

REDESIGNING WAREHOUSE LAYOUT TO IMPROVE THE COMPANY

PERFORMANCE: A CASE STUDY



**AN INDEPENDENT STUDY SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENT FOR THE DEGREE OF
MASTER OF SCIENCE IN LOGISTICS AND SUPPLY CHAIN**

MANAGEMENT

INTERNATIONAL COLLEGE

KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG

2017

KMITL-2017-IC-M-002-007

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CHANACHON SIRISUKEEPHADIT



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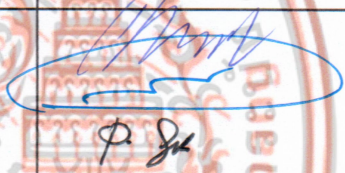
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ไม่ว่ากรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และต้องอ้างอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้



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Degree Master of Science
Program Logistics and Supply Chain Management (International Program)
Advisor Asst. Prof. Dr. Phaophak Sirisuk
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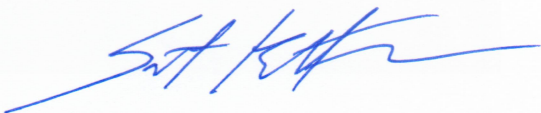
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KING MONKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG


(Assoc. Prof. Dr. Supat Kittiratsatcha)
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May 27th, 2017

เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า
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RESEARCH TITLE	Redesigning Warehouse Layout to Improve the Company Performance: A Case Study
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DEGREE PROGRAM	Master of Science Logistic and Supply Chain Management
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ABSTRACT

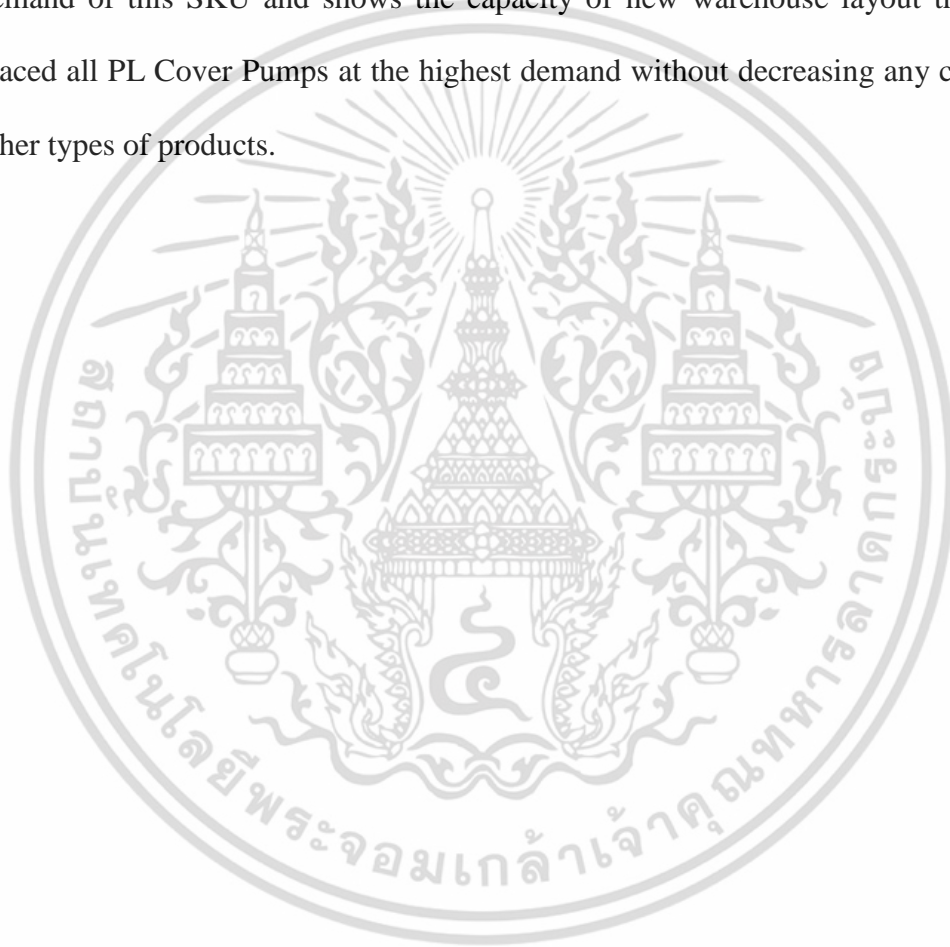
This research is aimed to increase the efficiency of the warehouse for ‘A’ company by redesigning the warehouse layout. The case study company is in the plastic injection industry for automotive parts, electronic parts and home appliance parts. The company has problems of the insufficient storage space; in this independent study, several methods are used to find the causes of the problem and the optimal solutions to solve the problem which are data collection, questionnaires, analysis of hierarchy process and fish bone diagram. The result of the problem analysis shows the best solution for the improvement of storage space. Therefore, the researcher started to redesign the warehouse layout. The main objective of redesigning the warehouse layout is to increase the capacity of storage area. First of all, the researcher analyzes the data to identify which SKU has an insufficient storage space problem and set the goal of redesign warehouse layout to increase the capacity of this SKU. The redesigning methods of this research focus on the zoning of storage space, use commodity system theory to classify the product and identify the code to each types of product include apply the first in first out (FIFO) theory to warehouse process.

The result of this research shows the comparison about the efficiency between current warehouse layout and new warehouse layout. The current warehouse layout has a non-usable area about 179 m², actual storage space about 163 m² but the new

warehouse layout has a non-usable area about 157 m², actual storage space about 185

เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า
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m². If counted as the whole pallet that can use to place the goods, the redesigning method has increased the capacity of warehouse from 82 pallets to 102 pallets or around 25 percent. It means that the new warehouse layout has more efficiency than the current warehouse layout. The SKU that has the insufficient storage space problem is PL Cover Pump. Therefore, the researcher considers on the demand information between January – May, 2016 to find the highest demand and average demand of this SKU and shows the capacity of new warehouse layout that can be placed all PL Cover Pumps at the highest demand without decreasing any capacity of other types of products.



เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า
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LIST OF SYMBOLS

n	the required sample size
N	the population size
p	the population proportions
z	the levels of confidence
e	the acceptable margin of error
t	value for selected alpha level
p	maximum possible proportion
q	1- maximum possible proportion
d	acceptable margin of error for proportion being estimated
n ₁	the sample size
n ₀	required return sample size
m ²	Square meter
%	Percentage

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LIST OF DEFINITIONS

SKU	Stock keeping unit
SCM	Supply chain management
ROA	Return on assets
JIT	Just in time
ERP	Enterprise resources planning system
FBD	Fish bone diagram
AHP	Analysis of hierarchy process
No.	Number (ordinal number)
QC	Quality control
SPSS	Statistical Package for the Social Sciences
e.g.	For example
MTO	Make to order
MTS	Make to stock
ATO	Assemble to order
PO	Purchasing order
et al.,	And other

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Injection molded plastic industry is one of many large industries in Thailand, for example, the automotive industrial, electronic industrial and home appliance industrial. The plastic industrial was exported to many countries. In Thailand, it is the fourth rank in export value (Ministry of commerce of Thailand, 2016). For the future trends, gross domestic product in Thailand is increasing and the economy of the partner countries will continually expand (Ministry of Industry of Thailand, 2016), this leads to the growth of plastic industry.

1.2 Background and Problem Statement

The case study company injects plastic for automotive parts, electronic parts and home appliance parts. It was established in 1986 under the name “A” with the capital about 4 million baht. The company owns injection molding machines about 18 machines, the size of machines between 40 tons to 650 tons, the different sizes of machines will produce the different products with the sizes. Its primary customers are Hitachi co., ltd., A&M Four P part., ltd. and Srithai Autoseat co., ltd., For “A” company, there are two formats to produce the product, make to stock (MTS) and make to order (MTO). The owner of company has set the visions and missions of company on quality of product (Q), cost (C) and on time delivery (D) in order to make the customer satisfaction. Therefore, they trusted the company in producing their parts and they will increase the orders in the near future.

The main problem of the company is about the inventory space. The company has very poor utilization spaces. According to the visions and missions of company, the owner set mission of the on-time delivery; they must finish the order 5 days before the delivering. It means the company have to produce the products to store the stocks sometimes because the customers may change the purchasing order (PO). For example, the customer “A” changes the PO from 5,000 to 8,000, if the company has no safety stock, it will not be able to deliver the products on time and there will the customer dissatisfaction. The added order cannot be injected within only a day because the production capacity of the company is approximately 800 pieces and maximum production capacity is 1,200 pieces each day. The customers of the company always set the delivery time at the end of each month, but the company must inject every day. Therefore, in the middle of the month, the company will not have enough space to store the products. The products that are the major problem are PL Cover Pumps because there are 2 pieces in each box (package), and the demand of this product is about 3,000 pieces or 1,500 boxes. That is why the company must rent outside warehouse to store their products which leads to the higher logistic cost and useless because the outside warehouse is used to store the products for only in the middle of the month so, it will be free at the beginning and end of the month.

Nowadays, warehouse is one of the most important things of a logistic system in every companies; the warehouse contributes about 20% of the logistic cost (Koster et al., 2007). The operation cost of warehouses in USA and Europe are 22% and 25% of the logistic costs respectively (Baker and Canessa, 2009). It means that the company can reduce the cost by improving the logistic activities and the most important activity that should improve is warehouse.

Consequently, the researcher is interested in the operation processes of the company to identify the causes of problems and redesign the warehouse in order to reduce the logistic cost as much as possible and to improve the efficiency of the company. This will lead to the maximum profit, includes the recommendation for a company to expand their business.

1.3 Objectives

1. To study the operation processes of the company and to determine the problems and identify which is the best solution to for the warehouse problem.
2. To analyze the comparison of the current warehouse layout design with redesigned method.
3. To improve the efficiency of the warehouse by redesigning based on reducing the space of the warehouse, in order to see the impact on storage capacity.

1.4 Scope of the research

1. Using data and information between April – July 2016, the company will use a case study approach to improve the processes.
2. Using several tools to identify the problems of the company.
3. Considering the SKUs, which SKUs has the worst problem, redesign the warehouse processes of the company.

1.5 Research methodology

The project is divided into seven parts namely:

1. Identification of the problem: The first step is to identify the problem of the company from the past information and processes.

2. Definition of the problem: After identifying what is the problem in the company, the researcher will consider what is the cause of the problems. This includes identifying the scope, aims and objectives of research.

3. Literature reviews: The third step is literature review, to review and study the literature that are related to the research, to study the models to apply in solving the problem includes reviewing the related theory and used as a guide for this research.

4. Data collection: The next step is data collection, gathering all data that are needed to solve the problem. Data for the study was collected from two primary sources. The first source is done by analyzing the past information, for example the past inventory stock and the past annual sales and studies of the operation processes of the company. The second source was collected by direct observation and the interviews of the owner, the employees in warehouse and observing in warehouse space.

5. Data analysis and plan: The fifth step, is the analysis data from the fourth step and classify the data into two groups, which is the data about producing processes and the data about warehousing processes. This step also includes making plans to solve the problems.

6. Implementation: The use of several tools to improve processes of the company, controlling and managing the processes for going as plan. Include redesigning the warehouse for better warehouse space utilization.

7. Mention and recommendations: After finishing the sixth step, the researcher will mention the results of the plans and adjust the plan once it has problems and also give the recommendations for the company to improve the efficiency of its processes.

CHAPTER 2

LITERATURE REVIEW

Nowadays, the company has high cost when the entrepreneurs have decided to start the business. The cost is the thing that determines the profit of each company, if the company can handle the cost efficiently, they will get high profit margin. The inventory cost is the cost that is included in cost of company. Almost every company has the warehouse, it means every company has inventory cost, and the inventory cost is the easiest cost to reduce. Currently, there are many theories to use to reduce the inventory cost, for example inventory management.

Inventory management is the most important thing; the managers should be priority because the inventory is a main factor in the process, if the company has over inventory level, it likes a waste because products in the inventory has value if company always keep it in stock, it cannot make a profit. In the same way, over inventory level is making a high holding cost. If the company doesn't have inventory, the company may lose some sales and lose the chances to make profits. Sometimes, it makes the customers don't trust the company. Currently, most companies have problems about inventory and warehouse. That problems may be the reasons that make the business fails. On the other hands, if the company can control the inventory and solve the problem, the cost of company are reduced likewise they can reduce the risk of liquidity and the company will generate more profits.

2.1 Supply chain management

The definition of Supply chain management (SCM), there are many professors give the meaning in specific. In each definition, it shows the different ways, different

meanings, different models and different concepts to comprehend and apply into in business processes. The meanings of SCM are;

Supply chain management is a network of facilities and distribution options that perform the functions of purchasing the materials, receiving the materials, stock the materials relocate these materials into the production processes, making until get the finished products, and shipping the products to customers (Gabeshan and Harrison, 1995).

Supply chain management is the strategic and well-organized coordination of the traditional functions in business and the tactics of the business functions to do across the processes on the company and over businesses within a supply chain, for the purposes of SCM, focusing on the long-term strategies and improving the long-term performance of the company include the performance of companies in a supply chain (Mentzer, DeWitt, Keebler, Min S., Nix N. and Smith, 2001). SCM is the theory about the management the relationship between upstream and downstream in a supply chain as a whole to added the value to customers and partners and the purpose of SCM is to manage the processes in the supply chain network for examples the suppliers through the partner manufacturers, retailer/wholesalers until a product reaches to end customer (Christopher 1998).

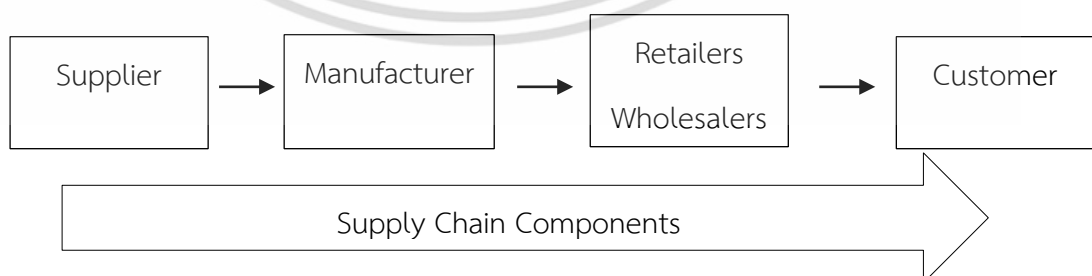


Figure 2.1 the components of supply chain

2.2 Warehouse management

A warehouse or distribution center is a commercial building used to keep the finished products including, raw materials and work in process products. The basic element of the warehouse is to process the purchased orders and to ship the products that are purchased by the customers to the customers or shipping carrier. The main target for warehouses and distribution centers is to support the movement of products from suppliers to customers based on time and cost-effective manner. The definitions of warehouse have been given as follows;

A warehouse is a facility in the supply chain to storage raw materials and finished products to reduce logistic costs, accomplish economies of scale in manufacturing, in purchasing and delivering (Bartholdi III JJ, Hackman ST 2006) Warehousing has accepted, it is one of the main operations that the companies can support their customer and complete a competitive advantage. There are numerous types of warehouses for example it can be separated into 2 types, production warehouses and distribution centers (Ghiani G, Laporte G, Musmanno R, 2004) and it has function in the supply chain that can be grouped as distribution centers, raw materials warehouses, work-in-process warehouses, finished good warehouses, fulfillment warehouses, local warehouses direct to customer demand and value-added service warehouses (Frazelle E, 2001). Warehouses are included in numerous stages of sourcing, production and distribution of products, controlling the raw materials and work in process (WIP) to get the finish products. Therefore, it is obviously, each company requiring the different characteristic of warehouse to achieve their operation for example require different place, different nature of facilities, different worker skill and include different equipment the suitable on each function. With the boundless of difference characteristic, the warehouse operations could be the highest cost of the

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supply chain (Rushton, Croucher, and Baker, 2010). According to Richards, 2011, the warehouse managers concerns to increase productivity and accuracy level, reduce costs and reduce inventory level while customer service was improved. The level of service provided is the critical in term of successful management of the warehouse, as well as handling the cost-effective (Rushton et al., 2010).

Warehouse management is an important factor to achieve the efficiency supply chain. The main function of a warehouse is to control the products from the first destination to next destination in the supply chain network without any damages to the products, on time delivery and low cost. Warehouse management has important role in distribution center. Warehouse is a building that is used to store the finished products or raw materials, which must be sent to customers in order to respond the customer requirements. In Figure 2.2, is shown the warehouse processes.

