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FACILITY PLANNING AND WORKSTATION DESIGN WITH CONSIDERING ERGONOMIC ASPECT TO DETERMINE NUMBER OF LABOR IN PT.ICS

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FINAL PROJECT

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ABSTRACT

ICS Group is a corporation focusing in Seafood Industry with shrimps and fishes as its main products. With integrated and widespread operation in most locations in Indonesia, ICS Group attempts to give their best service and the highest quality products through its 3E philosophy: Excellent Product, Excellent People, and Excellent Services as an effort to achieve customer satisfaction.

Unfortunately, ICS has a problem in balancing between production rate and the increasing wage rate of the labors. While the wage rates keep increasing every year, company's production is not increasing. Hence, the percentage of the labor cost in cost of good manufacture keep increasing over the time. Moreover, labors in ICS factory are mostly high school graduates or lower. Hence the knowledge of how important safety and ergonomic aspect become unimportant for them while doing their daily job. It became a concern for the company to create a better working environment, to reduce the number of accidents which will reduce the number of labors that can't come to work because of it.

The high number of workers that cannot come to work will reduce the production rate of PT ICS. Hence, the cost of good manufacture in PT ICS is high. Determining from that point, it is become a good point to redesign the work station in the factory. Which can possibly reduce the number of workers ill due to work and increase the production speed. In designing new station, we can consider both ergonomic and production speed, moreover both ergonomic and production speed have linear effect.

Using motion time study, the non-value-added activities can be detected and reduced or removed from the production process. Also, the new design will follow the ergonomic safety principal which will be assessed by the company before creating the new design.

Keywords: Production Rate, Ergonomic Aspect, Working Environment, Non-value-added Activity, Workstation Design, Motion Time Study

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FOREWORD

This Final Project is prepared to meet the requirements of completion of S1 study and obtain a Bachelor of Industrial Engineering degree in Industrial Engineering Department, Faculty of Industrial Technology, Sepuluh Nopember Institute of Technology Surabaya. During the process of Final Project, the author has received many influential support, input, and motivation from various persons. Therefore, on this occasion the author would like to thank:

1. Mother and brother who always give motivation, support, and prayer to the author while the Final Project was being worked on.
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4. Worker in PT.ICS who help in giving and gathering the data.
5. Friends that help and support the author while working on the Final Project

This Final Project does have some mistakes, the authors apologize if there is an error in report writing. Feedback and constructive criticism will be useful for the writer to improve the author's performance. The author hopes that this Final Report is useful for all parties who need future.

Author

Ikra Amiluta Nugraha

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CHAPTER 1
PREFACE

This chapter explains about the research background conducted. Problem formulation, research objectives, research benefits, the scope of research are tailored to the background of this research. This introductory chapter also discusses the systematics of report writing.

1.1 Background

ICS Group is a corporation focusing in Seafood Industry with shrimps and fish as its main products. With integrated and widespread operation in most locations in Indonesia, ICS Group attempts to give their best service and the highest quality products through its 3E philosophy: Excellent Product, Excellent People, and Excellent Services as an effort to achieve customers satisfaction.

ICS Group was established on 11 November 1987 focusing on seafood industry as its main business. The company had grown rapidly and expanded to Food Distribution to ensure availability of commercial products in Indonesia and international market.

Supported by vast experience in seafood export, ICS Group further extended its business by providing export services through ICS Export Division. There are currently 12 seafood factories spread all over Indonesia Certified as the best exporter of seafood Industry in Java (ICS, 2018).

Along with the development of the era and technology, the ease of many obtained by humans. Some of them is the capture and processing of seafood, such as fish, shrimp, and others, which makes the productivity of seafood industry increase.

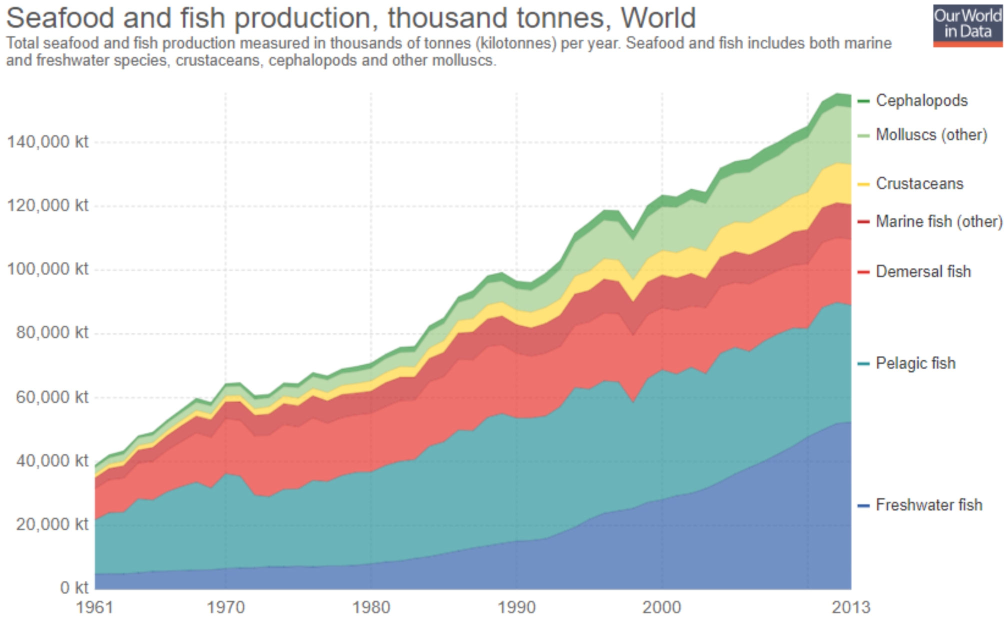

Figure 1.1 Seafood and fish production 1961-2013 (Food and Agricultural Organization)

From data provided by the Food and Agricultural Organization, in 2013 the demand for seafood reached more than 140,000-kilo tons and data trends show an increase in demand every year. However, due to the large demand and available technology, the number of companies producing seafood is also increasing. Based on Seafood Expo Global, there are more than 1500 companies that have been registered as seafood producers worldwide. Therefore, the competition between companies will increase to get consumers, especially in the export, because they must compete with more companies around the world.

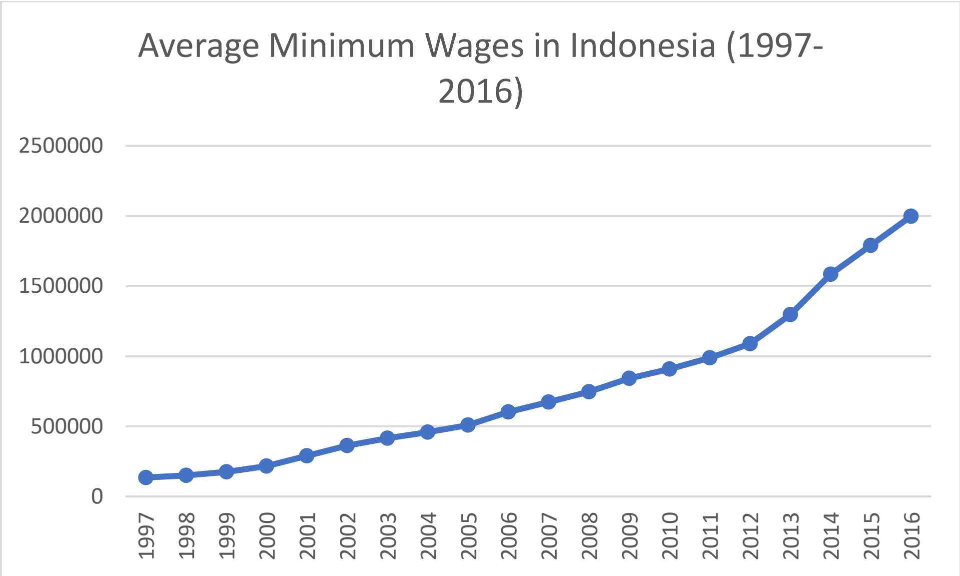

Figure 1.2 Average Minimum Wages in Indonesia 1997-2016 (BPS, 2018)

On the other hand, ICS as one of the fishes and seafood production that sell their product in around the world have a problem. Because of the increase in minimum labor wages every year, but the labor production speed has not increased. This makes ICS need to increase their product price, which is not good in competing for their product.

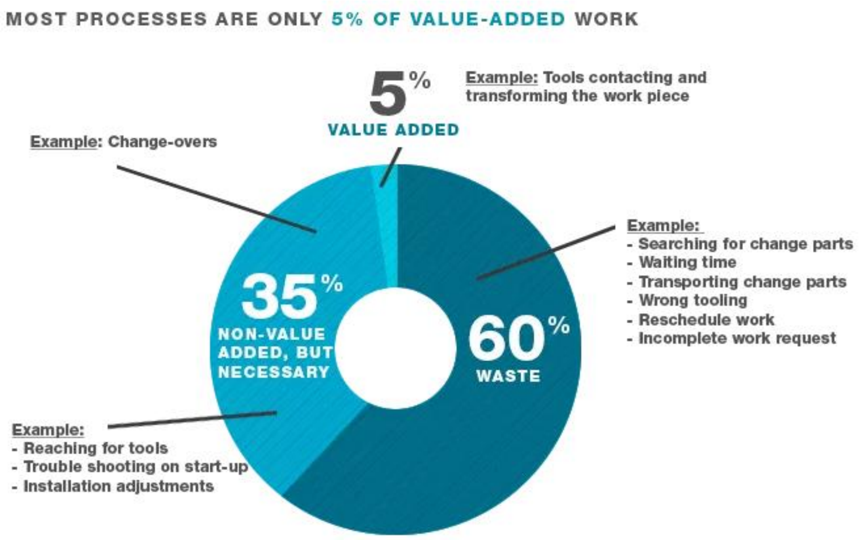

Figure 1.3 Percentage of value added in production process (Incito, 2018)

From total production time, only 5% used to give value added to the product. most of the time wasted on the non-value-added activity, such as searching for the part, waiting, transporting change part, wrong tooling, etc. Hence, the company can create a better design of a working system, so the reduce from non-value-added activity can be used to increase the value-added activity.

Another problem that occurs in many factories in Indonesia is the accident at work. the accident rate in the Indonesian industrial world shows a high rate, there are 105.182 accident and 2375 victim in 2015. One of the main causes of work accidents is the low knowledge and awareness of industry players to implement Occupational Safety and Health (Kompas, 2016).

Figure 1.4 Number of accident cases due to work 2011-2014

The highest number of accident cases in 2011-2014 in 2013 was 35,917 cases of work accident (2011 = 9.891, 2012 = 21,735, and 2014 = 24,910).

There are several factors that cause the occurrence of work accidents, namely unsafe condition, and unsafe behavior. Unsafe Behavior is a behavior and habits that lead to the occurrence of accidents such as not using Personal Protective Equipment (PPE) and the use of non-standard equipment. Unsafe Condition is a condition of unsafe workplace such as too dark, heat and disturbances of physical factors work environment others. These factors of occupational accidents can be eliminated by the company's commitment to establishing OSH policies, regulations, and supported by the quality of company's human resources in its implementation. Unfortunately, there are still few companies in Indonesia committed to implementing OSH guidelines in their work environment. According to the SPSI notes, only about 45% of the total number of companies in Indonesia (safetyshoe, 2018) contains OSH commitments in the collective labor agreement. If the company is aware, its commitment to implementing OSH policy can help reduce the number of workplace accidents in the workplace. The company will make various efforts to realize safe and healthy working conditions. The company's low commitment made worse by the still low quality of human resources in Indonesia contributing to the point of accidents, data from the Central Bureau of Statistics in 2003 shows that only 2.7% of the workforce in Indonesia has a college education background and 54.6% work only elementary school (safetyshoe,2018).

PT. ICS have a problem in balancing between production rate and the wages increase of the labor. While the wages keep increasing every year, company's production is not increasing. Hence, the percentage of the labor cost in cost of good manufacture keep increasing over the time.

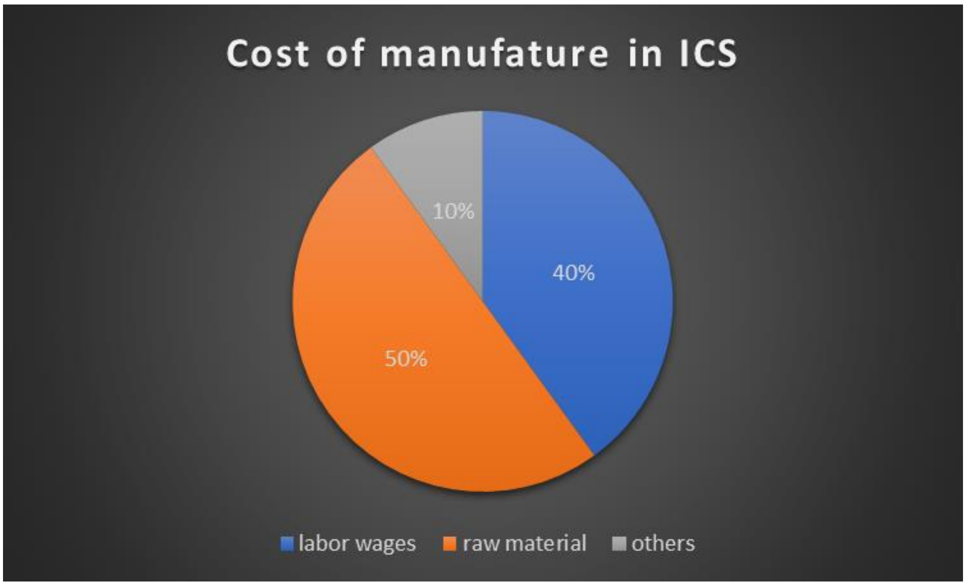

Figure 1.5 Cost of Manufacture in ICS

Moreover, labors in ICS factory are mostly high school graduates or lower. Hence the knowledge of how important safety and ergonomic aspect become unimportant for them while doing their daily job. It became a concern for the company to create a better working environment, to reduce the number of accidents which will reduce the number of labors that can’t come to work because of it.

In conclusion PT.ICS need to create a better working system design which also increases the ergonomic and safeties for the labor. Because creating a better working system can increase the productivity of the labor and implementing ergonomic design can reduce the risk of labor getting hurt while doing the job.

Using motion time study, the non-value-added activity can be detected and reduce or remove from the production process. Also, the new design will follow the ergonomic safety which will be assessed by the company before creating the new design. Hence it can be implemented in the new design. The workers which are chosen to gets observed are based on the information from the PT ICS supervisor, to determine which worker has a high level of experience. Moreover, the workstation that will be observed is chosen based on the number of labors and the probability of higher time reduction. Thus, the solution can reduce a higher process time in PT ICS production process.

1.2 Problem Identification

Based on the background in chapter 1.1, the issue that will be discussed is how to create a better workstation to increase productivity and reduce accident to labor while working. The workstation new design will reduce or remove the unnecessary activities and consider ergonomic aspect.

1.3 Research Purpose

Purpose of this research are:

1. create a safer working environment and efficient workstation design using time-motion study.
2. Create facility planning to reduce the safety risk and operation cost.

1.4 Research Benefit

The following are the expected benefits of this research:

1. Reduce the number of accidents in the workplace.
2. Increase production speed.
3. Increase company profit.

1.5 Scope of Research

The scope of this study consists of two things, namely limitation and assumptions used in research final project

1.5.1 Assumption

The assumption that used in this research are:

1. Labor working normally when the data is taken
2. The worker that gets observed have enough experience

1.5.2 Limitation

The limitation that used in this research are:

1. The workstations that gets observed only inside the factory
2. The ergonomic aspects that will include are only working posture, weight to carry, and working movement.

1.6 Writing Structure

Here is the systematic writing used in the preparation of this final project

CHAPTER 1 PREFACE

The first chapter of this final project is explained about the introduction that has the background content of the problem that became the basis of this final project, the formulation of the issues discussed, the objectives to be conveyed in this study, the expected benefits of this final project research, and the scope of the research.

