้อยละ 14.28

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ลายมือชื่อนิสิต .....
ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก .....

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This research designed a warehouse of a motor manufacturing company in Bangkok in order to support the growth of the company, in terms of holding capacity and operational performance. It began with the study on problems in the existing warehouse and generated solution concepts. The main causes of the problems were improper material storage equipment, inefficient warehouse layout and poor warehouse operation. The design process began with creating a conceptual design to take care of the problems and the company requirements. After that, a detail design was created with considerations on product categories, warehouse layout, the use of material handling equipment and material storage equipment, velocity based layout, new warehouse operations, product numbering, signage and shelf labels, security operations, warehouse safety, dead stock policy and 5S. Six key performance indicators were used to evaluate the design.

There were several improvements after implementing the design. The warehouse capacity was increased by 48.42 percent. The average time of all operations decreased by 33.33 percent. The product picking accuracy increased by 2 percent. The number of injured staff reduced from 3 persons to 0 person in the first three months. The loss and damaged product was reduced by 87.5 percent. Customer's satisfaction measured by the returning of new customers increased by 14.28 percent.

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Chapter 1: Introduction

1.1 Introduction

This study represents an analysis of the logistical principles relevant to the practice of warehousing for the specific purposes of a motor company. The question of whether or not and how much stock should be stored by a business organization is a complex issue pertaining to the fundamentals of resource management and allocation by that organization, included under the overall banner of logistics. In order to design any facility dedicated to a functional purpose relevant to resource allocation it is necessary to provide extensive background concerning the challenges inherent to this process, and how the business organization meets these challenges in light of modern technology and the presence of competitors.

This analysis will describe the underlying business factors determining resource allocation, relating to the practice of storage and warehousing. The business organization must develop a comprehension of these issues before any ground can be broken for the construction of such a facility. Strengths and weaknesses of the organization, in addition to prevailing market trends must be analyzed in order for management to determine what sort of warehousing is needed, whether it should be short or long-term. And what size will be necessary. These questions are pertinent with respect to how long the organization anticipates particular items will need to be stored, as well as the determination of how often these items are sold. Sale of these items is integral to any calculation on whether or not, and at what rates finished items should be transferred to other storage facilities, or retailers prior to final sale. The organization must develop a sense of how fast the items in question (motors) move through their

inventory. To determine this, the most probable rates of sale must be understood, and the ability of the organization to transfer resources and materials must be soberly assessed. The principal objective is to maintain a middle ground where both shortfalls and excessive surpluses are avoided.

For this paper, we study the case of Namsae International Company Limited. The company was founded in 1950. At the first period, the main area of the business was for the services and contractor of electronical task for the industrial factories. After that, company started to expand the business to several other fields, such as manufacturer of electronic fan, electric motor, grinder, and industrial blower, in the field of metal industry expanded to the manufacture of bolts and nuts, aluminum wire and copper wire. For this case study, I will focus only on the motor manufacturing part. The company's organization structure, percentage of sales for each product and amount of sales will be illustrated in Figure 1, 2 and 3.

Figure 1: The Organization Structure of Namsae International Company Limited

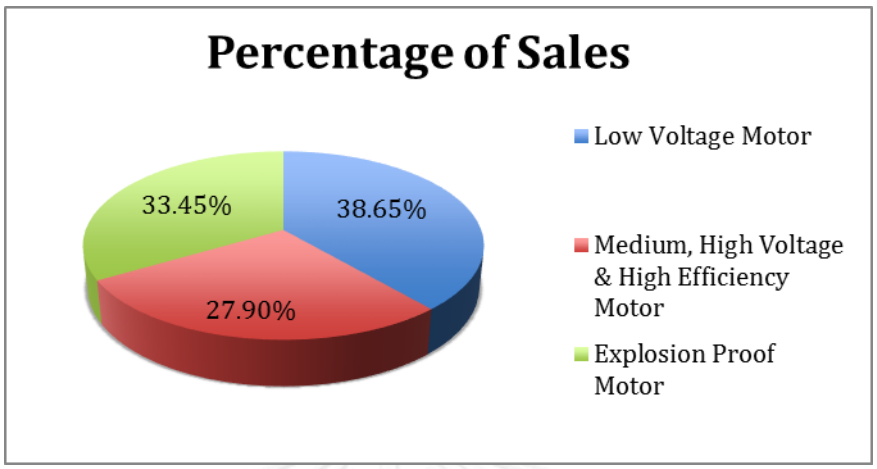

Figure 2: Percentage of sales for the motor manufacturing section

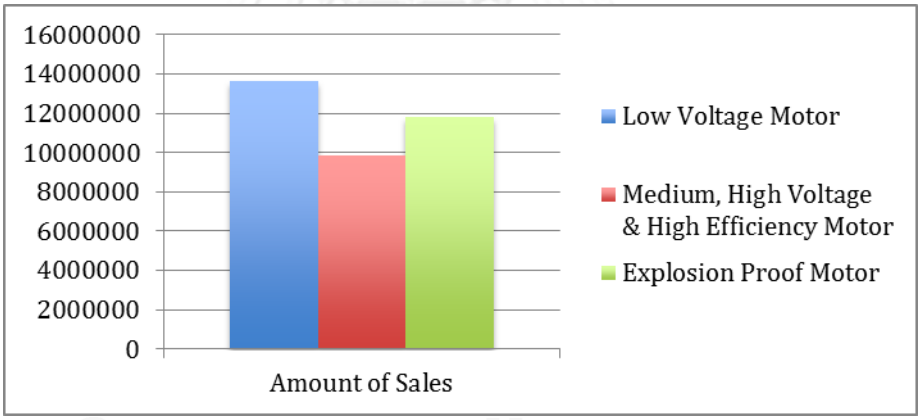

Figure 3: Amount of sales for the motor manufacturing section

1.2 Background

Too much of a given commodity (motors), space and resources must be wasted in order to house items the majority of which are not purchased. This situation would represent both a failure in planning, and a failure in market analysis with respect to

determining supply and demand specific to the item in question. It is also necessary to avoid persistent shortfalls of an item that is desired by customers. Where demand does exist, and is not met – the door is opened for competitors to fill the void. If customers genuinely desire a product, and a particular business organization is unable to fill its own orders in a timely fashion on a reliable basis, this can constitute a failure in customer service – as well as a logistical problem. Brand loyalty is likely to suffer, and potential customers are more likely to look elsewhere. Current demand must be understood in the context of efforts to identify trends that would permit the reasonable expectations of increases in demand.

Moreover, the business organization requires a long-term strategy with respect to warehousing. It is not enough to understand the market for a particular product in the short term. A prevailing strategy is needed based upon the aggregate of multiple cycles of rising and falling demand for a product. When possible, a rubric can be developed where an inventory strategy suggests itself based upon the capabilities of the company in question, and the apparent market trends. The challenge in that case becomes correctly guessing changes in the business cycle in order to take best advantage. These factors must be considered by organizations of any size when estimating issues of inventory control and warehousing.

1.3 Statement of Problem

Our old warehouse has 18 meters X 17 meters in dimension. There are 8 rows with 12 pallets per each and each row has 4 shelves. Each pallet can store about 500 Kilograms of product. So, the capacity of warehouse is 380 pallets, which can store

about 190000 kilograms of product. At this moment, the warehouse can store 13572 pieces of low voltage motor and 7403 pieces of explosion proof motor per quarter. The Figure 4, 5, 6 and 7 show the existing warehouse.

According to the growth of company, the production number is increase as shown in table 1 and also requires more pallets to store the entire product. For low voltage motor, we need to store 20000 pieces per quarter and for explosion proof motor, we need to store 11000 pieces per quarter. So, we need 560 pallets, which can store 280000 kilograms of product at least to fulfill with the company growth. So, we need another 180 pallets more for the new warehouse.

- The method of storing product in the old warehouse is not in order as shown in Figure 6. Moreover, the storage area looked dirty and messy. So, it is difficult to find the goods and takes a lot of time.
- The current warehouse operations can be described as poor and inefficient since no operational process both inbound and outbound activities existed in the warehouse.
- For our existing warehouse, most of pallets are wooden pallets. The disadvantage is they can get moldy if they are exposed to moisture, they can contain insects or they can be broken if carry too much weight item etc.
- Our product does not have a good numbering system. There is no information about year, month and date of the production. Sometimes this leads to the problem in delivery a right product to customer.

Figure 4: The existing warehouse

Figure 5: The biggest problem is not enough space for storing all products.

Figure 6: The storing method is not in order.

Figure 7: Have to keep products outside the warehouse.

Table 1: The number of production that increases every year continuously

PRODUCT	NUMBER OF PRODUCTION (Quantity in pieces Average Per Quarter)		
	2553	**2554**	**2555**
Low Voltage Motor (8 Kilograms)	13010	14110	15110
Explosion Proof Motor (11 Kilograms)	7021	9016	10023
Medium, High Voltage & High Efficiency Motor (around 1 ton)	2	1	3
TOTAL	20033	23127	25136

1.4 Research Objective

- To design a new warehouse for motor manufacturing company in order to support the company growth.

1.5 Research Structure

This research comprises of five chapters including Introduction Chapter, Literature Review Chapter, Warehouse Design Chapter, Results and Conclusions & Recommendations. Introduction Chapter gives an overview of this research, background of the company, statement of problem and expected benefits. Literature

Review Chapter talks about supplemental research based upon inventory management and production issues by a series of modern researchers on the subject. Warehouse Design Chapter gives many methodologies that will use and apply to the new warehouse. Result Chapter shows the results after implementing many methodologies in chapter 3. Conclusion and Recommendation Chapter gives a conclusion of everything done in this paper and suggests some ideas for future improvement.

1.6 Scope of Research

- Designing a new warehouse in order to fulfill with the company growth.

- Creating a new operational process within warehouse.

- Selecting suitable equipment both handling equipment and storage equipment.

- Creating warehouse safety and security system.

1.7 Methodology

As mentioned earlier, we try to design a new warehouse, in terms of layout and strategies to fulfill the company needs. The strategies that we choose to use in our new warehouse are as follow,

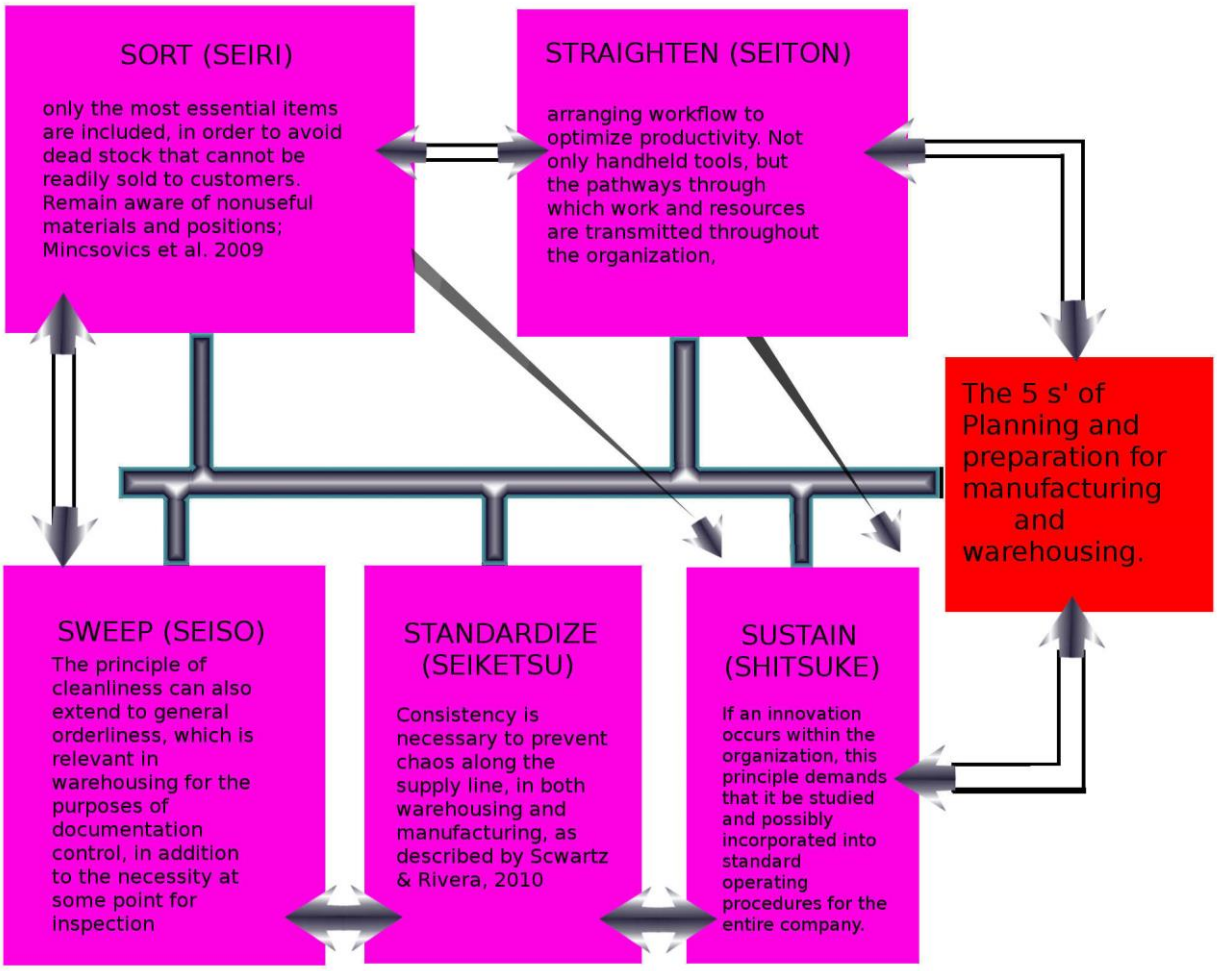

Figure 8: Common pitfalls associated with an untidy environment, combined with principles of preparation. These ideals are intended to remove waste from the planning process, and are relevant throughout the course of this analysis. The Five S's will be discussed

1.7.1 Product Categories

- Grouping our product into the category depends on the product type. This will improve the efficiency in storing the product and easier for employee to know the position of the item to be picked.

1.7.2 Warehouse Layout

- Layout has to meet all requirements especially the amount of capacity that has to reach the maximum flow of the production process and also have enough free space for the product volume that grow each year.

1.7.3 The Use of Material Handling Equipment and Material Storage Equipment

- Choosing the best and suitable equipment for the warehouse.

1.7.4 Velocity based layout strategy

- The most frequently picked products are placed near the shipping area and the least popular products are placed further away.
- Breaking the warehouse into 3-4 velocity zones. Zone 1 will be the fastest mover. Quantity picked is not a determining factor.

1.7.5 New Warehouse Operations

- Warehouse Operations will be developed in terms of inbound and outbound procedure.

1.7.6 Product Numbering

- The study through most of the famous method will be made and pick the one that is appropriate with our product and location.
- This strategy will help getting products from manufacturer to consumer, safely & accurately.

1.7.7 Signage and Shelf Labels

- Using a color to highlight and help every people to navigate through the warehouse.
- All of row numbers are adequately marked on the floor. The huge signs at the end of each aisle will be used. Paint the aisle letter, the first character in your row-locating scheme. Paint arrows on the floor to indicate the desired pick path.
- Create row maps and hang them around the facility.

1.7.8 Security Operations

- Our product is expensive and can get on fire. So, we plan to use fire alarms and sprinkler systems to protect the loss of the assets in the warehouse.
- Setting up security surveillance around the warehouse to record any activity of staff and visitor and also the theft. Our CCTV camera will be used 24/7 that means it still operate in the nighttime. So, we can check the video record anytime or the time that loss occurred.

1.7.9 Warehouse Safety

- Concerning about safety of worker in the warehouse during their operation. The dangerous may be occurred from the tools, equipment or environment that we will talk later in this paper.
- Using some tools and equipment and also creates a safety policy to protect the workers

1.7.10 Dead stock policy

- Concerning about dead stock and how to deal with them.

1.7.11 5 S and the implementation

- Clear the waste and improve warehouse environment.

1.8 Expected Benefits

- The new warehouse should have enough capacity to support the company growth.
- The new warehouse should be clean and being in order.
- The operational time in the warehouse is shorter.
- The warehouse safety and security is better.