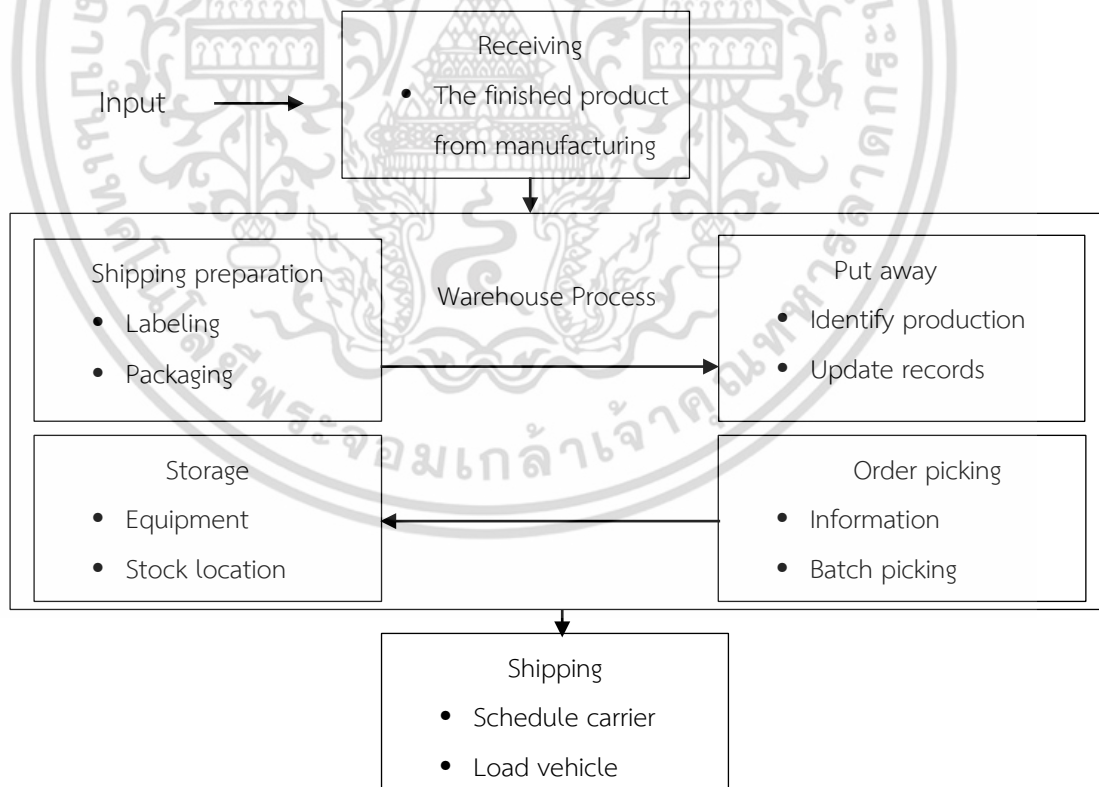


Figure 2.2 Warehouse process and activities

Source: Coyle, J.J, Bardi, E.J. and Langley, C.J. 2003. *The Management of Business Logistics*. 7th ed. Canada : South-Western Tomson.

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From Figure 2.2, the processes that are elements of warehouse are;

1. Ordering
2. Receiving
3. Put Away
4. Storage
5. Order Picking
6. Shipping preparation
7. Shipping

Storage is the placing process of products for waiting to react to customer demand. The factors that affect to structure of storage are size and quantity of the goods in inventory and the product's package (Tompkins et al, 2010).

Warehousing is necessary, it takes between 2% to 5% of the cost of sales of a company, and it has high competitive in global business environment. All organizations stress on return on assets (ROA). That's why; reducing the cost of warehouse is an important business issue (Heung Suk Hwang, Gyu Sung Cho 2006).

2.2.1 Types of warehouse

Currently, we have many types of warehouses. In each type of warehouse, there are different characteristics and responds to different needs. The types of warehouse may be grouped as follows;

- i. Private Warehouses
- ii. Public Warehouses
- iii. Government Warehouses
- iv. Bonded Warehouses
- v. Co-operative Warehouses

2.2.1.1 Private warehouse

The private warehouse is a warehouse that is owned and managed by the manufacturers or traders to stock the products exclusively, the own warehouse to stock the products is private warehouse. In general, the warehouses are always constructed near the supplier for examples, constructed by wholesalers and retailers near their business markets and by manufacturers near their factories. The products are the main factor to provide the facilities and design the structure of warehouse.

2.2.1.2 Public warehouse

The public warehouse is the warehouses which have process to store the products of the general public. Any companies can collect his products in these warehouses with an agreement or the payment for rent. An individual, a partnership firm or a company may own these warehouses. This type of warehouse requires the license from the government to start. The government also controls the functions and operations of these warehouses. The wholesalers, exporters, importers, government agencies manufacturers always use the public warehouse.

2.2.1.3 Government warehouse

Government warehouses are the warehouse that is owned, restricted and managed by the state government, public organization or local authorities. Government and private enterprises always use the government warehouse to collect their products.

2.2.1.4 Bonded warehouse

Bonded warehouse is the warehouse which is controlled, managed and owned by the government like a private agencies. Private bonded warehouse requires the license from the government. Bounded warehouse was used to collect the product which is imported from other countries and is waiting to pay the import duty. In case

of imported, the products are not allowed to receive or take away from the ports until the importers paid the taxes. The bonded warehouses are always found near the ports and the owner of this warehouse is dock authorities.

2.2.1.5 Co-operative warehouse

Co-operative warehouse is controlled, managed and owned by co-operative associations. The purpose is to provide the warehouse facilities at the most economical rates to the members.

2.2.2 Functions of warehouse

1. Receiving – The physical unloading of incoming transport, checking the goods, recording of receipts, and deciding placement for received goods in the warehouse are functions of receiving. It includes other activities such as unpacking and repackaging the goods, checking the goods by used the quality control before store in storage.

2. Inspection – Checking the quality and quantity about the required characteristics of incoming goods.

3. Repackaging – The incoming goods may have the different packaging or non-standard packaging which cannot store in warehouse. In this case, the incoming lot required to repack in unit loads/pallet load which is appropriate for the warehouse.

4. Put away – Moving and storing the goods in prepared location, including the temp locations from the receiving docking area.

5. Storage – Storing the goods that are approved to the prepared location or warehouse of company.

6. Order - Order picking / selection – Goods are selected from customer order based on the requirement of quantities and shipping time to respond the customer

orders. Picking often involves break bulk operations, when the company receives the เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า ไม่ว่าจะกรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และด้วย 11 บ้างอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

goods from suppliers, it comes with whole pallet quantities, but the customer order is less than a pallet quantity. Order picking is an important thing to achieve the high levels of customer service. The optimal management and design of picking systems and operations are affected to warehouse performance and effective of warehouse.

7. Sortation – This function is sorting the goods in warehouse into specific customer orders, for moving to order collation immediately.

8. Packing and shipping – Picked the goods from the customer order, the goods are combined and packed according to requirement of customer. It was shipped to the destinations where specify in customer orders.

9. Cross-docking – Moving the products from receiving to the shipping dock, the products will not be stored in the specific locations.

10. Replenishing – This is the movement of goods in colossal order quantities, for example whole pallets at a time , from reserve storage to order picking, to guarantee that order picking locations do not empty. The important things to achieve high levels of order fill is maintaining stock availability for order picking.

2.2.3 Storage strategy

2.2.3.1 Informal system

The informal system is the system that keep the product without recording in the system, and every products can be kept anywhere in the warehouse. The worker who works in that local will know where the products have been kept. We can see that this informal system is suitable for the small warehouses with little SKUs and little local to keep goods. Every worker will separate duties in every zone and every zone does not have the way to keep goods. Therefore, this may cause problems when the person who works in each zone does not come to work. We are going to show the advantages and disadvantages of informal system as below;

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Advantages of this system

- Do not need to maintain the tools.
- High flexibility

Disadvantages of this system

- Do not have an efficiency and difficult to search the products.
- The system efficiency depends on worker skill.

2.2.3.2 Fixed location system

This idea is come from the theory that every goods or SKUs have a fixed location. This system is suitable for the small warehouses with a few workers or the place to store the goods or SKUs was limited. By researching, this idea has a limitation when there is a big order over the goods that have in the moment. This makes a wide space for noting or useful thing.

Advantages of this system

- Easy to apply in the warehouse
- Easy to observe the process

Disadvantages of this system

- Cannot use a whole space
- Lose some space (In case of there are no goods in stock)
- Take a large location
- Difficult to expand the warehouse
- Difficult to remember where the goods have been kept

2.2.3.3 Part number system

The format of this system is to use part number of each product. This idea is similar to fixed location system, but the difference is the part number will have a step

for example, the product NO. A123 will be kept before NO. B123. This system is

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suitable for the company that needs import or export and the product that has stable number. By using this part number, it will make the store man know the location of the goods. But it is not flexible in case of the organization or the company is growing and requires to increase SKU to cause the problem in arranging the areas.

Advantages of this system

- Easy to search and pick up the goods in warehouse
- Easy to observe the warehouse process
- Do not need to record the locations of goods

Disadvantages of this system

- Inflexible and minimize space utilization
- Adding new SKUs will affect all of goods

2.2.3.4 Commodity system

The commodity system is the system to place the product classification the product based on the product type. Like a supermarket, they will place the same type of product together. It supports the storekeeper to place the products, check the products and pick the products and also improve the efficient of these processes, if the product was classified by the types of products, the storekeeper can pick up to deliver as fast as possible because they do not want to find the products and they know where the products are placed.

Advantages of this system

- Easy to find the products
- Easy to pick the products up
- Easy to implement
- Do not need to record the products places

Disadvantages of this system

- Inflexible
- Adding new products will affect the storage system

2.2.3.5 Random location system

The random location system is the system to place the products anywhere that the storekeeper wants without fixing the locations, so the product can be stored in any locations in warehouse. This system requires having some information system to mention the product information such as where is the product and the information must be updated. If the company applies the random location system to the warehouse process, the company will increase the capacity of the warehouse and its optimal for every size of warehouse.

Advantages of this system

- Maximum space utilization
- High flexibility
- Easy to expand the warehouse
- Easy to implement on the warehouse

Disadvantages of this system

- When moving the products to warehouse, it requires recoding the product information and location information.
- Having information system cost

2.2.3.6 Combination system

The combination system is the system that mixed all of strategies above, the storing location will be considered from the restriction of the product for example, if the company has 2 types of the products that are the chemical and food products, the

company should fixed the location for chemical products separated from food products, and for the other locations, they can use random location system.

Advantages of this system

- Combine the other systems advantages
- High flexibility
- Available for changing the storing location all the time.
- Easy to expand the warehouse

Disadvantages of this system

- Confusing to store man because it has 2 systems in a warehouse
- The uncertainty of space utilization.

Moreover, Charles (2002) presents 2 concepts to storing the product as below;

1. Random storage is a technique to store the products anywhere in the warehouse without fixing the locations
2. Volume-based storage is a technique to store the products that have high volume near the shipping zone. There are several advantages and disadvantages of each concept between Random storage and Volume-based storage. The advantage of Volume-based is the reduction of time and distance to pick the products and disadvantage is the unbalancing on the storage. The advantage of Random storage is the company can use maximum space utilization and the disadvantage is that it consumes a lot of time to pick the products.

2.2.4 The ideal warehouse

According to Rohan Agarwal, an Ideal warehouse constitutes of the following features;

1. Proper location; for effective movement of goods and cost saving, warehouses should be established at places, where are comfortable to the seller and

the buyer. These warehouses should be located near the railway stations, major highways, both of ports that are seaport and airport, where goods can be loaded and unloaded comfortably. It is also recommended to have go downs in open places so that the vehicles can move around easily.

2. Use of mechanical machines; in the warehouses, mechanical machines should be used to load and unload the goods. It not only results in safety of employee and material but it can reduce about the wastage in handling goods and overall costs.

3. Sufficient space; for an ideal warehouse, sufficient space should be covered for maximum storage and it should be enough to store all of goods. Each trader (big or small) would want that all of his goods should be placed in a same warehouse so that he does not need to travel to several places for manage the loading and unloading of his goods.

4. Proximity to the market; the warehouses should be located at a place where is closest as possible for buying raw materials and selling the goods. This is the reason that big warehouses are always close to the commercial places or bus stands.

5. Parking Facility; the traders will have the harrowing experience, if the company has poor parking facility for example, they must parking along road, public places in the urban/suburban areas. Hence, in warehouses, suitable management should be made inside the property that supports to loading and unloading activities include having the safe parking.

6. Safety measures; A warehouse, which is used to store the foods or perishable products like butter, bread, milk, fruits and vegetables should be equipped the suitable cold storage and moisture resistance etc. facilities. Furthermore, efforts should be made to protect the warehouse against the theft and damage from the

natural factors such as heat, rainwater, insects and fire. The use of safety alarms, fire extinguishers, budgets and twenty-four hours security arrangements should be there to protect the warehouses from unexpected things.

7. Economical; the warehouse location, layout, construction and maintenance should support the maximum storage of goods with minimum cost.

8. Optimal management; if warehouses are not managed appropriately, all the money spent will be useless. Mismanagement may lead to many risks such as theft, loss and errors. Therefore, the optimal management on the warehouse is necessary on permanent basis. A permanent officer should be appointed for suitable arrangements of incoming and outgoing goods.

2.3 Inventory management

The meaning of 'Inventory' and 'stock' are always used to relate to the similarly thing (Wild, 2002). Inventory management is the philosophy about specifying the size, characteristic of storage and location of storage. Inventory management is one of the important elements that supports the protection of the production from running out of raw materials or products. Inventory management generally has two main targets (Reid & Sanders, 2007); firstly, good inventory management is that the company can handle their raw materials or goods for availability to use. It is necessary for production lines or running operations that required the materials or goods immediately at right quantities, right quality and at the right time in order to gain the level of service. The second goal is to achieve the highest service level with cost-effective.

According to Wanke and Zinn, (2004, p.466) they define that inventory management is a "function of product". It is operational and demand related variables such as delivery time, efficient of variation of sales, and inventory turnover.

The scope of inventory management is broader than stock. According to Coyle, 2003, fundamentally inventory management can be described as “management of materials in motion and at rest.” The inventory management is the group of actions that used to control lead time, holding costs of inventory, asset management, forecasting the inventory, inventory valuation, inventory visibility, forecasting about future inventory price, physical inventory, available physical space for inventory, replenishment, quality management, defective and return goods and forecasting the demand.

2.3.1 Definitions and concepts

2.3.1.1 Definitions

1. Inventory

Inventory can conceal an error and allow management not to notice, (Fogarty et al, 1991). What is Inventory? Inventory includes raw materials, suppliers, components, work in process and finished products that appear at various points throughout a firm’s production and logistics channel, (Ballou, 2004). According to Chase et al, (2009), describes that the inventory system is the guidelines of policies and regulations that control levels of inventory and support to specify what levels should be applied in process, when the firm should be order the goods and how many lot size should be ordered.

2. Lead time

It is an important path in manufacturing performance and distribution centers. It is the duration between the receipt of product and reorder point. It compose of order preparation, release time, controlling time from supplier and transportation time to distribution center. Lead time has an influence on work-in process, finished products, inventories, quality management and customer service.

3. Ordering cost

Ordering cost is the cost that covers all cost occurring when the company orders the goods or products regardless the volume or quantity of order. It includes the costs and time that used on requesting for entering purchase order. In the same way, if the company can reduce or control the ordering cost, the total cost will be decrease.

4. Shortage Cost

It is the cost that happens when the raw materials or goods is out of stock for sale or produce, that make the customer cancel the order or the company cannot run their production lines.

5. Holding cost

The holding cost is the cost to store the products, goods and raw materials. It includes the cost to protect the product to be safe without damage and about risk such as special storage such refrigeration, finance cost, racking, insurance, renting and building cost.

6. Handling cost

The cost involved in handling inventory in a warehouse. It does not influence the minimization total inventory cost if all demand is satisfied. This cost is focused on the design and controlling of warehouse.

7. Purchasing Cost

Purchasing cost is variable cost that depends on the amount of items in the order, include the variable cost about purchasing a single unit of a product for examples, variable labor cost and overhead cost. But for the product that is ordered from external suppliers, it includes transportation cost or shipping cost.

2.3.1.2 Inventory concepts

1. Safety stock

The safety stock used for the product protection, goods or raw materials out of stock, to protect the loss of profit situation and to against uncertainty demand.

2. Inventory on hand

It is the actual number of item in the storage at the present. It is known by physical counting stock and it can be used to determine holding cost

3. Net stock

It calculates from the on hand inventory minus the amount of backlog.

4. Inventory position

It is the totality between on hand stock and the on order stock minus backordered stock.

5. On-order inventory level

It is defined as on hand inventory plus inventory that has been ordered.

2.3.2 Types of inventory

According to Leenders (2006) inventory can be classified as follows;

1. Transit or pipeline inventories:

These are products that are on the route from one destination to the other destination; they are determined to be the stock, in spite of they are still on the way.

2. Cycle inventories:

It is inventory that is needed the predictable demand. It balances the decision involves purchase, produce, or sell in lots rather than individual units.

3. Buffer or Uncertainty inventories:

Buffer inventory is the inventory that an uncertainty of supplier performance for example shutdowns, strikes, type of lead time, late send a raw materials and the products that cannot accepted because the products has poor quality.

4. Anticipation:

This inventory is collected the products, material, or goods on hand to respond seasonal situation in over demand or to meet the deficit caused by uncertain demand. It can be called anticipation inventory, build stock, seasonal inventory, or seasonal stock. It is different from buffer inventory, the anticipation inventory has less risk and it has sure for example seasonal inventories.