CHAPTER 2 LITERATURE REVIEW

The second chapter of this final project consists of a literature review that used as the basis, including Occupational Safety and Health, facility planning, motion time study, ergonomic, lean manufacturing, lead time, and workstation design.

CHAPTER 3 RESEARCH METHODOLOGY

The third chapter discussed the steps undertaken in the study. Stages are done is required in accordance with the scientific stage so that the research conducted still has a good structure and correct. The research methodology consists of several stages, namely the literature study stage, data retrieval, ergonomic assessment, workstation design, and benefit analysis.

CHAPTER 4 DATA PROCESSING

In this chapter will be discussing the existing company process flow and the problem that the company has. the problem will be processed by using motion time study and other methods from facility planning

CHAPTER 6 RESULT ANALYSIS

This chapter discussed the benefit from the new design, comparing in production speed, reduced risk, and the number of labors. This chapter will also discuss other things that could increase the production speed.

CHAPTER 7 CONCLUSION AND RECOMMENDATION

In the last chapter is explained about the conclusions on the results of research conducted and can be given useful advice for subsequent research.

CHAPTER 2
LITERATURE REVIEW

This chapter will explain the literature study that will used in this final project. It is consisting of occupational safety and health, facility planning, and ergonomic.

2.1 Occupational Safety and Health

Occupational safety and health (OSH) are generally defined as the science of the anticipation, recognition, evaluation, and control of hazards arising in or from the workplace that could impair the health and well-being of workers, considering the possible impact on the surrounding communities and the general environment (alli, 2008). The purpose of OSH is to maintain the health and safety of the working environment. OSH also protects others who may also be affected by the working environment. All organizations have a responsibility to ensure that workers and others involved remain in the safe condition when working. Occupational safety and health (OSH) practices include prevention, sanctioning, and compensation, as well as wound healing and care for workers and providing health care and sick leave.

The World Health Organization (WHO) defines occupational safety and health as "occupational health deals with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards." (WHO, 2015). OSH is a multidisciplinary field of healthcare concerned with enabling an individual to undertake their job and task, in the way that causes the least harm to their health.

Since 1950, the International Labor Organization (ILO) and the World Health Organization (WHO) have shared a common definition of occupational health. It was adopted by the Joint ILO/WHO Committee on Occupational Health at its first session in 1950 and revised at its twelfth session in 1995. "The main focus in occupational health is on three different objectives: (i) the maintenance and promotion of workers’ health and working capacity; (ii) the improvement of working environment and work to become conducive to safety and health and (iii) development of work organizations and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings. The concept of working culture is intended in this context to mean a reflection of the essential value systems adopted by the undertaking concerned. Such a culture is reflected in practice in the managerial systems, personnel policy, principles for participation, training policies and quality management of the undertaking." (ILO, 1995).

ILO (International Labor Organization) said six facts about Occupational Safety and Health (OSH) to note are (ILO, 2018):

- Each year approximately 24 million people died due to accidents and illnesses in the work environment including also within 360,000 fatal accidents and predicted 1.95 million dues to fatal illnesses that appeared in the work environment.
- It means that at the end of the year. Almost 1 million workers natural accident as well as around 5500 workers died by accident or illness in work environment. 25 trillion of the Global Gross Domestic Product (GDP) or in an economic perspective, 4% or USD 1, allocated for the cost of accidental workplace losses and diseases in the work environment, compensation for some workers, cessation of production, and some healing costs workers.
- The potential for occupational hazards predicted to result in 651,000 deaths, especially in developing countries. Even the numbers may be even greater once the reporting system and the notifications are better.
- Data from some industrialized countries show that some construction workers have a potential death due to work accidents 3 to 4 times the greater.
- Lung disease is infected with some workers in oil & gas, mining and similar companies, so asbestos, coal and silica exposure are still concerned with developed and developing countries. Even death from accidents from exposure to Asbestos alone has reached 100,000 and is increasing every year.

- Occupational Safety and Health (OSH) of companies in Indonesia, in general, is in fact still low. Based on the ILO, Indonesia ranks 26th out of 27 countries. Predicted only 2% of the 15,000 more large companies in Indonesia who have applied the OSH Management System.

2.2 Facility Planning

Facilities can define as a gathering place for people, materials, machinery etc. to achieve a goal of goods or service industry. Facility planning is defined as a two-to-five-year facilities plan encompassing an entire portfolio of owned and/or leased space that sets strategic facility goals based on the organization's strategic (business) objectives (IFMA, 2009).

In general, well-planned plant layout will also determine efficiency and in some cases will maintain the viability or success of an industry's work. Equipment and a good product design will be meaningless due to a haphazard layout plan. Since the production, the activity of an industry must normally last a long time with a layout that is not always changing, and then any errors made in this layout plan will cause no small losses. The main objective in the design of the plant layout is to minimize the total cost, which includes the cost elements such as the cost for construction and installation for both machine building and other production facilities. In addition, the cost of material transfer, production cost, repair, security, half-finished product storage cost and optimal factory layout arrangement will also facilitate the supervision process and face future plant expansion plans.

Benefits include increased production, reduced waiting times; reduce processing time for moving materials, saving the use of areas for production, warehouses and services, the greater utilization of machinery, labor, and production facilities. In addition, a shorter manufacturing process reduces operational health and safety risks from operators, improves morale and job satisfaction, simplifies supervision activities, reduces congestion and confusion, and reduces factors that can harm and affect the quality of raw materials or finished products.

Broadly speaking, the main purpose of layout design is to manage the work area and all production facilities in it to form the most economical, safe, convenient, effective and efficient production process. In addition, the layout design also aims to develop good material handling, efficient land use, ease of maintenance, and improve the convenience and comfort of the work environment. There are several advantages of good facility layout:

1. Increase production output

   In general, a good layout will provide greater output with smaller or equal work costs, with smaller work hours and smaller machine hours.
2. Reduce the delay

   Setting a balance between the time of operation and the load of each department or machine is part of the responsibility of the facility layout designer. A good setting will reduce the excessive waiting or redundancy time that can caused by backtracking, cross-movement, and congestion that cause the transfer process to be inhibited.
3. Reduce the moving distance of goods

   In the process of production, the movement of goods or materials must occur. Starting from raw materials entering the initial process, the transfer of intermediate goods, until ready-to-market ready goods are stored in the warehouse. Given the large number of moving goods going and how big the role of moving goods, especially in the production process, the design of a good layout will minimize the cost of moving the goods.
4. Saving area utilization

   The design of a good layout will overcome the waste of excessive use of space.
5. Maximizing the use of machinery, labor, and / or other production facilities

   By reducing bottleneck in production process makes the production process goes faster. Hence, the machine and labor can work more efficient with less idle time.
6. A shorter manufacturing processes

   By shortening the distance between the production processes and reducing the bottleneck, the time required to work on a product will be shorter so that the total production time can shortened.

7. Reduce the risk of work accident

   The design of a good layout also aims to create a safe working environment, and convenient for workers associated with it.

8. Create a comfortable working environment

   With a good working arrangement, orderly, good lighting, good air circulation, etc., then a good working atmosphere will create so that morale and job satisfaction of workers will increase. This effect on employee performance will also increase so that work productivity will maintained.

2.3 Motion Time Study

Time-motion study is a combination of motion study of Flank and Lilian, combined with time study of Fredrick Winslow. At the beginning, time study developed in the direction of establishing standard times, while motion study evolved into a technique for improving work methods. The two techniques became integrated and refined into a widely accepted method applicable to the improvement and upgrading of work systems (Zandin, 2001).

Time study is a direct and continuous observation using timekeeping device such as stopwatch. It is often used when:

1. Repetitive work
2. Variety of work
3. Process control elements constitute a part of the cycle

By considering the unnecessary movement that can be remove or reduce from the production process, the production time can be reduce and increase the production output.

Hence, motion time study can maximize the use of labor and machine. Moreover, by creating a better workstation using motion time study, the company can reduce numbers of labor.

2.4 Ergonomics

Ergonomics is the study of how equipment can be arranged in the order that people can do work or other activities more efficiently and comfortably. Ergonomics is a science that examines the interaction between human and machine, and the factors that influence it with the aim to improve overall system performance

(Bridger, 2009). ergonomics itself comes from the Greek language, namely ergon and nomos. Ergon means work and nomos means rules, principles, or rules.

In European countries, the popular ergonomics word used in the United States, says human factor used to replace the word ergonomics. these two words equally emphasize the discussion on the performance and human behavior, only different emphasis only. The first economy popularized by professor Murrel in 1949 as the title of his book. thinking about ergonomics itself has existed since ancient times when humans began to make tools to help the work of their hands to survive. however, the development of ergonomics at the time was not rapidly developed. along with the development of science, ergonomics began to be developed and used more widely. according to Dan Macleod (1995), the application of ergonomics has been started in the past 4000 years ago, when humans began to make simple tools of stone to facilitate the work of their hands. Along with the development of culture, then made improvements and changes in the aids so in addition to aims to facilitate the work of human hands but also allows users to use the tool. for example, is a change in the design of equipment used by early humans. at first, most of the tools used are from an unformed vein, then the amorphous stone is transformed into a pointed stone by sharpening certain sides of the stone. then, the sharp stones are carved on the top of the globe so that the hand is easy to hold and used by humans. The development of ergonomics in this era also signifies the development of human culture at that time. however, these ergonomic developments occur irregularly and unfocused, sometimes even by chance. There is no specific science that develops this ergonomics more broadly and structured. Just in the 20th century, people began to develop this ergonomic science in a more systematic and structured way (Scribd, 2018).

There are several benefits when ergonomic is applied in the workstation, such as:

1. Reducing cost, by applying ergonomic in the workstation, it can reduce the ergonomic risk factors that can cost the company.
2. Increase productivity, the ergonomic workstation will make the labor more comfortable to do their task and make them work better.
3. Increase quality, not only the number of the product that will increase but also the product quality will increase due to the more comfortable workstation.
4. Improve morale, labors will trust company management more because of the effort management give to labors.
5. Creating healthy culture, healthy culture can be created by applying safety procedure and design in the company. Moreover, it gives the benefit to the company in long run by creating safety environment.

Manual handling is transporting or supporting loads by hand or using bodily force. Many people hurt their back, arms, hands or feet lifting everyday loads, not just when the load is too heavy. More than a third of all over-three-day injuries reported each year to HSE and to local authorities are the result of manual handling. These can result in those injured taking an average of 11 working days off each year (HSE, 2003). There are no legal limits for the weight that can be lifted at work. 20-

25kg is considered heavy for most people. The limit of checked baggage weight at airports is 23kg. the amount of weight you can transport depends on 4 factors:

1. The task – if it is carried out too frequently or for too long, it may impose the unnecessary strain on the person’s body, regardless of whether it hits the 25kg mark or not.
2. The individual –Several factors will contribute to this, such as the person’s age or their physical dimensions.
3. The load – if it is oversized and bulky, then it might be hard to get a solid grip. This could lead to the load slipping out of your hands.
4. The environment – if there isn’t enough space or you can’t see properly, the manual handling tasks are simply riskier to carry out.

Manual handling relates to the moving of items either by lifting, lowering, carrying, pushing or pulling. The weight of the item is an important factor, but many other factors can create a risk of injury, for example the number of times the labor have to pick up or carry an item, the distance the labor is carrying it, where the labor is picking it up from or putting it down (picking it up from the floor, putting it on a shelf above shoulder level) and any twisting, bending, stretching or other awkward posture the labor may adopt while doing a task. Moreover

Manual handling injuries are part of a wider group of musculoskeletal disorders (MSDs). The term ‘musculoskeletal disorders’ covers any injury, damage or disorder of the joints or other tissues in the upper/lower limbs or the back. Statistics from the Labor Force Survey (LFS) indicate that MSD cases, including those caused by manual handling.

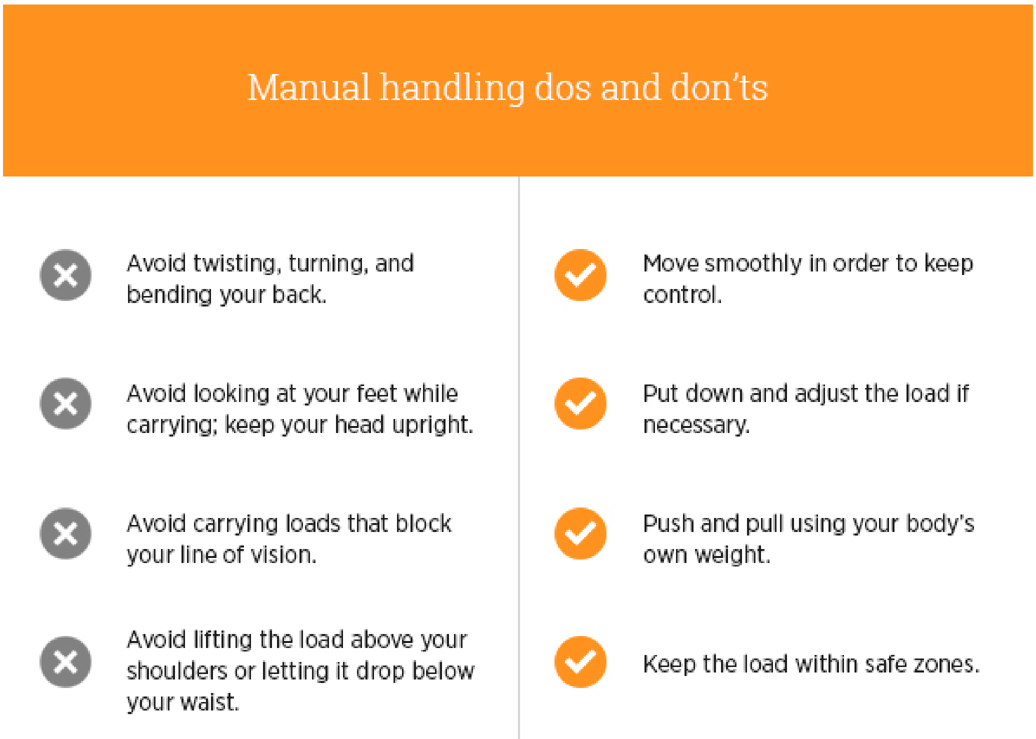

Figure 2.1 Manual handling do's and don'ts (highspeedtraining, 2018)

The safe zones determine what the suitable weight and height of a load should be for safe maneuvering. It also addresses the way the load should be held. If the load passes within zones and is kept close to the body with downward pointing arms, then the upper weight limit can be selected. So, for example, if a woman is carrying a box at elbow height, the load should not exceed 13kg. If the load passes within zones but is not kept close to the body and is held with extended arms, however, then the lower weight limit must be selected. If a woman is carrying a box at elbow height under these conditions, it must not exceed 7kg. Moreover, doing it repetitively can give a repetitive strain injury. Repetitive strain injury (RSI) is a broad and generic term that encompasses a variety of injuries resulting from cumulative trauma to the soft tissues of the body, including tendons, tendon sheaths, muscles, ligaments, joints, and nerves. Such injuries are typically associated with the soft tissues of the hands, arms, neck, and shoulders (Goetsch, 2001).

Figure 2.2 Manual Handling Weight Limits Men and Women (highspeedtraining, 2018)

Another ergonomic aspect is proper lighting. People receive about 85 percent of their information through their sense of sight. Appropriate lighting, without glare or shadows, can reduce eye fatigue and headaches; it can prevent workplace accidents by increasing the visibility of moving machinery and other safety hazards. Good quality lighting also reduces the chance of accidents and injuries from "momentary blindness" (momentary low field vision due to eyes adjusting from brighter to darker, or vice-versa, surroundings). The ability to "see" at work depends not only on lighting but also on:

1. The time to focus on an object.
2. The size of an object.
3. Brightness.
4. The contrast between an object and its immediate background.