Chapter 2: Literature Review

The following chapter focuses on the literature part of the dissertation, whereby several resources will be examined to see what they represent about the topic of warehousing design. It gives a general explanation of the construction of the research's framework.

2.1 Introduction to Warehousing

A warehouse refers to a place where various products are accumulated for a short period or stored. The need for a warehouse comes as a result of the lack of adjustments between the production times and consumption times of the goods. At present moment, the items are produced for demand in advance. Therefore, before bringing of the products to the market, they should be kept. The storage of the goods is done in the warehouse from the production time to the time that they are sold. In this manner, we find that the warehouse eliminates the time hindrance between the production places and consumption places. The warehouse provides facilities to the businesspersons to obtain loan from the credit organizations on the goods kept. The credit companies will be able to provide loans by transferring warehouse receipt, which can be used as a negotiable tool of title. It also gives goods facilities in the cases of ownership transfer of goods stored there in without doing the actual goods transfer just by the warehouse warrants transfer with the approval of the owner thereon.

2.2 Warehouse Design

The design of a system of a warehouse involves a large number of decisions that are interrelated (Keyte (2004)). The structuring of these decisions is in the following hierarchical framework:

2.2.1 Design methods of a warehouse

The process of design runs through various consecutive stages namely concept, acquisition of data, functional specification, equipment and means selection, technical specification, layout and control and planning policies selection. Again, these decisions can be put at a strategic, operational or even tactical level. For example, decisions about the process and the automation level ideally fall under the category of functional, and to some extend the technical specification and of a tactical nature Fredendall (2001). In addition, the selection of basic systems of storage is one that is strategic, while the systems' dimensioning as well as the layout's determination are strategic decisions. Comprehensive policies of control ideally fall under the category of operational level.

The acquisition of data and conceptual stage and that of implementation are also important. It is obvious that most decisions are indeed interrelated even though the hierarchical framework shows the decision's horizons whereas the solutions selected at a higher level offer the restraints for design problems of lower level. Beginning with a limited detail, we find that a rough design is outlined Nagurney (2006). This is also called the top-down method, different from the bottom-up method. The typical design approach clusters related issues at the same level of design and choses a solution by concurrently optimizing the different sub-problems for the purposes of

reaching a global optimum. Moreover, it is essential to take into consideration the connections between sub-problems, to be in a position of avoiding solutions that are sub-optimal.

2.2.2 The warehouse design framework

The process of warehouse design characteristically runs through various consecutive stages. The combination of the fundamental warehouse design elements with particular tools and techniques enhances the overall procedure of warehouse design Andersson (2002). This framework's six major steps are selected because they include the man features of different methods that are found in the literature.

Table 2: Framework of warehouse design

Step	Design techniques, tools and major references
1. Definition of major requirements and identification of the warehouse's role	Warehouse objective evaluation Assessment of distribution network
2. Definition of supplementary Services	Assessment of operational requirements Specifications of extra equipment
3. Define and collect data	Review of database Mapping of process activity
4. Evaluate and characterize data	Models of spreadsheet Profiling and benchmarking of activity Control of statistical process
5. Consider possible strategies of operation	Picking vs storage requirements Evaluation of picking method Policies of item allocation
6. Identification of preferred design alternative	SWOT analysis Financial approximations Assessment of standards System functionality

Despite the significance of warehouse design, many literature or authors have concluded that quite little has been written about the methodical approach that warehouse designers should take Baker (2009). The reviews have shown that there are a lot of information about the analysis of a specific aspects or features of the design of warehouse. What seems to be lacking is the analysis of these techniques. In view of the framework discussed here are the phases of design from the moment when a particular need of warehousing is determined through to a specification that is operational, which is produced with details like methods of operation, layout and equipment Baker (2009).

Definition of basic requirements and identification of the role of warehouse

Matters in relation to the warehousing role in an organization are discussed in the text. Identification of the requirements or overall business strategy and the system whereby the warehouse operates is essential as it describes the improvement objectives and the applicable or relevant constraints Jacoby (2009).

Definition of supplementary services and the ancillary operations

It is important to specify whether the warehouse is meant to perform supplementary services as it influences ensuing steps of the process of design. Professional designers of warehouse might use some checklists for the purposes of examining operational requirements together with extra equipment specifications, but generally it is not easy to use any standardized methods or planning approaches to the design phase Blanchard (2010b).

2.3 Warehouse layout setup

Manufacturing or production is a very competitive field. There are very slim profit margins and several organizations have decided to outsource fabrication to regions that have lower costs of labor. However, the advantage of low cost production comes at a price. The longer supply chains need more inventories for ensuring that product or item is available to the shifting demand. Nonetheless, this excess inventory requires unloading, storing and keeping safely in the warehouse until it is wanted by the client. Whether producing locally or offshore, optimization of storage space in a warehouse is a critical requirement is an organization wants to remain competitive Bell (2002). The layout of a warehouse and choice of racks are very critical factors in making sure there is efficient flow of products Bell (2002). A warehouse that is set up in a proper manner will decrease costs considerably, by decreasing the amount of inventory that is to be stored, reducing forklifts and related costs of repair and fuel and doing way with tiresome physical count by having a better organization of the product.

Before any warehouse racks are set up, the general storage strategy should be taken into consideration. In order to avoid monotonous travel, we find that routes should be established to enable the forklifts move short distances to common locations of storage. The lanes should generally be designated as a single way. This will greatly bring down the number of accidents and enable drivers move at higher speeds. A good design of a warehouse avoids the dead spaces where goods can be lost and never to be found Carmignani (2009). Corners that appear to be awkward and undesignated spaces enable handlers of material to set pallets down temporarily, only

for them to be left there indefinitely. It should be ensured that all the areas are allocated to particular product and labeled in a proper manner. Following the way of product from coming in to going out will show any limitations or bottlenecks in flow. For the high volume warehouses, it might be essential to have different docks of loading and unloading. In this way, there will be flow of product from one dock to the other Bourlakis (2004).

Immediately the implementation of the general flow of the warehouse is done, racks have to be selected to make a proper use of the space available on the floor. Since nearly all the material that is transported by truck is kept on pallets, it is important to use different variations of the pallet racks. Pallet racks that are standard are the ideal choice for facility with high turnover and several different products. The forklift driver has easy access to all the pallet on a pallet rack. Every location of storage can be named and identified on a master list, regardless of whether it is electronic or even just on a piece of paper. The handler of material can follow a grid schematic easily, keeping track of columns and rows until they reach the site where the material is kept Storey (2006).

This advantage of easy access however is not cheap. An aisle is required between the sets of pallet racks, to enable the forklift get to the pallet easily. In most instances, this level of accessibility is not important. At times, all of the trucks do the same thing of delivering the same item. These skids do not essentially need to be accessibly separately. Since they are all similar, their storage could be in rows, whereby the back ones are buried until the removal of the front ones. Pallet tracks that are double deep give room for the storage of two pallet rows, at the expense of the one

at the back not having easy access. With two pallets of similar material, whereby one is in front of another, we find that the double deep pallet racks make the space on floor increased by removing extra aisles. However, forklifts require distinctive extended length forks to be able to reach the pallets' second row Storey (2006).

The push back racks can serve as an option to the double deep racks that do not need forklifts that have distinct equipment. The first pallet is loaded by a forklift onto a rolling cart that is on a track in row one. Then the following pallet is loaded in the same place, with the first pallet being pushed to the back row, since it is free rolling on the cart. The removal of the front pallet forces the back one to roll forward to the front. The drive-through and drive-in racks offer maximum density by enabling the forklifts to move right into the rack. This implies that it is possible to store more than two or three rows in front of one another Waters (2007).

2.4 Material storage

Storage is a very critical part of every space of a warehouse, and a fundamental part of every business of material handling. When a company has the appropriate products and systems of storage, they have available space for the equipment and stock. Most significantly, it can enhance efficiency of their operations. A warehouse storage system can also be referred to as a warehouse management system as it means equipment of storage used for helping in the easy management of warehouse and keeping the employees together with the items and products inside the warehouse secure Waters (2007). The following are the common kinds of warehouse storage systems and their uses:

- Storage cabinets – these are used for the storage of big or small products depending on the cabinets' size.
- Pallet storage systems – They operate just as a cabinet in the storage of items and the only distinction is that in place of cabinets, the products are kept in pallets and are stacked on the racks for avoiding any disorder.
- Mezzanine storage system – This kind of system of storage adds extra space to the storage site for stacking products high up.
- Automated systems – This is used to refer to any kind of equipment of storage in the warehouse that can operate automatically or are automated.

A system of racking can make or break the warehouse. Even if there are plans of making changes and reclaiming spaces in an already existing warehouse, it is important to take into consideration, the unique operating needs and physical constraints before choosing a racking system. A racking system of a warehouse that is properly designed saves the company money by:

- Reduction of the costs of labor in the selection and stocking of goods
- Reduction of damaged goods or products by keeping them in the kind of racking that is designed for that particular product
- Postponement of the need for expansion or movement by maximizing the efficiency of storage in the available space

In order to be in a position of creating a cost effective and efficient racking system in a warehouse, the following factors should be taken into consideration:

- The kind, weight and size of products for storage
- The kind of lift equipment owned or that are to be bought
- The available space in the warehouse, taking into account factors like the dock doors placement, logical flow of products, the height of the ceiling and the staging space required Waters (2007).

2.4.1 Advantages of a warehouse storage system

A warehouse system of storage is regarded as one of the best solutions to the problem of storage due to the several advantages that it can give the owners of warehouse. Some of them include:

- A warehouse that is more organized – it makes a warehouse to be more organized and well planned. The warehouse's organization is the major reason of these storage systems and thus, they are designed to offer the workers and owners of warehouse the convenience of maintaining or management of a warehouse. It can actually be difficult to manage or maintain a warehouse particularly if the items are in a complete mess and since a system of storage can help in having a warehouse that is more organized, it will save the company from the stress of warehouse maintenance Waters (2007).
- A warehouse that is safer for workers and products – it makes a warehouse to be more organized, thus making it safer because there is reduced mess that can risk the safety of the employees when they are doing their duties. The items are also kept very safe and under protection as they are kept inside their appropriate places.

- Saving time and effort – Warehouse maintenance can always be time-consuming particularly if the handlers are keeping track of the items manually and also taking the goods out of the containers manually. With a warehouse storage system, it is easy to sate effort and time as it would be easier for them to keep track of the goods, keep or even take them out of their storage containers Waters (2007).
- Saving space – since a warehouse is organized by a warehouse storage system, it also helps in saving space as the system enables the stacking of goods high up above rather than cramming all of them in a single post rendering the warehouse crowded.

When doing warehouse management, it is not sufficient to envision that a lot of products will be stored or even goods within it, so a bigger warehouse is required. Instead, it is essential to envision the way the management of such big warehouse is to be done, and hence it implies that it is essential to ensure that there is a warehouse storage system to assist as well Copacino (1997).

2.5 Material handling

Products like cart, pallet racking and shelving belong to the storage and handling. Most of these products are usually called ‘catalogue items’ as they generally have an internationally recognized standard and always sold as stock materials out of the catalogues of material handling. The industrial trucks often refer to either motorized warehouse vehicles that are driven by the operator, and are powered manually by electrically or gasoline. The industrial trucks help the system of material-handling with flexibility; they reach where it is not possible for engineered systems

Blanchard (2010a). The most common type of industrial truck is forklift. Stock chasers and tow tractors are more examples of industrial trucks. The major advantage they have is with the extensive range of attachments they have; these actually increase their ability of handling different shapes and kinds of material.

2.6 Warehouse safety

A warehouse that is safe, efficient and orderly is critical to successful operation. It plays a critical role in the manner in which items are sent, stored, received and even moved all through the facility. As there are a lot of activities going on in a warehouse, it might also have a more potential for eventualities or accidents as compared to the areas that have more limited functions. Therefore, it is particularly imperative to take seriously the warehouse safety. There are several kinds of hazard that might be encountered in a warehouse. The most common groups of hazard include slips, falls and trips. When items are carried and moved on different levels, as well as on different kinds of surfaces of floors, it becomes easy to lose balance and fall Copacino (1997).

Another worrying factor within the warehouse is being hit by free falling objects. Goods that are not stacked carefully on the floors, shelves or even some other surfaces can fall of a body or head. There is an additional danger when items are put in storage, or removing them. Any slightest fumble or slip can make those items fall, and the individual handling them might as well go along with them. Another common danger is posed by warehouse equipment. The forklift trucks, conveyers and the hand trucks can result in accidents or harms if the individuals handling them are not very careful. More so, the individual's own body can turn out to be a hazard if materials are carried and lifted inappropriately, risking injuries on the back. It is also good to be careful with the equipment that is used in the loading, packing and unpacking such as the skids,

cutting tools, pallets and strapping. The materials that are kept in a warehouse can also be hazardous. Every individual knows well that they are supposed to protect themselves from both health and physical dangers when working in a warehouse with potentially dangerous items or materials that are flammable Cattaneo (2010).

The warehouse is not a risky place at all, but it contains several potential dangers. No one wants to get involved in moving materials in and out such that they forget to do it carefully and safely. Luckily, the safe way of running a warehouse is also the smoothest way. Therefore, following guidelines and rules of safety is not just a formal requirement but a good sense. Proper housekeeping is the best way to make sure that a warehouse is safe. The whole warehouse should be kept neat and clean always, with everything in order. There should be no blocking of aisles or leaving of materials around for somebody to fall or trip over. Items should not be kept on ladders, racks or shelves so carelessly that they may fall on somebody below or even at the slightest touch. It is important to put on protective gear and then pay close attention to the signs of warning and to the work that is being done around Cattaneo (2010).

The right of way should be given to the hand trucks and forklift trucks. There should be careful handling of equipment; by watching steps taken or movements within the warehouse and keeping the loads secure and stable. When carrying and lifting, it should be done properly in a manner such that the legs are left to do the work and not the back. There should also be a preview of each job before beginning to ensure that equipment is well and that there is proper protection. Individuals within the warehouse should inform their fellows about any potential danger around them so that they can find a way of dealing with them and avoid being injured. In short, it is

important to ensure that everything is in good condition within the warehouse and that there is no potential hazard, so as to stay safe always Cattaneo (2010).

2.7 Warehouse security

The combination of prized property and theft opportunities, especially during the processes of loading and unloading or packing and unpacking makes the security of a warehouse a vital element in the prevention of infringes of the distribution chain of the cargo that can lead to severe losses. The reduction of crime and vices is all about the comprehension of susceptibilities and taking proper measures to bridge the gaps. Just like most high-risk surroundings, proper warehouse security brings together the best of novel technological knowhow with proper procedures that have been designed, tried and tested for many years Cattaneo (2010).

The point of departure is addressing the basic issues of design. Concerning this issue, there should be a very limited number of entrances, like a single one during the day, and the areas of staging should be situated away from the loading docks in order to prevent the easy and fast moving of stolen items to vehicles. The points of delivery and dispatch should stay apart to hamper theft during the arrival or departure time, which are the most common means of theft of cargo. The location of the cloakrooms, toilets and car parks of the employees should also be taken into consideration. Such places offer unnecessary chances for the removal or covering of the stolen items if they are near the stored goods. Foliage and refuse containers put beside the external doors also provide concealment dangers that can be evaded with a little consideration Cattaneo (2010).

Unfortunately, theft by employees is one of the common kinds of theft. Dangers can be essentially decreased through the implementation of through procedures of vetting for the new workers and insisting that the providers of transport take care too Blanchard (2010b). This combination of reviewing the employment history of individuals and considerate layout are critical to the creation or an atmosphere where deceit is made both as improbable and as tough as possible. Nonetheless, only when these critical measures are in place, it becomes proper to consider the next level of security planning; that is adequate physical supervision and protection. The first step is making sure that all the external doors that are accessible during the working hours are well monitored. The best way of doing it is by sealing or locking the superfluous entrances and ensuring that the emergency exits are fitted with alarms. The staff should also know that the organization reserves the right to frisk individuals and vehicles that leave the site Blanchard (2010b). This is a deterrent that can only remain relevant and effective if the searches are carried out always.