2.3.3 Functions of inventory

Functions of inventory having an amount of stock is costly and can cause numerous additional risks. Waters (2003) define the following: “stocks are expensive, because of the costs of tied-up capital, damage, warehousing, protection, deterioration, loss, natural disaster, insurance, packaging and administration the inventory”. That’s why inventories are being maintained by organizations. According to the Just in-Time philosophy (JIT) when all materials arrive at manufacturing on time, it does not needed the stock and thus inventory management will not have to manage with the temporary storage of all these products (Coyle et al., 2003). This is how managers often describe the JIT philosophy. Unfortunately the JIT philosophy cannot always be used and Just in-time is a way to handle in a situation where

production takes place based on an order (no mass production). Just in-time does not

mean to non-inventory, but the goals of JIT are to elimination of unnecessary stocks during the production and to decrease the holding cost as well as increase space utilization of company.

2.3.4 Reason for having inventory management

Inventory is the biggest costs in businesses; it is hidden cost (Harrington, 1996). Therefore, this is the first reason for having the inventory management in the businesses. On this topic, I will describe the other reasons having inventory management as follows;

Firstly, inventory is an important part that affect to the total costs in the businesses, it is up to about one third (Goor & Weijers, 1998). Inventory costs also stand for an essential component of total logistics costs (Coyle et al., 2003). Hence, reducing the total cost is the biggest benefits. Stocks are a very useful resource to invest (Wild, 2002), (Fawcett et al., 2007). However from a company perspective, the capital invested in stocks is a useless waste of money but the investment in inventory management is a good thing to improve the business performance. Reducing the inventory cost of company, it will affect to decrease the total cost of company. Increasing competitive advantage is the goal of businesses, so reducing the costs using efficient inventory management is a way to achieve this goal.

Secondly, stocks are a source for risks (Visser & Goor, 2004), (Fawcett et al., 2007). For instance, stock can be stolen, catch fire, taken damage or decay overtime. Therefore, these incidents might affect the manufacturing or production process, the process could be stopped or the orders are delivered too late. The risks related to the stock level, if the business has low level of stock the risks will be reduced. The company can reduce the risks by maintaining the stocks, it can protect these risks but the costs will be increased.

Lastly, the inventory cost is the first thing that is easiest to identify and reduce when the business confront with supply chain problems (Johnson & Pyke, 2001). The optimizing internal logistic is the best way to reduce the cost (Ploos van Amstel, 2008). Using enterprise resources planning system (ERP) to control the stock is the best way to achieve the goal; it is able to reduce the stock and able to reduce cost and risks because the goals of inventory management are to control materials, reducing the costs and risks.

2.4 Manufacturing operational strategy

2.4.1 Make to order

A make to order structure is common strategy for company that product features based on the consumers desires and the products are only produced on customers demand.

In case of the Make to order strategy, the manufacturing is started after they got the receipt of customer's order. The manufacturers will not start to make the products until they received a customer's order. Figure 2.3 is shown the operation of make to order strategy. The make to order strategy is optimal for products with the following characteristics;

- 1.) The features of product based on the requirements from customer.
- 2.) The final product is a combination between the standardize of product and the custom-designed from customer to meet the special needs of the customer.

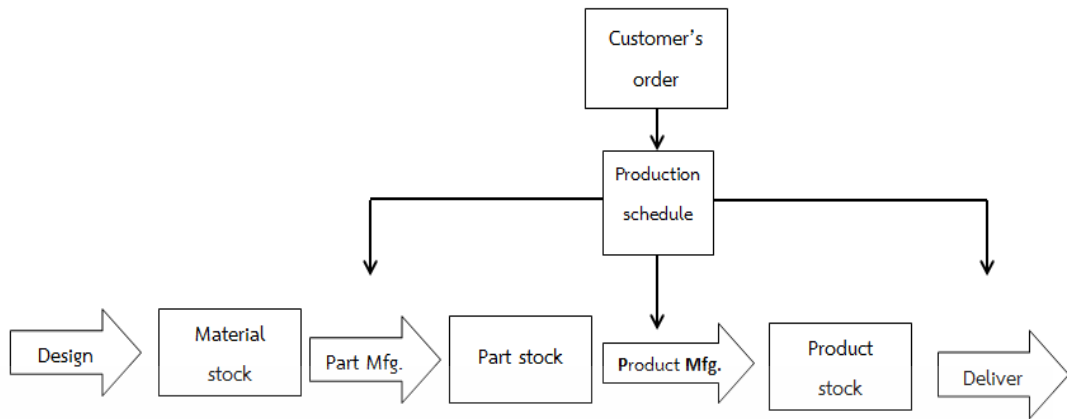


Figure 2.3 Make to order strategy

2.4.2 Make to stock

In this structure, products are manufactured, irrespective of any order placed by customers. It is even possible that products are produced, but there is (hopefully temporarily) no demand at all. The pressure in this structure is on the sales department when the demand was dropped.

Make to stock strategy is a production environment to make the product finished before the receipt of customer order. The product features was specified by the company. Figure 2.4 shows a process of the MTS strategy.

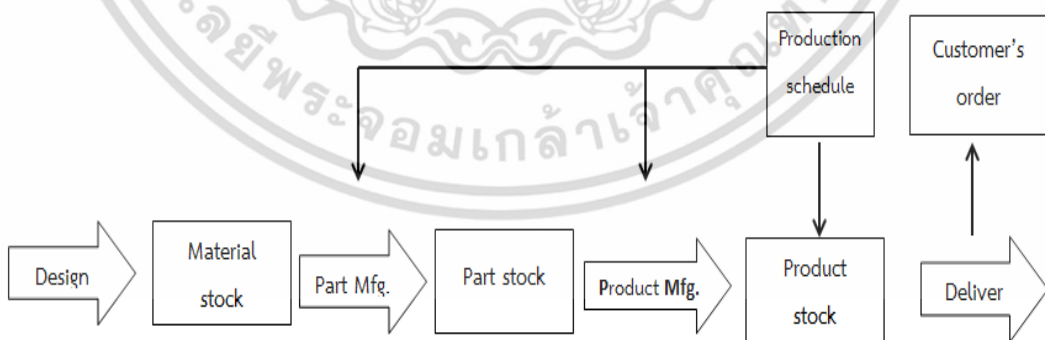


Figure 2.4 Make to stock strategy

2.4.3 Assemble to order

Some manufacturing companies are doing only assemble. They combine different components based on the desired configuration of the customer. Using a limited number of components, they are able to produce various different end-products. Automobile is an example to offer various components from supplier and they only assemble it to sell on the store where the customers are able to pick from.

Assemble to order means to a production method in the customer must inform the order before the manufacturing assembles the product. The different between manufacturing order and making to order strategy are, the assemble to order manufacturing is only assemble based on customer order but make to order strategy will be produced when they got the customer order, so the customers can quickly receive products customized to meet their needs. Figure 2.5 shows a process of the ATO strategy.

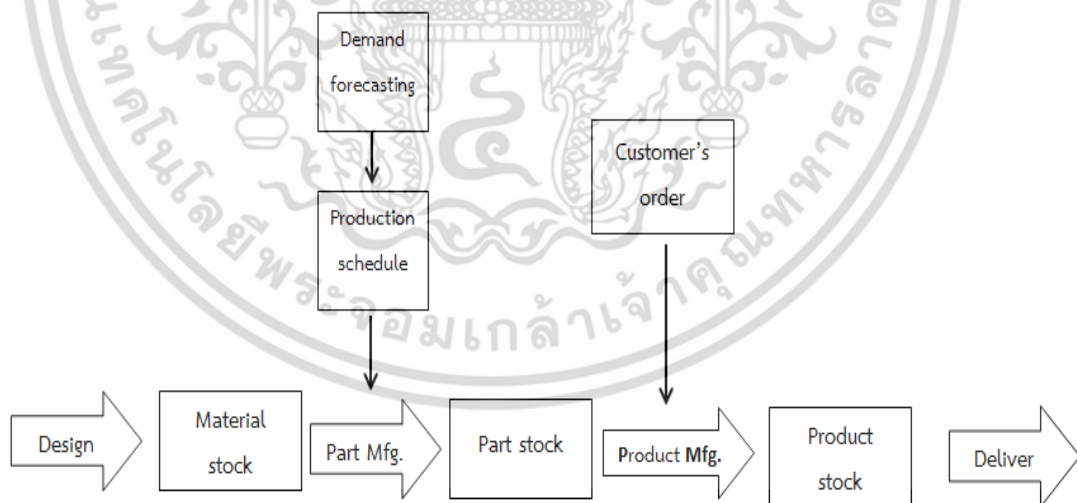


Figure 2.5 Assemble to order strategy

2.4.4 Deliver from stock

The deliver from stock strategy looks similarly to the make-to-stock structure. However in this case the classification is much bigger and products are not being manufactured first. This structure is usually found at a wholesaler or retailer.

However, Hoekstra & Romme (1991) also mention a fifth structure called 'purchase and make to order'. This is an even more specific case of the make to order structure. The four structures that described above will present the influences from the customers that affect to the product features. In case of the make to stock strategy, the interaction with the customer takes place at the end of the production process (Hoekstra & Romme, 1993), (Coyle et al., 2003). Has not any influence during the process from the customer, whereas in the make to order strategy the customer has an influence at the beginning of the production process. The point in the process at which the customer gets an influence is called Push/Pull-boundary (Simchi-Levi et al., 2003).

The basic structure is to define the amount of stock that is placed. In case of make-to-order for example materials cannot be held in stock, because the materials required depend on the customer order. If the company does not have any inventory and the required materials are delivered on time when they are required. This principle named Just-In-Time (JIT) delivery. Using JIT, the make to order structure could in theory thus do without any inventories, if all materials and sub components are delivered on time.

2.5 Research tools

In operations research, there is a need to gather information to analyze for the purposes of the research. The research tool is important in data collection what to

study. The tools used in the research are numerous but whether any research tool. All เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า ไม่ว่าจะกรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และตั้ง 27 ว่าจะอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

have the same aim, to obtain data that meets the facts. To make research results more reliable and useful as possible.

Types of research that are mostly used are;

- Questionnaires
- Interview and observation forms

2.5.1 Questionnaire

A questionnaire is a means of inquiring the feelings, beliefs, experiences, perceptions, or attitudes on some sample. As a data collecting instrument, it could be structured or unstructured.

The questionnaire is most frequently a very succinct; design the set of questions to asking about specific information to meet a need for research information about a relevant topic. The research information is achieved from respondents from the target area. The dictionary definition gives the definition of questionnaire is: A questionnaire is a written or printed that used to gather information on some topic from sampling group, consisting of a list of questions related to the topic.

Advantages

- Economy – The questionnaire can reduce the expense and time to training interviewers and the cost of sending them to interview.
- Uniformity of questions - The respondent receives the same set of questions. The result from questionnaires may have more benefit than information obtained through an interview.
- Standardization – The questionnaire will have standard, if the questionnaire has highly structured on the questions and having the conditions to control their answer.

Disadvantages

- Respondent's motivation is difficult to control, it affects the validity of questionnaire.
- Without the random sampling, the result of questionnaire may be shown on invalidity.

2.5.1.1 Two types of questionnaire

1. Closed or restricted form – it calls for a "yes" or "no" question, short answer, like scale and checklist; this type of questionnaire is easy to understand, tabulate, and summarize.
2. Open or unrestricted form – it calls for free response from the respondent or open-ended questions; allows for greater depth of response; it is difficult to understand, tabulate, and summarize.

2.5.1.2 Characteristics of good questionnaire

1. Related to a main topic, the respondent will remember the topic to answer the questions. The questions of questionnaire should be easy to understand, clear and involve to the topic, the reliability of questionnaire will come from these things.
2. Asking only the information or data which cannot be gotten from other sources such as the attitude of respondent.
3. As short as possible, the question should be short and concise to get the essential data. The long questionnaires frequently makes the respondents feel terrible to answer the questionnaire.

According to (Berdie 1973), the summary of knowledge concerning the relationship between questionnaire length and response rate: "Common sense suggests that the shorter question, will represent more high response rate, and persons

who studying about the questionnaire efficiency have tended to accept this belief even if it has little evidence to support it.

4. Directions are clear and complete, important conditions are defined, each question only has a one idea to understand, all of questions are writing with simple structure as possible, and the categories provide an opportunity for easy, accurate, and clearly responses.

5. Questions are objective, with no any factor leading to the desired response.

6. Questions are shown in good psychological order, proceeding from general to more specific responses. This order supports the respondent to organize his own thinking, so his answers are valid and objective. It may be wise to present the questions that create a favorable attitude. If possible, the annoying questions should be avoided.

7. Easy to tabulate and understand. It is suitable to pre-construct a tabulation sheet, expecting how the data will be tabulated and understood, before the final form of the question is decided upon. Working backward from a conception of the final analysis of data is an important step to avoid the uncertainty in questionnaire. If used the tabulating system, it is necessary to define code numbers for all possible answer because the code will support to fill the data into the system.

Groves, Cialdini, and Couper (1992) also list interview (interviews will discuss in the next section) length is a factor that influence to questionnaire, but they are not specific about the amplitude of that influence. They said respondents "are likely to base their decisions on highly prominent and normally diagnostic attentions."

2.5.1.3 Strategy for determining sample size

There are several methods to define the sample size. These include using a census for small populations, copying a sample size of similar studies and applying formulas to calculate the sample size. Each strategy is explained below.

2.5.1.4 Sample size for small population

One method is to use for all of population as the sample. Although, if considered about the cost, it will be impossible to use on large populations, this method is attractive for small population (less than 200). A census reduces the sampling error and affords data on all the individuals in the population. Moreover, some costs such as questionnaire design and developing the sampling frame are fixed. It means they will have the same cost for samples of 50 or 200. Finally, using all of population as the sample should be applied in small populations to achieve a desirable level of validity.

According to Evan Morris, with large populations, the sample size is determined by using the normal calculation it is called binomial distribution. This calculation is very precise when the population is large, and the sample size is small. However, for a population of 200 persons, then for a given accuracy, it would require a smaller sample than that calculated using the normal calculation to the binomial. To determine the sample size for small populations, we use the normal calculation named hyper-geometric distribution. The sample size formulas for large (binomial) and small (hyper-geometric) populations are shown below.

1. Hyper-geometric distribution

$$n = \frac{N(z^2)(p * (1 - p))}{e^2(N-1) + (z^2)(p * (1 - p))} \quad (2.1)$$

2. Binomial distribution

$$n = \frac{z^2(p * (1 - p))}{e^2} \quad (2.2)$$

Where

- n is the required sample size
- N is the population size
- p is the population proportions. (the researcher unsure about the sample proportion so the researcher set it as 50%.)
- z is the levels of confidence at 95%.
- e is the acceptable margin of error = 3%.

For the very small populations (50 or less), it almost used the entire population to achieve accuracy. There is a limit on the accuracy that can achieve with small populations. The maximum resolving can achieve for a proportion is 1/N. If E is set smaller than 3%, you can never reach this accuracy even if you survey using all of population.

2.5.2 Interview

An interview is a face-to-face attempt to achieve the valid and reliable measures in the form of oral responses from one or more respondents. It is a conversation in which the roles of the interviewer and the respondent change continually.

Advantages

1. Allows the interviewer to simplify questions.
2. Can be used with young children and uneducated people.
3. Allows the informants to respond in any manner they see.

4. Allows the interviewers to observe oral and non-oral behavior of the respondents.
5. Obtaining the personal information, attitudes, perceptions, and beliefs.
6. Reducing the anxiety so that potentially threatening topics can be studied.

Disadvantages

1. Unstructured interview data is often difficult to summarize or evaluate.
2. Adding some cost to improve or prepare the interviewers such as training interviewers, sending them to meet an interviewee, and estimating their effectiveness.

The decision to use interview method as a data gathering method was affected by Ely et al (1991: 4), who maintain that "qualitative researchers want those who are studied to speak for themselves, to provide their perspectives or attitude in words and the actions." According to Welman (2001: 158), the interview is one of data-collecting method which usually involves personal visits to respondents at home or at work. In the interview, the interviewer asks the questions that they prepared and record the conversations. Interview method is very valuable because the highly specific data can be achieved in a very short of time. The interview is also useful to obtain about the opinion, attitude and perception of people.

The Sharp and Frankel study (Frankel and Sharp, 1981) obtained some other proofs which support the belief that interview length does not have a significant effect on subsequent response in a survey. When asked the attitudes about being re-interviewed a year later, with more length of interview (75 minutes) interview

respondents said they would not agree to be re-interviewed a year later. However, a เอกสารนี้เป็นเอกสารทลวงเวสำหรับการเงงานเพื่อกการศึกษาเท่านั้น ไม่นุญาดเหนาเปเชบระเษนดานการคา
ไม่ว่ากรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และด้อย 33 ำงอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

year letter when actually contacted for a second period of interviewing, the response rate for the group which had received the long length of interview a year before (85%) was about the same as for the short length interview group (88%)

For semi-structured interviews, the terms and interview guide is the things that desired. Welman (2001: 161) defines an interview guide is a list of topics and aspect of the topics that support the interviewer to asking on the interviewee and a list of data that are requires to do a research.