2.5 Lean Manufacturing

Lean is a continuous improvement philosophy which is Synonymous with Kaizen or the Toyota Production System. This concept was developed to survive with the minimum amount of resources in economic crisis (Cirjailu, 2016). The history of lean management or lean manufacturing is traced back to the early years of Toyota and the development of the Toyota Production System after Japan's defeat in WWII when the company was looking for a means to compete with the US car industry through developing and implementing a range of low-cost improvements within their business (Willey, 2001).

Lean manufacturing has 4 principles:

1. Pull

   Avoid producing as much as possible by simply responding to customer requests only. Pull principle can minimize overproduction, inventory, and working capital in a company.

2. One-piece flow

   All production processes are focused and adjusted by adding value one by one and eliminating all vain and unimportant activities to process their production. This principle can minimize working progress, process and eruption, lateness, and waiting time. So, it is expected to improve quality & flexibility.

3. Takt

   Takt refers to the rhythm of the production process of a good or service. With a consistent and continuous rhythm will make it easier to organize and respond flexibly to fluctuating changes. Takt time depends on monthly production demand, if the demand increases the Takt time decreases, if the demand decreases the Takt time increases which mean the output interval increases or decreases (Sundar, 2014)

4. Zero defect

   Zero Defects is identifying errors or defects as quickly as possible. By doing so, the company does not remain silent on defects or continue its production process. However, problems are resolved quickly and efficiently to avoid rework that can aggravate the quality of a product.

In lean manufacturing, waste is any expense or effort that is put forward which does not transform raw materials into an item the customer is willing to pay for. There are 8 types of waste in Lean Manufacturing. Seven of the eight wastes are production process oriented, while the eighth waste is directly related to management's ability to utilize personnel. 8 types of waste in lean manufacturing are:

1. Defect

   One of the most easily recognizable waste in lean manufacturing is the production of Disabilities. Examples The defects in manufacturing include waste such as scrap parts, products that require rework, or missing details assemblies. Defects are often regarded as one of the most significant manufacturing wastes because they can lead to the generation of additional wastes such as Overproduction, Transportation, and Excess Processing.

2. Nonstandard processing

   If the product does not meet customer requirements, the product must be repaired or reproduced to meet customer needs. If customer requirements are unclear, more work can be done during the manufacture of the product that is needed, (such as smooth polishing surfaces that look shiny), even if the customer does not ask for it. Repairs, remanufacturing, and processing are more examples of lean manufacturing waste called Excess Processing.

3. Overproduction

   Of all 8 wastes in manufacturing, Overproduction has so far had the most negative impact on success. Overproduction occurs whenever more parts or products are produced than those consumers are willing to buy. Like the production of Disability and Other Excess Processing, Overproduction can also lead to the generation of additional manufacturing waste such as Waiting, Inventory, and Motion, spending a lot of time and resources.

4. Waiting

   Waiting is a reference to slowness that adds cost to products produced for the customer. This happens because overhead costs continue to increase if the product waits to be transformed. When the product waits, no value is produced but overhead operating costs continue to grow, potentially reduce selling profits from the sale. Waiting not only destroys material and information flows, but also produces excess Inventory.

5. Excess inventory

Inventory is a manufacturing waste because it is a value held at a certain cost. In the most literal sense, Inventory is a valuable product or material waiting to be sold to the customer or subsequently transformed into something of greater value. Throughout the time the product is in the Inventory, the profit margin is reduced because overhead must be paid to keep the product in the Inventory. Maintaining Inventory requires the addition of Motion and Transport waste.

6. Transportation

Moving a product will cost money, which is why transportation is classified as a category of manufacturing waste. Unless the transformation of added value is made to the product or material during transportation, the transport of a product or material is a waste of activity. A large amount of resources and time consumed moving materials while no value is added for sale to customers.

7. Motion

When Motion occurs, the value is not added to the product or material produced. Motion can be a person or a machine, but most often it is human resources whose effort and time are wasted. Inefficient store floor layouts, and improper equipment can lead to unnecessary movement. Employee efforts are not only wasted, but Motion can also result in physical injury to employees that result in greater business costs.

8. Intellect

This type of manufacturing waste occurs when management in a manufacturing environment fails to ensure that all their employee talent potential is in use. In relation to Motion waste, if an employee aimlessly removes material around the production area without adding value to their business is wasted where they can engage in value-added activities. Non-Utilized Talent also refers to the ability of management to utilize critical thinking and continuous improvement feedback from employees to improve lean manufacturing processes

2.6 Lead Time

Manufacturing lead time is the period between the customer's order and the time the order is completed. Short lead time becomes a competitive advantage, as many customers want their product delivery as soon as possible. Lead time consists of waiting time and throughput time, and usually lead time is measured in a matter of days.

Lead time is made of 3 parts:

1. Preprocessing Lead Time: It represents the time required to release a purchase order or create a job from the time you learn of the requirement.
2. Processing Lead Time: It is the time required to procure or manufacture an item.
3. Postprocessing Lead Time: It represents the time to make a purchased item available in inventory from the time you receive it

There is other type of lead time, it is called Order Lead Time (OLT). Order Lead Time is a lead time that related to customer order. It is important to differentiate the definitions that may exist around this concept. Although they look similar there are differences between them that help the industry to model the order behavior of their customers. The four definitions are:

1. The Actual Order Lead Time (Kumar, 1989) The order lead-time, refers to the time which elapses between the receipt of the customer's order (Order Entry Date) and the delivery of the goods (Gunasekaran, 2001).
2. The Requested Order Lead Time represents the time between the Order Entry Date and the customer requested delivery date (Causens, 2009).
3. The Quote Order Lead Time is the agreed time between the Order Entry Date and the supplier’s committed deliver date of goods (Silva, 2013).

4. The Confirmed Order Lead Time represents the time between the Order Entry Date and the by the supplier confirmed delivery date of goods (Silva, 2013).

2.7 Workstation Design

A well-designed workstation is important for productive work. Most garment workers repeat the same or similar tasks throughout each shift, which, if performed efficiently and quickly, can result in greater productivity. Moreover, each workstation should be designed to suit the needs of the individual worker (dependent upon height, reach, size, etc.) and consider the type of machine being used and the task being performed. A well-organized workstation (and workplace), that is well-lit, free from chemical hazards and noise, and that minimizes material handling, will improve efficiency and reduce worker fatigue. Sometimes even minor ergonomic changes in the design of equipment, workstations or job tasks, that cost very little, can make significant improvements in worker comfort, health, safety and productivity.

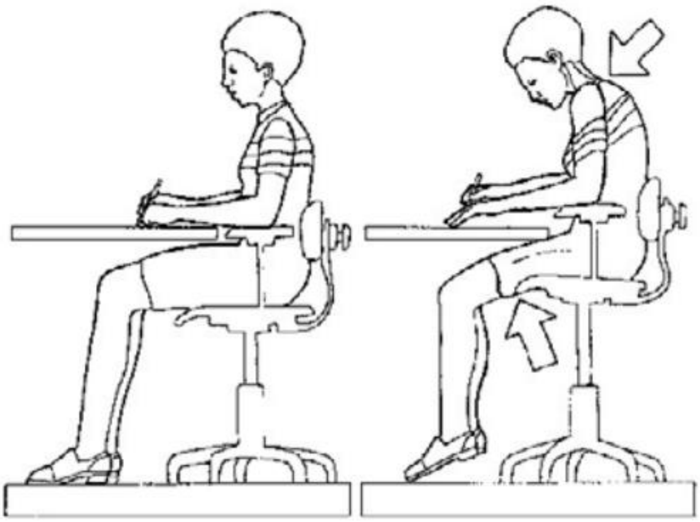

Figure 2.3 Good and bad posture of sitting position (coursehero, 2018)

In the Figure 3 we can see that the posture of women on the left are slightly bent because of the chair setting to high. This kind of posture can give a back and neck pain. Hence, by modified the workstation into the left one, the back pain and neck pain risk of injured can be reduced.

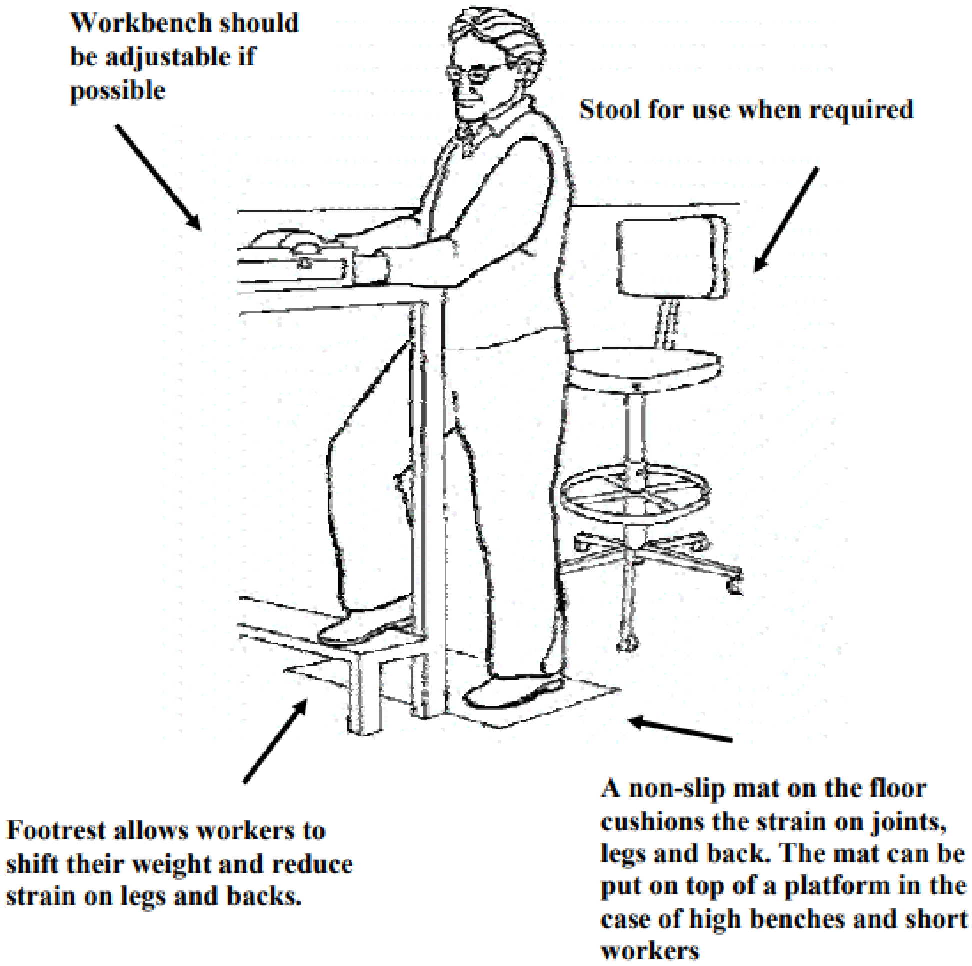

Figure 2.4 Ergonomic standing workstation (coursehero, 2018)

Many garment workers stand all day at their workstation. Standing for long periods on hard concrete floors, often in bare feet, can cause backpain, sore feet and tired muscles. If a job must be done in a standing position, a chair or stool should be provided for the worker so that he/she can sit down at regular intervals.

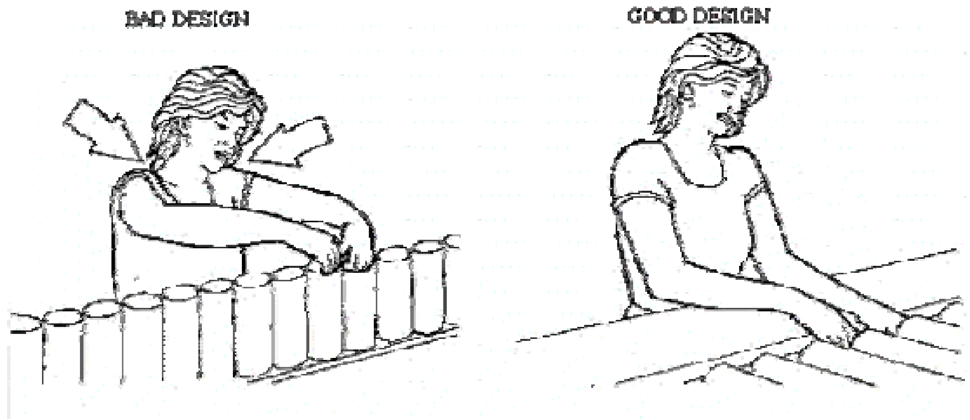

Figure 2.5 Height of the work bench (coursehero, 2018)

When considering the height of workbenches, the job should be designed to allow the worker to keep his/her arms low and the elbows close to the body, either by lowering/raising the bench if possible, or by raising the worker with a platform. A well-designed workstation is important for improving productivity. Improvements can be made by designing the way jobs are done so that the contents of the task and the methods in which they are carried out, consider individual workers. Many of these improvements are simple to introduce and cost very little.

2.8 Supply Chain Management

A supply chain is a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. Supply chain activities involve the transformation of natural resources, raw materials, and components into a finished product that is delivered to the end customer. In sophisticated supply chain systems, used products may re-enter the supply chain at any point where residual value is recyclable. Supply chains link value chains (Nagurney, 2006).

In commerce, supply chain management (SCM), the management of the flow of goods and services, involves the movement and storage of raw materials, of work-in-process inventory, and of finished goods from point of origin to point of consumption. Interconnected or interlinked networks, channels and node businesses combine in the provision of products and services required by end customers in a supply chain (Gordon,1999). Benefits of an integrated Supply Chain Management Systems include;

1. Lower Costs - By adding an effective SCM system to a business, the added global efficiency can lead to lower costs of raw materials. This system efficiently plans for materials to be brought to your company from the lowest cost provider possible and at just the right time to ensure there is no excess or deficiency in the material. A SCM system can improve your company's relationship with vendors so that there are opportunities to cut costs like through a volume discount.
2. Improved Collaboration - A SCM system wired in to the latest software allows you to know the position your raw materials and your finished products are in by tracking both your suppliers and your distributors. These companies can also track where you are at in receiving or sending those materials. This knowledge can keep relationships between these businesses strong. This system often includes the development of reports on how the chain of goods progresses from supplier through distributor. These reports help your businesses to determine potential areas of improvement.
3. Cycle Times - The cycle time can be defined as the time it takes your business to turn over a product from raw materials, give it to your distributor to sell and then make enough money to purchase new raw products to start the cycle over. If at any point it takes too long to obtain these raw materials, production may have to stop which will slow down your organization. A SCM system improves cycle times and ensures that raw materials are provided when your business needs them so that you never have to stop production.

2.9 Previous research

There are a lot of research that has been done around the world that has similarity or and connection with this final project. It is important to use the previous research as one of the basic in the final project, so we can know the fundamental element in the topic that has been chosen.

2.9.1 Path Process Chart - A technique for conducting time and motion study

There are many techniques for conducting time and motion study. This paper reports the development of a new technique called Path Process chart which studies both the path taken by the worker. By listing all the process step on the paper, the result can give information about process flow, equipment needed, time, etc.

Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S	TIME	EQPMT	REMARKS
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S	7.00		Enters
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S		sink	Goes to sink
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Washes hands
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S	7.01	Refr.	Goes to Refr.
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Takes out bread
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Goes to *R
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Takes out plate.Puts bread
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S		Refr.	Goes to Refr.
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Takes out butter
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Goes to *R
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S	7.02		Applies butter to bread
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S		Refr.	Goes to Refr.
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Takes out Cucumber
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S		sink	Goes to sink
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S	7.03		Washes cucumber
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Goes to *R
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Chops cucumber
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S	7.04		Places on bread
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S		Refr.	Goes to Refr.
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Takes out lettuce
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S		sink	Goes to sink
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Washes lettuce
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S	7.05		Goes to *R
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Chops lettuce on bread
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Takes out salt bottle
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Sprinkles on veg
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S			Covers with another bread piece
Do	*S	S	S*	*R	R	R*	RF	EA	1	2	3	AO	O	T	D	S	7.06		Picks up and leaves
													9	12		6			

Figure 2.6 Recording Path Process Chart (Magu, 2015)

2.9.2 *Virtual reality-based time and motion study with support for real walking*

This paper introduces a system that allows performance measurements of manual operations completely within a virtual environment. It will thus extend the existing MTM by novel capabilities such as walking and automatic transcription. Instead of physical mock-ups, virtual representations of workplaces and machines will be generated out of existing CAD data. As a significant extension of the existing MTM, real walking in such a virtual environment will allow perceiving sizes and distances, and thus to measure walking times of the worker in all levels. Instead of videotaping and later manual transcription of motions, all worker operations will be automatically captured and evaluated.