Internal security is also critical, both in the reduction of the opportunities for crime and introduction of a culture of cognizance. This encompasses a combination of the physical supervision and protection. Partitions with gates that are lockable, wire mesh cages and security cabinets can be used to store property that is of high value and that is easily movable. These measures should be backed up with a frequent system of record checking a regular security or supervisory staff availability in the premise Blanchard (2010b). Another thing that should be taken into consideration is how to prevent theft by reducing chances for thieves to operate without being discovered. The improvement of visibility in this manner might be as easy as installing quite cost-effective items like convex mirror to do away with the ‘blind spots.’

Electronic systems of security encompass an important third phase in any all-inclusive security program. For example, card access provide a cheap and versatile means of regulating entry to the building in general and to particular high-risk internal regions. In addition, they offer more facilities like recording of transaction for the identification all movements for investigation purposes. Modern systems of access control can also be applied to afford various levels of authority to different individuals, employ ‘time windows’ for the prevention of the out-of-house use as well as the reduction of costs of administration like by giving time for the purposes of payroll.

2.8 Product categories

For supply to stores that are company-owned, it might be prudent to produce styles and keep in stock for quite some time before taking them to the stores. This is important because it makes up for the minimum slots of production, and also due to the fact that these styles are supplied partly in quantities. Moreover, whereas the corporation need to have the standard quantities in the warehouse for every dimension and sub-category, it must also ensure that overstocking in these sub-categories is avoided Blanchard (2010b). To choose the number of days that a stock is to be kept in the warehouse, it is essential to be aware of the lead time needed from the time of sending the order for processing until the time that the stocks are acquired or received.

Whereas doing stock maintenance in the warehouse, the whole space can be divided based on the sales configuration evaluation of the significant dimensions and sub-categories. Then the space can be allocated as orders to be put with their department of production.

2.9 Product numbering

The item identification numbers are usually used to distinctively identify goods that are carried in inventory. Some corporations may call them product codes, part numbers or even model numbers. However, whatever they are called, they are very important to their handlers and the systems that they use. If an individual and their systems cannot distinctively identify a product, it becomes very difficult to account for its whereabouts and activities within the inventory. Product numbers also act as shorthand for longer descriptions of items Blanchard (2010b). Rather than entering a whole description or name for a product, a much smaller product number can be used. This enhances the process of inventory management. Big corporations and retail products usually use numbers that are long and very complicated for their product numbers. This is appropriate if it is for a complex warehouse.

2.10 Signage and shelf label

Location labels for shelves and racks – fast picking needs fast location. The company should make sure that racks and shelves are labeled clearly with labels that are durable and long-standing. The shelf labels are usually white with special direction indicators and color coding. The printing of the racks and shelves can also be done with the use of Retro-Reflective Label Materials, which enables long-distance barcode scanning Blanchard (2010b).

Location Labels for Bins – Bins and Totes can be market with the plastic labels that are durable, and that bond well to all kinds of storage and inventory containers.

2.11 Warehouse KPI

In order for a business investments in the management of a warehouse to have a three hundred and sixty degrees view, it is important to develop key performance indicators for efficient and effective business decision. The KPI (key performance indicator) refers to a measure of the business performance for the purposes of benchmarking against the competition and exploring the probability of improving so as to gain a competitive advantage Blanchard (2010b). The function of warehousing is very important within any supply chain. Nonetheless, if the goods do seamlessly not move within the supply chain, the company would likely face serious challenges that are service related. Thus, it is important to drive the warehouse performance through key performance indicators. In a continuous environment of improvement it is important for the benchmarking against the standards of the industry for driving improvement.

2.12 Dead stock management

Dead stock refers to a product or good that has not had any sales in the past twelve months. Dead stock affects the flow of cash, takes up precious space in the warehouse and freezes revenue that should otherwise be committed to the purchase of items or products that generate revenue. Dead stock usually slips through the cracks without being noticed for longer periods in most warehouses Blanchard (2010b). It is beyond reasonable doubt that poor inventory management encourages dead stock in warehouses. When individuals do not pay close attention to their inventor's movement, dead stock takes place. However, it is good to take the time and comprehend the dead stock's root cause, and design inventory tactics and purchasing

criteria around doing away with it. It is only through this that the company will be able to reduce the dead stock inventory from hampering their profitability.

2.13 Warehouse activities categorization

The priorities and objectives of a warehouse together with its role supply chain role define the kind of activities as well as resources that are required. The different activities that are carried out in a warehouse together with their sequence need to be identified to help in the development of layout structure that is functional. Since warehousing is an essential cost activity, we find that it is imperative to fully make use of the warehouse resources like labor, equipment and space. The incorporation of the activities of warehouse into a sensible process flow plays a significant role in the achievement of this goal Blanchard (2010b).

The major function of a warehouse is the reception or orders from customers, retrieval of items that are required, and finally preparing and shipping those items. There are several ways of organizing these operations even though the general processes in many warehouses have the following phases in common:

- Receiving- this is the process of unloading, confirmation of checking of quality and repackaging of the items for the purposes of storage.
- Put away- this is the definition of the exact location for goods and their transfer to the identified location of storage awaiting demand.
- Order picking- this is the retrieval of items from their locations or sites of storage and moving them either to processes of sorting or straight to the area of shipping.
- Shipping- this is the process of inspection, palletizing, packaging, and loading of

the goods or items into their carrier for their delivery.

Out of all these activities, reception, and put away are in the processes of inbound logistics, which implies that their main concern is the steady materials flow to the warehouse. On the other hand, shipping and order picking belong to the processes of outbound logistics, which are concerned with the moving of materials away or out of the warehouse Hugos (2011). The figure below is a representation of the practical or ideal cost distribution between different activities of warehousing as a fraction or representation of the total costs of warehousing Hugos (2011).

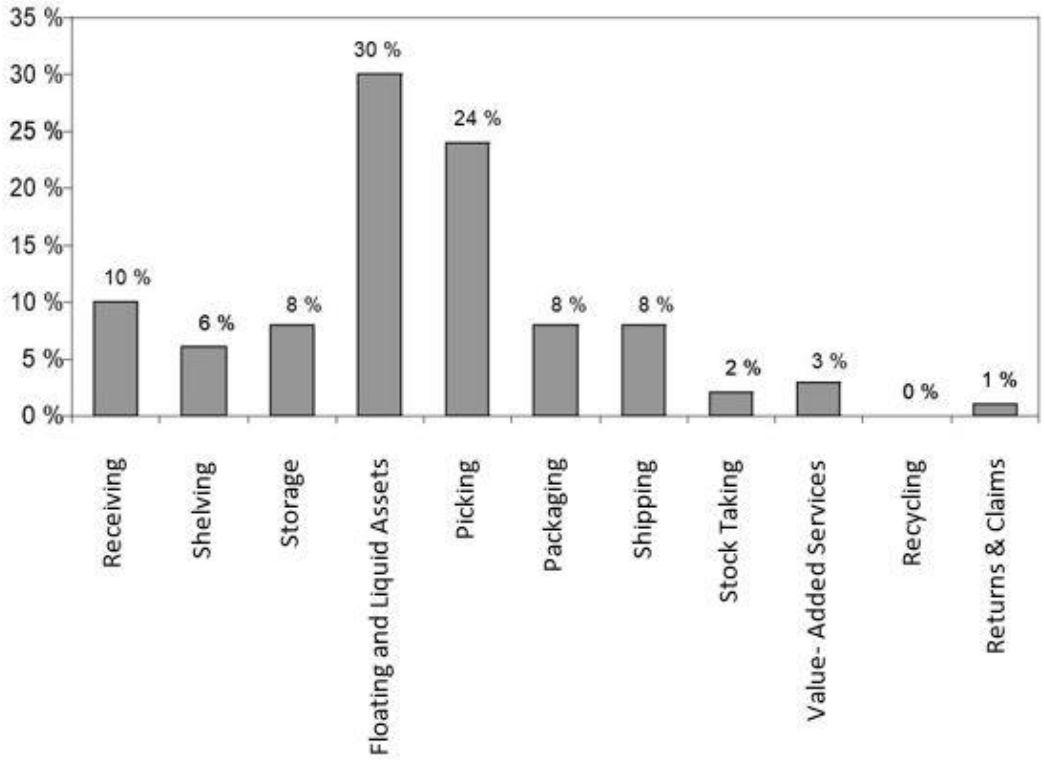

Figure 9: Average warehousing operations cost

The manner in which different functions of warehousing are arranged is dependent of several issues. The first one is that the warehousing facility's physical quality might set particular conditions Aminoff (2002). For instance, the functions of shipping and receiving should always be located close to the facility points of input and output. On the other hand, the facility might have some fixed barricades hampering the entering and the performing of some tasks in some areas. The second one is that the management ideally wants to ensure there is balancing of the patterns of flow between different activities and reduce the distance of travel for the movement of stock. This can be attained via methodical identification of the locations of stock and the requirements of adjacency between various activities of warehouses

Baggaley (2003). The last one is that product attributes might need some kind of procedures of handling. For example, some items might be sensitive to temperature, which requires their processing in a location that is climate controlled Cristopher (2005).

2.14 Warehouse resources

Distinctive issues that are involved in the designing and the performing of processes of warehousing include allocation of resources in terms of their capacity and costs. When taking a look at the service or product value, the objective is having the value of the final product surpass the cost of its production Cooper (2010). Identification of the value added activities within the process of warehousing is a fundamental but difficult task. Essentially, the assessment of value is made by appraising every activity within the warehousing process and definition of its importance to operations. The product or service cost is inclusive of all the resources that are used in its production, such as the raw material, space of storage, equipment, labor and transportation Baker (2004).

It is easy for the identification of the following list of distinct resources of warehouse

- Units of storage - these are used for storing products like boxes, pallets and trays.
- Systems of storage - these may range from simple shelves to conveyors and cranes that are automated.
- Pick equipment - these are used for retrieving items or goods from the system of storage like reach trucks, standard forklifts and pallet trucks.

- Auxiliaries- these are equipment like barcode scanners, which support the activities of warehouse.
- Computer systems – These enable the processes of computer control
- Material handling equipment – These are equipment for the preparation of items that are retrieved such as truck loaders, sorter systems and palletizers.
- Personnel – These are human resources than run and control all of the resources prescribed.

The warehouse resources usually represent a considerable capital investment. About fifty percent of the costs in ideal warehouse are those that are labor-relate, whereas equipment of storage, machinery and facility represent a very smaller percentage of the investment. Decreasing the amount of labor or even acquiring higher labor productivity can actually be regarded as a way of reducing the operating costs of a warehouse. This is usually done by acquiring very expensive warehouse technologies. Nevertheless, to get a good rate of return on the investments on equipment, they should be chosen and used in a proper manner Baker (2004).

2.15 Warehouse technologies

Most developments in the efficiency of warehouse have been eased as a result of the developments in the warehouse technologies. It is important to think about the warehouse technologies as constituting two elements; the first one involving the use of computers for the purposes of directing and planning of activities and another one being the level of automation or mechanization. Traditionally, the aim of automation of the operations of warehouse is enhancing the efficiency of handling materials via

reduction of costs of labor and raised through output. The development of systems established for warehousing is not much distinct from several other technology solutions in that majority of them are on the basis of a few major functionalities whereby the developers have begun the addition of smaller features on top of them that they have regarded as essential for the achievement of a particular task.

2.16 Warehouse Design Research and Study Guide

The fundamental components of a warehouse must include the three basic functions of receiving, storage, and eventually shipment when the materials are moved again. The warehouse is the fundamental link in the logistical chain between production and consumption. In keeping with efficient design principles as discussed throughout this analysis, it is essential to optimize the use of space within the warehouse, and for all actions therein to proceed with a minimum of wasted effort, consistent with the objective of the 5S's as described in the introductory chapter, as well as the chapter 3 and conclusion.

On the storage side, the organization must consider proximity to larger marketplaces, and the proximity of the location to major routes of commerce. If primary methods of distribution are intended to be along a highway system, then it is most cost-effective to locate the storage facility as close as possible to the largest nexus of roadways in the region. This is more likely to be relevant in an environment of dynamic warehousing, with more rapid changes in inventory on a regular basis. In this instance, if transportation options involve regular truck shipments, then locating the facility near a major highway system will ease travel to and from the warehouse in question. Naturally, this is also true of the organization's competitors. And thus a

cost-benefit analysis is necessary in order to determine what value can be gained by locating the warehouse in the most convenient, centralized location available.

Based upon specific travel needs, flexibility exists concerning this factor. If an organization found it effective to do most of its transportation by airfreight, the most relevant factor becomes proximity to the nearest suitable airport. The relative cost of transportation options must be weighed against the cost – or benefit of the property in question, which is a fundamental component of real estate businesses. Moreover, if economic conditions invite changes in these factors, it may be necessary to reconsider a storage location. If a new highway system diverts traffic, and makes ground transport more time-consuming, then the organization must also consider whether to continue to use an existing facility, downgrade its importance, or building new one. Or increase usage of a previously underutilized warehouse closer to the new direction of traffic. A decision must be made based upon minimizing the complexity of the resulting supply chain, which is essential for the purpose of reducing the risk of errors and unexpected delays. Management of an organization must determine both the most probable, and all possible paths by which goods can be delivered to a consumer based on the location of the facility in question. This must be factored into any judgment of how much stock to retain under what circumstances.

A consistent theme throughout this analysis is the need for all professional organizations to develop a monitoring process, and a mechanism by which information is gathered and reported as part of either a regular reporting process to management, or for the purposes of documentation for inspection as needed, but often both. The organization must determine how much information is or is not necessary about day-to-day operations. It may not be worth reporting when each employee takes a

bathroom break, but hourly employees in many instances operate under a time clock using punch cards or some digital analog. The organization must determine how much of this information is or is not vital.

Other operations, such as highly technical procedures involving materials subject to safety inspection in most cases are legally mandated to maintain records of the operation. In the case of automobile manufacture, many components going into the car must have a serial number that documents when and where each piece originated. Most organizations over the years have devised reasonable strategies in compliance with all pertinent legal regulations concerning what they must to document and when. However, information management is an important part of logistics, and there are more complexities in terms of information management pertaining to a supply chain.

In addition to the decision on what operations must be documented, it is also necessary for the organization to decide when and to what extent documentation should be shared. Legal authorities and inspectors have exacting requirements on what information must be shared with them in order to comply with the law, but there are fewer certainties in the logistical context pertaining to other organizations, or even different departments within the same organization. It may be necessary to document through a punch card system when an employee takes a break, but that information is likely only to be relevant to human resources. Much of the data gathered by an organization need not be shared even within that organization. However, the possibility exists during an unexpected incident that more information will be requested than is anticipated. In case of unexpected shrinkage or a threat to inventory, it may be necessary to contact specific individuals and ask them exacting questions, or to obtain

documentation of the movements of individuals or items at a specific time as part of some unforeseen incident.

To prevent irregularities concerning inventory, it becomes necessary to explore additional details concerning the physical structure of the warehouse itself, in terms of the rhyme and reason of the internal layout and structural decisions. Both as a way to protect inventory, and to optimize the utilization of storage space it becomes necessary for the warehouse to be situated on the ground as flat as possible. If there are no special circumstances facilitating cheap and easy air travel, the warehouse should be situated near accessible land close to a national highway system. Failing that, a flat location close to a maritime port would be advantageous. In order to retain its place within the supply chain, it should have access to all lines of communication which the company has available. Transportation options should be implemented, primarily in support of ships or trucks that will be moving inventory there is a need for fleet parking whenever possible, as well as room for large tractor-trailers to maneuver.

Modern warehouses are typically constructed using sheet metal, based upon recommendations included in WarehouseDesignConcepts (2013). Careful attention must be paid to the foundations, as they require cement flooring with a weight-bearing capacity calculated to match legally mandated standards specific for the stock in question. To optimize storage capacity, the inside flooring must of course also be as flat as possible, with smooth surfaces to accommodate the use of forklifts and other loadbearing machinery within the structure.

In terms of the size of the structure, it is necessary to optimize vertical space as well. But there are limits to how high the ceiling can be. If the ceiling is too low

then that limits the number of crates that can be stacked one atop the other. It is also necessary to create lanes of transit inside of the warehouse in order to rotate stock as needed. A warehouse packed completely throughout all of its volume would be extremely impractical, as extraordinary means would be necessary to access crates farthest from the door is. Utilization of vertical space is more efficient. However, if the ceiling is too high then the moving heavy freight from the top shelves would require the use of additional equipment or elevator systems which themselves would prove costly in terms of space, producing diminishing returns if extraordinary constructs and machinery are needed to access the highest levels. The roof height should be calculated for the purpose of vertical racking, but not so high that extraordinary measures necessary to move stock become more trouble than they're worth.