Although all respondents are asked in the same questions, but the interviewer may use the different methods to ask their respondents. (Welman, 2001:161).

2.6 Fishbone diagram

A fishbone diagram is a visual way to analyze the cause and issue of the effect. It is a more structured method than other method or tools available for brainstorming on causes of a problem (e.g., the Five Whys tool). The problem or effect represents at the mouth or head of the fish. Each smaller bones of fish show about the possible causes. A fishbone diagram can be accommodating to identifying the possible causes for a problem or effect that might not be considered or analyzed by directing the team to look at the categories and think about the other causes that are related. Include the team members who know about the processes and systems involved in the problem or event to be considered.

According to Dhandapani, 2004, the Fishbone diagram (FBD) is also known as the diagram that considered about the cause and effect, the root cause analysis and the other name is Ishikawa diagram, it named after its originator Kaoru Ishikawa, the Japanese quality innovator. The diagram looks similarly to the fishbone, so it called the Fishbone diagram. The Fishbone diagram is important tool uses for analyze at the

root cause of a problem through brainstorming. Fishbone diagram was used in many เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า ไม่ว่าจะกรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และตั้ง 34 ำงอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

sectors in order to structure, identify and look for the large picture of the problem. According to Ilie & Ciocoiu, 2010, they applied the fishbone diagram for identify the risk for an event in order to develop the suitable risk management strategies. Dhandapani, 2004, applied the fishbone diagram by merging with Pareto philosophies for Software industries. Behnam & Alvelos, 2011, applied the fishbone diagram to the root causes that exist during retreading in tire industries. Chang & Lin, 2006, applied the fishbone diagram to analyze on the root causes in tanker storage accident. Chow-chin, Chun-wei, & Jon-chao, 2008, they applied the fishbone diagram in order to find root causes analysis of teaching strategy to train primary pre-service science teachers.

In simple terms, Fishbone diagram is the tool to brainstorming in a structured format (Ilie & Ciocoiu, 2010). The technique of fishbone diagram is use graphical to shows the causes that related to the problem, in other words, to define about the causes and effect. The diagram focuses on the causes more than the effect. Since there may be various causes for a problem, this technique supports to identify the root cause of the problem in a structured and uncomplicated method. It also supports to work on each cause prior to finding the root cause.

2.7 Analysis Hierarchy process (AHP)

Analysis hierarchy process is the process to measure the priority of an issue, to make a decision as efficiency as possible. The results of this process will lead a company achieve their goals. The Analysis Hierarchy Process (AHP) was invented on 1970 by Prof. Thomas Saaty from University of Pennsylvania.

Since the Analysis hierarchy process was invented, there are a lot of people use it as a tool to support their decision making for example, the decision in business processes such as purchasing raw material process, selecting the plant location,

determining the marketing strategy and determining a best solution for the problem.

To make a decision in a company, the way to generate priorities, we need to separate the decision into 4 steps.

1. Determine the problem and define the knowledge sources
2. The structure of analysis hierarchy process, the goal of decision will be set on the top, then the objectives in the next level. In the third level, will set the criteria on which subsequent elements depend and the lowest level will usually set about the alternatives
3. Construct a set of pairwise comparison matrices. Each component in an upper level is used to compared the components in lower level respectively.
4. Use the priorities that gained from the comparisons to weigh the priorities in the lower level. Do this for every component. Then for each component in the lower level add its weighed values and gain its overall or total priority. Continue this method of adding and weighing, until the last priorities of the alternatives in the bottom most level are obtained.

2.8 Related research

Thomas Lacksonen (2004) who wrote the research named 'RE-DESIGN WAREHOUSE PLANT LAYOUT FOR A FOOD COMPANY' This research paper presents a comprehensive look at the issues involved in increasing production by increasing the number of operation lines within a food company at Eau-Claire, Wisconsin. Nestle was the company especially selected for this study, which includes redesigning warehouse storage process, redesigning the layout of warehouse, and improving on efficiency of their existing warehouse. The purpose of redesigning warehouse for this research, he has a lot of purposes such as improving the capacity of the warehouse; improving efficiency of forklift and reducing dependence on outside warehouses.

Hui LIU (2012) who wrote the research named 'WAREHOUSE REDESIGN OF FACILITY LAYOUT FOR WEGMANS FOOD MARKET' This report shows the warehouse redesign of Wegmans Food Markets' grocery warehouse located in Pottsville, PA. The objective of this research is to make an alternative plan for the facility that can maximize the efficiency and increase the capacity to fulfill the requirements for the future growth. The current warehouse layout and processes were reviewed and some methods about quantitative analysis were used to calculate the current process performance and inventory status. Afterward, the two main areas which influence the majority of processes were defined -- the Floor Picking area and the High Velocity Picking area. Two alternative redesign methods were proposed for each area and for combinations of these alternatives have been calculated. The final alternative plan which was defined to be the best integrated the additional Rack Picking and Floor Picking area together and reorganized the High Velocity Picking area with narrow aisles and adding the level rack for replenishment. This alternative improved the efficiency of operations; will have the low implementation cost and short reconstruction time.

Maryam Daraei (2013) who wrote the research named 'WAREHOUSE REDESIGN PROCESS: A CASE STUDY AT ENICS SWEDEN AB' the purpose of this research is to develop a method for redesigning production warehouses, and analyzing main problems during the redesign method. This research is a case study research, and the data collection and analysis used a mix of quantitative and qualitative methods. The methodology focuses on the warehousing process and redesign method as explained in the literature. The results of the research presents about the seven steps for redesigning method of the production warehouse, also

described about the several problems and challenges are faced during the redesign method.

Chatree Polchai (2011) who wrote the research named ‘THE LAYOUT PLANNING FOR LIQUOR CASE STUDY: A LIQUOR COMPANY’ The purpose of this research is to plan to develop the inventory management case study company and develop it to improve the storage efficiency of oak barrel in production of white liquor and brandy in the fermentation process. The planning system of this research similarly to the redesign warehouse layout method, the planning system for redesigning warehouse layout can classify as the space for each type of liquor, clearly set up for the staff walk way and forklift way. The clearly setting up for the way improves the efficiency of loaded, unloaded activities and make the staff to be able to count the quantities of barrel and checking the leakage of oak barrel as well. In addition, the new planning can control and check about the quality of liquor because it applied the first in first out theory into the inventory management. The researcher shows the result of this research as a comparison table between 4 layouts, the table is shown the ability for each layout.

CHAPTER 3

PROBLEM ANALYSIS

3.1 Company overview

The case study company is the company that is producing the plastic parts in automotive industry and electronic industry for examples, cover pumps, fans and electronic parts. The company was established in 1986 with the capital about 4 million baht. The main process of company is injecting the plastic parts; there are 18 plastic injection machines and the size of machines between 40 to 650 tons. The company has its main customers whose purchasing order is more than 70 percent of the production. For the manufacturing operational strategies, the company has 2 strategies, make to stock and make to order. The company focuses on the second strategy that is making to order, but the company must have the warehouse for stocking the product for deliver to the customers. The company has 4 main departments including;

1. Purchasing department: This department receives the order from the customers and sends the order to technical department to check the blueprint of product and to planning department to draft the production planning.

2. Planning department: This department will analyze the order from customer and draft a production plan to production department. Likewise, the planning department will check the materials for manufacturing if it is not enough, the planning will order to procurement.

3. Production department: This department is making the products from raw material to response the order from customer. It includes quality control (QC), the finished product requires the quality control before moving to warehouse.

4. Warehousing: the function of this department is to store the raw materials that is waiting for manufacturing and finished product that is waiting for shipping to the customers.

The management of company focuses on the quality of the products, total cost and on time delivery for satisfy the customer. That is why the company is trusted by the customers to produce their materials for a long time.

3.1.1 The processes of company

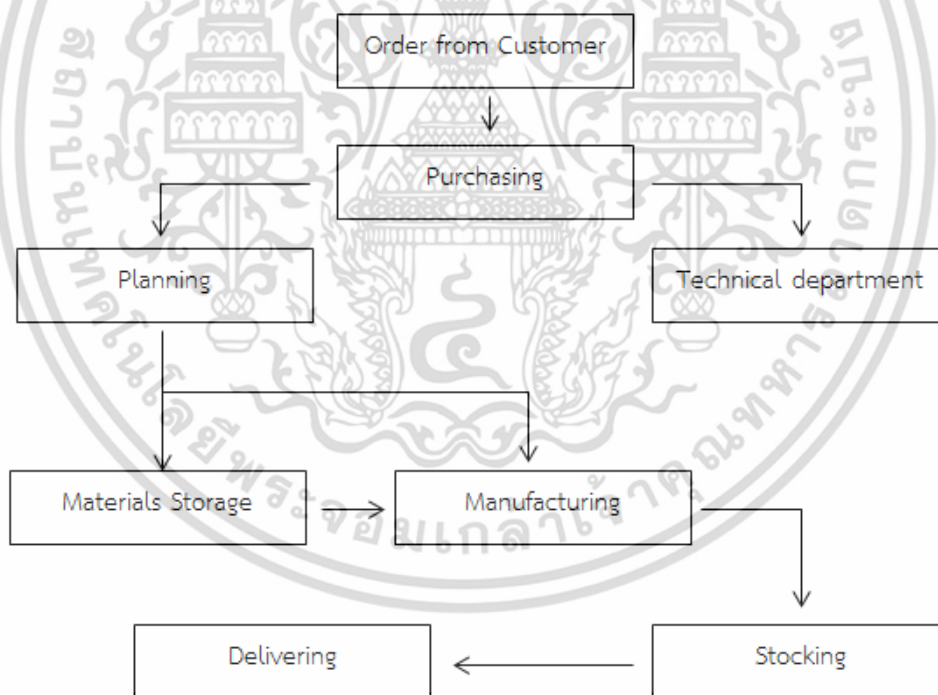


Figure 3.1 The processes of company

The relationship between each process, the researcher was described in Section 3.1 Company overview. The business of company goes well, but the problem

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of company is about poor management. The researcher will focus on warehouse problem because it is the main problem of 'A' company. As confirmed later in Section 3.2 and 3.4, the problem is the case study company has not exploited any warehouse management concept; they always put the finished products into the warehouse so the warehouse will not have enough space to store the finished products or it means that the company has poor space utilization. The company strategy is make to order so the company should not have the problem about the storage but this company needed to have the warehouse because the production capacity of company for one day is about 800 items but the order from customers is more than 5,000 items for each time and sometimes the customer change their purchasing order (PO) so the company have to stock the finished products for shipping to customers.

3.2 Collecting data

There are two different types of data. Quantitative data which are in numerical form information that can be measured and written down with numbers and qualitative data that is not in numerical form and information that can't actually be measured. The qualitative data could be in text, video, photograph, sound recordings. They are related to each other; all quantitative data are based up on qualitative data and all qualitative data can be described with numbers (Trochim, 2006). For this research the quantitative data collects from documentation and interview include questionnaire. The qualitative data is collected from interviews such as sound recording and opinion from employees. It also includes direct observation such as picture, video and the problem that the researcher found when walking around the company.

There are six different sources for gathering data: documentations, archival records, interviews, direct observation, participant observation, and physical artifact.

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Each of these sources has its own strengths and weaknesses (Yin, 2009). Three following sub sections describe the sources that are used in this thesis; documentation, interview and direct observations.

3.2.1 Documentation

According to Yin (2009) one of the most common and important sources which plays an explicit role in any data collection is documentation. In case studies the most important use of documents is to admit and add evidence from other sources. These documents could be in form of letters, emails, agendas and minutes of meetings, announcements, reports, and proposals. Using of documents has three main benefits: first, they are helpful to identify correct titles or names in the organization; second, they can provide specific details from other sources; and third, it can be made inferences from documents (Yin, 2009).

In this case, the researcher separates the data from documentation into two different groups based on the further analysis;

Group one: collecting the basic information about the company, to know a little about the company's history, goal and other general information including the assets of company.

Group two: collecting the data about the processes of company. To view the common data such as data about the SKUs, processes, warehouse and logistic activities and used the data on this stage to identify the problems of company.

3.2.2 Interview

One of the most important sources of evidence of a case study is interview, because most case studies are about human affairs and behavioral events and a well-designed interview will provide good information about the case (Yin

2009). According to K.vale (1996), it is an interchange of views between two or more
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people on a topic of mutual interest, sees the centrality of human interaction for knowledge production.

There are three types of interviews that can be used in case studies; first is a focused interview that a person attends the interview as an interviewee for a short period of time to answer specific questions, but it can be open ended. Second one is semi-structured interview that a person attends the interview as an interviewee for a short period of time and the topic and headlines are determined but no specific list of questions are selected. The interview will start with a general question and interviewee's answers will make next questions and conducts the interview. The third one is a formal survey and it is following both the sampling procedures and the instruments used in regular survey (Yin 2003).

Interviews and discussions with employees of the company was one of central sources to gather information for this research. The researcher used two types of Interview in this research: Firstly, unstructured interviews which were with the owner of company, managers and leaders on each department and workers or employees with different job position. We interview those people to find the problems and collects common data of company. In this type of the interview, there were not specific question prepared before, we just talked about the problems of company, which are problems, which are the clause of problems, asking about general information and collecting the opinion of employees.

The other one was focused interview. The researcher focuses to interview with the owner of company and manager on each department. We discussed about the problems that we found in each department. In this type, we prepared the question about the problems based on the other data collection to ask on focus group.

3.2.3 Direct observation

Since this thesis is a case study, it is obvious that it should take place at the case location, so direct observation is an important source for gathering data. Direct observation could be in qualitative or quantitative form (Yin, 2009). The researcher studies either a course of events and notices what is happening. Events which often are observed are meetings, work processes and flow of for example material and information (Felix G, 2015).

According to Yin (2003) observations can involve, meeting, sidewalk activities, and processes of company and in less formal way can be made throughout a field visit. Direct observations in this research, the research walked around the factory to observe on the processes of company to collect the data and identify the problems.

3.3 Summary of data collection

After collecting data, documentation, interview and direct observations. The researcher analyzes the data and separate it into two groups, firstly the summary about the overview of company and secondly is the summary about problems in company. The researcher shows the both information as a table to make it easier to understand.

3.3.1 Overview of company

Firstly, this topic will explain about the overview of company. The researcher divided the information into four topics that are processes in the company, product in the company, lead time and logistic activities. The summary on each topic shows about the common data, ability and performance of the company, it shows on the Table 3.1.

Table 3.1 Summary an overview of company

Topic	Summary
1. Processes in the company	<ol style="list-style-type: none">1. The company strategies are made to order and made to stock but the main strategy is made to order.2. The customer will send the purchasing orders to the company about 15-30 days before the delivered time.3. Have 18 machines for injection, the size between 45 – 650 tons.4. Finish the PO before delivered time for 5 days.5. Used full-loaded every shipping times.
2. Product in the company	<ol style="list-style-type: none">1. The company has several products including cover pumps, vacuum parts, fan parts, refrigerator parts and other electronic parts.
3. Lead time in raw material purchase	<ol style="list-style-type: none">1. 5-7 days for the materials that can be bought in Thailand.2. About 30 – 60 days for the material that is imported from other countries.

Table 3.1 Summary an overview of company (COUNT.)

Topic	Summary
1. Warehouse and shipping	<ol style="list-style-type: none">1. The company has poor warehouse management and design.2. The company has 3 cars for shipping, 2 cars are 6 wheels and a car for 4 wheels.3. Sometimes the company used third-party to ship the products.4. Some order the customer will take care about the shipping, the customer will take a truck to carry the product.

3.3.2 Problems of company

Secondly, the summary about the problems of company. According to the collecting data and questionnaire, the company has 3 problems that affect the total cost and company performance. After the researcher can define the main problems, we used the interview method to study about those problems. It shows on Table 3.2.

Table 3.2 Summary the problems of company

Problem	Causes about the problem
1. Long lead time to purchase the raw material from other countries.	<p>Question: Why does the company have a long lead time to purchase the raw material?</p> <p>Answer: Some materials have to be bought from other countries and the supplier ship it by boat so it takes a long time.</p>
2. Over plan injection	<p>Question: Why does not the company inject the product on plan?</p> <p>Answer: The company injects the product over plan because we reserve it for the customers, sometime the customers change the purchase order (PO). If we inject on plan, we cannot deliver the product on time because it takes a long time to setup the machine, change the blueprint and stability of machines. When we change the blueprint that is a cost, each product has different type of raw material and color so if the company changes blueprint several times the cost of company and waste will increase and each product requires different size of machine as well as the big size of product will use the big machine to inject. That is why the company must inject over plan.</p>

Table 3.2 Summary the problems of company (COUNT.)