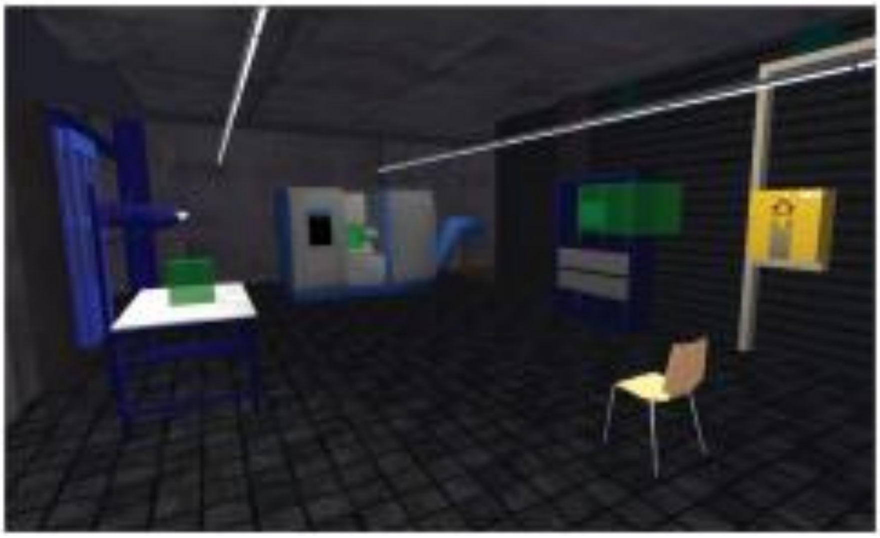

Figure 2.7 Screenshot of the virtual scene used for the evaluation (Kunz, 2016)

2.9.3 *A Time and Motion Study*

The object of this paper is to record the proportions of time expended on the various activities of the day in an individual practice; to show the need to assess one's methods at intervals. Using time and motion study method, this paper finds the standard time of a doctor need to do their job (Wood, 1961).

2.9.4 *Time motion studies in healthcare: What are we talking about?*

This journal is about implementing time motion study in biomedical. Not only using direct observation, the time motion study that implemented are considering survey, interview, etc. But, at the end of the journal, it stated that direct observation gives the largest impact and hopefully can maintain the use of time motion study in biomedical.

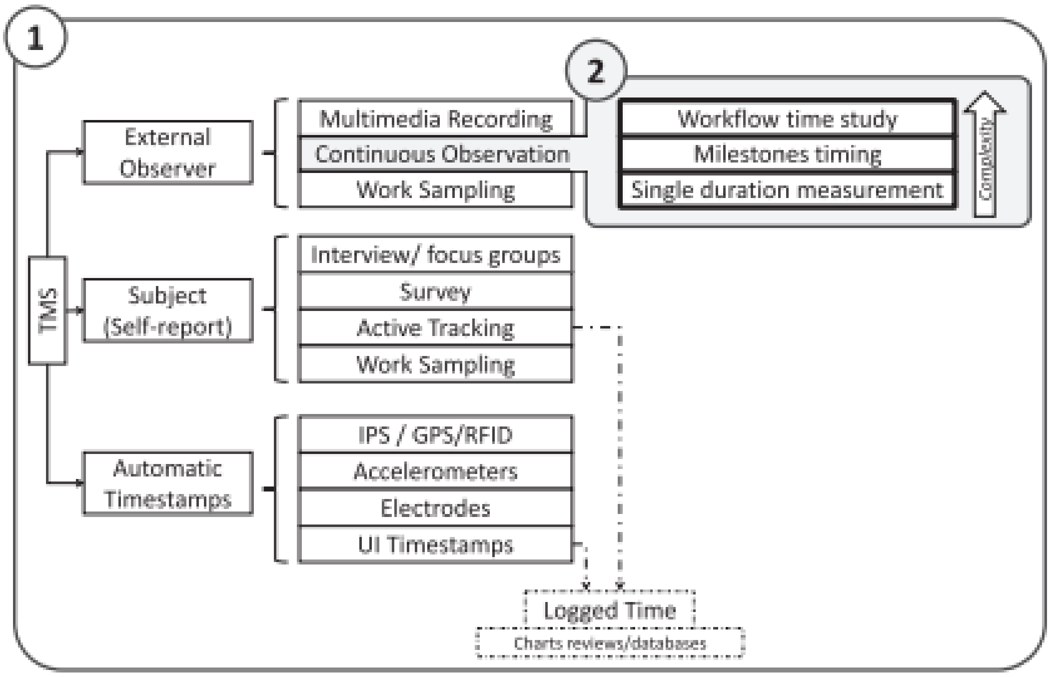

Figure 2.8 Time motion study method types (Lapotegui, 2014)

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CHAPTER 3
RESEARCH METHODOLOGY

This chapter describes the steps and methods of doing this research. This methodology is used as a guide for writing the final task to be more systematic and structured. The description can be seen from the explanation of each step or based on the flowchart on figure 3.1.

3.1 Literature review

The first stage in this research is the literature review stage to find out what information is needed and in accordance with this research. This stage is also the basis for conducting research. literature review that used as the basis, including Occupational Safety and Health, facility planning, motion time study, ergonomic, lean manufacturing, lead time, and workstation design.

3.2 Data Collection

At this stage of data collection, any data collection is needed to support this research. The data collected can be informed by the resource persons, information listed, and other literature sources. The interview will be done with the manager, this will give us information about everything that happened inside the factory while the production process is running. Moreover, secondary data and historical data would be collected to know if there are problems happened in the factory lately; especially in ergonomic aspect.

First, because if the limitation from the company to take a video of working process, the data taken only based on direct observation with stopwatch and list of the working step of the worker. Numbers of data that taken are based on the result of data adequacy from data processing. The first data taken for adequacy test are ten data. The focus of data taken are based on the roughly estimation of the number of workers can be reduce. The estimation is based on the current number of worker and the design idea. The new design is applied to collect the new time result, which will be tested with data adequacy test. To reduce the disturbance from the test, it is done at 3 P.M. -4 P.M. when the works are mostly done. Moreover, the workers that become the samples are the one with experience. This is done to reduce the number of data error due to the incompetence of the worker.

Thereafter, the data that gather are validated with production supervisor from PT.ICS. The validation process is based on comparison of the average time that the supervisor knew and the time that has been collected based on the stopwatch time. If there are some data that have large different, the data will be re-take to get the real result.

3.3 Data Processing

In data processing will discuss how the data from data retrieval will be processed. The data will be processed using motion time study, then by using adequacy test, the minimum samples are determined. From the result, the unnecessary movement is able to detect and can be reduced or even removed. Hence, it will be possible to create a new design with lower processing time. Moreover, the new design will be enhanced by considering the ergonomic aspect for the labor safeties.

The first processing is the adequacy test, to determine how much data have to be taken. After the data is enough, the next step is redesigning process. The redesigning process is created based on the distance, necessities, and the value added. After the new designs are made, the design gets consulted with the production supervisor to determine whether it is possible to use the design or not. Sometimes the problem of applying the new design is the availability of the budget, because of PT.ICS is a new company which really have a tight budget to spend.

After the designs are approved, the data retrieval test done again with the new design application as the observation. If the time is higher or the same, then the design needs to redesign again to get better process time. Moreover, in creating the design, the ergonomic aspect needs to consider to reduce the risk of getting injured while working.

3.4 Analysis

In the analysis, the first to analyze is the current work process, whether the current design has an efficient work process or not and what is the problem that creates the design no efficient. Next is tool design, it is analyzing which part of the design can be developed to create a more efficient design. The third is analyzing the worker habit, the worker there is mostly high school graduate, hence it is needed to analyze the working pattern and the habit of the worker. Some of the solutions that given can reduce the efficiency to one and another, therefore it is considered to be important to analyze it. The last is to analyze the benefit of the solution is implemented. Based on the number of workers reduced and the risk reduced by implementing ergonomic aspect. The benefits analysis is done for both the workstation design and the conveyor placement design.

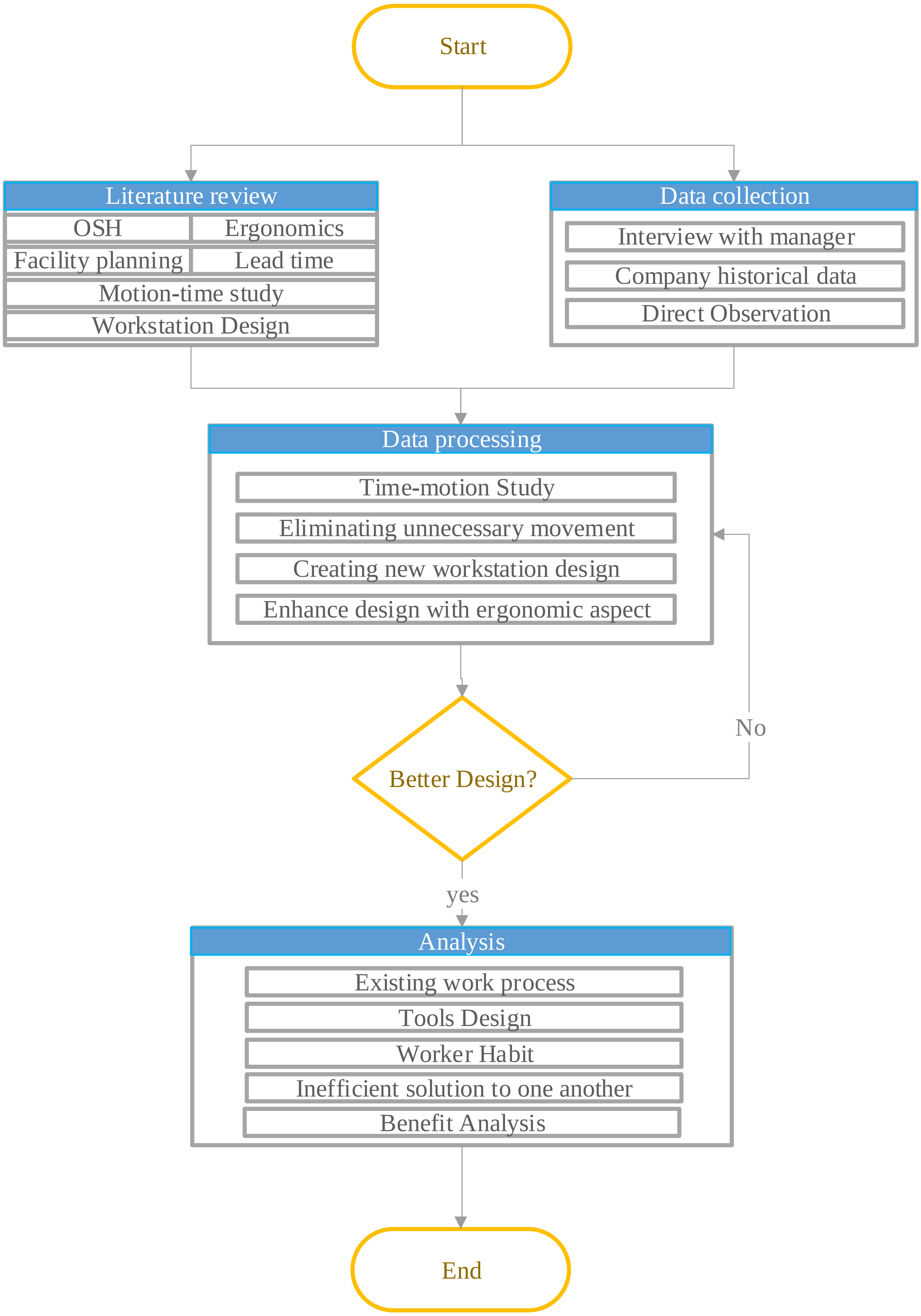

Figure 3.1 Flow Chart of Research Methodology

CHAPTER 4
DATA PROCESSING

This chapter will be discussing the existing company process flow and the problem that the company has. the problem will be processed by using motion time study and other methods from facility planning.

4.1 Company Process Flow

In Value Added there are several different products, such as shrimp ekkado, shrimp kekian, shrimp rollade, cheese shrimp ball, shrimp siomay, lolyfish, fish meatball, fish scallop, fish sausage, fish cake, and shrimp surimi.

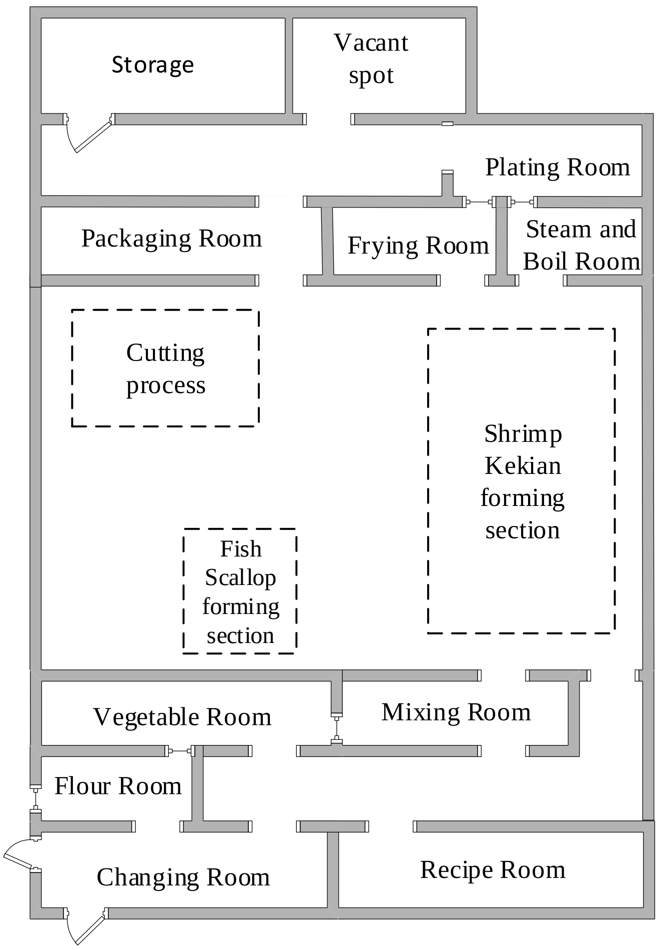

Figure 4.1 Value Added factory layout

But in this final project only fish scallop and shrimp kekian that get observed, due to limited time and data availability. Fish scallop and shrimp kekian got similar ingredients, hence it produces at the same time. moreover, when the observation was conducted, products that produce by Value Added are fish scallop and shrimp kekian. The company shop floor design can be seen in figure 4.1. The factory layout of Value Added is not efficient, because when it was built there is no planning for the further expansion, new machine, etc. Now there are some spots that unused and some problem when the factory wants to expand or applied big machine.

The production processes flow in the factory are shown in figure 4.2, it shows the process from the raw material preparation until the last stored in the cold storage. The processes that both of product need to went through are marked by the red line, for the process that only through by the scallop are mark by the blue line and the process that only through by shrimp kekian are mark by the brown line. It can be seen in figure 4.2 that PT ICS have a lot of material and product movement that back and forth through the cold storage, which is not efficient for the production process.