It is also necessary to plan the loading and unloading docks at the entrances to the warehouse in terms of operational and loading efficiency. The warehouse should include at least one specialized loading dock that can be made continuously available whenever delivery occurs, a 24-hour dock available in any weather. Ramps and forklifts should naturally be included, and interior space should not be so crowded as to prevent the movement of these vehicles. Forklifts themselves will require the installation of ramps.

The docks themselves must be situated in a way that facilitates the most efficient allocation of arriving material into available storage locations, or conversely racked storage should be positioned with ease of access to where ever the loading docks must be. Options include wooden pallets, in addition to crates or specialized shelves and storage binning. The possibility also exists of automated racking systems with automatic retrieval based on some form of mechanical conveyor system. But this

decision depends upon the value of the items stored, and the warehouse should not be so high that this form of equipment detracts significantly from storage space for intended inventory.

Once the foundations have been built in a suitable location with a balanced amount of ceiling space it is necessary to devise additional systems for how inventory will be organized within the warehouse. Once inside, inventory can be received and entered into a storage system where each unit represents a point value weighed against a maximum capacity for the warehouse. The total points of inventory within the warehouse must be monitored constantly by management, if the points are too low then there is a danger of shortfall and thus inability to meet consumer demand. The point value is too high, then the supply chain is inefficient, and a surplus of unsold goods exists – which may lead to dead stock. Different items may be assigned different point values depending upon their size, and any challenges concomitant with their storage.

There is another inventory option consistent with the need for greater flexibility in terms of storage and manufacturing. A possibility is to use a material requirements planning system, in which stored items within a warehouse are kept at a minimum, and instead some levels and manufacturing occur in direct response to purchase orders. A customer could order a motor, and this will set in motion a chain of events leading to additional acquisition of raw materials, processing and assembly of the components – some of which may occur in the warehouse. Small orders to individual customers could in some cases be met by a warehouse that stores rudimentary components which could be assembled with in the warehouse itself in order to meet small quantity purchases. This method would also allow a degree of customization.

Universal components of the product could be stored in the factory, and stochastic orders from customers could be met more efficiently by assembling only the motors corresponding to a purchase order as it happens.

This increases flexibility in keeping with overall themes throughout this investigation, allowing managers to meet demand in real time, without needing to store large numbers of motors – some of which will not be sold. Management must decide whether the core of the business entails bulk orders to industry, or will be more focused upon the fluctuating demands of individual private consumers. On a limited scale, this process will be implemented in the hypothetical example.

This method supplements a third possibility with respect to inventory planning. Many operations attempt to avoid the bullwhip effect through a strategy where production of new items only occurs in direct response to a customer's order. Using this strategy, known as the Pull method, stocks are not built in advance awaiting an eventual purchase that may or may not come. Production only occurs in direct response to a purchase. This method is consistent with the material requirements planning system, but this principle is extrapolated throughout the company’s production capacities. If there are no predictions concerning future demand, then this strategy will limit waste – but it depends upon the assumption that there will be no spikes in demand. If the supply chain is adapted to a low volume of orders in which every item is produced only when a sale is certain, the possibility exists of a sudden influx in demand, which the organization may not be able to meet in a timely fashion without stockpiles of the items in question.

This strategy would be most useful with respect to extremely costly 'big ticket' items, in the case of rare goods priced beyond the reach of an average consumer. An extremely powerful, highly specialized engine used for emergency vehicles, or perhaps military use might fall under this category. In these cases, high-performance items should not be stockpiled, as there is no reasonable expectation for them to be sold by a casual consumer. Items sold on a regular basis to the general public may be subject to unpredictable – or surprising fluctuations in demand, and the organization will miss out on a sales opportunity if it is unable to meet this need as it occurs. But rare specialty items should in most cases be built only to order based upon the Pull method.

When bookkeeping and management issues have been solved, there are additional physical issues concerning how items are to be stored. The racks upon which inventory is placed should be adapted for ease of placement and removal. An item such as a motor is likely to need mechanical assistance in order to lift, such as that supplied by a forklift. Extremely flat items or layered materials could be stored on wooden pallets that could be raised from underneath by a forklift. In order for this to work with a motor or similarly sized mechanical device some form of crate is necessary. And the rack system must be adapted with this in mind. Gravity or pushback racks that depend upon the item being able to easily and safely flow or tumble in sequence for easy retrieval are unlikely to be a viable option in this case.

Selective pallet racks are the best option for a motor manufacturing company with multiple models available. This method allows for selectivity, if all of the crates are adequately labeled with documentation available. This would allow the specific

movement of an individual unit by heavy machinery on demand. Any sort of gravity racking system would put the items and personnel at risk for devices of this sort.

Chapter 3: Warehouse Design

In this chapter, the warehouse design will be made also with a lot of strategies that will be implemented in order to make a new warehouse to be ready and can support the company growth. The conceptual design will be discussed first and then follows by the detail design.

3.1 Conceptual Design

According to the statement of problem in section 1.3 and the objective in section 1.4, the warehouse conceptual design is defined as

- Meet the company requirement in terms of warehouse capacity.
- The inflow and outflow within the warehouse flow efficiently.
- Easy to understand by every staffs.
- Provide a safety for every staffs.
- Provide a security for goods and asset.

3.2 Detail Design

The warehouse detail design will be mentioned in this section according to the warehouse conceptual design. The 11 methodologies below will be applied to the new warehouse in order to fulfill the company requirement.

3.2.1 Product Categories

Grouping our product into the category depends on the product type. This will improve overall efficiency in storing the product in terms of ease of placement for the benefit of employees. All products are organized under a system that categorizes everything based on a consistent inventory plan. After grouping, the items must be arranged based on this plan, in sequential order for ease of access and documentation.

There are other categories relevant to inventory management that should be considered when stocking. Cost: special security and safety provisions may be necessary for items with an extremely high monetary value, or some form of insurance policy in the event of breakage. Turnover: items, which sell the fastest, should be the most easily accessible. Moreover, the numbering system also be created in this categorize strategy. The best-selling product which has a very fast turnover rate will get number 1 and the worst selling product which has a very slow turnover rate will get the last number.

Our company has a lot of products around 100 items. According to the cost factor and turnover rate factor that mentioned earlier, we can categorize our product into 5 different groups as follow:

1. Very expensive products (VE): This is the only one group that concerning about cost factor, so we separate them from another group that use turnover rate factor based. The company has 4 types of very expensive products. The products in this group have very high in cost which has the cost per pallet equal to or more than 100,000 Baht.

The code VE1 – VE4 will be created depends on the turnover rate that mentioned above.

2. Fast moving products (FM): The company has 9 types of fast moving products. The products in this group have 1-3 days turnover rate. The code FM1 – FM9 will be created for them depends on the turnover rate that mentioned above.

3. Normal moving products (NM): The company has 58 types of normal moving products. The products in this group have 4-7 days turnover rate. The code NM10 – NM67 will be created for them depends on the turnover rate that mentioned above.

4. Slow moving products (SM): The company has 27 types of slow moving products. The products in this group have 8-14 days turnover rate. The code SM68 – SM94 will be created for them depends on the turnover rate that mentioned above.

5. Very slow moving products and dead stock (VD): The company has only 2 types of very slow moving products and dead stock. The products in this group have more than 14 days of turnover rate. The code VD95 – VD96 will be created for them depends on the turnover rate that mentioned above.

Table 3: The summary of categorize strategy with 5 different groups of products and the numbering

VERY EXPENSIVE PRODUCTS (VE)	FAST MOVING PRODUCTS (FM)	NORMAL MOVING PRODUCTS (NM)	SLOW MOVING PRODUCTS (SM)	VERY SLOW MOVING PRODUCTS AND DEAD STOCK (VD)
VE1 – VE4 (4 items)	FM1 – FM9 (9 items)	NM10 – NM67 (58 items)	SM68 – SM94 (27 items)	VD95 – VD96 (2 items)

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3.2.2 The Use of Material Handling Equipment and Material Storage Equipment

Heavy movers will be required in order to receive and prepare inventory for transport, but the utilization of this equipment should be limited so that equipment to move stock itself requires extraordinary provisions for storage. A forklift and hand pallet truck would only be sufficient under the slowest business conditions; the warehouse should have the capability to increase movement of inventory on demand. Useful principles for design include full utilization of vertical space as much as possible, in addition to accessibility of materials. In addition, the choice of items must be determined with capacity in mind; absolute space must be sufficient. The layout of the warehouse must be suitable for the items stored; as the three potential layouts

will be illustrated. Naturally, safety is also a required consideration. Methodology 9 has more details on exact items utilized for security.

In this methodology, we will talk about which type of storage equipment that the management team are interested in and which type of handling equipment are they going to used.

3.2.2.1 Storage Equipment

There are only 3 types of racking system that the company interested in after collecting the data from a lot of staffs and management team.

- Selective Rack

The system is designed to accommodate the storage of goods placed on pallets by the products are heavy or large. This type of rack suitable for the storage of various types of things from raw material to finished goods. We can easily choose the location to store the goods and conveniently take them out from any position. The design is simple, stable and strong structure with theory supported and certification. Every type of forklifts can be used and controlled by a mid-level skilled staff and above.

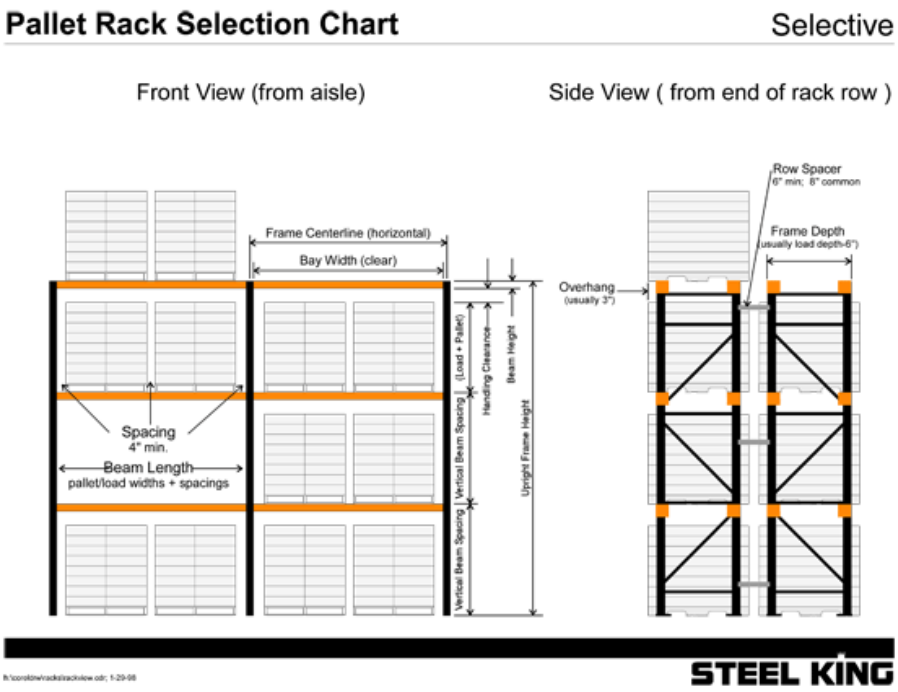

Figure 10: Selective rack system

http://www.rackexpress.com/blog/pallet-rack/various-pallet-rack-configurations/

- Cantilever Rack

The special shelves use for storage goods, special raw materials in stores or maintenance material that looks like a long tube or roll sheet. The rack's main structure is a single pole with outstretched arms to both sides in opposite directions in order to achieve a balance of structure that designed to receive a higher weight. This type of rack will not be a problem for travelling in the warehouse. The shelves level can be easily adjusted. The material can be laid off easily and look orderly.

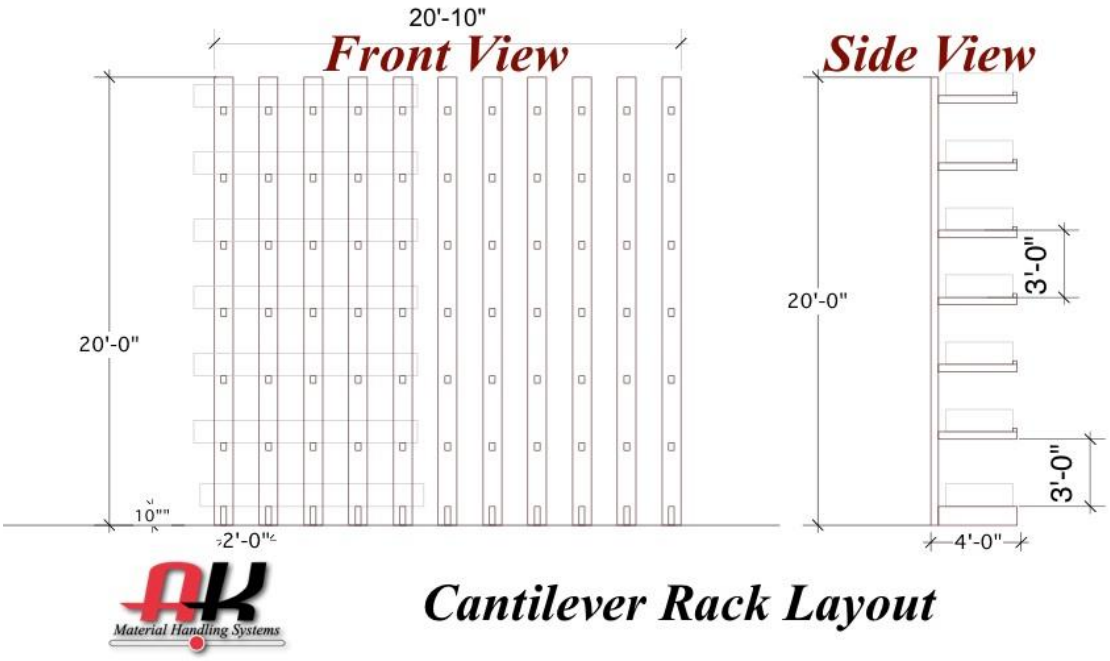

Figure 11: Cantilever rack system

http://blog.akequipment.com/2013_05_01_archive.html

- Gravity flow Rack

This type of rack often used for storing goods with high demand. It is suitable for storing goods with the same size and shape. The product will be delivered to the back of shelves. Then, moving to the front, which is tilted. Then the staff will pick out through the front of the rack.

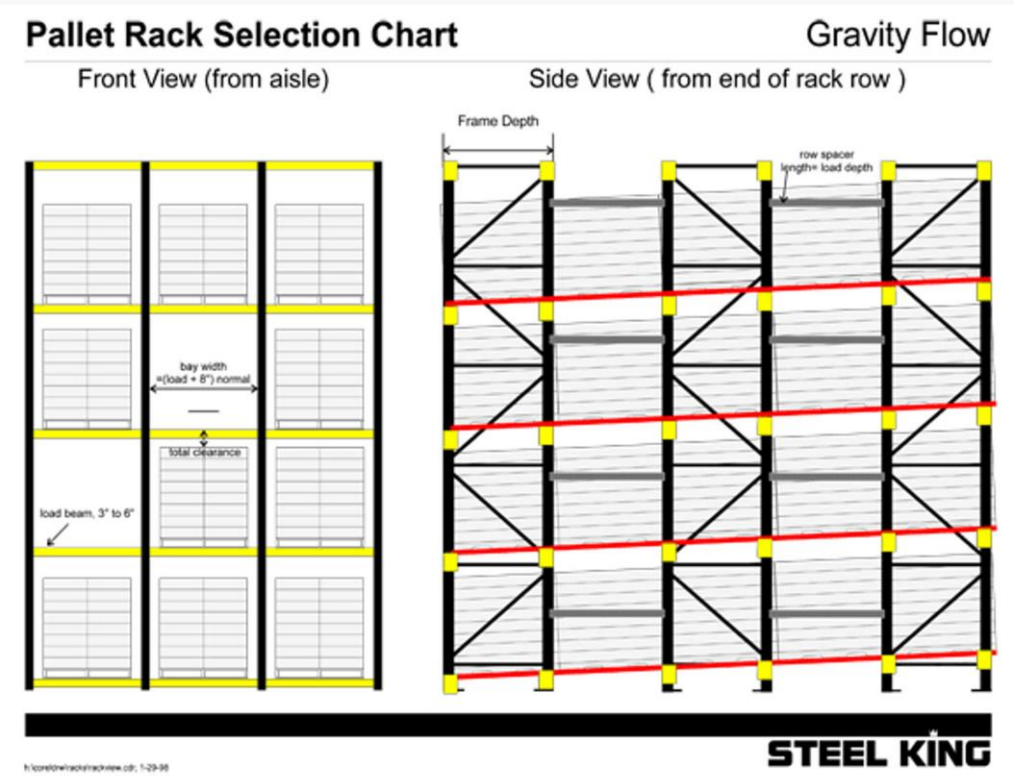

Figure 12: Gravity flow rack system

http://www.rackexpress.com/blog/pallet-rack/various-pallet-rack-configurations/

- Pallet

Pallet is one of the key equipment that will help optimize the storage system. Choosing the right pallet can result in cost reduction and expenses as well. Nowadays, there are 4 types of pallet that used in warehouses. They are different in materials that are produced from wood, plastic, paper and steel. But the most widely used is pallet made of wood and plastic.