Problem	Causes about the problem
<p>3. Not enough space for storage the finished product.</p>	<p>1. The company has a policy that is to finish the order from customer 5 days before delivery time and the purchase order (PO) from the customer always have delivery time between the middle of month to end of month, so the warehouse will free on early of month and over capacity at the end of month. The researcher asked the owner of company to reduce the time for 5 days to 2-3 days but the owner declined the suggestion and give the reason is; “it is necessary to have 5 days, we tried to reduce it into 2 or 3 days already but we have a problem about we cannot delivery on time when the customer change the purchase order and we lost the customer satisfaction. The customer satisfaction is a very important thing for me because it is all about trust and reliability”</p> <p>2. Some product has a big size of packaging, for example the cover pumps, on each box it can carry only 2 pieces and the order from customer for each month is more than 2,500 piece so, it take a lot of space to store this product but for the small size of product it can carry a lot for each packaging so it is not a problems</p>

Table 3.2 Summary the problems of company (COUNT.)

Problem	Causes about the problem
	<p>3. The company has poor warehouse management, they did not have any method to store the finished product, and they always place the finished product to the location that can be placed without any method or theories.</p> <p>4. According to the first problem, long lead time to purchase raw material. The company has to use the space in warehouse to store the raw material because each time that the company imports the raw material from other countries it can use for up to 3 months.</p>

3.4 Questionnaire

In addition, the data from documentation, interviewed the owner and manager and direct observation, so the researcher needs to know about the employee opinion in 'A' company about the problem of company. To verify which problem that the researcher found from data collection that match with the problem that employees found. In the same way, the researcher uses the questionnaire to find the solution for 'A' company and uses the analysis hierarchy process (AHP) to choose the best solution to implement for improving the 'A' company processes.

3.4.1 Population and Sample size

The determination of sample size is a common task for many organizational researchers. An inappropriate, insufficient, or inordinate sample size เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า ไม่ว่ากรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และต้องอ้างอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

has an influence to the quality and accuracy of research. According to Section 2.5.1.3, the researcher explains about how to determine the sampling size. The ‘A’ company has the employees about 60 persons. Show on the Table 3.3, the total employees of ‘A’ company.

Table 3.3 The total employees of ‘A’ company

Department / Position	Procurement	Finance and accounting	Production	Warehouse and Storage	Total
Manager	1	2	2	1	6
Leader	1	1	2	2	6
Worker	5	3	20	20	48
Total					60

According to Evan Morris, he said that the determination sample size for small population, we use the normal calculation to the hyper geometric distribution. The sample size formulas for large population called binomial and the formula for small population, named hyper geometric. The calculations for both formulas are shown in the Section 2.5.1.4, the researcher selected to use the hyper geometric distribution and Cochran’s (1977) formula to determine the sample size as below;

Hyper geometric distribution

$$n = \frac{N(z^2)(p(1-p))}{e^2(N-1) + (z^2)(p(1-p))} \quad (3.1)$$

$$n = \frac{60(1.96^2)(0.5(1-0.5))}{0.03^2(60-1) + (1.96^2)(0.5(1-0.5))}$$

$$n = \frac{57.624}{1.0135}$$

$$n = 56.856 \approx 57$$

Where

- n is the required sample size
- N is the population size
- p is the population proportions. (the researcher unsure about the sample proportion so the researcher set it as 50%)
- z is the levels of confidence at 95%.
- e is the acceptable margin of error = 3%.

In the same way, the researcher used other calculation to confirm the sample size of survey. It is called Cochran's Formula.

Cochran's Formula

$$n_0 = \frac{(t^2) (p)(q)}{d^2} \quad (3.2)$$

$$n_0 = \frac{(1.96^2) (0.5)(0.5)}{0.03^2}$$

$$n_0 = 1067.111$$

Where

- t = value for selected alpha level of 95% = 1.96
- p = maximum possible proportion = 0.5
- q = 1- maximum possible proportion
- d = acceptable margin of error for proportion being estimated = 0.03
(error researcher is willing to except)

The required sample size is about 1068. However, that is only the sample size to get the levels of confident and margin of error. The next step of Cochran's (1977) correction formula will used the population to calculate the final sample size. The calculations are as follows:

$$n1 = \frac{n0}{(1 + (n0 / \text{Population}))} \quad (3.3)$$

$$n1 = \frac{1067.111}{(1 + (1067.111 / 60))}$$

$$n1 = 56.806 \approx 57$$

Where

- population size = 60
- n0 = required return sample size according to Cochran's formula= 1,067.111
- n1 is the sample size

After the researcher calculated both formulas, Hyper geometric distribution and Cochran's Formula. The researcher decided to do the questionnaire with 60 sample size or it means, the researcher use the entire population as the sample.

However, the researcher reviews several literatures about the sample size determination, The lowest population to do the survey is about 100 people but professors described about the sample size for the population less than 100 people as following; most statisticians agree that the minimum sample size to get any kind of meaningful result is 100, if your population is less than 100 then you really need to survey all of them. And one approach is to use the entire population as the sample although cost considerations make this impossible for large populations, a census is attractive for small populations (e.g., 200 or less) (Glenn D. Israel, 1992).

3.4.2 Questionnaire analysis

The researcher used computer software named Statistical Package for the Social Sciences (SPSS.) to analyze the data from questionnaire. This topic will show about the information that the researcher collected from owner, managers, leaders and workers of ‘A’ company. The questionnaire has four parts;

1. Personal information
2. Company processes
3. Problem analysis
4. Recommendation.

The researcher show the summary of questionnaire as table as following;

Table 3.4 Personal information of sample

		N = 60	
Personal information	Amount	Percent (%)	
Gender			
Male	34	56.7	
Female	26	43.3	
Total	60	100.0	
Age			
Less than 25 years	12	20.0	
26 – 35 years	31	51.7	
36 – 45 years	15	25.0	
More than 46 years	2	3.3	
Total	60	100.0	

Table 3.4 Personal information of sample (COUNT.)

N = 60

Personal information	Amount	Percent (%)
Education Background		
Less than senior high school	28	46.7
High vocational certificate	23	38.3
Bachelor degree	8	13.3
Master degree or higher	1	1.7
Total	60	100.0
Position		
Worker	48	80.0
Sub manager	6	10.0
Manager	5	8.3
Owner	1	1.7
Total	60	100.0
Working time with 'A' company		
Less than a year	7	11.7
1 – 2 years	25	41.7
3 – 4 years	23	38.3
More than 5 years	5	8.3
Total	60	100.0

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From the Table 3.4, the summaries of personal information for the sample are, the most employees of the 'A' company are male with 56.7%, group of age is during 26 to 35 years old with 51.7%. In case of the education background, 46.7% of employees finished on less than senior high school and 38.3% of employees finished on high vocational certificate, the 'A' company has the workers about 80%. The most employees of 'A' company has working period around 1 – 2 years with 41.7% and secondly is 3 – 4 years with 38.3%.

Part 2: Company Processes

The researcher separates the company processes into 4 main departments; procurement department, production department, accounting and finance department and warehouse department and the summary are shown as a table below;

The Table 3.5 shows the degree of problem in procurement department, it has 3 main processes which are ordering materials, purchasing order form customer and preparing materials. For the evaluation about the degree of problem, in this department is in low level, the worst problem in this department are purchasing order from customers and ordering materials.

Table 3.5 The degree of problem in procurement department

Company process	Mean	Evaluation
Ordering materials	2.27	Low
Purchasing order from customers	3.23	Middle
Preparing materials	1.75	Lowest
Total score	2.42	Low

The Table 3.6 shows the degree of problem in production department, it has 4 main processes, which are planning the production plan, production line, setting

machine and controlling quality. For the evaluation about the degree of problem in this department, it is in the middle level, the worst problems in this department are production line with high level problem and setting machine respectively.

Table 3.6 The degree of problem in production department

Company process	Mean	Evaluation
Planning	2.02	Low
Production	3.45	High
Setting machine	2.90	Middle
Controlling quality	2.37	Low
Total score	2.68	Middle

The Table 3.7 shows the degree of problem in accounting department, it has 2 main processes that are cost analysis and financial report. For the evaluation about the degree of problem in this department is lowest, the worst problem in this department is cost analysis.

Table 3.7 The degree of problem in accounting department

Company process	Mean	Evaluation
Cost analysis	1.77	Lowest
Financial report	1.53	Lowest
Total score	1.65	Lowest

The Table 3.8 shows the degree of problem in warehouse department, it has 4 main processes, including, material handling, plant and warehouse site selection,

warehouse management and design and logistics and transportation. For the เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่นิยมนำไปใช้ประโยชน์ด้านการค้า ไม่ว่าจะกรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และต้องอ้างอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

evaluation about the degree of problem in this department is in high level, the worst problem in this department is cost warehouse management and warehouse design.

Table 3.8 The degree of problem in warehouse and storage

Company process	Mean	Evaluation
Material Handling	3.03	Low
Plant and warehouse site selection	3.28	Middle
Warehouse management and design	4.47	Highest
Logistics and transportation	2.85	Middle
Total score	3.41	High

The Table 3.9 shows the summary degree of problem in company processes, the worst departments are warehouse and storage department has high level of problem and planning and production department with middle level of problem respectively.

Table 3.9 The total degree of problem in company process

Company process	Mean	Evaluation
Procurement department	2.42	Low
Planning and production department	2.68	Middle
Accounting and finance department	1.65	Lowest
Warehouse and storage department	3.41	High
Total score	2.54	Low

The Table 3.10, it shows the frequency of department that should be improved in the employees opinion, the department that should be improved most is warehouse and storage department with 53.3%.

Table 3.10 The frequency of department should be improved

N = 60

Information	Amount	Percent (%)
Department		
Purchasing and procurement department	7	11.7
Production department	16	26.7
Accounting and finance department	5	8.3
Warehouse and storage department	32	53.3
Total	60	100.0

Part 3: Problem Analysis

According to Section 3.2 data collection, the researcher analyzes the information that is collected from documentation, interviewed and directs observation. We can define the problem of the company into 5 sections; long lead time, setting machine/ poor skill worker, over plan injection, insufficient storage space, and transportation/shipping. The Table 3.11 shows the evaluation of the degree of each problem, the worst problems in this company are insufficient storage space and over plan injection respectively.

Table 3.11 The degree of each problem in company

Company process	Mean	Evaluation
Long lead time to purchase raw material	3.15	Middle
Setting machine / poor skill worker	2.92	Middle
Over plan injection	3.70	High
Insufficient storage space	4.25	Highest
Transportation and shipping	2.58	Low
Total score	3.32	Middle

From the questionnaires, the researcher can conclude the information that, the department which has the worst problem and should be improved most is warehouse and storage department, and the problem in 'A' company that collect from the data collection from executive and manager, the worst problem is insufficient storage space.

3.5 Analysis Hierarchy Process (AHP)

After the researcher does the questionnaires, the researcher got 3 worst problems that are insufficient storage space, over plan injection and long lead time. Therefore, the researcher conducted the interviews with the owner, all of manager and leader to find the solution of that worst problem. Finally the researcher got 3 solutions which are changing the suppliers, adjusting production plan and improving on warehouse. That is why the researcher would like to know which department is the most important for company and which solution is the best solution, so the researcher

uses the analysis hierarchy process (AHP) to compare the important in each department and solution.

Analysis Hierarchy Process (AHP) is the efficient decision process; it compares the priority of each solution, which solution is the best solution to achieve the goal. The AHP has 3 levels; the highest part is goal to achieve. The middle part is criteria, it shows about the factor that related to the highest level and the lowest is the solution to achieve the goal (Thomas L. Saaty, 2008).

3.5.1 Hierarchy diagram of the decision

The goal is to improve the company performance, so the researcher collects the data by documentation, interview, direct observation and questionnaire to find the solution and the factors that are related. There are 7 pairwise comparison matrices between the criteria level and the solution. The summary to do the Analysis Hierarchy Process (AHP) shows as a diagram on Figure 3.2.

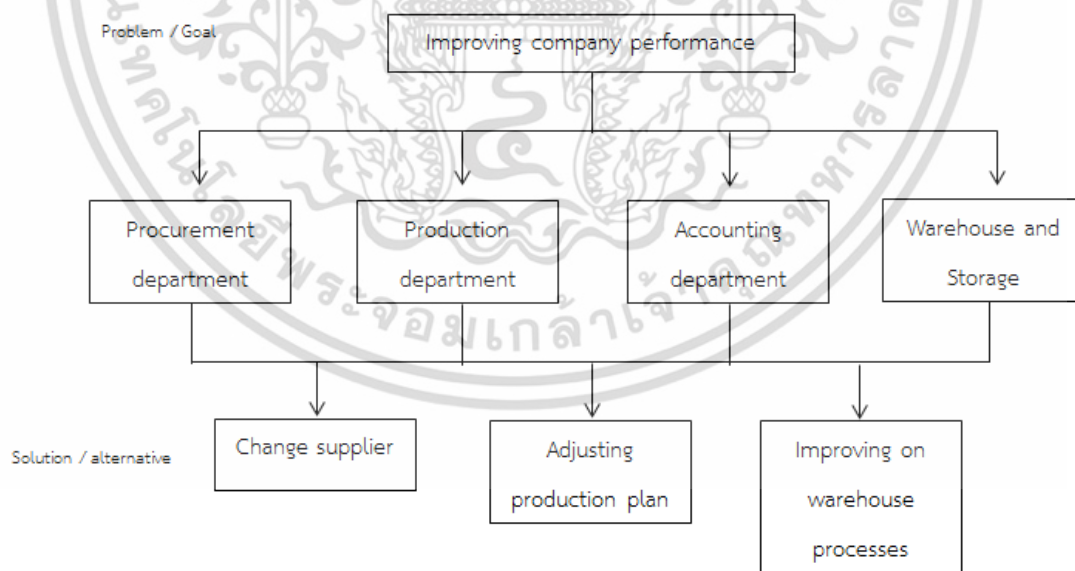


Figure 3.2 Hierarchy diagram of the decision

3.5.2 Pairwise comparison

According to data collection, the company has 4 main departments including procurement department, production department, accounting and finance department and warehouse and storage. The researcher would like to know which department is the most important for the owner, so the researcher drew the matrix to compare each department as Table 3.12.

If $A_{ij} = 1/3$ means factor A_i has less important level than A_j

If $A_{ij} = 1$ means factor A_i has same important level with A_j

If $A_{ij} = 3$ means factor A_i has more important level than A_j

Table 3.12 The comparison on each department

Department	Procurement	Production	Accounting	Warehouse
Procurement	1	1/3	1/3	1/3
Production	3	1	1	1/3
Accounting	3	1	1	1/3
Warehouse	3	3	3	1
Total	10	5.33	5.33	2.00

For instance, the procurement department has less important level than production department (1/3), accounting department (1/3) and warehouse department (1/3). The production department has more important level than procurement department (3) and less important level than warehouse department (1/3). After we get the important level between departments, the researcher will calculate the total percentage for each department as table 3.13.

The Table 3.13, it means the warehouse and storage department is the most important for the owner with 48 percent, the second are production and accounting department with 21 percent and the lowest is procurement department with 10 percent.

Table 3.13 The total percentage in each department

Department	Procurement	Production	Accounting	Warehouse	(sum total / 4) x 100%
Procurement	0.10	0.06	0.06	0.17	10%
Production	0.30	0.19	0.19	0.17	21%
Accounting	0.30	0.19	0.19	0.17	21%
Warehouse	0.30	0.56	0.56	0.50	48%
Total	1.00	1.00	1.00	1.00	100%

3.5.2.1 The degree of influence on each solution to warehouse

From the interview, documentation and direct observation, the researcher gets 3 choices to improve the company performance; 1) changing the suppliers to reduce the lead time and improve on the cash flow. 2) Adjusting the production plan to control the production to inject on plan without safety stock and over plan injection 3) Improving on warehouse processes to manage the process include redesign the

warehouse layout for reduce the logistic cost and total cost.

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The researcher would like to know which solution most influence the warehouse and storage department, so the researcher drew the matrix again to compare the influence between each solution and warehouse department. As the Table 3.14;

If $A_{ij} = 1/3$ means factor A_i has less influence than A_j

If $A_{ij} = 1$ means factor A_i has the same with A_j

If $A_{ij} = 3$ means factor A_i has high influence than A_j

Table 3.14 The influence between each solution and warehouse

Warehouse department	Change supplier	Adjusting production plan	Improving on warehouse processes
Changing suppliers	1	1/3	1/3
Adjusting production plan	3	1	1/3
Improving on warehouse processes	3	3	1
Total	7	4.33	1.66

For instance, changing suppliers has less influence to warehouse department than adjusting production plan (1/3) and improving on warehouse processes (1/3) and adjusting production plan has high influence to warehouse department than changing suppliers (3) and has less influence to warehouse department than improving on warehouse processes (1/3). Likewise, the researcher will calculate the score on the matrix to percentage as the Table 3.15.

Table 3.15 The percentage in each solution to warehouse department

	Changing suppliers	Adjusting production plan	Improving on warehouse processes	(Total / 3) *100%
Change supplier	0.14	0.08	0.20	13.99%
Adjusting production plan	0.43	0.23	0.20	28.64%
Improving on warehouse processes	0.43	0.69	0.60	57.36%
Total	1.00	1.00	1.00	100.00%

3.5.3 The priority comparison (pairwise comparison)

According to section 3.4.3.2, the researcher knows which department is the most important and which solution highly influences to that department. Next the researcher will calculate the degree of influence between each solution and department, used the same matrix with table 3.14 and 3.15. The degree of influence between each solution and department shows as a Table 3.16.