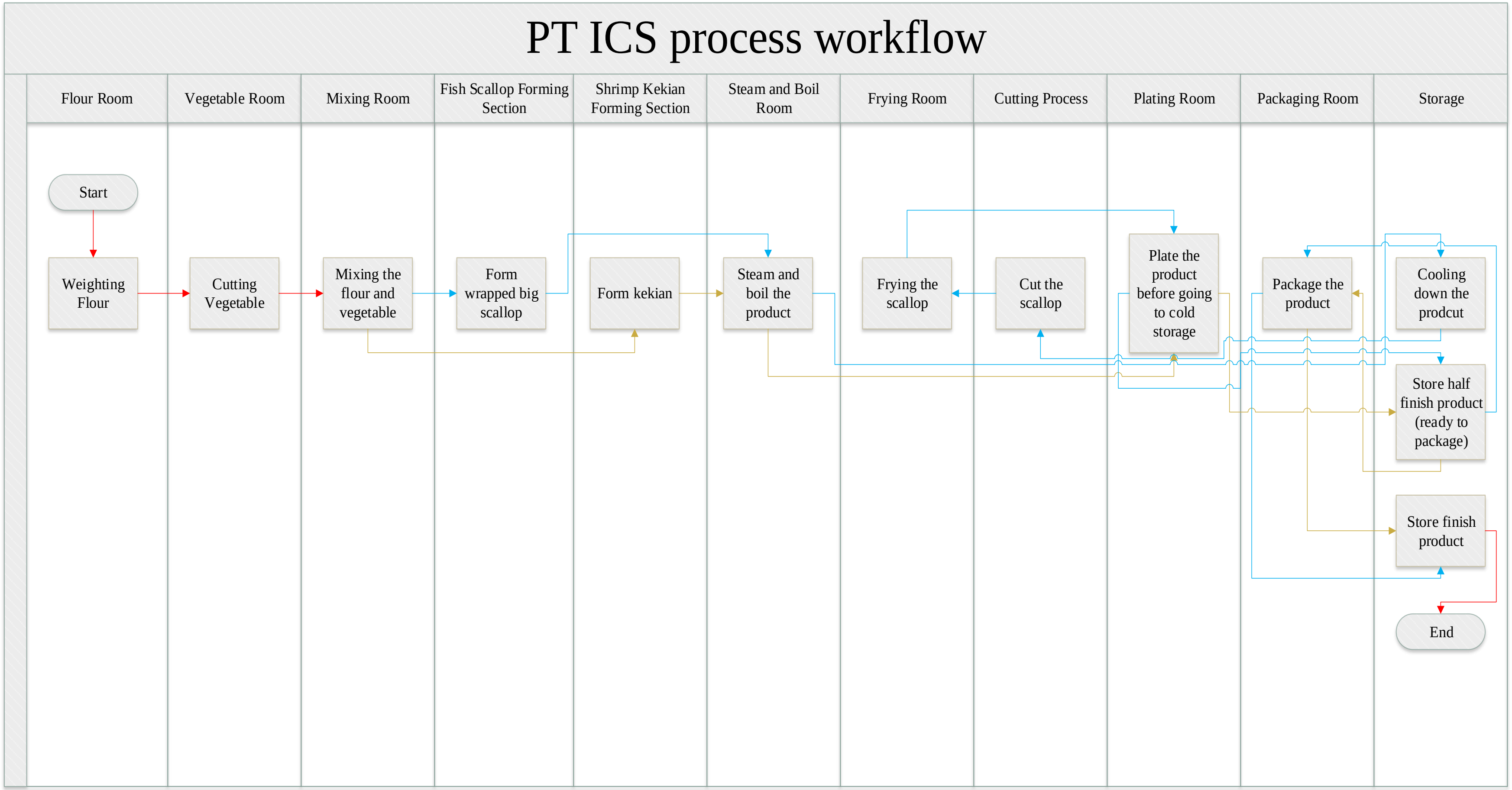

Figure 4.2 PT ICS Workflow Diagram

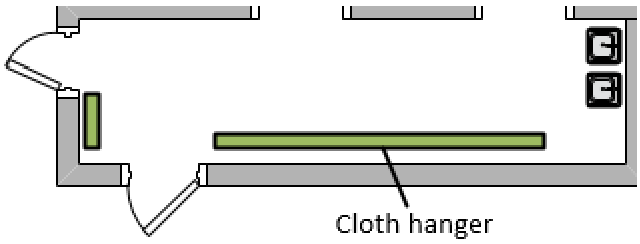

Figure 4.3 Changing room

PT.ICS is concerned about keeping their product clean and sterile, hence every person that want to go inside the factory need to use special clothes and wash their hand using alcohol. This procedure must be done in the changing room which can be seen in figure 4.3, both put on the special clothes and take it off. It is needed to keep the clothes sterile from unwanted bacteria and virus.

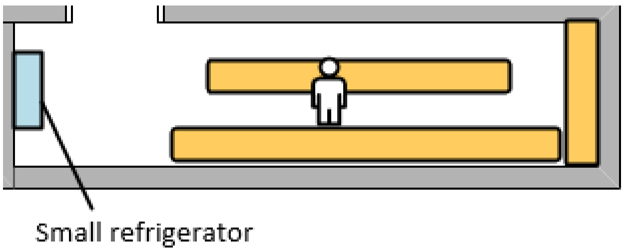

Figure 4.4 Recipe room

All recipes of Value Added are made in recipe room which can be seen above. Here the test and formula making are created and conducted. This part of the room is the only one that not connected in the daily production process, but still become the important part in the development of Value Added products.

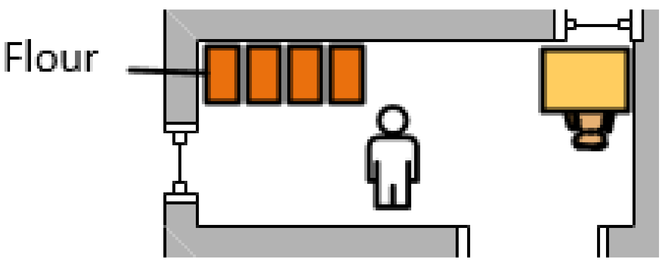

Figure 4.5 Flour room

Flour room that can be seen in figure 4.5 is where different kinds of flour are stock and process before used in production. There are two windows in flour room, one for receive flour from outside and the other to send flour to the vegetable room. In the morning based on the production schedule, the worker in flour room will mix and weigh the flour to be used in production process per batch. Moreover, the worker will also record numbers of flour used, hence it will be easy when data about the number of flours are needed.

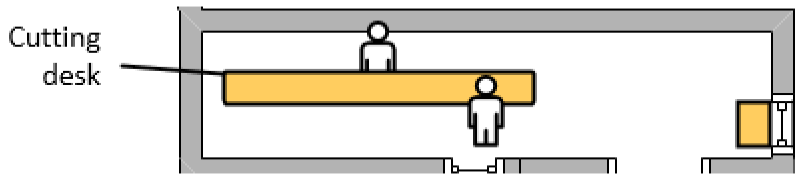

Figure 4.6 Vegetable room

Vegetable and fish are processed in Vegetable room, not like flour room, vegetable and fish that used for production are stored in storage outside the factory. Hence based on the production schedule and volume. The worker will take the necessary amount of vegetable and fish from the storage in the morning. As we can see in figure 4.6, after cutting vegetable and fish that necessary for one batch production, the vegetable, fish, and flour will be sent to mixing room through a small window.

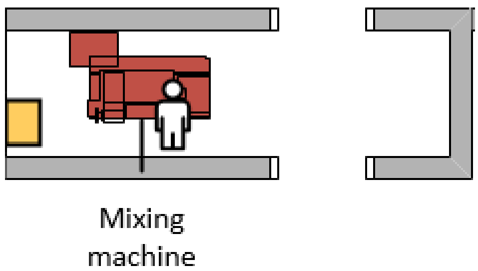

Figure 4.7 Mixing room

In mixing room, the vegetable, fish, and flour are mixed using automatic machine. All of them mixed into a dough that will be used in production process. From figure 4.7, we can see that there is a table to put the ingredients in the vegetable room. From the mixed room, the dough will be used in both fish scallop and shrimp kekian, one will go to shrimp kekian forming section and the other one goes to scallop forming section.

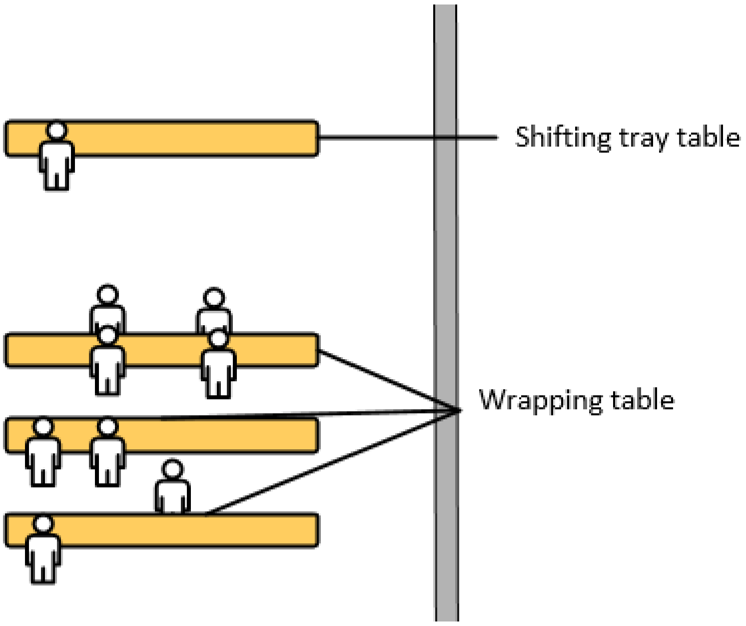

Figure 4.8 Shrimp kekian forming section

In shrimp kekian forming section the dough is wrap with a thin layer of flour sheet. As shown in figure 4.8, there are two workstations, the wrapping table and shifting tray table. There are several people that weigh the dough and others wrap the dough in wrapping table. After the number of raw shrimps kekian is enough, it needs to be put in the tray one by one before got steamed in shifting table. After the tray is full, it moved to steam and boil room.

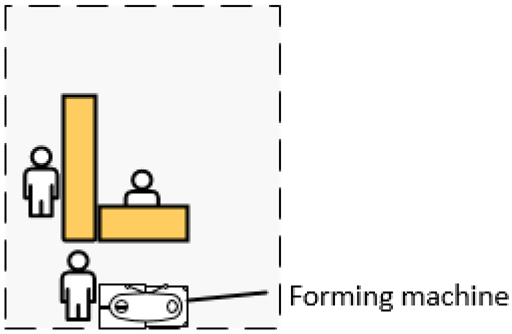

Figure 4.9 Fish scallop forming section

We can see in figure 4.9 more efficient method is used in fish scallop forming section, this part of the process uses a semi-automatic machine. The machine is operated by 3 workers, one to press the on and off button, one to hold the plastic while the process is running, and the other holding plastic for the next process. After the plastic filled with the dough, both ends of the plastic is tied, and the dough will have big sausage shape. After that, the plastic is poking to create small holes which use to release air when the dough got boil in the next process. Next, the dough brought to steam and boil room which can be seen in the figure below.

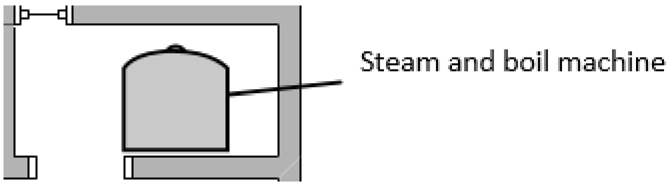

Figure 4.10 Steam and boil room

Some process parts are not starting when the beginning the factory started, steam and boil room are one of the process parts that need to be prepared before the process can be run. In the morning the worker that has the responsibility in steam and boil room are pre-heating the machine and cleaning the workstation. The machine can be used after one hour of pre-heating, it is not disturbing the production process because the steam and boil room needs to wait for the material come from the forming sections.

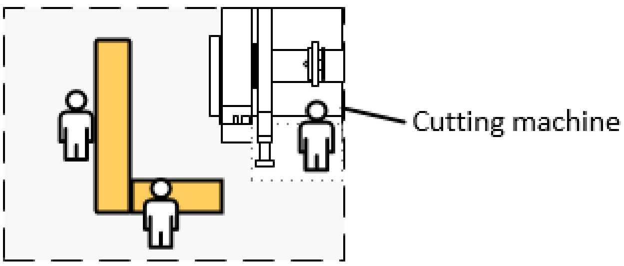

Figure 4.11 Cutting process

As we can see in figure 4.11, the fish scallop that has been boiled will go to the cutting process, the cutting part will have divided into two. The first cutting part is done by machine and the other is done manually. The cutting process that done using machine will leave some part of the product which will be cut manually by the worker.

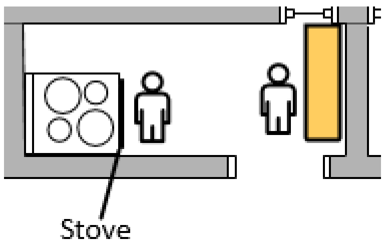

Figure 4.12 Frying room

After fish scallop cut, some of them will be fried in frying room that can be seen in figure 4.12 and some others will be put in the storage. This happens because the frying process can only accommodate to process half of the production every day. Hence, sometimes the factory stops produce fish scallop because the storage is full. Same as steam and boil room frying process also need to do pre-heating process before it can be used in production process.

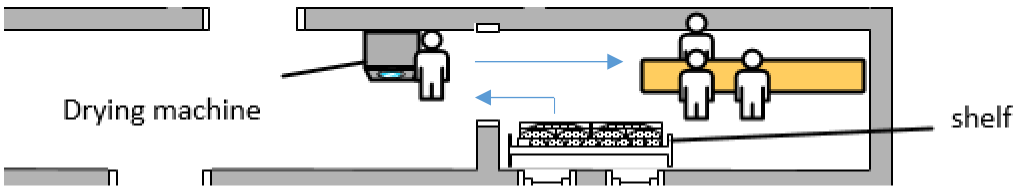

Figure 4.13 Platting room

Scallop that has been fried and the shrimp kekian that has been steamed will be arranged in plating room before saved in the storage. Both are passed through a small window on frying room and steam and boil room and put on the shelf, as we can see in figure 4.13. Shrimp kekian that pass will directly plate on a tray, on the other hand, scallop needs to be processed using a machine to remove the excessive oil. The plating process cannot operate in the early production process, because it needs to wait for the production from frying and steam process. Hence, the workers in plating room do some cleaning and helping to move half-finished product and material that want to be used.

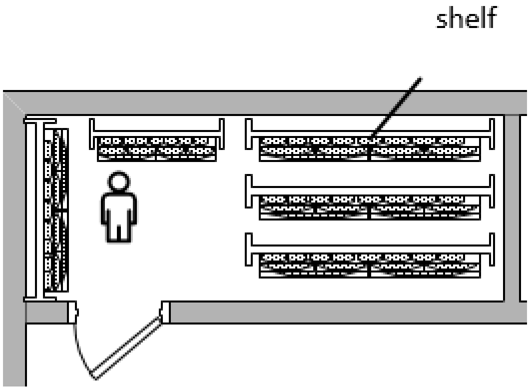

Figure 4.14 storage

The storage in figure 4.14 is a cold storage to keep the product quality, the storage does not only keep the finished product but also half-finished product and material that haven’t processed such as dough and unfried scallop.

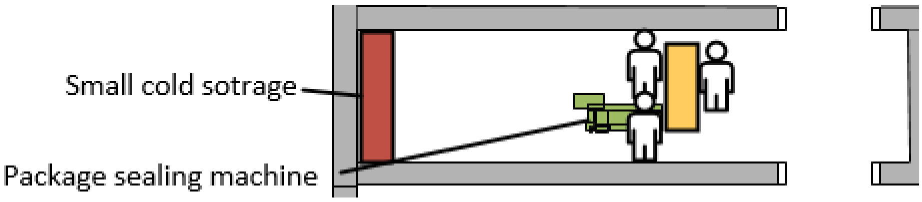

Figure 4.15 Packaging room

The last process is packaging process, as can be seen in figure 4.15, the packaging process is divided into two part, but the product inside the package and seal the package. To put the product in the package, the worker did manually without any helping tool. On the other hand, the sealing is done with a semi-auto machine. To cope up with the difference in speed, there are three workers to put the product inside the package and one to seal the package.