Table 4: Comparison factors between wood pallet and plastic pallet

COMPARISON FACTORS	WOOD PALLET	PLASTIC PALLET
Suitable for	Selective Rack System only	Every type of rack system
Place	In door warehouse	In door warehouse
Physical Resistance	Have a chance to tear or broken when hit by another equipment	Withstand the crash and bumps
Environmental Resistance	Sunlight resistant, but not resistant to rain and moisture.	Rain resistant, moisture resistant, but not resistant to sunlight
Price	Very cheap	Made of PE 100%, the price will be very high Made of Mixed PE the price is cheaper

Wooden pallets, mostly applied to the product and applications that are not damp or wet. Plastic pallets are used for general warehouse. The other comparison is as follows,

As mentioned earlier in the introduction part, our old pallet is wood pallet and we met with a lot of problems when the pallet applies with moisture. Moreover, there are some insects that occurred with the wood material. Additionally, our wood pallet always breaks while using. All things taken into consideration, the management team would like to choose the plastic pallet.

3.2.2.2 Handling Equipment

There are 2 types of handling equipment that we will use in our new warehouse that are,

- Forklift

Nowadays, forklift is needed as the one used in the industry. It can reduce working time in handling, lifting and moving. It also reduces injuries from lifting heavy objects, reduces cost of employment and reduces human resource using.

We already use the forklift in our old warehouse and we still make decision to go on using it.

Figure 13: Forklift

http://www.natrajenterprises.net/forklift.htm

- Hand Pallet Truck

A heavy truck use for moving heavy items that placed on pallet within warehouses with a wide range of applications. The hand pallet truck that we use can make a turn up to 200 degrees and have 2.5 tons capacity. Our hand pallet truck has overload valve that can prevents lifting overweight goods. It also has long operating life and low maintenance cost.

Figure 14: Hand pallet truck

http://www.natrajenterprises.net/hydraulic-hand-pallet-truck.htm

3.2.3 Warehouse Layout

The Layout has to meet all requirements especially the amount of capacity. Total storage volume must maximize flow of the production process and also have enough free space for the product volume in response to annual growth. We will use the data in this analysis to study the production increase of the company from statistic to predict how long the new warehouse can accommodate all products without overflow.

In addition, this analysis also considers the type of rack strategy, with the benefits of gravity flow rack, cantilever rack and selective rack.

3.2.3.1 Layout 1

It may be possible to store certain components using a cantilevered rack system, and with protruding shelf space permitting items to slide easily and the accessed. However, this warehousing and rack structure is primarily beneficial for tubing and piping, or for bundles of linear objects. There are hoses and certain forms of wiring applicable to automotive design that might benefit from the structure, but for the purpose of storing motors this is both impractical and unsuitably dangerous. Potential layouts are depicted below:

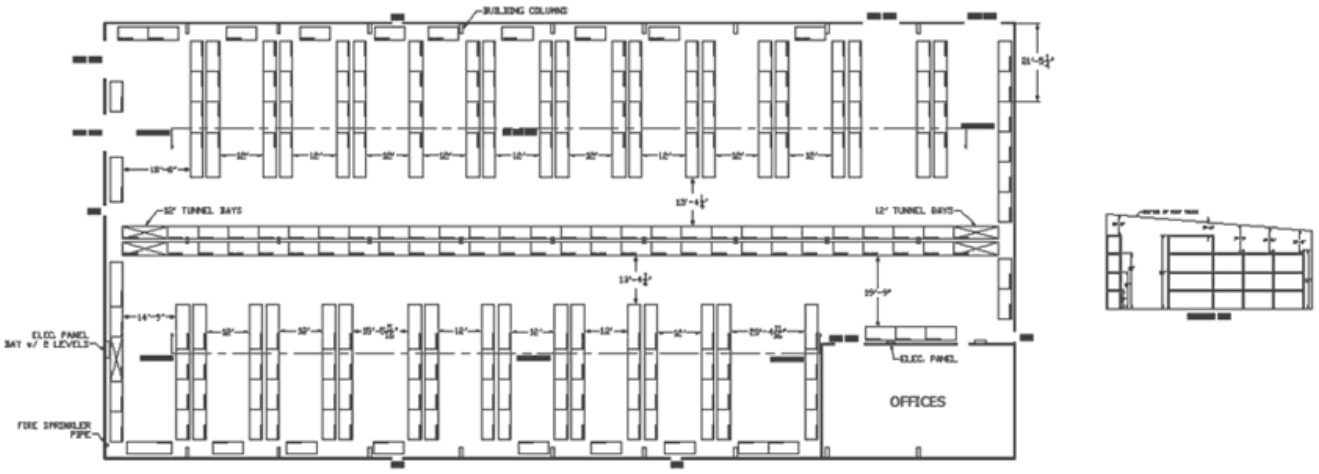

Figure 15: Layout 1 with Cantilever rack
Rackexpress.com (2010)

Layout 1: The cantilever rack specifications are 453 kg/arm. There is 6 arms for each rack, so weight capacity equals 453x6 per unit = 2718 kg. Based on this layout, there are 129 items of these units possible based on total rack space, so the ultimate capacity of this layout is 2718x129 = **350,622 total kg in storage**. This is based on a count of each individual racking unit depicted in the layout above. Here, the problem

is safely storing an engine on the cantilevered rack; challenging without some specialized pole or hanging structure. Moreover, even with this arrangement it would be dangerous to access motors without a forklift; and forklifts are not ideal for the structure depicted. While this warehouse could contain 280000 kg, the limit for our construction, it is not efficient to design a structure so far in excess of our actual needs; even if a support structure could be inserted to allow easy forklift access to the cantilevered racks.

Figure 16: Cantilever rack

http://racks.apluswhs.com/cantilever-racks/button-on-cantilever-rack/. Accessed: 1/8/2014129

The chart below systematizes the pros and cons of Layout 1:

Table 5: Pros and Cons of Layout 1

ADVANTAGES	DISADVANTAGES
Accessibility of Stock (2 points)	Falling Hazards
Office Space for Documentation	Lack of Modification area for small orders
Loading dock area for truck	
Weighted Score: 2	

3.2.3.2 Layout 2

Warehouses and rack could also be arranged based on a gravity flow system, as described earlier in which the racks are designed to flow and shift in response to movement. This will be the subject of the next design. Moving one object allows the next object to roll into place. This current design would benefit considerably from arrows and signage.

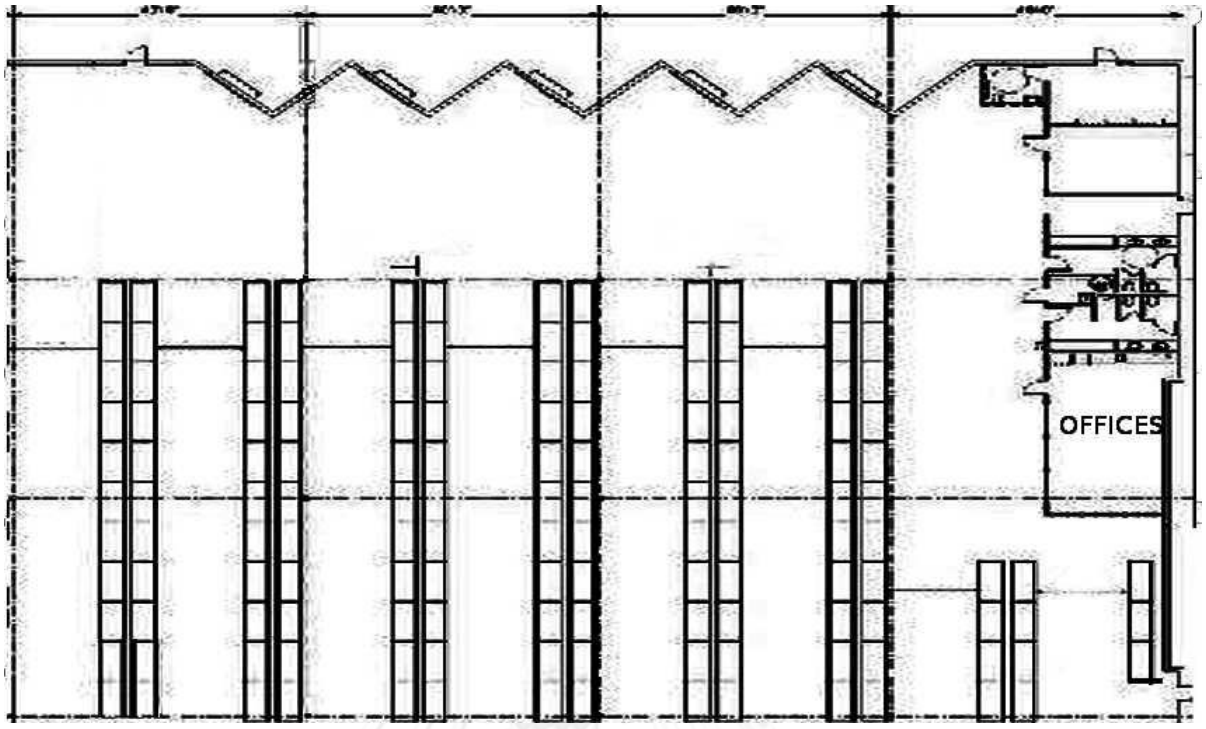

Figure 17: Layout 2 with Gravity flow rack

Layout2: The Gravity flow rack specifications are 460kg/unit with 2 meters in height and 2.6 meters in length. Stack in double rows 4 meters in height. Based on this layout, there are 251 items of these units possible based on total rack space, so the ultimate capacity of this layout is 251 units x 460kg/unit = **115,460 total capacity**. This rack has a hinge structure permitting pallets to slide downward as needed. This is far below our figure of 280,000 kg. Regardless of specialized pallets used, the total complement of stock would not fit.

This could be a viable storage option for car tires, which are intended to roll. Motors and motor parts are not, and therefore this pattern is counter indicated by the needs of basic safety. But in general, this layout has a modification area for small

orders, to its credit. This layout also has specialized and stable racks position on top of each other, but the space is so densely and there is an interior layer inaccessible from the outside. The structure has suitable docking areas, a receiving area, and aisles in which heavy movers can travel to any stored location. Each items stored can be moved by a forklift without disrupting the stability of the others.

Figure 18: Gravity flow rack

http://www.rackexpress.com/blog/pallet-rack/various-pallet-rack-configurations/

The chart below systematizes the pros and cons of Layout 2:

Table 6: Pros and Cons of Layout 2

ADVANTAGES	DISADVANTAGES
Accessibility of Stock (2 points)	Falling Hazards
Small order modification	Interior layer inaccessible from outside
Loading dock area for truck	Lower storage capacity
Weighted Score: 1	

3.2.3.3 Layout 3

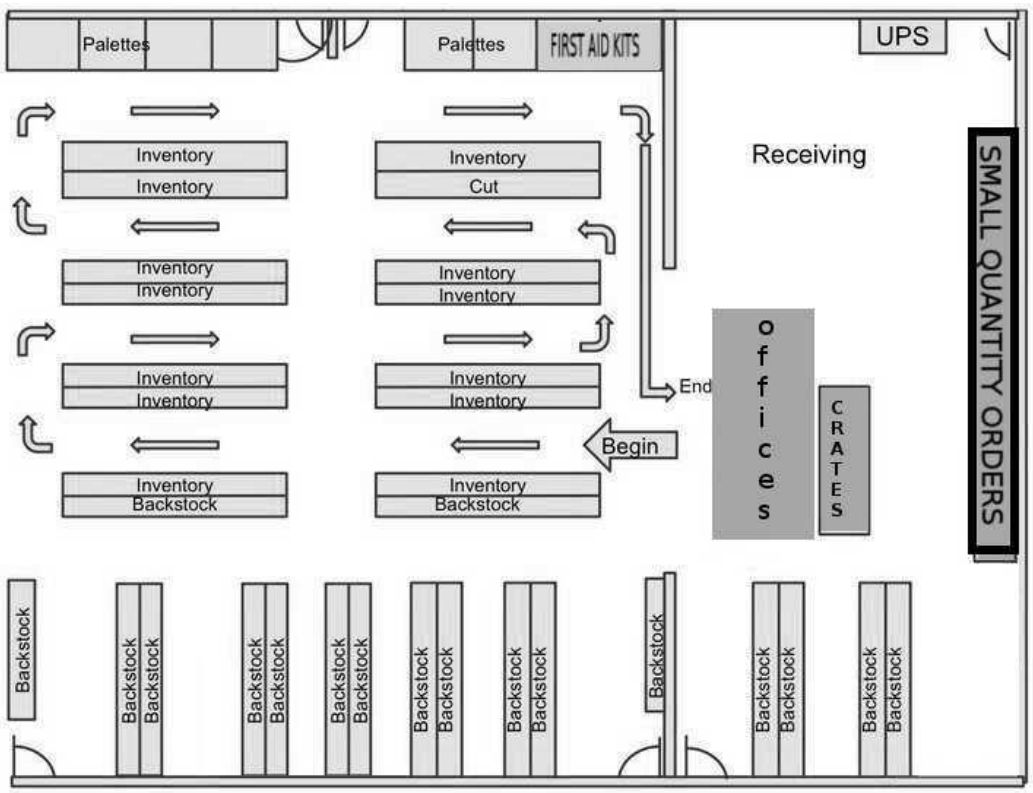

Figure 19: Layout 3 with Selective rack

Layout 3: This design has 15 meters in length for each row. Racks are 2 meters in length, 2 pallets will fit on each level, for 7.5 individual rack-units per row. At the ends, one rack will be turned sideways, with 7 laterally placed side to side. Each rack can holds 1200kg/unit, equaling 1200kgx7.5 = 9000 kg per row. Total count equals 30 rows: 30X9000kg = 270000kg. There is two racks at 2/3 the length of the others so, they are 10/2=5 units for each reduced row. This includes two of the backstock rows with different lengths than the others. Counting each row and multiplying by the total weight capacity of each rack provides us with a calculation of the total warehouse

capacity: 1200Kgx5unit = 6000kg x 2 = 12,000kg. **So in total, 270000+12,000 = 282,000 kg**. This value is closest to our figure of 280,000 kg.

Figure 20: Selective rack

http://www.busytrade.com/selling-leads/1121062/Sell-Warehouse-Rack-heavy-Duty-Warehouse-Rack.html#.Us8Kbp5dVKo. Accessed: 1/8/2014.

The chart below systematizes the pros and cons of Layout 3:

Table 7: Pros and Cons of Layout 3

ADVANTAGES	DISADVANTAGES
Accessibility of Stock (2 points)	Office Space is very small
Short distance from office/docks to stock	
Loading dock area for truck	
Weighted Score: 3	

* The issue of accessibility is the subject of extensive mathematical modeling for the purposes of optimization; and can be presumed to take priority Kapetanios et al. (2009). This prioritization is justified based on the premise described in elogistics101.com (2014) wherein spatial increases are described as a way to evaluate the utility of warehouse layouts.