Table 3.16 The degree of influence between each solution and department

Solution	The degree of influence to each department			
	Procurement	Production	Accounting	Warehouse
Changing suppliers	43%	20%	45%	14%

Table 3.16 The degree of influence between each solution and department (COUNT.)

Solution	The degree of influence to each department			
	Procurement	Production	Accounting	Warehouse
Adjusting production plan	43%	60%	23%	29%
Improving on warehouse processes	14%	20%	32%	57%
Total	100%	100%	100%	100%

From the table 3.16, changing suppliers has the most influence to accounting department (45%), the second is procurement (43%). Adjusting production plan has the most influence to production department (60%) and second is procurement department (43%) and improving on warehouse processes has the most influence to warehouse and storage department (57%) and the second is accounting department (32%).

The last Analysis Hierarchy Process (AHP) method is to order the priority in each solution, which solution is the best way to improve the company performance, as Table 3.17.

Table 3.17 The priority of each solution

Solution	The degree of influence to each department				Overall Priority
	Procurement (10%)	Production (21%)	Accounting (21%)	Warehouse (48%)	
Changing suppliers	$(0.43)(0.10) + (0.20)(0.21) + (0.45)(0.21) + (0.14)(0.48)$				24.67%
Adjusting production plan	$(0.43)(0.10) + (0.60)(0.21) + (0.23)(0.21) + (0.29)(0.48)$				35.65%
Improving on warehouse processes	$(0.14)(0.10) + (0.20)(0.21) + (0.32)(0.21) + (0.57)(0.48)$				39.68%

The result of analysis with Analysis Hierarchy Process (AHP) method show is the third solution, improving on warehouse processes, is the best solution to improve the company performance (39.68%) and second one is adjusting production plan (35.65%) and the last one is change supplier (24.67%).

The result from Analysis Hierarchy Process (AHP) match with the questionnaire analysis, on company processes and problems analysis, the questionnaire shows warehouse and storage department has the worst problem in company processes and the worst problem that should be improved from the opinion of the owner and employees is the problem about warehousing and storage.

3.6 The tool used to analyze the problem

After the researcher gets the result from questionnaire analysis and Analysis Hierarchy Process (AHP), the researcher knows which is the worst problem that company needs to improve so the researcher used the Fishbone diagram as a tool to analyze the problem and used the information from data collection again to analyze the problem. For the fishbone diagram theory had explained in Section 2.6

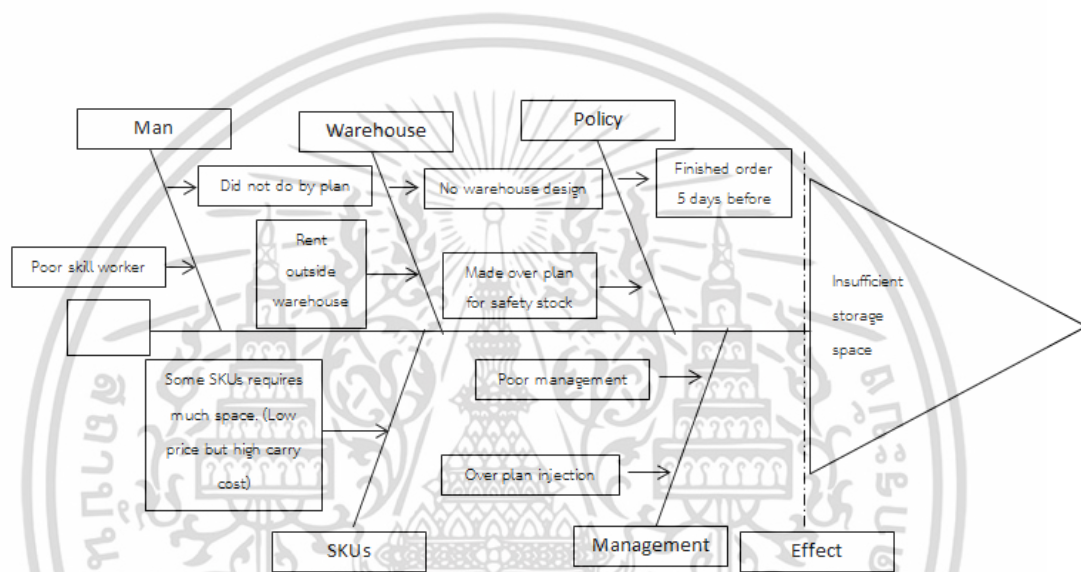


Figure 3.3 A fishbone diagram to analyze the issues and causes.

Fishbone diagram is a summary of each issue, divided as follows:

1. The issue from SKUs. The company has many types of finished product such as vacuum parts, water pump parts and other electronic parts. In this topic is concern the finished goods in each part. Some goods require a lot of space to place the goods. According to the data summary, the information shows the part that is worst problem is water pump parts, the SKU that is the problem is PL COVER PUMP. In each packaging, it can contain only 2 pieces per box and it took a lot of space to place each package. For other SKUs, it is not a problem because on each package, it can carry numerous pieces.

2. The issue about policy, it has 2 causes. The owner of the company needs to finish the orders from customers about 5 days before the shipping time because sometimes the customer changes their purchase order, for example they change the PO from 5,000 items to 8,000 items but not expand the shipping time, so the company must have safety stock to encounter on uncertain order. The company must injects over plan because if the company changes production line to do the order that added from customer, it involves change the blueprint, change material and time for setting machine. The production manager told researcher, if we change the production line several times, the company will has a lot of waste and high cost. It will affect to warehouse because if the customer did not change their purchase order, the company must keep the finished product until next order.

3. The issue about the management of company. In this topic, it is the main cause that effect to the problem. The main problem of case study company is high warehousing and storage cost, they have poor management on warehousing. They did not have any management in the warehouse; they always focus on production department. For the last cause in method is over plan injection, for the over plan injection the researcher was explain in the issue about policy, the company has to inject more than the customer's order to reserve the uncertain order. The company focuses on the customer satisfaction because the owner believed the trust and reliability are the important factors to do the sustainable business. That is why the company has to produce over plan and store the finished product

4. The issue about the workers of the company, this topic will be focused on the worker skill and attitude of workers. The first problem is poor skill worker, the company have a lot of workers that always do only their job and cannot do other things for example the company have only 3 workers that can setup the injection

machines, but the company have 18 machines so it will take several days to setup the machines (It takes half a day to setup each machine). And the second problem is the attitude, the workers want to do their job easily, quickly and comfortably so the finished products are defect or they have low quality.

5. The issue in warehouse side, in this issue the researcher will explain about the warehouse problem in this company. According to the data collection, interview and direct observation, the company has poor warehouse management and warehouse design. The company did not control about the processes of warehouse such as they do not classify the location to place each type of product, they place the products all together so when they ship the products to the customers, it takes time to find the goods and that is why the company has insufficient storage space. The insufficient storage space is the cause of renting the outside warehouse; renting the outside warehouse is a thing that makes a lot of warehousing cost and transportation cost.

From the several methods that used to identify the problem in 'A' company which are data collection, questionnaire and analysis hierarchy process. It shows the department which has high level of problem is warehouse and storage department and the worst problem for 'A' company is insufficient storage space. Likewise, the researcher uses the fishbone diagram to analyze the insufficient storage space problem, it shows various cause and issue in the Section 3.5.

According to analysis hierarchy process (AHP), the best solution to improve the 'A' company is improving in warehouse processes. That is why the researcher will focus on the issue about warehouse in fishbone diagram. From the issue about warehouse in fishbone diagram, it has 2 causes for these issues; there are no warehouse design and rent outside warehouse. The 'A' company rents outside

warehouse to solve the insufficient storage space problem and it makes high cost for the company, so the researcher will improve on the other causes that is no warehouse design because if the researcher redesign warehouse the company will have enough space to place the finished products and the company will not need to rent outside warehouse. That is why the researcher will redesign the warehouse layout for ‘A’ company and the method of redesign warehouse layout and result will show in the next chapter.



CHAPTER 4

Redesigning Warehouse

4.1 The current state of the warehouse

The current area of the warehouse was about 700 m², including the area for verifying the quality control of finished product, shipping zone, parking zone and storage area. For the parking zone and shipping zone, they are reserved for parking 2 six wheels trucks, 4 four wheels cars, 2 forklifts and a hand lift. The owner of the case study company requires to improve only the storage area, not changing anything about shipping zone and parking zone. Therefore, the researcher will focus on only the storage area. Figure 4.1 shows the current area of the warehouse.

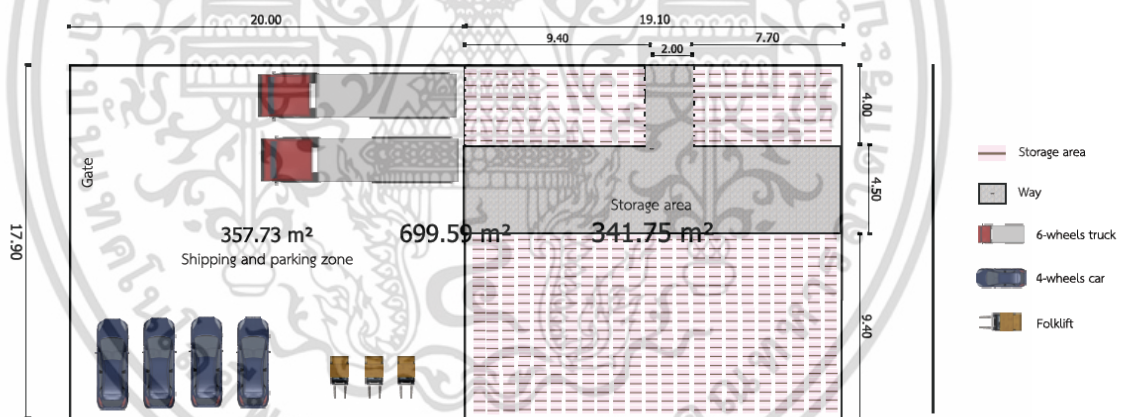


Figure 4.1 The current area of the warehouse

The researcher focuses on improving the storage area. The storage area was about 342 m². According to the problem analysis using fishbone diagram, the company has very poor space utilization because it has poor operation management and poor warehouse design. Figure 4.2 shows the storage layout of the company.

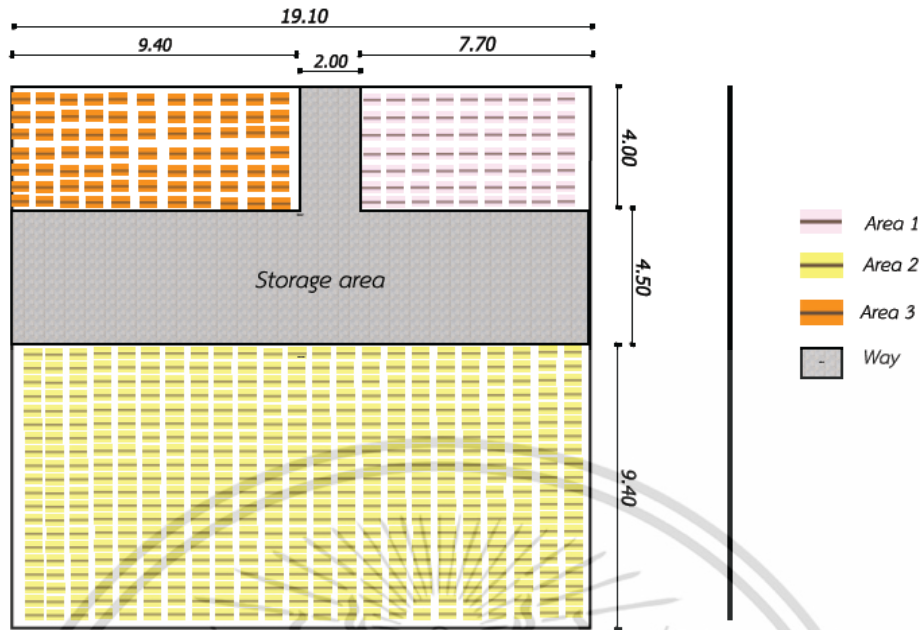


Figure 4.2 Storage area of the company

The current warehouse design is separated into 2 sections; The first section includes area 1 and area 2, which are the area to store the box of finished goods and the next section is area 3, it is used to place the finished goods to check the quality before they are moved to the storage area. In the storage area design, the company designed the area to store and the forklift way as Figure 4.3.

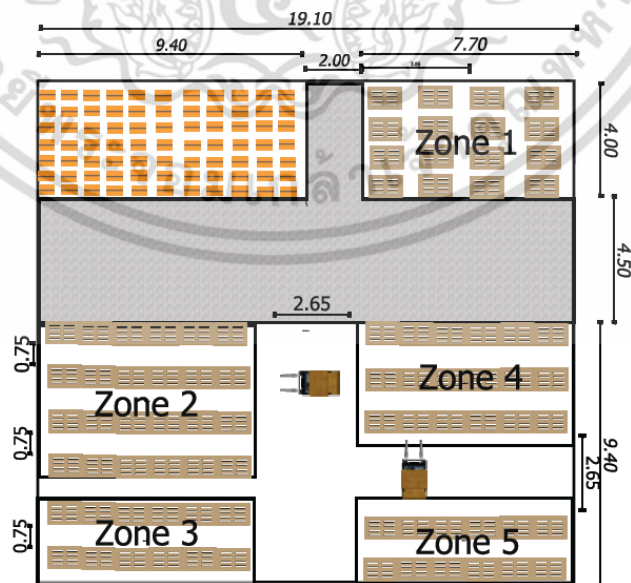


Figure 4.3 the design of storage area and forklift way

เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า
ไม่ว่ากรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และด้อย72่างอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

According to the Figure 4.3, the objective of this design is to separate the storage area into 5 zones. Zone 1 and 2 are for placing the parts of water pump, zone 3 is for the parts of refrigerator, zone 4 is for the parts of vacuum, and zone 5 is for the parts of fan, washing machine and other parts. The owner designed this layout without analyzing about the factors affecting the warehouse, for instance, the space utilization, time to store the product and time to find the product. That is why the company has the problem about the spaces of storage.

4.1.1 Products Information

According to the Section 3.2 data collection, the researcher collects the data about the used area proportion for each type of finished goods to find which one takes the largest area to store, as Table 4.1.

Table 4.1 the used area proportion on each type of product

Type of finished goods	Used area proportion (%)
Vacuum	20
Water pump	55
Refrigerator	10
Washing machine	5
Fan	5
Others	5
Total	100

The product that used highest proportion area is the water pump. Therefore, the researcher focuses on that type of product. The researcher found the problematic SKUs, it is PL Cover pump. PL cover pump is a part of water pump and there is a problem because for a carton, it can contain only 2 pieces of PL cover pump. If look at the demand on Table 4.2 and Table 4.3, the average demand of PL cover pump for each month is 3,500 pieces. Therefore, the company needs to place the carton around 1,500 cartons each month and it takes a lot of space to place the finished goods.

Table 4.2 The demand of PL cover pump between January – May 2016

Month	P/NO	P/NAME	Quantity (pieces)	Total (pieces)
January 2016	1PP035461	PL PUMP COVER	87	3,194
	1PP034677	PL PUMP COVER	1,876	
	1PP046512	PL SQUARE COVER	1,231	
February 2016	1PP035461	PL PUMP COVER	167	3,577
	1PP034677	PL PUMP COVER	1,630	
	1PP046512	PL SQUARE COVER	1,780	
March 2016	1PP035461	PL PUMP COVER	930	3,421
	1PP034677	PL PUMP COVER	1,357	
	1PP046512	PL SQUARE COVER	1,134	
April 2016	1PP035461	PL PUMP COVER	93	3,396
	1PP034677	PL PUMP COVER	1,260	
	1PP046512	PL SQUARE COVER	2,102	
May 2016	1PP035461	PL PUMP COVER	74	4,140
	1PP034677	PL PUMP COVER	2,272	
	1PP046512	PL SQUARE COVER	1,794	

Table 4.3 The total average of PL cover pump between January – May 2016

Product number	Product name	Average quantity (pieces)	Total average (pieces)
1PP035461	PL PUMP COVER	271	3,559
1PP034677	PL PUMP COVER	1,679	
1PP046512	PL SQUARE COVER	1,609	

4.1.2 Packaging and Shipping Information

On this topic, the research would like to show the packaging information of 'A' company and the size of the box that is used to placed the product and the size of pallet that they used to place the box. The information is shown as list below;

1. The box size; they use cartons to pack the products. There are 2 sizes of carton. Firstly, it is the middle size carton to pack the small parts of products with 31 cm. x 36 cm. x 26 cm. (width x depth x height). Secondly, it is big carton to pack the big parts of products such as the product that the researcher focuses in order to improve, it is PL Cover Pump. The size is 55 cm. * 35 cm. 30 cm. (width x depth x height).