4.2 Problems Identification and Solution

4.2.1 Wrapping Table

Every worker that work as a dough wrapper needs to get dough supply from dough maker. The dough wrapper needs the dough from dough maker before they can start their job. Dough wrapper that works in the same table with the dough maker have small moving time to get the dough, but the other tables have higher time to get the dough because of the distance.

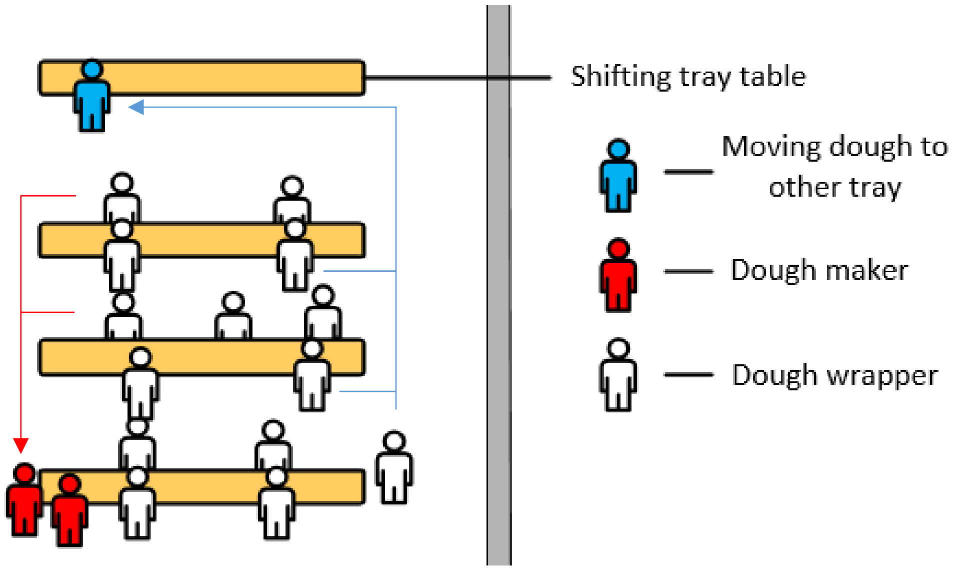

Figure 4.16 Current workstation design in PT.ICS

Current workstation design is not considering the travel distance of each individual, in fact, the time needed for dough wrapper to go to dough maker can have an impact on the production process. It can be seen in figure 4.16, centralizing raw material that needed by other workstation can lead to high process time due to the unnecessary movement of material. Not only the unnecessary of movement, the distance increase the laziness of the worker to move from their workstation to the dough maker.

By using stopwatch time study method, it can calculate the average time needed by the dough wrapper to get the dough from dough maker. First, is finding the data adequacy, after that find the data needed to be based on the adequacy test result. The result of the average per table then will be averaged to get the average time to get the dough per worker in one product.

Table 4.1 Dough Wrapper Time to Get Dough Adequacy Test

No	Table 1 (second)	Table 2 (second)	Table 3 (second)
1	5.34	33.3	70.3
2	5.4	32.6	68.2
3	5	34.4	75.4
4	4.9	30.2	77.7
5	5.5	31.4	76.9
6	5.45	35.7	73.2
7	5.33	32.1	72.7
8	5.12	32.2	71
9	5.27	34.9	74.7
10	5.4	33.6	73.9
Average	5.271	33.04	73.4
Standard deviation	0.199969442	1.676769381	2.974334659
adequacy data	**2.211634579**	**3.95766223**	**2.523246491**

From table 4.1, table 1 need three workers to get sufficient data, table 2 need four workers and table 3 need three workers as sample. The average that will be used is the average that gather from the sample test data from table 4.2-4.4.

Table 4.2 Table 1 Average Time to Get the Dough

Table 1 (second)			
No	**Worker 1**	**Worker 2**	**Worker 3**
1	5.44	5.48	5.22
2	5.10	5.10	5.39
3	5.16	5.02	5.11

Table 4.2 Table 1 Average Time to Get the Dough (cont.)

Table 1 (second)			
No	**Worker 1**	**Worker 2**	**Worker 3**
4	5.48	5.22	5.09
5	5.50	5.26	5.38
6	5.28	5.13	5.42
7	5.46	5.12	5.05
8	5.32	5.06	5.41
9	5.34	5.39	5.06
10	5.01	5.26	5.28
Average	5.31	5.21	5.24
Total Average			**5.25**

Table 4.3 Table 2 Average Time to Get the Dough

Table 2 (second)				
No	**Worker 1**	**Worker 2**	**Worker 3**	**Worker 4**
1	30.34	32.81	30.83	31.91
2	31.18	30.72	34.16	34.72
3	32.00	34.26	33.56	32.46
4	31.39	30.07	33.76	30.90
5	30.26	30.31	33.72	31.74
6	31.32	32.78	30.86	33.21
7	34.58	33.41	30.21	30.76
8	33.37	31.39	34.38	31.03
9	30.24	33.50	34.47	34.85
10	33.88	30.33	34.48	32.11
Average	31.86	31.96	33.04	32.37
Total Average				32.31

Table 4.4 Table 3 average time to get the dough

Table 3 (second)			
no	**worker 1**	**worker 2**	**worker 3**
1	70.34	72.23	70.54
2	71.03	73.30	68.01
3	68.62	69.75	73.39
4	68.73	72.03	70.31
5	69.25	69.76	72.17
6	71.13	73.83	72.54
7	73.99	69.98	73.22
8	72.40	70.37	73.92
9	69.96	69.09	70.34
10	69.20	73.83	70.80
average	70.46	71.42	71.52
total average			**71.13**

Total average time per worker = $(\bar{X}_1N_1 + \bar{X}_2N_2 + \bar{X}_3N_3) / N_{total}$.................... (1)

The average time per worker on the current workstation design is 31.4 second, 1 batch of taking the dough is 10 doughs. Hence there is additional 3.14 second in dough wrapping process to take the dough from dough maker. This time will include in calculating dough wrapping process time. Moreover, there is also additional time for bringing the wrapped dough to shifting tray table. The product bought to shifting tray in batch, every batch have 100 pieces of product. Thus, the total time of bringing the dough to shifting tray need to divide by 100. The average time is 3 minutes, so the average time per product is 1.8 seconds.

Table 4.5 Current total process time

no	**job description**	**time (second)**
1	taking dough	3.14
2	taking flour sheet	4.7
3	put the dough	2.3

Table 4.5 Current total process time (cont.)

no	job description	time (second)
4	wrap the dough	14.4
5	put wrapped dough to tray	1.7
6	bring wrapped dough to shifting tray	1.8
total process time		**28.04**

To create the new design, method that been used is applying supply chain management into current production process. By considering the distance between each worker, the best position of dough maker can be found. With formula:

$MinZ = \sum_{0}^{n} D_n$ .... (2)

n = Number of dough wrapper

D = Distance from dough maker to dough wrapper

In choosing the most efficient placement of dough maker, trial and error test are done in this designing. The first design that created is put both of the dough makers in the middle. The problem occurs when the outside part of the left and right table wants to get the dough because the worker needs to go around the table to reach the dough wrapper.

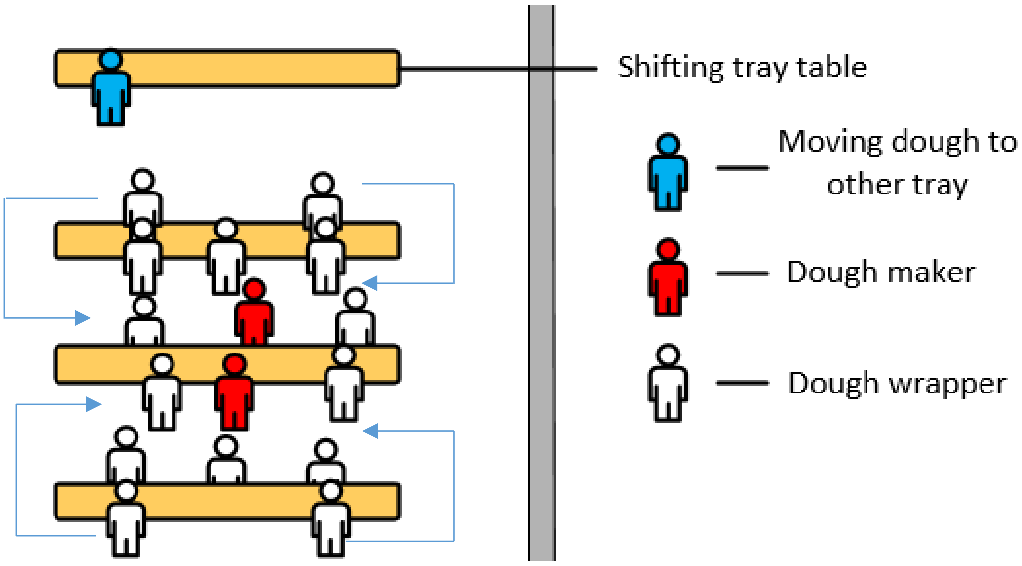

Figure 4.17 Wrapping Table first design

The new design of workstation has a smaller gap between dough maker and dough wrapper. The dough makers are not centralized in one point but separated into two table. Therefore, the time needed for a worker to taking the dough can be reduced. The dough maker is placed on the right side and left side table, hence table in the middle can get the dough from both of them depending which one is the closest.

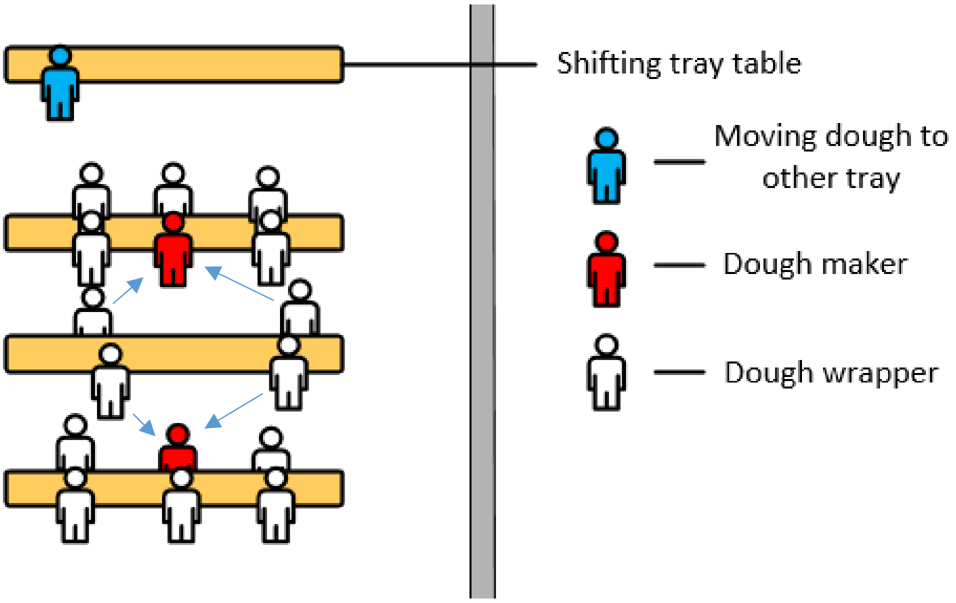

Figure 4.18 Wrapping table new design

The dough makers are placed on the right side and left side table, hence table in the middle can get the dough from both of them depending on which one is the closest. On top of that, every table now have the same number of people, so the working space can be divided evenly.

Table 4.6 Dough wrapper time to get dough adequacy test (new design)

no	table 1 (second)	table 2 (second)	table 3 (second)
1	4.4	28.6	4.6
2	4.9	27.8	4.7
3	4.7	28.4	4.4
4	5.2	29.4	4.8
5	4.6	25.3	4.9

Table 4.6 Dough wrapper time to get dough adequacy test (new design) (cont.)

no	table 1 (second)	table 2 (second)	table 3 (second)
6	4.5	26.9	4.2
7	4.3	27.7	4.5
8	5	29.6	4.5
9	4.9	28.7	4.8
10	5.2	28	4.9
avg	4.77	28.04	4.63
std	0.319895816	1.253616989	0.231180545
adequacy data	**6.911184655**	**3.071467001**	**3.831005001**

From table 4.6, table 1 need seven workers to get sufficient data, table 2 need four workers and table 3 need four workers as sample. The average that will be used is the average that gather from the sample test data from table 4.7-4.9.

Table 4.7 Table 1 average time to get the dough (new design)

Table 1 (second)								
no	**worker 1**	**worker 2**	**worker 3**	**worker 4**	**worker 5**	**worker 6**	**worker 7**	**worker 8**
1	4.43	4.39	4.44	4.84	4.41	4.42	4.70	4.92
2	4.13	4.44	4.42	4.37	4.53	4.49	4.89	4.27
3	4.61	4.71	4.02	4.17	4.36	4.02	4.11	4.81
4	4.06	4.11	4.22	4.20	4.28	4.82	4.82	4.68
5	4.93	4.19	4.84	4.82	4.14	4.51	4.88	4.02
6	4.49	4.91	4.84	4.69	4.31	4.31	4.70	4.40
7	4.39	4.52	4.11	4.33	4.06	4.13	4.17	4.90
8	4.67	4.27	4.51	4.15	4.45	4.04	4.66	4.45
9	4.45	4.61	4.08	4.21	4.14	4.03	4.66	4.65
10	4.95	4.95	4.50	4.09	4.06	4.18	4.35	4.40
average	4.51	4.51	4.40	4.39	4.27	4.29	4.59	4.55
total average								**4.44**

Table 4.8 Table 2 average time to get the dough (new design)

Table 2 (second)				
no	**worker 1**	**worker 2**	**worker 3**	**worker 4**
1	28.58	27.68	25.51	26.39
2	27.67	25.38	26.67	27.88
3	29.09	29.22	26.38	26.80
4	25.45	28.53	25.43	25.91
5	27.86	27.62	25.27	28.42
6	28.93	25.96	27.57	28.82
7	26.13	25.26	25.78	28.21
8	26.73	28.70	28.09	28.95
9	29.47	25.83	28.36	29.43
10	26.87	29.50	29.51	29.31
average	27.68	27.37	26.86	28.01
total average				**27.48**

Table 4.9 Table 3 average time to get the dough (new design)

Table 3 (second)				
no	**worker 1**	**worker 2**	**worker 3**	**worker 4**
1	4.27	4.53	4.65	4.64
2	4.81	4.31	4.21	4.33
3	4.25	4.04	4.60	4.93
4	4.17	4.07	4.99	4.71
5	4.97	4.49	4.44	4.13
6	4.89	4.21	4.69	4.98
7	4.83	4.20	4.78	4.96
8	4.71	4.75	4.61	4.08
9	4.71	4.67	4.27	4.22
10	4.92	4.83	4.51	4.15
average	4.65	4.41	4.58	4.51
total average				**4.54**

Table 4.10 new design total process time

no	job description	time (second)
1	taking dough	1.24
2	taking flour sheet	4.7
3	put the dough	2.3
4	wrap the dough	14.4
5	put wrapped dough to tray	1.7
6	bring wrapped dough to shifting tray	1.8
	total process time	**26.14**

Moreover, the worker that has a job to move the wrapped dough to another tray in shifting tray table can work something that actually needed in a process. The process of moving dough taking 992 seconds on average per batch with the worker average speed 1.24 second per piece. The boiling tray is too big to put in wrapping table, hence by creating a tray that has specification as a steaming tray with 1/8 size of the actual steaming tray could speed up the process time. After the wrapping process is done, the worker can put the tray directly to the bigger tray, because of this, the worker in shifting table can do another job that is necessary. Another small tray can be put beside the shifting tray table.