3.2.3.4 Comparing the 3 layouts and racking system

When compared to layout 1, layout 3 minimizes the distance ratio from the office and stock section. Layout 2 involving a gravity racking system similar in distance

to layout 3, but does not have a circular flow arrangement. Layout 1 is efficient for storing highly linearized objects, but less so with respect to engine components. The linear distance of layout 2 is less than 1, but will not allow the same circuit in stock rotation as layout 3. Given similar dimensions, it is likely to acquire more time to access and move items furthest from the office. This is unlikely to be a factor in layout 3. Layout 3 also includes surrounding rows for backstock in case of overflow.

The specialized rack model in layout 3 is equipped with horizontal supports to increase load-bearing capacity. It is a comparatively simple design not requiring unusual engineering or specialized machinery to install or construct. Compared to gravity flow options, this system is more economical. Cantilevered designs are impractical for the storage of entire engines, while gravity flow entails a falling risk, and is likely to be more expensive. (http://www.californiapalletracking.com/pallet-racks/). This selective system is considered the most advantageous option. This is superior to a simple pallet design by allowing vertical stacking, but without the added expense and danger of a gravity-flow structure. Cantilevered design is unlikely to be effective for most engine components.

With an efficient organizational network to handle documentation issues, layout 3 combines safety with accessibility. A stable and segregated rack system can be employed to allow heavy movers to move inventory safely, and without the falling hazards presented by the other models. The design of layout 3 would be beneficial for efficiency and safety reasons, so gravitational and cantilevered practices will be rejected.

Also another consideration is the weight-bearing capacities of the respective rack systems. These can be evaluated based the total capacity of the warehouse in question. At 280000 kilograms total, the weight capacity of each rack becomes a factor based on dividing this number. This factor represents the number of total purchases of rack units necessary to entirely utilize the total capacity. Layout 3 has the best result with the value that most closest to our requirement.

While a cantilevered system is unlikely to fit the stock in our warehouse, the gravity rack system would require fewer purchases. But a specialized pallet/container system would be required to contain whole motors in order to move them freely by forklift. If a specialized system could be found at an affordable rate, selective rack could be a preferred option.

All things taken into consideration, the management of company has made a decision to choose layout 3 with selective rack system.

3.2.4 Velocity based layout strategy

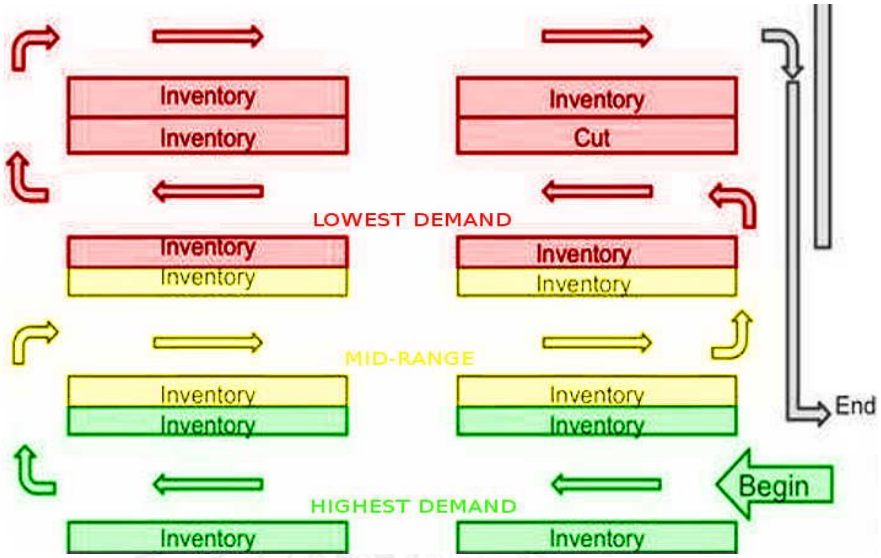

Figure 21: The velocity based layout strategy

Using this outline, it is possible to prioritize to the hour and minute how often a particular item enters or leaves stock. This allows management to plan out the hours in the day and the best strategy for heavy equipment usage. By calculating the number of forklifts each day for instance, it is possible to optimize the movement of items based on turnover rate and cost. Analyzing the daily schedule of the amount of work typically done aids in eliminating wasted time, with the potential to increase the number of total forklifts in a workday.

This policy is consistent with the research of Mincsovics et al. (2009), in the interest of rapid tactical response capability. Products that move fastest through the warehouse must be given preference in order to maintain efficiency and flexibility in terms of inventory decisions. It is also necessary to plan the loading and unloading docks at the entrances to the warehouse in terms of operational and loading efficiency.

The warehouse should include at least one specialized loading dock that can be made continuously available whenever delivery occurs, a 24-hour dock available in any weather. Ramps and forklifts should naturally be included, and interior space should not be so crowded as to prevent the movement of these vehicles. Forklifts themselves will require the installation of ramps.

The docks themselves must be situated in a way that facilitates the most efficient allocation of arriving material into available storage locations, or conversely racked storage should be positioned with ease of access to where ever the loading docks must be. Options include pallets, in addition to crates or specialized shelves and storage binning.

3.2.5 New Warehouse Operations

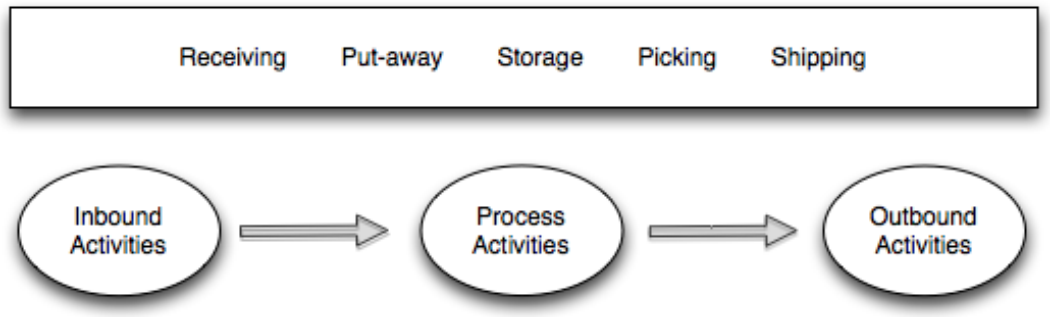

Figure 22: Operational Process within warehouse

As mentioned earlier in the introduction, our old warehouse process is very poor and inefficient. There is no formal systemic process at all. So, the new warehouse

operation must be built in order to support the company growth. There are 7 main operational processes in our warehouse that is

3.2.5.1 Receiving

This process is about receiving the good from our factory to warehouse. The process begins with unloading the goods from the vehicle. Then, the staffs count and identify them in order to ensure the type and number of product. After that, they will have a quality checking to check whether the goods are in the right condition or not. If the product are damaged or broken, the staffs will send it back to the factory. The last step is registering the product into the system and prepares them to be ready for put-away process.

3.2.5.2 Put-Away

This process is about internal product movement. The staffs move the goods that are finished from the receiving process into the warehouse by using forklifts or hand pallet. Then, they categorized the product based on categorize strategy that mentioned before. After that, the staff palletizes the goods and prepares them to be ready for Storage process

3.2.5.3 Storage

This process is about putting the product into their place. When placing goods on the rack, the staff has to concern about keeping identity visible and manufacturing date visible. These will benefit for the picking process that we going to talk about next.

3.2.5.4 Picking

This process is about picking the goods from the storage area. In our warehouse, there are 2 picking method that are low level picking and high level picking. Low-level picking is picking the goods from the ground or first level of the rack. Every staff can easily pick the goods by this method. High-level picking is picking the goods from the second level of rack or above. The staffs that operate in this method must have a lot of experience and trained due to the safety concerns.

Moreover, the picking techniques have been created for the new warehouse for better performance. There are 2 techniques that are order picking and line picking. Order picking is picking the product only for 1 purchase order. When the staffs finished picking, they will send them out for packing process immediately. Order picking technique is used only for the most urgently order. Line picking is picking the product for many purchase orders, which will save the time and resources using. This technique is the most used by the new warehouse.

After finished picking, the staffs have to re-check again with the purchase orders for the correct type and correct quantity of goods before preparing them to be ready for packing process.

3.2.5.5 Packing

This process is about grouping the product according to the purchase order and then packing it together. After that, all goods are ready for the final process “Shipping”.

3.2.5.6 Shipping

This process is about shipping the product to the customer. First, staffs have to print out an invoice and let the manager sign and stamp to confirm the document. Then, the staffs will make an appointment with carriers. When the carriers are coming, they will load our goods on the vehicle and delivered them to customer. When the process finished, staffs have to update the stock as same as the receiving process.

In order to prevent inaccurate estimations of customer demand, upon packaging or arrival digital technology should be used to communicate as quickly as possible these actions to a centralized location with the goal of forecasting customer demand. Whatever items enter or leave the warehouse the customs must be updated using telecommunications options in real time whenever possible, in order to avoid the bullwhip effect.

3.2.5.7 Inspecting and Updating

An instant updates system will expedite the record-keeping process. For long orders, it is necessary to check in as soon as a particular item is delivered at the warehouse. Incoming material should be inspected upon delivery. The details should then be reported to the purchasing department now that the order has been fulfilled. The appropriate department should provide documentation, ideally a signature sheet as part of an invoice. Only then should the appropriate items be placed in accordance with their relative demand in order to optimize the flow of materials through the warehouse. Instantaneous electronic updates expedite these fundamentals.

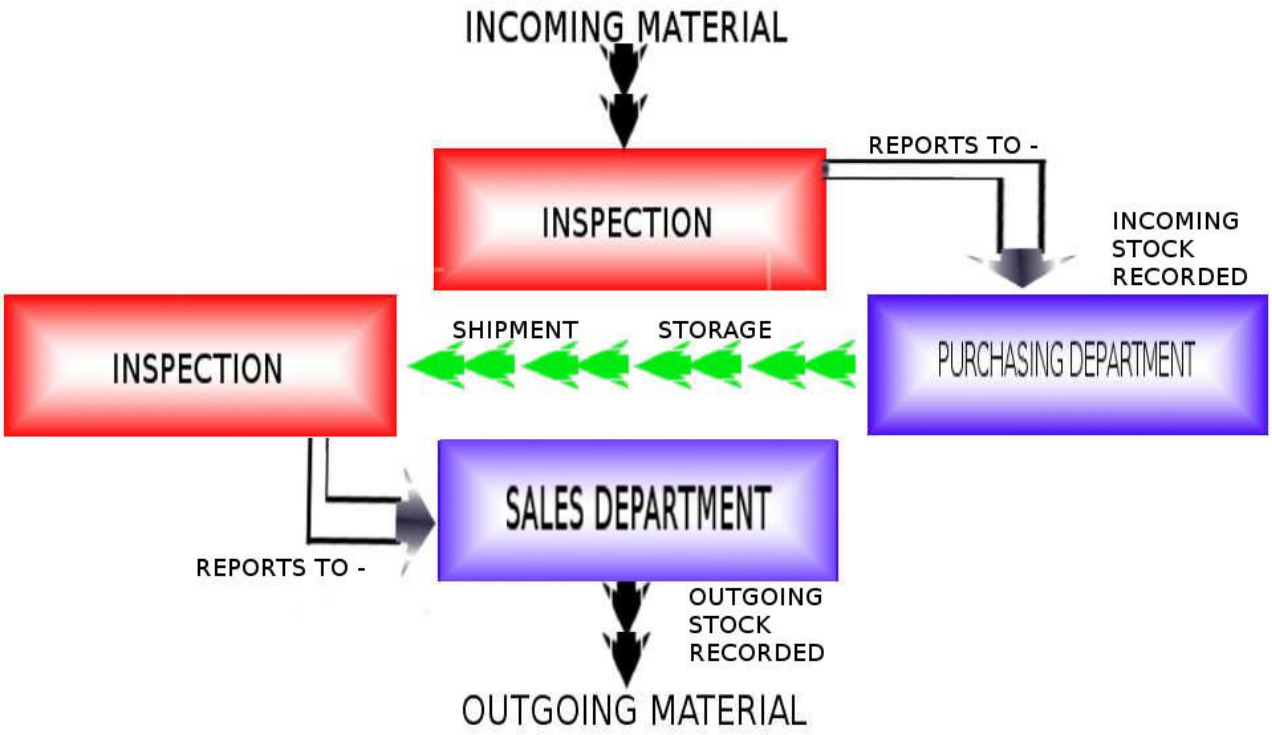

Figure 23: Inbound/Outbound procedures

The outgoing process can be derived from the logical reversal of the inbound procedure. The material leaving the warehouse must wait until inspectors are able to verify the size and identity of the shipment. A sales department or suitable analog should provide documentation requiring a signature that the appropriate order is now outgoing. Changes in the inventory levels, including the prior placement of the items in question should be documented. Electronic updates can expedite this process where possible, and the flow of materials both inbound and outbound could be aided by overlapping shifts among workers and inspectors to prevent delivery personnel from needing to waste time waiting around for the appropriate clearance.

3.2.6 Product Numbering

Pursuant to a broader warehouse management system it is necessary to include a product numbering plan for easy and efficient reference for all items stocked by the warehouse. This system is interconnected with the map detailed in Figure 21 as seen above, the higher the number, the further it will progress from the green zone. The labeling system should be straightforward, and simple enough that all workers can readily comprehended with a cursory glance, yet it must contain sufficient detail that it can account for thousands, or hundreds of thousands of items.

There is a set of basic information that a labeling system should include: **the product type and year of production, month, date, and lot sequence** for item codes. The new product numbering will be “Type Date Month Year – Position”

Table 8: An example of product numbering and positioning

ITEM	POSITION
LV010110-01	1
MH020511-34	34
EP040312-50	50

Item number refers to the type of motor, manufacturing date and position number on the rack. Starting from the top left corner, the sequence moves from right to left until rack space runs out, then moves to the next level. Each rack is filled before the next is used, in order to maximize space. Using Figure 21 as a guide, the rack numbers start with the green zone, with three units per level, stored on the pallets accessible by forklift. As the numbers increase, the yellow and red racks will be used.

For our warehouse, there are three basic motor categories. Low-voltage motor, as described by the abbreviation LV. Mid-performance motor (medium and high voltage motor), described by MH. Explosion-proof motor, indicated by EP. The rack numbers describe placement in terms of shelf order. Figure 21 above describes the color-coded priority system. Lower numbers will be in green, as Rack numbers increase, they will be delegated to yellow, and eventually red.

For example, LV010110-01 is low-voltage motor manufactured on 01/01/2010 and the location is number 1 on the first rack in the green zone.

3.2.7 Signage and Shelf Labels

Signage systems and color-coding will be used to assist with navigation through the warehouse. Foot traffic markers and all of row numbers are adequately marked on the floor, and on the ends of each aisle. Letters and arrows will be used accordingly. Row maps will be created and distributed throughout the facility. Figure 21 above shows the colored pathways through the warehouse.

For this strategy, aisle and floor marking tape will be used. The tape that the company selected can be also glow in the dark that means it can still useful when the staff operates in the nighttime or with the dim condition. This can also increase the safety factor of the warehouse.