2. The pallet; they use the Europe standard pallet to contain the cartons. There are several sizes of pallets to contain that is 120 cm. x 80 cm. x 14.4 cm. (width x depth x height) with the big size of carton, it can contain 4 boxes per tier and for the small size of carton, it can contain 6 boxes per tier. A pallet can be stacked 4 tiers. As Figure 4.4, show the size of carton and pallet.

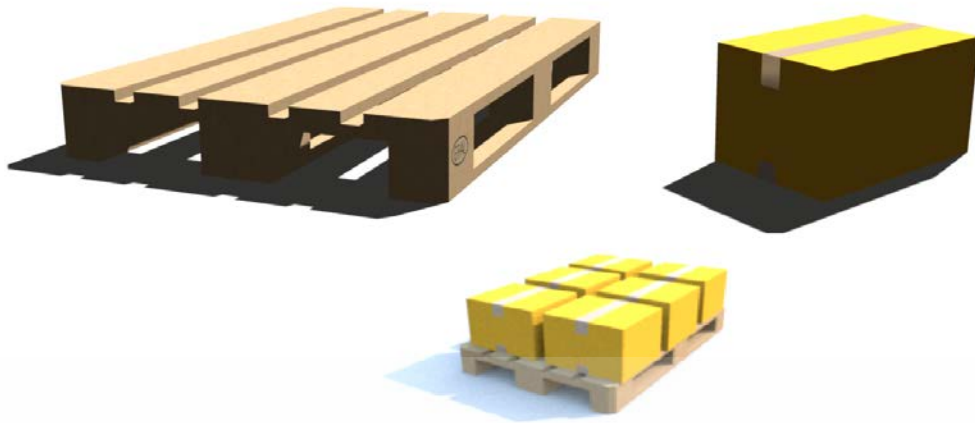


Figure 4.4 The size of carton and pallet.

For the shipping information, they use the forklifts to pick up the pallet to 6 wheels truck. There are 3 small forklifts with 90 cm. x 210 cm. x 250 cm. (width x depth x height).

4.2 The objectives of warehouse

Before starting to plan the layout, the specific objectives of a warehouse layout should be determined. In common, the objectives of warehouse layout are shown as following;

1. To use space efficiently
2. To allow the most efficient material handling
3. To provide the most economical storage in relation to cost of equipment, use of space, damage to material, handling labor and operational safety
4. To provide maximum flexibility in order to meet changing storage and controlling requirements
5. To make the warehouse model of good housekeeping

The first three objectives above are likely be the overall objectives of the warehouse. The objectives of warehouse are;

1. To maximize effective use of spaces
2. To maximize effective use of equipment
3. To maximize effective use of labors
4. To maximize the accessibility of all items
5. To maximize the protection of all items

While it is true that the objectives of both a warehouse itself and of the warehouse layout are almost redundant, it demonstrates the importance of layout planning to warehouse planning. Without a good warehouse layout, it is impossible to have a good warehouse. The objective of layout planning is to arrange and coordinate the space, equipment and labor resources of the warehouse. Poor layout planning can undermine superior space, equipment and personnel problems. In other words, accomplishing the objectives of warehousing depends on having a good layout, if the warehouse layout is bad, chances are the warehouse as a whole is worse.

Considering to the fourth objective of a warehouse layout, in the fact the warehouse environment such as policy, facility and location and demand are changing all the time. If the mission of a warehouse changes, the warehouse layout should be changed too, to achieve the new mission. However, a good warehouse layout possesses the flexibility to absorb minor variances in expected storage volumes and product mixes with few or no alteration required. The flexibility allows the warehouse to function even if forecasts on which it was planned prove to be wrong, as they inevitably do.

The last objective of warehousing follows the principle that there is the efficiency in order. Good housekeeping is essential to good warehousing; a good warehouse cannot exist without good housekeeping. Yet, good housekeeping by itself

will not ensure a good warehouse. If the space, equipment, personnel and layout are

เอกสารนี้เป็นเอกสารทสจว.สงวนลิขสิทธิ์สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปเผยแพร่โดยไม่ได้รับอนุญาต
ไม่ว่ากรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ตัดแปลงเนื้อหา และด้อย่างยิ่งถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

not properly planned, all the housekeepers in the world could not get a warehouse to function. But poor housekeeping will surely undermine good space, equipment, personnel and layout planning. (James A. Tompkins, 1998)

Consequently, the researcher found the warehouse of 'A' company does not response to the objectives of warehouse for example, when the researcher observes in the warehouse and found that they cannot use the space efficiency or it means that they have low space utilization. That is why, they got insufficient storage space problem, so the researcher will redesign their warehouse layout to improve the efficiency of and improve the space utilization.

4.3 Redesign warehouse methodology

4.3.1 The concepts of zoning

According to chapter 2, zoning system concept, there are 6 types of zoning method to support the worker or storekeeper to place the product that are informal system, part number system, commodity system, random location system and fix location system. The concept that is suitable for warehouse of 'A' company is commodity system, the researcher will show the definition of commodity system below;

4.3.1.1 The commodity system

The commodity system is the system to place the product classification based on the product type. Like a supermarket, they will place the same type of products together. It supports the storekeeper to place the product, checking the product and picking the product and improve the efficient of these processes, if the products were classified by types of product, the storekeeper can pick up to delivery as fast as possible because they do not have to find the product, they knows where the product

Advantages of this system

- Easy to find the products
- Easy to pick up the products
- Easy to implement
- Do not need to record the product place

Disadvantages of this system

- Inflexible
- Adding new product will affect to the storage system

From the definition, the researcher makes decision to use the commodity system to 'A' company warehouse because the 'A' company has about 6 types of products, if they use random location system, it will take a lot of time to find the product and the commodity system supports the store man to checking product, placing product and picking the product. The researcher will redesign the warehouse layout of 'A' company based on the conditions that the owner gave to the researcher.

4.3.2 Terms of redesigning warehouse

The owner of 'A' company gives the conditions to redesign the warehouse as

Table 4.4 below;

Table 4.4 Terms of redesign warehouse

Subject	Description
1. Types of product	<ul style="list-style-type: none">- They need to place all types of products in a warehouse and separated from other type.- Having clearly identified the types of products and placing zone.

Table 4.4 Terms of redesign warehouse (COUNT.)

Subject	Description
2. The width of way	<ul style="list-style-type: none">- Not less than 0.75 meters for the storekeeper for checking, placing and pick up the product.- Not less than 2.65 meters for the forklifts way to pick up the products and the forklifts can access to all types of products.
3. Storage area	<ul style="list-style-type: none">- Redesign only storage area, not the parking zone.- The quality checking zone is required in the same size.
4. Capacity ability	<ul style="list-style-type: none">- Increase the capacity to place the PL Cover pump and vacuum part as much as possible.- Will not decrease the capacity of other products.- Apply the First-In, First-out (FIFO) if it is possible.

4.3.2.1 Types of the products

The researcher identifies the code in each type of the products to separate the placing zone, the explanation show as table below;

Table 4.5 The code explanation for each type of products.

Code	Meaning
P	- Part of water pump
V	- Part of vacuum
R	- Part of refrigerator
F	- Part of fan
W	- Part of washing machine
O	- Other parts

The other code for classifying the storage, the researcher uses the number to identify the row of storage and types of parts in each types of products as Figure 4.5.

And the meaning of coding will be shown in Table 4.6;

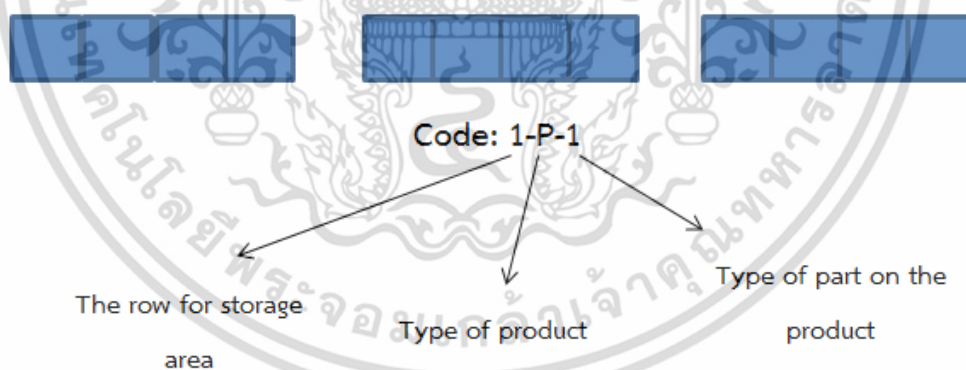


Figure 4.5 The sample explanation of coding for each product.

Table 4.6 The meaning of coding for storage area

Coding	Meaning		
	Row	Type	Part
1P1	1	Water Pump	Cover pump
1P2	1	Water Pump	Cover pump
2P3	2	Water Pump	Cover pump
3V1	3	Vacuum	Small part
4V2	4	Vacuum	Big part
5P4	5	Water Pump	Small part
6R1	6	Refrigerator	-
7P5	7	Water Pump	Cover pump
7F1	7	Fan	Small part
7W1	7	Washing machine	-
7F2	7	Fan	Big part
7O1	7	Other	-

According to Section 3.2, the ‘A’ company does not have any codes to classify the types of products; it means that they stored all the products together. However, in the Figure 4.3, they separated the storage area into 5 zones to store the finished products but with this process, they cannot achieve the maximum capacity because there are some limitations. For example, the limitation about the weight; for water pump part, if they place the cartons of PL cover pump as a base on ‘X’ area. In the ‘X’ area they can place only cartons of PL cover pumps above because the small parts of water pumps are heavier than PL Cover pumps, if they place the cartons of small parts above the cartons of PL cover pumps, the cartons of PL cover pumps will be

damaged. Figure 4.6 is shown the diagram of storage area before redesigning warehouse.

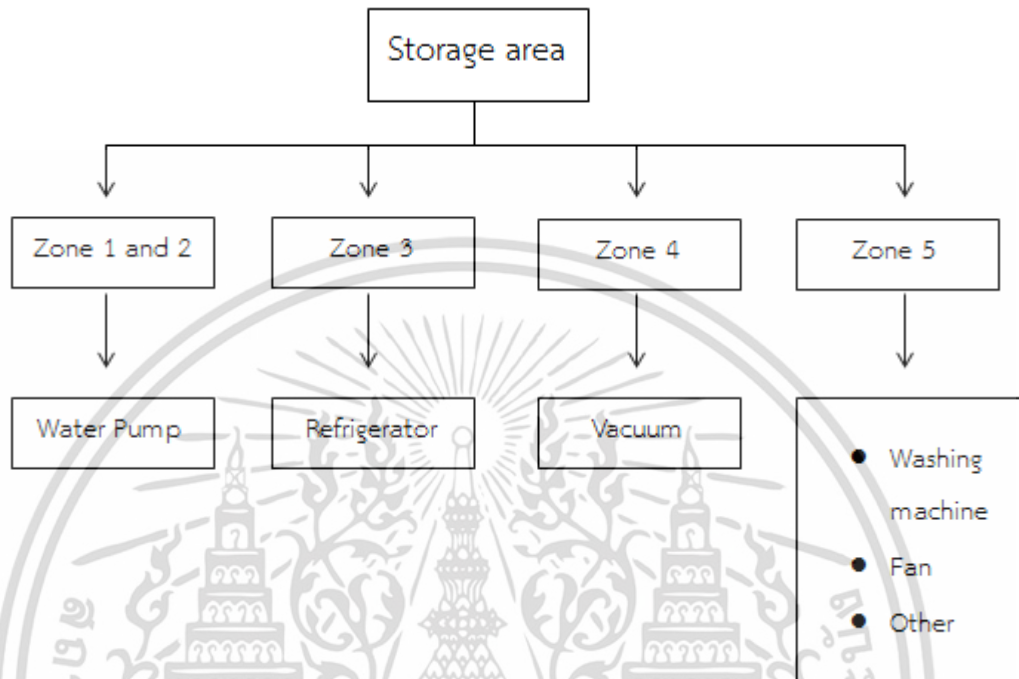


Figure 4.6 The diagram of storage area before redesigning warehouse.

After redesigning the warehouse, the researcher used coding theory to classify the parts of products so, the products in each zone will have the same or nearby weight. Therefore, they can place the cartons about 12 layers in every zone to achieve the maximum capacity. Figure 4.7 is shown the diagram of the storage area after using coding theory. The warehouse layout for each code will be shown in the next section, 4.3.2.2 storage area.

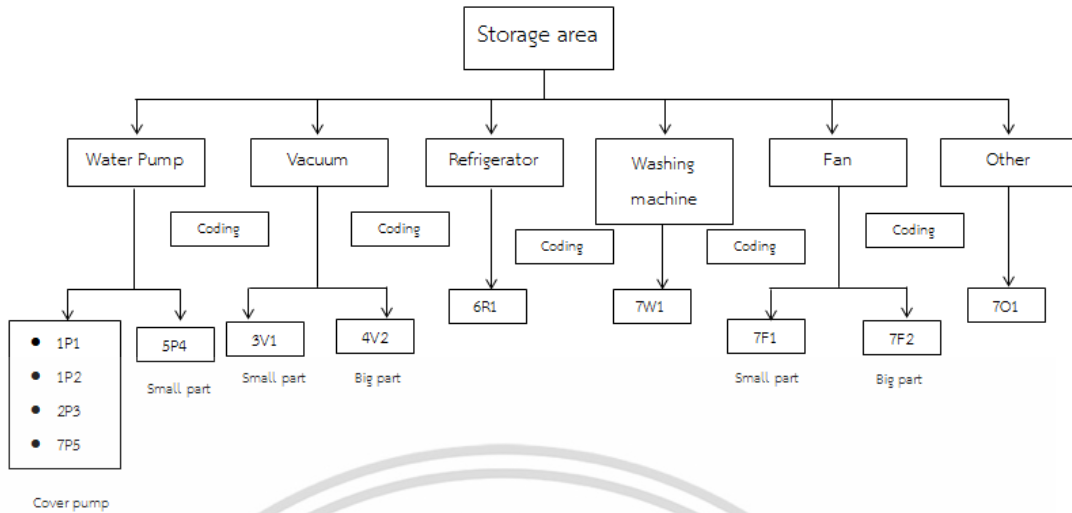


Figure 4.7 The diagram of the storage area after using coding theory.

4.3.2.2 Storage area

In this section, the researcher will identify the codes of warehouse layout to show the locations of each code that identify in Sector 4.3.2.1 since 1P1 until 7O1 as Figure 4.8. Moreover, the researcher will explain about the capacity for each pallet to contain the cartons and how many layers that can be placed in each pallet.

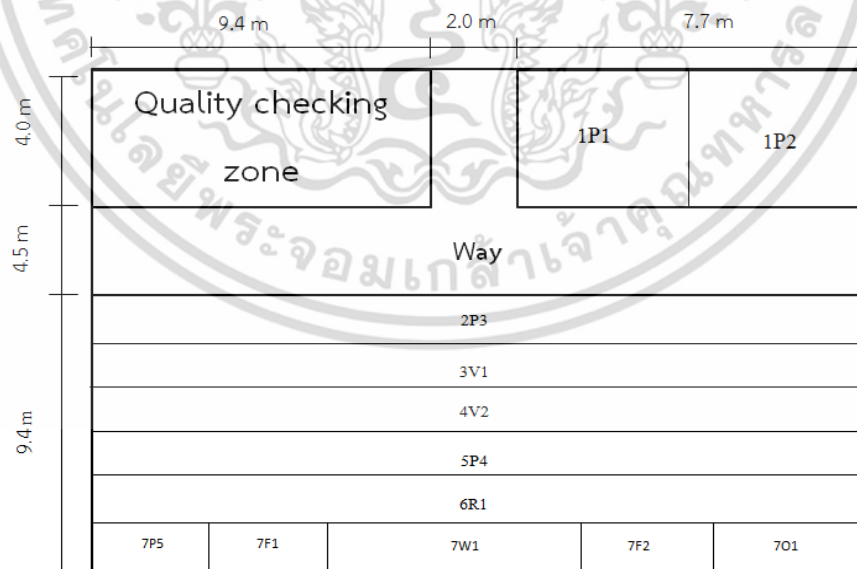


Figure 4.8 The locations in warehouse for each code.

According to Section 4.1.2, it is about packaging and shipping information. They have 2 sizes of carton, middle carton (31x36x26 cm.) and big carton (55 x35x30 cm.) and only one size of the pallets that is Europe standard to contain the cartons.(120x80x14.4 cm.) For the middle carton, it can be placed 6 cartons per layer and for the big carton; it can be placed 4 cartons per layer. However, the researcher will use only big carton to calculate the capacity of the warehouse because the big carton is the main packaging area for ‘A’ company and the problematic products (PL Cover Pump) need the big cartons to be placed. According to data collection, the height of warehouse can be placed around 12 layers of cartons, but for each pallet, it can be placed 4 layers. Therefore, if they want to place 12 layers of cartons, they must use 3 pallets to contain. As Figure 4.9, is shown the capacity for each pallet.