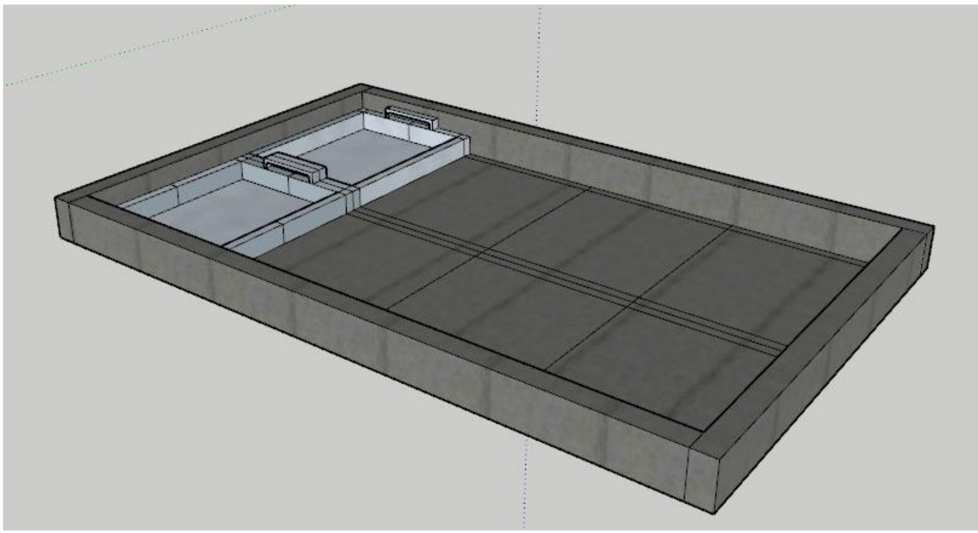

Figure 4.19 new design tray

4.2.2 Scallop Forming

In scallop forming section, they use a machine to put the dough in a plastic container. The plastic container has tube shape and the tube shape scallop will be cut later into smaller pieces. After the dough put into a plastic container, plastic will be tied and poke by a needle to create a hole. This hole is needed as an airway out when the scallop is boiled. The machine workstation, use three persons as the operator, first to hold the plastic, second for holding plastic when the process is running, and the last is for turning the machine on and off.

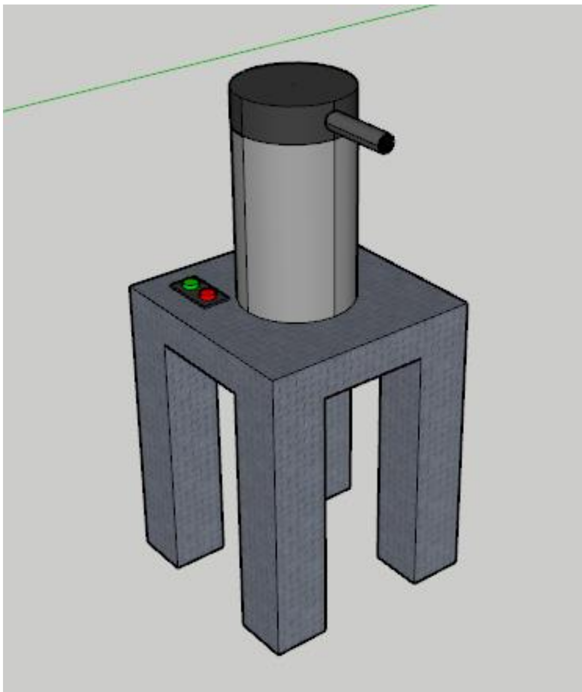

Figure 4.20 Scallop forming machine

The used of three persons to do this job is unnecessary, this job can be done by one person. The first operator that only holding the plastic to use in every process sequence can be replaced by a table and the on and off button can be done while holding the plastic (figure 4.21). The plastic that needs to behold when the process is run can be held by one hand, and the other hand can click the on and off button. It becomes easier for the worker because the worker that holding the plastic also can handle the on-off button, which reduces the probability of late pushing the off button and makes the plastic overload. Moreover, as can be seen in figure 4.22, the plastic is change, from two holes in both end into one hole. Before the worker need to grab both ends when filling, but with one hole the worker only needs to hold one side of the plastic. The closed end plastic also needs a small hole to let the air out when the filling process is run.

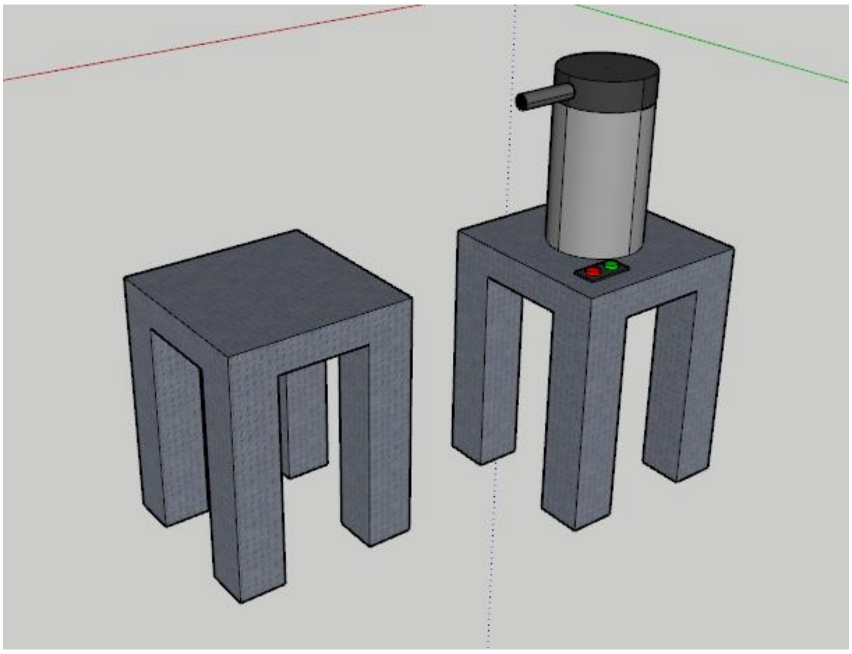

Figure 4.21 Scallop forming machine new design

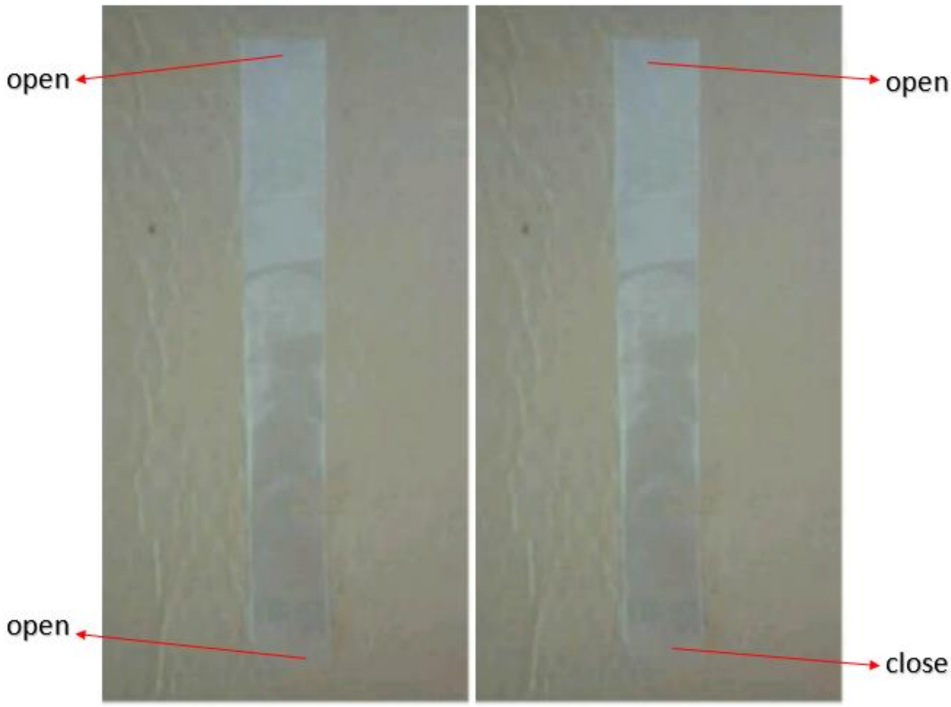

Figure 4.22 Before and after plastic container hole

4.2.3 Frying Room

The capacity of frying process is not enough to cover scallop production every day, so the company wants to increase the number of the stove. The problem is they don't know whether they need to increase the number of the workers or not. Right now, there are 2 persons in frying process, one for frying the scallop and the other taking the scallop from the storage.

Table 4.11 Frying time adequacy test (second)

no	**take and put scallop to stove**	**stirring**	**taking out the scallop**	**idle**
1	12.0	10.7	10.4	119.4
2	11.8	10.5	10.4	117.7
3	12.4	10.9	10.4	106.5
4	12.4	11.3	9.9	118.5
5	11.4	11.2	10.0	114.1

Table 4.11 Frying time adequacy test (second) (cont.)

no	take and put scallop to stove	stirring	taking out the scallop	idle
6	11.4	10.5	10.0	114.3
7	12.3	10.3	10.2	117.1
8	11.3	10.2	10.3	114.5
9	12.2	10.5	9.8	113.9
10	12.2	11.2	10.4	114.6
avg	11.9	10.7	10.2	115.1
std	0.5	0.4	0.2	3.6
adequacy data	**2.2**	**2.1**	**0.8**	**1.5**

From table 4.11, take and put scallop to stove need three workers to get sufficient data, stirring need three workers, taking out scallop need one worker, and idle test need two worker as sample. The average that will be used is the average that gather from the sample test data from table 4.12-4.15.

Table 4.12 Take and put scallop to stove average time

take and put scallop to stove (second)			
no	**worker 1**	**worker 2**	**worker 3**
1	11.0	11.1	11.1
2	11.6	11.7	11.6
3	12.3	11.4	12.4
4	11.7	12.3	11.9
5	11.2	12.2	11.3
6	11.7	12.1	12.0
7	11.9	12.1	12.1
8	11.8	11.8	11.6
9	11.5	12.2	11.3
10	12.1	11.4	11.3
average	11.7	11.8	11.7
total average			**11.7**

Table 4.13 Stirring average time

stirring (second)			
no	**worker 1**	**worker 2**	**worker 3**
1	10.7	10.7	10.6
2	10.0	10.3	10.1
3	10.5	11.2	10.1
4	10.2	10.4	10.8
5	10.5	10.6	11.5
6	10.6	10.1	10.3
7	10.4	11.4	10.6
8	10.0	10.3	10.1
9	10.1	11.4	11.4
10	11.4	11.1	11.3
average	10.4	10.7	10.7
total average			**10.6**

Table 4.14 Taking out scallop average time

taking out the scallop (second)	
no	**worker 1**
1	9.8
2	10.4
3	10.0
4	10.2
5	10.2
6	10.2
7	9.8
8	9.6
9	10.2
10	9.9
total average	**10.0**

Table 4.15 Idle average time

idle (second)		
no	**worker 1**	**worker 2**
1	111.3	117.0
2	118.3	118.4
3	105.3	108.6
4	115.2	106.2
5	115.8	115.9
6	111.0	110.2
7	107.2	109.9
8	107.4	115.1
9	118.8	117.9
10	107.5	107.2
average	111.8	112.6
total average		**112.2**

Table 4.16 Total frying time

no	job description	time (second)
1	take and put scallop to stove	11.7
2	stirring	10.5
3	taking out scallop	10
4	idle	112.2
total process time		**144.4**

The other worker in frying room has job take the scallop from the storage and prepare it before it cooked. He needs to go to storage, take the scallop, bring the scallop to the frying room, and prepare it before it cooked. The worker brings eight trays of scallop and each tray has three plastics from storage each period, and one plastic have 144 second of total process time.

Table 4.17 Frying preparation time adequacy test

no	frying room to storage (second)	taking scallop in storage (second)	storage to frying room (second)	Preparation for frying (second)
1	291.7	175.7	261.5	104.1
2	257.1	172.2	272.0	101.6
3	289.2	151.6	296.6	104.8
4	273.6	165.3	282.1	109.4
5	259.3	158.6	293.7	103.1
6	259.9	169.1	280.1	103.9
7	268.7	169.6	264.0	108.2
8	273.3	176.6	273.9	115.2
9	256.6	170.8	285.1	111.5
10	274.5	166.3	293.3	116.4
avg	270.4	167.6	280.2	107.8
std	12.7	7.7	12.3	5.2
adequacy data	**3.4**	**3.2**	**3.0**	**3.6**

From table 4.17, from frying room to storage need four workers to get sufficient data, taking scallop form storage need four workers, from storage to frying room need three workers, and preparation need two workers as sample. The average that will be used is the average that gather from the sample test data from table 4.18-4.21.

Table 4.18 Frying room to storage average time

frying room to storage (second)				
no	**worker 1**	**worker 2**	**worker 3**	**worker 4**
1	262.4	266.3	280.4	277.6
2	280.6	259.1	257.2	288.5
3	279.5	291.1	286.2	277.0
4	250.4	258.5	269.3	292.7
5	284.8	284.2	299.8	263.6
6	292.0	290.4	270.3	266.3
7	297.1	289.4	288.3	257.5
8	256.2	282.1	274.9	284.3
9	274.6	281.1	293.3	293.2
10	253.5	265.7	262.8	298.5
average	273.1	276.8	278.2	279.9
total average				**277.0**

Table 4.19 Taking scallop inside the storage average time

taking scallop in storage (second)				
no	**worker 1**	**worker 2**	**worker 3**	**worker 4**
1	172.1	172.3	153.0	176.3
2	167.8	167.7	165.1	150.7
3	166.1	162.2	169.7	176.0
4	166.7	161.6	163.5	175.1
5	163.3	177.1	172.4	150.8
6	170.4	151.1	174.0	165.8
7	167.0	171.2	156.1	179.7
8	179.0	159.9	156.0	167.0
9	160.7	159.9	171.5	153.9
10	150.2	151.5	172.1	178.7
average	166.3	163.4	165.3	167.4
total average				**165.6**

Table 4.20 Storage to frying room average time

storage to frying room (second)			
no	**worker 1**	**worker 2**	**worker 3**
1	293.4	278.2	267.1
2	258.8	295.8	276.2
3	272.6	259.5	271.4
4	274.1	259.1	298.7
5	271.1	296.3	259.8
6	270.5	269.3	279.5
7	254.7	280.6	284.0
8	280.8	266.7	289.1
9	268.9	255.2	274.2
10	253.4	289.5	267.9
average	269.8	275.0	276.8
total average			**273.9**

Table 4.21 Preparation average time

Preparation for frying (second)				
no	**worker 1**	**worker 2**	**worker 3**	**worker 4**
1	107.6	102.6	100.6	114.8
2	103.7	103.6	106.7	105.9
3	107.9	119.0	110.7	112.8
4	105.5	100.4	116.9	113.5
5	112.2	116.6	101.5	103.4
6	118.3	108.3	104.5	116.0
7	117.5	102.5	118.7	109.3
8	109.4	117.1	103.5	113.4
9	103.4	107.9	109.0	113.2
10	105.5	102.5	113.8	111.1
average	109.1	108.0	108.6	111.3
total average				**109.3**

Table 4.22 Total average time to prepare before frying

no	job description	time (second)
1	frying room to storage	277
2	taking scallop	165.6
3	storage to frying room	273.9
4	preparation for frying	109.3
total process time		**825.8**

4.2.4 Plating Room

In plating room, there are some issues in ergonomic workplace design. The design of this station is not considered the worker posture while worker. Moreover, the worker often got back pain after working due to repeating movement. The repeating movement can be worst if the workstation design not considering the ergonomic aspect. It can lead to back pain, sprain, strain, etc.