Figure 24: Footprints, Arrow Signage, Corners, Letters and Numbers

http://www.the5sstore.com/aisle-floor-marking.html

Figure 25: The aisle and floor marking tape glow in the dark.

http://www.kofflersales.com/p/glow-in-the-dark-tape.asp?cid=856

Moreover, the tape that the company used will be divided into many colors to separate each area and function as following:

Table 9: The meaning of each colored tape

COLOR	MEANING
Red	The hazardous Area
Yellow	The access aisle area
Blue	The receiving area
White	The shipping area
Green	The exit

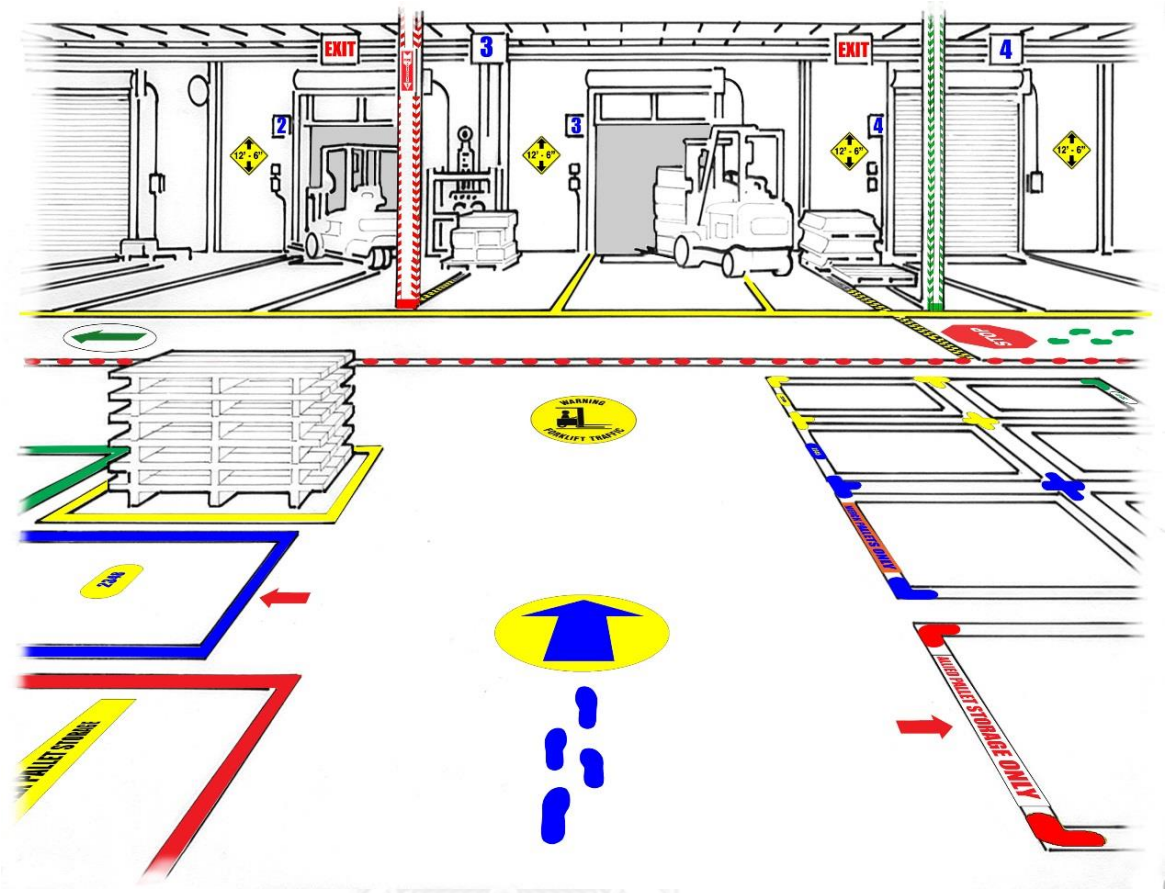

Figure 26: The different colored tap

http://www.prweb.com/releases/samplepack/5sfloortape/prweb9104231.htm

3.2.8 Security Operations

The company is trafficking in motors and related components, these components carry some degree of fire risk, and basic precautions must be taken such as preventing body parts from entering any active units. Moreover, safety is also a consideration with respect to property and inventory shrinkage, which has been

discussed throughout this analysis. Theft prevention can be served through the use of surveillance systems.

These are appropriate versions of standard items needed to prevent unlawful access by identifying perpetrators through security footage. Physical safety is enhanced through the use of fire alarms and sprinkler systems to extinguish flames damaging to stock and structure of the warehouse.

Figure 27: The Security Items

3.2.9 Warehouse Safety

We are also concerned about worker safety in the warehouse during active operations. Danger may occur from tool, equipment or environmental factors. Any facility using or storing heavy machinery or must maintain mandatory safety standards. Employees should be subjected to mandatory training in terms of safety protocols. Storage strategies as they pertain to warehouse design are important, as the racking methods used are important determining factor concerning the likelihood of injury. Only those sources will be used for rack materials with a positive safety record. For

our purposes it is useful to organize safety requirements into a checklist, described in more detail in the appendix of this document. The interest of safety often competes with the interests of production quality, cost, and time. **Below are the features included in the formulation of a security strategy:**

- The leadership of the organization must be committed to a training policy dedicated to the interests of safety training and ongoing improvement through effective communication of risk factors and the requirements of safe utilization. **Ongoing Safety training is mandated.**
- The company must devise a clear and unambiguous safety policy that is definitively stated to all warehouse employees, or any employee handling heavy equipment. **Clear Safety policy.**
- It is essential to clearly outline all responsibilities and commitments of every employee involved. **Public communications on basic policy and any changes as they occur.**
- The mandate should be to reduce accidents and injuries while enhancing employees' health and lives. **Policy of evidence-based continuous improvement.**
- Ultimate responsibility for safety rests with the warehouse manager.

3.2.9.1 Safety policy

The safety policy will be delivered to all of staffs by training. Ultimate penalty will be applied to the staff who obey the safety policy. The following is the safety policy.

- Every employees is participated in the safety training once a year both new employees and the old one.
- Matching the right people to the right jobs.
- The protective equipment, helmet, must be used during the operation time.
- The employee that is not relate to the storage section is not allow to be in the storage area.
- Smoking in the warehouse is strictly prohibited.
- The safety checklist has to be done by a staff every morning before operating.

A proposed checklist is listed in the appendix.

3.2.10 Dead Stock Policy

There are few options available if it appears that a persistent stockpile of unsalable items exists in warehouses. With respect to dead stock, it is important to consider that warehousing space has value, and is better used where there is hope of a sale. To minimize the probability of a supply crisis (either a shortfall or excessive surplus and dead stock) management of the business organization should develop data extending through multiple cycles where sales rise and fall based upon fluctuations in market forces.

There are inevitable risks when producing specifically to meet particular orders, rather than independently producing a large volume of stock. An essential component of a management strategy is to maintain a chain of documentation to prevent new items from being casually managed; inefficiency in this regard will separate purchase quantities from real-time supply and demand. Regular updates, documentation, and

internal reports are needed as a monitoring process. But it is axiomatic that all methods of demand calculation entail risks, too much production without adequate attention to what the marketplace will support creates the probability of dead stock.

Possible options for items that seem beyond any hope of selling might include returning item if applicable to the manufacturer, who may charge a restock fee. This can still be advantageous, depending upon the pricing and demand of whatever new items replace the dead stock. If considered carefully, the ultimate profit of selling high-demand items can compensate the organization for the restock fee. Another way is setting clearance sales by decreasing the product price to be nearly original price or gain only little profit. The clearance sales can persuade a lot of customer due to the competitive price. Next option, the company will appoint the aged staff that going to be retired soon to be a dead stock manager. The dead stock manager has to control and deal with the dead stock directly. This could be a very good way for the old people that worked for a company for long time to have a job at their retired age. The company can think that this is the way to compensate these people and another side the company will get the experienced guy who will manage the dead stock. The last option if another option is not successful is charitable donations if appropriate, as a way to generate goodwill for the organization. Moreover, the company can also take tax deductible by this charity.

3.2.11 The 5S and the Implementation

A variety of manufacturing operations have been able to encapsulate successful strategies based upon a series of five Japanese principles which when

transliterated into English all begin with the letter S. These systems are of use in many industries, taking into account information and principles described during the course of this investigation. These methods enhance preparation and planning phases of a manufacturing operation, as well as focusing upon waste steps that may be eliminated from a manufacturing process is a way to save costs (The Folk Group, 2009).

The 5S's consist of:

- Sort (Seiri)
- Straighten (Seiton),
- Sweep (Seiso),
- Standardize (Seiketsu)
- Sustain (Shitsuke)

Figure 28: The 5S strategy

http://kaizenwarehouse.blogspot.com/2012/06/about-5s.html

The benefits of this approach include improvements in overall hygiene, with concomitant increases in efficiency. Operational costs, as well as delivery times will be made more effective as well. Waste can be eliminated, and if implemented correctly morale can improve. The descriptions below provide more detail.

3.2.11.1 Sorting

A practical example of the sorting principle is to separate items into discrete categories based on dispensability. Item should be grouped on whether or not they have a present use, or can be discarded. These items may be prioritized through the designation of first in first out, or last in first out (FIFO, LILO). In this regard it will be possible to systematically identify and remove unneeded items in the warehouse. A supplemental labeling system (Red tag), as shown in appendix 4, is possible to easily identify large numbers of items, which may not be necessary. The sorting process will be shown in Figure 29. Sorting is exemplified by examining a work area at optimizing the space to ensure that only the most essential items are included, in order to avoid dead stock that cannot be readily sold to customers. Articles not relevant to the process should be reduced, stored, or discarded. This is relevant for the purposes of manufacturing to some extent in terms of employees. Temporary employees taken on based on a strategy of resource contingency can be utilized on a contractual basis as the situation warrants. As long as requirements and expectations are previously established; this also holds true for subcontractors. An organizational growth of this principle of eliminating waste could be expressed in a reluctance to take on new permanent commitments, or facilities if they are not clearly advantageous to the organization as a whole.

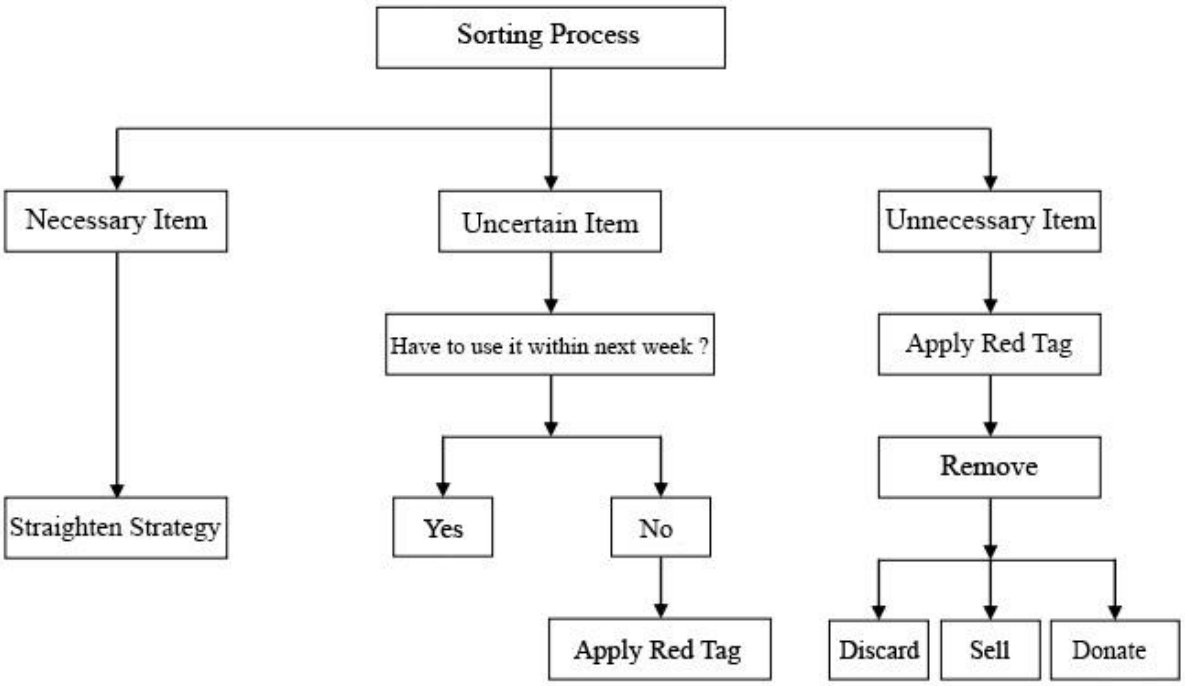

Figure 29: The Sorting Process

3.2.11.2 Straighten

This is an organizational principle whereby the workplace is arrayed for maximum efficiency. An initial first step is the streamlining of both the stock and the inventory system in the warehouse. This is among the most challenging components of the 5S system. The methodology is described in chapter 3 expand upon ways that the workflow can be optimized. There may be complexities in implementing this part of the 5S system, since there is no singular pattern that is effective for all warehouses at all times. Each facility must be investigated individually, in order to devise an optimal streamlining strategy. This must be accomplished before standardization can be achieved.

This has implications for the overall warehousing objectives in terms of storage requirements as well as objective goal, concerning layout and organization of the warehouse. On an organizational level, this principle can be described in terms of arranging workflow to optimize productivity. Not only hand held tools, but the pathways through which work and resources are transmitted throughout the organization should be simplified so that information and materials can be transmitted as needed within the organization as smoothly as possible.

3.2.11.3 Sweep

Good housekeeping is essential to the principle of Seiso. A vital component of the cleanliness process is to expedite the correction of any accidents. Any sort of container rupture, or chemical spill must be cleaned or removed immediately. The immediate correction of any possible hazards and sources of disorder prevents this organization from building. To this end, it is important that managers pay attention to the presence of janitorial supplies and suitable spill kits appropriate for any chemical agents used in the facility. This principle connects with the basic warehousing objectives by augmenting the physical principles of fire safety while aiding in storage requirements. On a purely physical basis, a cleaner and more orderly warehouse will also assist the objective of first aid by reducing the probability of injuries, and decreasing the likelihood of an unsanitary warehouse that may harbor disease. The principle of cleanliness can also extend to general orderliness, which is relevant in warehousing for the purposes of documentation control, in addition to the necessity at some point for inspection, as described in warehousing objective.

3.2.11.4 Standardization

A crucial element of this process is to maintain a series of consistent standards applicable to all employees. An excellent implementation is to devise or improve work manuals and safety documents to ensure that standard operating procedures for both routine functions and safety are well known and available. A new safety initiative would benefit from charts or posters within the warehouse that provide a reminder of the specified workflow requirements. Not only training for new workers, but refresher courses for existing workers based upon standardized manuals is an essential component of the Seiketsu principle.

In order to sustain improvements devised through the implementation of these procedures, a regular process of inspection and evaluation is necessary in order to prevent workers and managers from slipping back into old habits. This is consistent with the core warehousing principles discussed in the introduction.

Practical tools include a signage system, as covered in the methodologies of chapter 3, in addition to floor and aisle markers. An inventory system including labels or tags is essential to designate rack locations. This principle is exemplified in most of the core research articles detail throughout the literature review. Nene's proposes a mechanism whereby decision-making in terms of inventory can be standardized based upon estimates of minimum and maximum fluctuations in demand. Even within an environment of seeming randomness, rational principles can be implemented to devise a consistent decision-making strategy. Standardization is essential for organizational control, and assists with the principles of communication pertaining to the flow of information. Unified protocols are necessary to allow coordinated action and implementation of decisions on a consistent basis.

Standardization is also essential with respect to the issue of demand forecasting, as described throughout this analysis. The issue of the bullwhip effect is an illustration of a lack of coordination and standardization in terms of a necessary process of information gathering. Consistency in this regard becomes essential to prevent chaos along the supply line.

3.2.11.5 Sustain

This principle represents an ongoing commitment to improvement. The changes described throughout this analysis and during the preparation of a planning horizon are not useful unless they represent a comprehensive corporate culture dedicated to adaptability, efficiency, and coordination for the benefit of all involved. Management must be on guard so that the organization does not permit the advantages gained through the research insights described in this analysis to fade away by falling back into inefficient, earlier modes of operation. To prevent this, it is necessary to discuss future recommendations for action and operational efficiency.

Chapter 4: Results

The new warehouse have been described and apply in terms of the layout 3 design also with the used of another 11 methodologies that mentioned earlier in chapter 3. This confers on the company the following benefits:

4.1 Better warehouse condition

A more organized warehouse reduces dead stock, and items move more readily through the inventory system, making it easier to maintain orderly and hygienic conditions within the warehouse. Unnecessary items are eliminated or sold and popular items are quickly transported through inventory. All working equipment needed to load and unload items will be stored at their proper locations easing the operation. A safer work environment corresponds with the warehouse objectives from the introduction by making first aid and fire safety easier. The reduction of dead stock decreases the total inventory holding costs.

4.2 Shorter the operational process time

The time necessary for each operation is reduced without untidy displacement of items. A system as described above whereby all items are numbered and categorized insurance that workers know where to position each item, but also allows managers to ensure there is sufficient space. This permits managers to plan ahead with an understanding of their inventory capabilities. The working environment is more efficient, reducing idle time of both workers and machines.

From the data of company, in each day, 40 to 50 trucks are leaving the warehouse for delivering products to customers. Each trip, the forklift accesses products 1-2 times to fulfill the order. For each time, it takes about 15 minutes. Hence, new warehouse may decrease the access time for forklifts in each turn approximately 5 minutes. Company will have 250-500 minutes more each day, 1500-3000 minutes per week. Therefore, the new warehouse not only decreases the access time of forklifts, but also makes operation running smoothly with higher products volume, which will increase the company's revenue in long term.