Figure 4.9 The capacity for each pallet

4.3.3 New warehouse layout design

Redesigned warehouse layout for 'A' company, the area of warehouse is about 342 m², width 19.10 meters and depth 17.90 meters. The researcher uses all conditions that got from the owner to redesign the layout. For example, the new warehouse layout has the aisles more than 0.75 meters, and has 2.65 meters for forklifts way. The forklift can access to all types of products and it can clearly identified where the location to place for each type of products. For the conditions about increasing the capacity, the redesigning process increase the capacity for example, the water pump part; the new warehouse layout has increased the capacity of water pump part from 40 pallets to 56 pallets and for other capacity will be shown in Section 4.4. Figure 4.10 is shown the new warehouse layout for 'A' company.

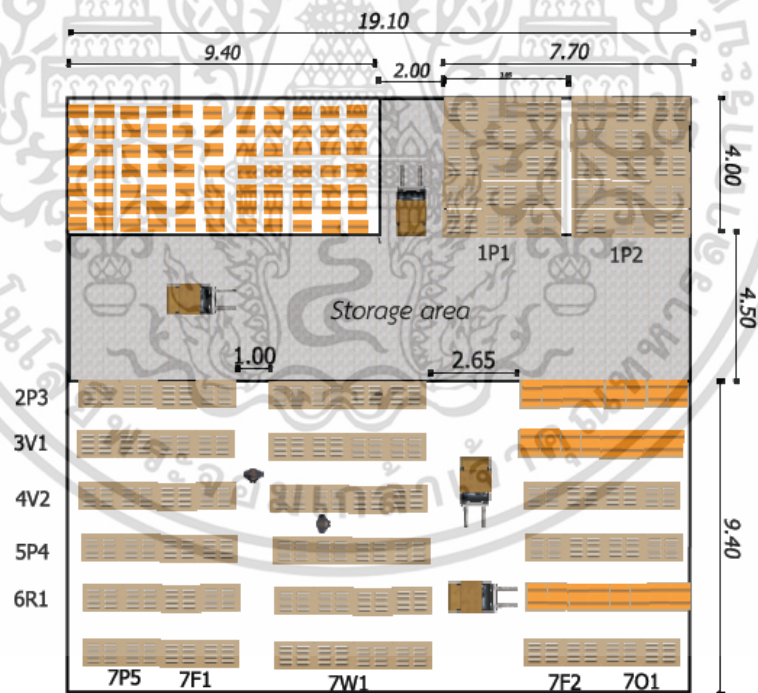


Figure 4.10 The redesigned layout of warehouse

4.4 Measurement

The researcher will measure the result of this redesign warehouse layout from the conditions that the owner gives, to increase the capacity of warehouse and to solve the insufficient storage space for PL Cover pump problem.

4.4.1 The comparison of each design

After the researcher finished redesigning warehouse layout, the researcher will explain the difference between the old warehouse and new one including, total storage space, total non-usable area, actual storage space, the comparison for each type of product (count as the pallet). The total capacity for old and new warehouse layout is shown in a table below;

Table 4.7 The comparison of old and new warehouse layout

	Old warehouse layout	New warehouse layout
Total storage space	19.10 * 17.90 m. = 342 m ²	
Non-used area		
- Quality checking area	39 m ²	39 m ²
- Forklift way	140 m ²	118 m ²
Total non-used area	179 m ²	157 m ²
Actual storage space	163 m ²	185 m ²
Comparison for each type of product (pallet)		
- Water pump	40	56
- Vacuum	18	24
- Refrigerator	12	12
- Washing machine	4	4
- Fan	4	4
- Others	4	2
Total capacity (pallet)	82	102
Capacity increased (percentage)	-	25 %

- Non-used area, it is the area that should be used to place the product includes the quality checking area that the owner does not want to change and forklift way.

- Actual storage space, it is calculated from total storage space minus total non-usable area.

For the first-in, first-out (FIFO) method, if we look at the operational strategy, make-to-order needless to apply FIFO system to the warehouse because they will start to produce the products once they receive the customer orders and produce exactly the same amount of customer orders. Therefore, they will clear all inventories at the end of the month. Nevertheless, the 'A' company has some product that must be stocked for over a month or they do over plan injection to store the product. That is why they need to have FIFO in their warehouse processes. The FIFO for this company, the researcher will focus on pallet by pallet. It means that the pallet number 1 is the pallet that is contained the cartons that finished before pallet number 2 so when the storekeeper pick up the carton for deliver to customer, they will pick up the pallet number 1 first and next is pallet number 2, 3 , ... respectively. As Figure 4.11;



Figure 4.11 First-in, first-out (FIFO) for the company

4.4.2 The capacity for PL cover pump

According to the Section 4.1.1, it is product information. The researcher found the SKUs that has a problem is PL cover pump, it uses high area proportion and takes a lot of space to place the products. That is why the 'A' company has an insufficient storage space problem, so the researcher sets the aim to store the PL cover pump at

the highest demand based on demand information between January – May 2016. As Table 4.8;

Table 4.8 The highest demand and average demand for PL cover pump between January – May 2016

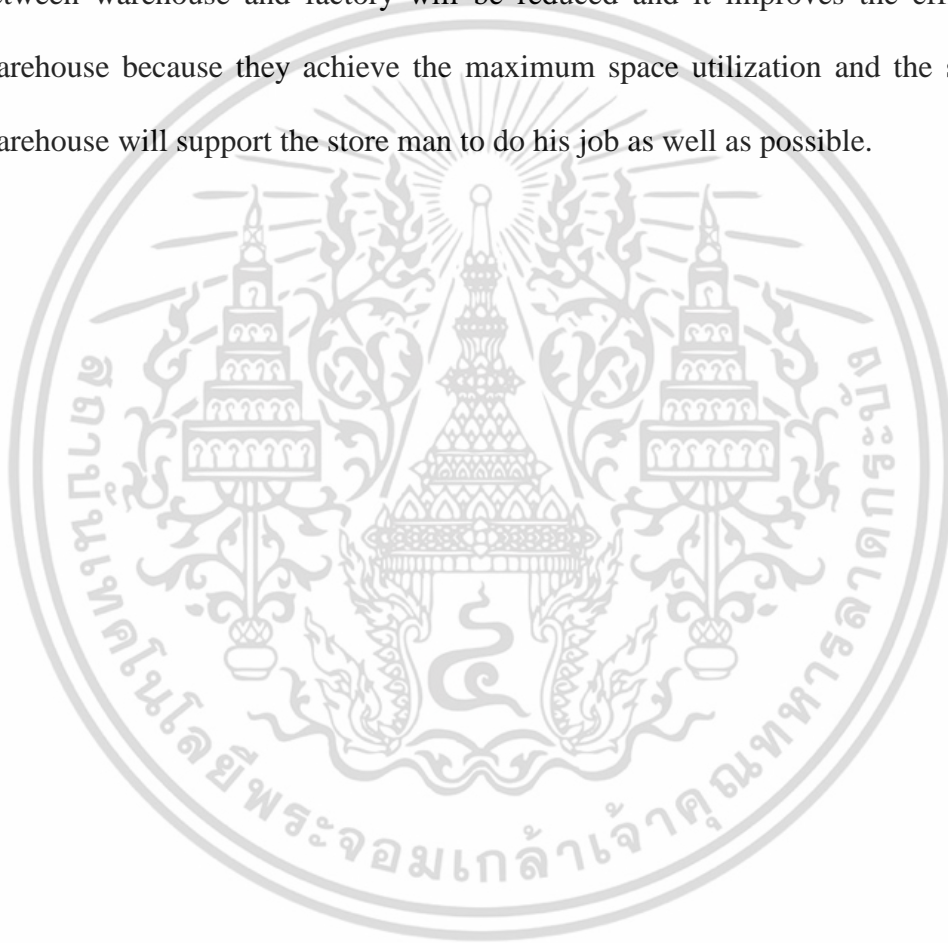
Month	P/NO	P/NAME	Quantity (pieces)	Total (pieces)
May 2016	1PP035461	PL PUMP COVER	74	4,140
	1PP034677	PL PUMP COVER	2,272	
	1PP046512	PL SQUARE COVER	1,794	
Average	1PP035461	PL PUMP COVER	271	3,559
	1PP034677	PL PUMP COVER	1,679	
	1PP046512	PL SQUARE COVER	1,609	

The researcher separates 4 areas to place the carton of PL cover pump, there are 1P1, 1P2, 2P3 and 7P5. The capacity of each area is calculated from the amount of pallet in each area, for 1P1 and 1P2 it has 15 pallet, 2P3 it has 12 pallet and 7P5 has 2 pallet. The pallet can be placed 4 cartons per pallet per layer and with the height of warehouse; it can be placed 12 layers to store the products. The total capacity for each area is shown as table below;

Table 4.9 The capacity of area for PL cover pump

Code Number	pallet x carton x layer	Amount of carton (boxes)	Amount of goods (pieces)
1P1	15 x 4 x 12	720	1,440
1P2	15 x 4 x 12	720	1,440
2P3	12 x 4 x 12	580	1,160
7P5	2 x 4 x 12	100	200
Total		2,120	4,240

According to the Table 4.8, the highest demand for PL cover pump between January – May 2016 is 4,140 pieces and the average is around 3,559 pieces but the capacity for the new warehouse layout it can be placed around 2,120 pallets or 4,240 pieces. It means that the warehouse of ‘A’ company can be placed the PL cover pump at the highest demand. If the warehouse can store all of finished product, the ‘A’ company does not need to rent outside warehouse, the cost of shipping and operation between warehouse and factory will be reduced and it improves the efficiency of warehouse because they achieve the maximum space utilization and the systematic warehouse will support the store man to do his job as well as possible.



CHAPTER 5

CONCLUSION

5.1 Conclusion

Chapter 1 explains about the background and the problem of the company, for the main problem which is about the insufficient storage space for placing finished products. There are about 6 types of products including vacuum part, water pump part, refrigerator part, washing machine part, fan part and other parts. The most problematic one is water pump part. For PL Cover Pump which is the biggest part of the company, the cartons can be placed for only 2 pieces. Every month, purchasing orders for PL Cover Pump are approximately 3,000 pieces or about 1,500 cartons, so it takes most of the area proportion to stock the products. For the objectives of this research, firstly, 'to study the operation processes of the company in order to determine the problems and identify what is the best solution for the warehouse problems.' The process to determine the problems, the researcher has explained in chapter 3 and has applied the fish bone diagram theory to analyze the cause and issue. The fish bone diagram shows the best solution to solve the insufficient storage space problem which is redesigning the warehouse layout. Secondly, the researcher shows the current state and after redesigning of the warehouse layout as figure in chapter 4. Finally, the improvement from redesigning method is explained as the table in chapter 4. Chapter 2 explains about the theory, content, tools and method that are related and can apply to this research.

Chapter 3 explains about 3 things, a company overview, data collecting and the problem and solution identification. First is a company overview, the researcher

explains about the common information such as the departments, the processes and เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า ไม่ว่ากรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และต้องอ้างอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

the operational strategies of the company. For collecting data, the researcher collects the data in 3 ways which are documentation, interviews, and direct observation. For the documentation, the researcher analyzes the data from the past and the data that is gotten from this method is common data such as the data about SKUs, processes, warehouse and logistic activities. For interview, the researcher has a chance to talk with the owner, manager and leader of the company and ask about the problems of company, as well as the processes of the company and personal opinion. For direct observation, the researcher walks into the company and warehouse to observe the company processes to collect the data and identify the cause of problem. Lastly, the problem identification, the researcher collects the data in 3 ways that has mentioned above and other methods that the researcher used to identify the problem is questionnaire, the researcher does the survey on the employees, leader, manager and the owner of company to analyze which department has a worst problem and what is the worst problem of company. For the best solution identification, after the researcher does the questionnaire, there are 3 worst problems including the insufficient storage space, over plan injection and long lead time to purchase raw material respectively. Therefore, the researcher does the group interview with manager and owner of the company to find the solution. After that, the researcher got 3 solutions which are changing supplier, adjusting production plan, and improving on warehouse. The researcher uses the analysis hierarchy process (AHP) theory to find the best solution for the company. The result of AHP shows is to improve the warehouse so the researcher used fish bone diagram theory as a tool to determine how to solve the insufficient storage space problem by focusing on the warehouse issue. According to warehouse issue, there are 2 causes about the warehouse issue including the rent outside warehouse and the current warehouse of 'A' company has no design.

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ไม่ว่ากรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และตั้ง ๑๒ ว่าจะอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

Therefore, the researcher determined to redesign the warehouse layout of 'A' company. The main objective of redesigning warehouse layout is to increase the capacity of the warehouse.

Chapter 4 shows about the method of redesigning warehouse and the result of the redesigning warehouse in order to explain the details about the second and the last objective. At the beginning of chapter 4, the researcher explains about the current warehouse layout, the area proportion for each type of products and show the demand of PL Cover Pump for the last 5 months. For the redesigning warehouse method, the researcher used zoning concept, commodity system theory and identify coding as tools to redesign the warehouse layout under the terms of the company, it is shown in section 4.3 redesign warehouse methodology and the result of redesign warehouse, the current warehouse layout of 'A' company has an unavailable area about 179 m², the actual storage space about 163 m² and the total capacity (counted as pallet) is 82 pallet. On the other hand, the new warehouse layout has an unavailable area about 157 m², the actual storage space about 185 m² and the total capacity (counted as pallet) is 102 pallets increased from the current warehouse layout about 25 percent. Likewise, if focuses on the capacity of the SKU that has the insufficient storage space problem, the new warehouse layout has enough space to place PL Cover Pump for the highest demand, it is shown in table 4.9, the capacity of each area for PL Cover Pump.

5.2 Problems and Barriers

The researcher lists the problems and barriers of this research as below;

1. Some data that is needed for this research is the company' secret. For example, the data about supplier, cash flows, and customers orders. They are not able to provide the exact document because they concern about the competitors' issues.

เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่นิยมนำไปเผยแพร่โดยไม่ได้รับอนุญาต
ไม่ว่ากรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และด้วย 93 ว่าจะไปถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

2. The researcher cannot change the policy of the company. Some policies directly affect the storage space such as the policy about finished the customer's order 5 days ahead of the shipping time.

3. The company does not want to redesign the parking zone and raw material warehouse. In the researcher opinion, if we can redesign the warehouse layout includes the parking zone; the company will have more storage space to place the finished products because there are a lot of available spaces on parking zone.

5.3 Recommendation

1. The company should reduce the parking zone area to increase the storage area because 'A' company has a lot of available spaces on the parking zone.

2. The company should switch to the new suppliers, the company purchases the raw material once a month and has to purchase the raw material in large amount. Therefore, it takes a lot of space to store the raw materials. If the company can separate the purchasing into 2-3 times per month, the company will has more available spaces to place other products, no need to pay in large amount at once. As a consequence, it helps to increase the cash flows efficiency and reduces the risk about raw materials.

3. The production department should control the over plan injection issue especially on PL Cover Pump. If the production department injects over customer order, the finished product will not be shipped to the customers and it will be placed in the warehouse and the PL Cover Pump takes specious area to be placed which will affect other storage spaces.

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APPENDIX A
QUESTIONNAIRE

No. □-□□□

The questionnaire to identify the problem

Part 1: General Information

1. Gender Male Female

2. Age

Less than 25 years old

26 – 35 years old

36 – 45 years old

more than 46 years old

3. Education Background

Less than Senior High School

High Vocational Certificate

Bachelor degree

Master degree or higher

4. Position

Worker

Sub manager

Manager

Owner

5. How long did you work at 'A' company?

Less than a year

1 – 2 years

3 – 4 years

more than 5 years

เอกสารนี้เป็นเอกสารที่สงวนไว้สำหรับการใช้งานเพื่อการศึกษาเท่านั้น ไม่อนุญาตให้นำไปใช้ประโยชน์ด้านการค้า
ไม่ว่ากรณีใดๆ ทั้งสิ้น อีกทั้งห้ามมิให้ดัดแปลงเนื้อหา และต้องอ้างอิงถึงเจ้าของเอกสารทุกครั้งที่มีการนำไปใช้

Part 2: Company processes

Please tick (/) in the columns that represent your opinion about the problems in each company processes.

5. = highest 4. = high 3. = middle 2. = low 1. = lowest

The degree of problems in each company processes	5	4	3	2	1
Procurement					
1. Ordering materials					
2. Purchasing Order from customers					
3. Preparing Materials					
Planning and Production					
1. Planning					
2. Production					
3. Setting Machines					
4. Controlling quality					
Accounting and Finance					
1. Cost analysis					
2. Financial report					
Warehousing and Storage					
1. Material Handling					
2. Plant and Warehouse site selection					
3. Warehouse Management and Design					
4. Logistics and Transportation					

Which department should be improved?

- Purchasing and Procurement department
- Production department
- Accounting and Finance Department
- Warehouse and Storage department

Part 3: Problems analysis

Please tick (/) in the columns that represent your opinion on each following problems.

5. = highest 4. = high 3. = middle 2. = low 1. = lowest

The degree of problems	5	4	3	2	1
1. Long lead time to purchase raw materials					
2. Setting machines / poor skill worker					
3. Over plan injection					
4. Insufficient storage space					
5. Transportation and shipping					

Part 4: Recommendation

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