4.3 Better warehouse safety

Since the old warehouse does not has any safety policy, so the staff always injured resulted in cost and time consumed. With proactive safety measures by using warehouse safety checklist (appendix), and a clear comprehension of policy by all workers, evidence exists that the need for injury compensation and loss of time due to injuries is reduced.

4.4 Better warehouse security

Since the old warehouse does not has any security tools, in the past the old warehouse was on fire because the staff was smoking in the warehouse and threw the cigarette away without concerning that the motor has contain oil, which is one of the best fuel that can be easily burnt. The one big lesson has taught the company to concern more about security part.

Moreover, the company still wondering that some items always be missing while they are still available on the system, so the CCTV are apply according to this reason.

After implementing security tools, the result shows that the number of loss in product is reduced and every staff and visitor concern more before doing anything because they know that the CCTV keep watching on them all the time.

4.5 Better customer satisfaction

In the past, when the customer want to order some items from us, sometime they were out of stock. Sometime the staff have found them in the system but cannot find them in the warehouse because of the warehouse's messy condition. These factors make our company lose a lot of benefits in terms of loyalty and income. But after we implemented the new warehouse, everything is changed in the positive way. The number of out of stock item is significant decreased also the brand loyalty is stronger. The company can get some of the lost customer back also with a new customer, which has returned to buy from the company for a second times.

4.6 The KPIs

The key performance indicators will be used to measure the warehouse performance after applied and implemented with many strategies in chapter 3 as following;

Table 10: The KPIs

THE AREA	KPIs	BEFORE	AFTER	CHANGES IN %
Capacity	The capacity of warehouse	190000 KG	282000 KG	48.42 %
Operational Time	The time consumed for operational process per week	9000 minutes	6000 minutes	- 33.33 %
Order Picking Accuracy	The number of correct order picking per month (100%)	98 %	100 %	2 %
Safety	The number of injured staff per month	3 persons	0 person	- 100 %
Security	The number of loss and damaged product per month	32 items	4 items	- 87.5 %
Customer Satisfaction	Number of new customer that returned for the second time	21 companies	24 companies	14.28 %

Chapter 5: Conclusion & Recommendation

5.1 Conclusions

The objective of this research paper is to design a new warehouse for a motor manufacturing company in order to support and fulfill with the company growth.

The scope of work is to design a new warehouse layout that is suitable with the company requirement. Creating the operational process within the warehouse both inbound process and outbound process. Selecting the suitable equipment both material handling equipment and material storage equipment. Creating safety and security system for the warehouse.

When the research objective and scope of work are clear. The research paper begins with identifying the problem. At first the warehouse of a motor manufacturing company has a lot of problems that need to be solved in order to support with the company growth. The root causes are identified as following;

- First, the capacity of warehouse is not enough due to the increasing in production rate every year.
- Second, warehouse operational process at that time is very slow, time consumed and inefficient result in the loss of resources, time and money.
- Third, warehouse condition is dirty and messy because there is no storing method or any strategy at all.
- Fourth, sometime the company delivers wrong product to customer because the product numbering that used at that time is not good.

- Fifth, there are some problems with the storage equipment, especially for pallet that always broken and wood material can meet with the insect problem.

When the statement of problem is clear. The warehouse design process begins with creating the conceptual design according to the statement of problem and the requirement of the company. The main idea of conceptual design are about warehouse capacity that has to meet with company requirement, the operational process within the warehouse should be flow efficiently, the new layout is easy to understand by every staffs and also provided safety and security to all of them.

After finishing the conceptual design, the process continues with detail design which has 11 methodologies that will be implemented. This research paper has proposed a lot of strategies according to the conceptual design. Categorize strategy is grouping every product by concerning about their cost and turnover rate. After categorizing, there are 5 groups of product that are very expensive products (VE), fast moving products (FM), normal moving products (NM), slow moving products (SM) and very slow moving products and dead stock (VD). The use of storage equipment and handling equipment strategy is providing the detail for storage equipment and selecting the suitable handling equipment. The new warehouse layout strategy is selecting the most suitable warehouse layout and storage equipment by using weighted score table. Product numbering strategy is creating the numbering system for all goods. The new item code includes the product type and year of production, month, date, and lot sequence. After product numbering, the item stores according to velocity based layout strategy, which the highest demand item will be stored the nearest to the office, that make it easier for the staff, in terms of picking, delivering and tracking. New warehouse

operations strategy is creating the new operational process in the warehouse both inbound and outbound process. There are 7 main operational processes that are receiving, put-away, storage, picking, packing, shipping and inspecting and updating. Signage and shelf labels strategy makes every process in the warehouse flow efficiently by providing aisle and floor marking tape also with the row map all over the warehouse that can easily understand by all workers. Warehouse safety strategy and security operations strategy can make the warehouse safer, protect the asset and reduce the number of injured staff. Dead stock policy helps in reducing the dead stock and earn some benefits to the company. At last, 5S strategy uses to improve the warehouse environment to be better for working.

After implementing, the research paper used the key performance indicator (KPI) as a measuring tool for measuring the warehouse performance. The key performance indicator (KPI) concerns about 6 areas that are the capacity of warehouse, the time consumed for operational process per week, the number of correct order picking per month in percentage, the number of injured staff per month, the number of loss and damaged product per month and number of new customer that returned for the second time.

5.2 Recommendation

For the future improvement, the company may think about long-term warehouse management. In five to ten years, every system and process within warehouse should be in fully automated system for faster throughput rate. Namsae International should invest for the specific software that is Warehouse Management System (WMS). This system can be applied and used with the current technologies that are exist in the warehouse, for example, internet and intranet within the organization. The software is also come with the latest technology and will be implemented in the warehouse that is radio frequency identification system (RFID) and barcoding system.

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APPENDIX

APPENDIX A: SAFETY CHECKLIST

Safety Checklist	
	Aisles
☐	Good Condition
☐	Clean and Dry
☐	Obstacles
	Work Environment
☐	Illumination of the work area
	Material Handling and Material Storage
☐	Good condition
	Fire Protection
☐	Emergency phone
☐	Fire Extinguisher
☐	Sprinkler
	Personal Protective Equipment
☐	Warning signs
☐	Safety Helmet
☐	First aid kits

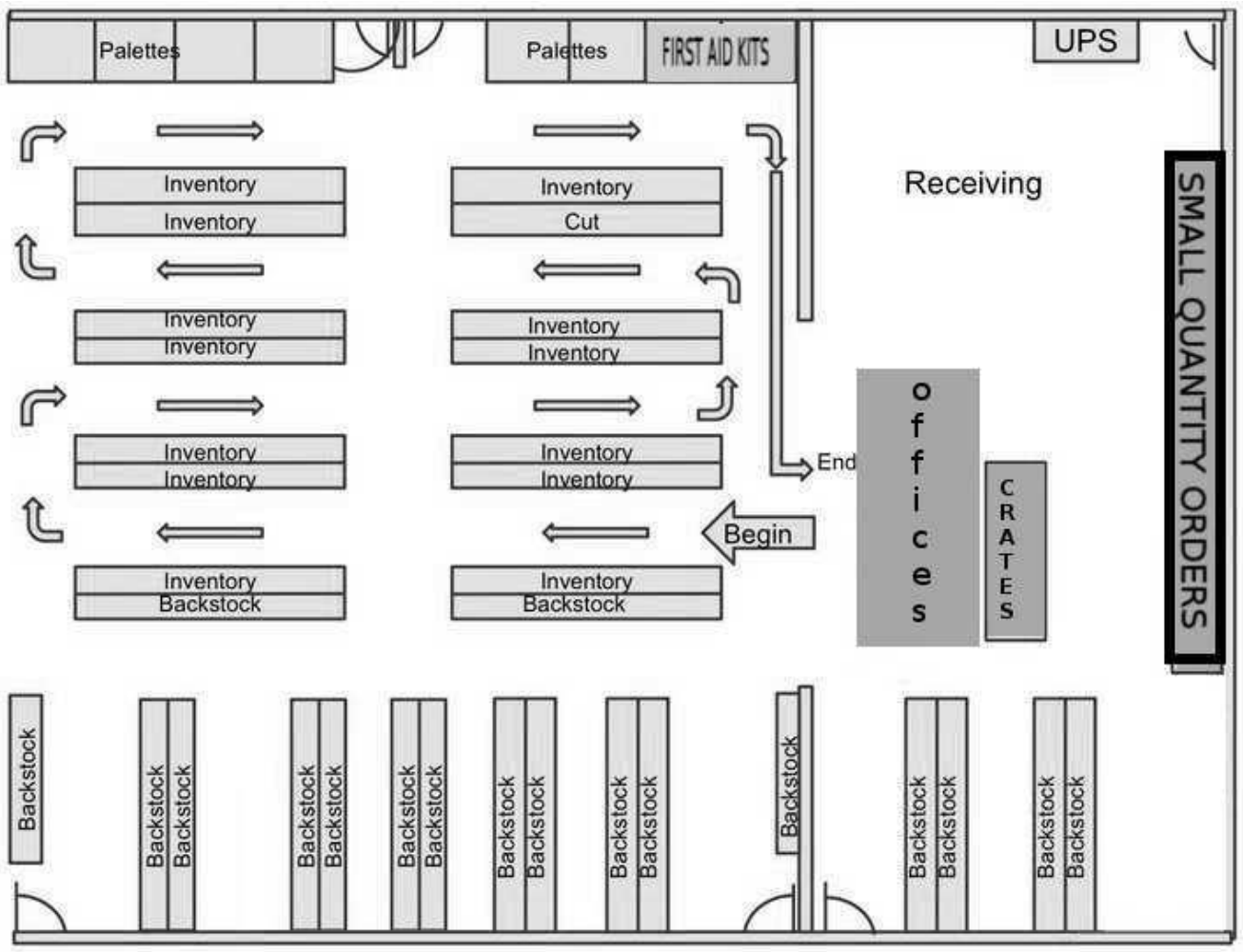
Comments:

_____

Staff Name: _____ Date: _____

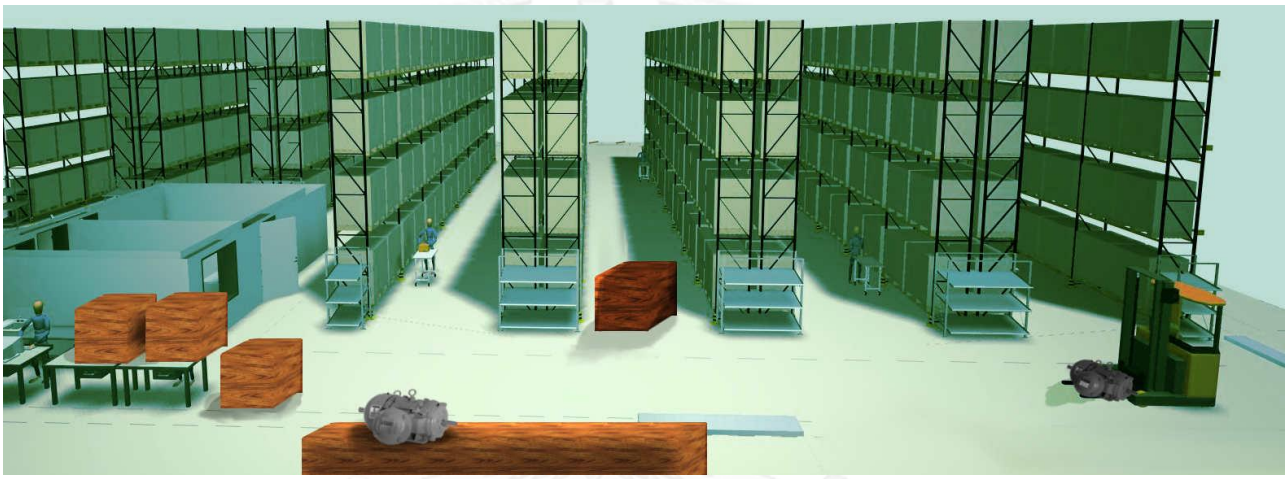
APPENDIX B: FINAL LAYOUT

First Aid kits can be seen along the northern wall. The pallet for small quantity orders can be used as a way to standardize shipment options into a single transit operation.



APPENDIX C: FINAL LAYOUT IN 3D

The figure shows 3D extrapolation of the new warehouse from the direction of small quantities shipping table. At this table, modifications can be made in order to convert or assemble a new motor from stored parts in response to individual purchases.

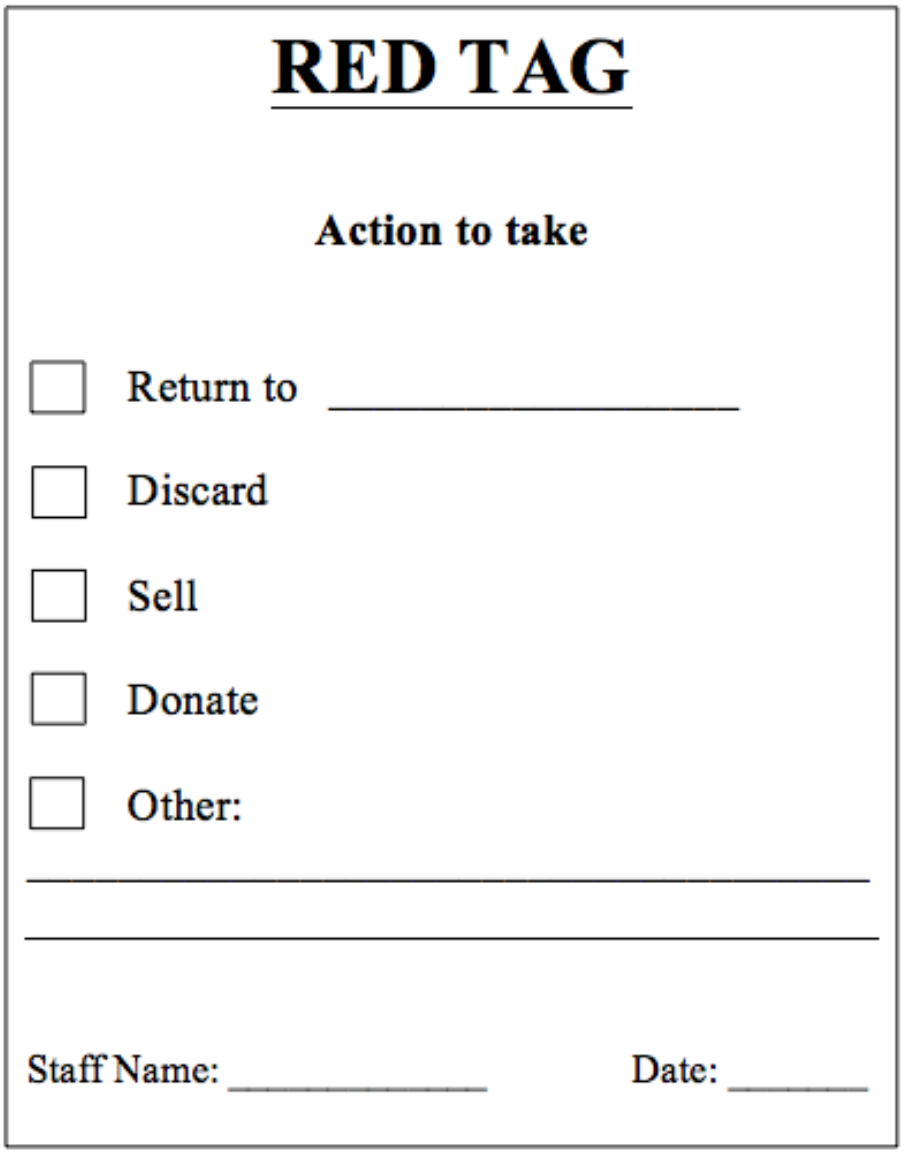


APPENDIX D: SIGNAGE WITHIN THE WAREHOUSE

The figure shows the warehouse with aisle and floor marking tape. This signage can easily navigate everyone who comes into the warehouse.

APPENDIX E: RED TAG

The figure shows the red tag that used in the 5S Strategy, sorting process.



VITA

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