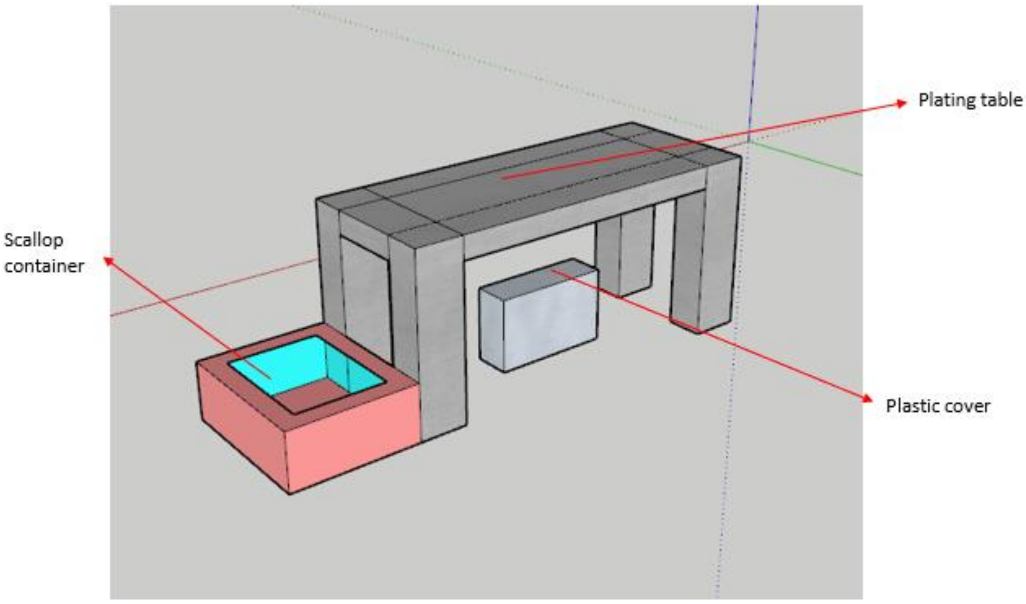

Figure 4.23 Plating room design

In one storage tray, it can be stacked up to four stacks. Each stack will be layered by a plastic cover to prevent the product to stick with each other. The positioning of plastic cover placement become an issue, as can be seen in figure

4.23, because the height is too low and there is a table on top of it, make it harder to reach. Moreover, the scallop that has been dried from the oil, will be put in the scallop container that put on the side of the table with unproportionable height. Hence it makes the worker need to bend over to take the scallop before plating on the table.

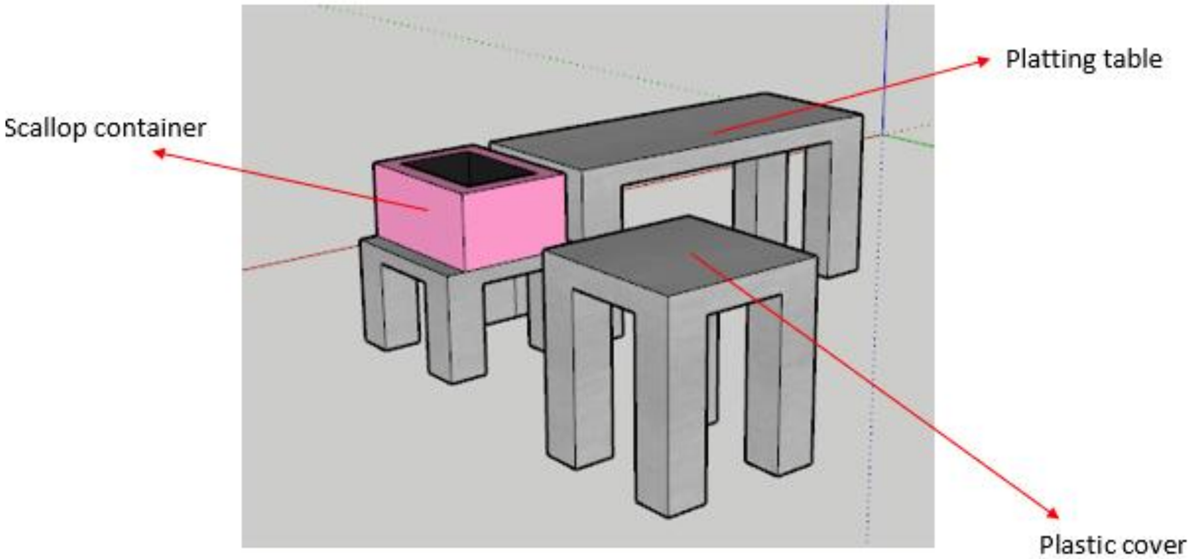

Figure 4.24 Plating room new design

In new design (figure 4.24), the scallop container has a small table under it to make the scallop container have enough height for the worker to reach with a good position. As well as the plastic cover, the plastic cover placement moved into the table near the platting table. Therefore, the worker can easily grasp the plastic cover without having to bend over. There is no significant difference in time, but this design is focused on reducing the possibility of worker ill due to work. Based on "antopometri Indonesia" the height of Indonesian people elbows on age 20-21 (average PT.ICS worker) is 95.75 cm, with 95th percentile at 110.14 cm. Hence, creating a table with height from 95.75 cm – 110.14 cm will fulfill some of the ergonomic aspect requirement and reduce the risk of getting injured due to work.

On the other hand, to reduce the process time, some tools to help the worker to plate the product need to be applied. the current condition is the worker move the product manually into the storage tray without any helping tool. Hence, creating or using tools to help the worker moving the product can reduce the process time of platting the product in the storage tray.

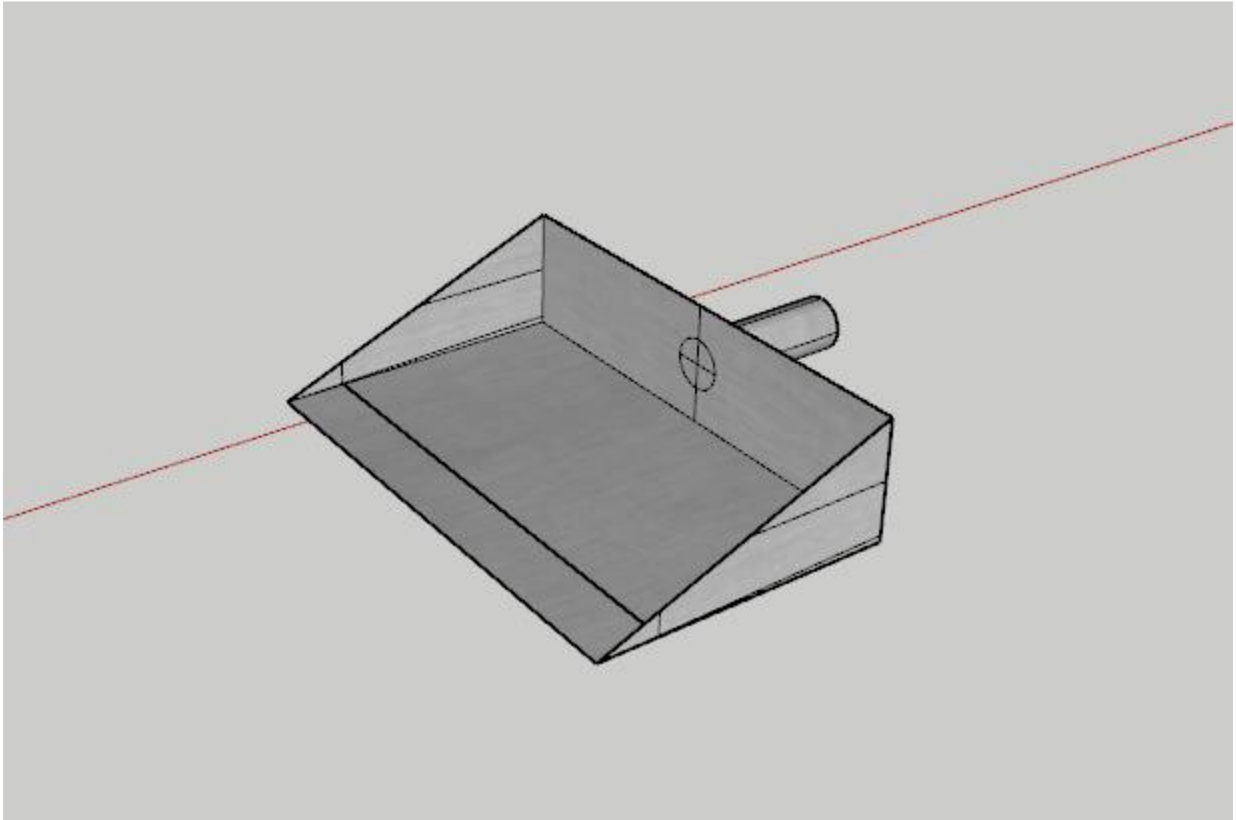

Figure 4.25 Tool to help plating the product

Using this tool in figure 4.23, the worker can take 20 products at a time. But, because there are walls on each side of the tray, this tool cannot be used from the beginning. The worker needs to do it manually until two rows of the tray are empty then the tool can be used. The test of the tool is done using similar shape product ("Pengki Kecil"). Based on "Antopometri Indonesia" the palm of Indonesian people with age between 20-21 have wide of 9 cm with 95th percentile in 10.65 cm. in this design using the 95th percentile is better, because if the worker has a big hand, the worker will have a problem in gripping the tool's handle.

Table 4.23 Plating adequacy test

no	platting with hand (second)	plating with tool (second)
1	1.4	0.5
2	1.4	0.3
3	1.2	0.4
4	1.1	0.4
5	1.4	0.5
6	1.2	0.5
7	1.4	0.4
8	1.1	0.4
9	1.5	0.5
10	1.4	0.5
avg	1.3	0.4
std	0.2	0.1
adequacy data	20.8	21.4

.

4.2.5 Packaging Process

The problem in packaging process is the same as in plating room, the worker in packaging process work manually without any tool to help. First, the worker put the scallop by hand, then weight the product. after that, the product is sealed using a semi-automatic machine. Using the tool to help the worker in putting the scallop the package can reduce the process time.

Moreover, because the worker handles the process manually and no process standardization, the method that the workers use is vary from each other. Most of the method that used is to take the scallop one by one to reduce the error possibility. The other method is used by the more experienced worker, the experienced worker just takes grasp of scallops and put in the package. Even though this method has lower process time, but the error is higher.

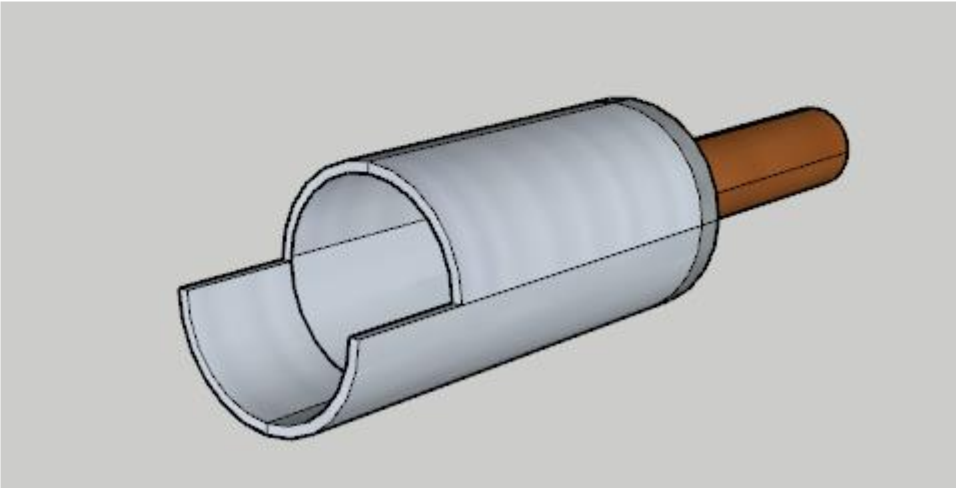

Figure 4.26 Tool to help package the product

The ways of working with this tool in figure 4.26 are by determining the height of the tube, which will determine the number of scallops that will take the tool. Using repeating test and the probability distribution, it can be determined the height which the tool has lowest error point. Hopefully, with this tool, the worker can work faster and have a low error.

4.2.6 Conveyor Placement and Benefit

PT.ICS have a plan to increase the capacity of the Value-Added cold storage by creating a new building beside current Value-Added factory. The problem is to keep the high-quality product, it cannot move in the high-temperature area. Hence, as the solution PT.ICS want to use conveyor from each building. On top of that, the use of conveyor can reduce the number of the worker for at least one person, so the calculation of conveyor benefit is needed.

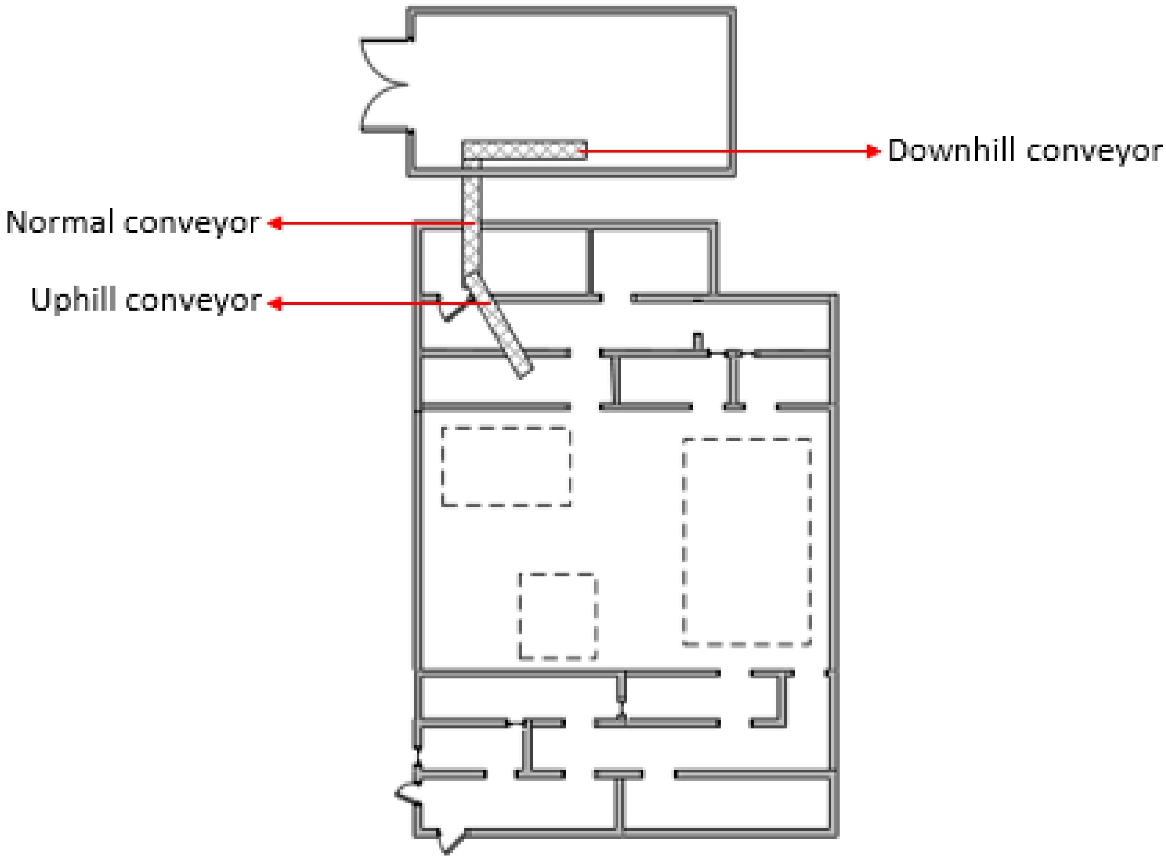

Figure 4.27 Conveyor placement plan for storage expansion

The design that PT.ICS creates is by combining uphill, normal, and downhill conveyor (figure 4.27). The uphill conveyor is needed because the conveyor path is crossing with worker walking path to and in storage. In consequence, downhill conveyor is needed in the storage so the worker able to reach the conveyor. The uphill conveyor will have height more than the worker, but PT.ICS have not calculated how long the conveyor or the slope of the conveyor. On the other hand, the new design in figure 4.28 only uses standard conveyor. But the placement of the workplace is reassembled.

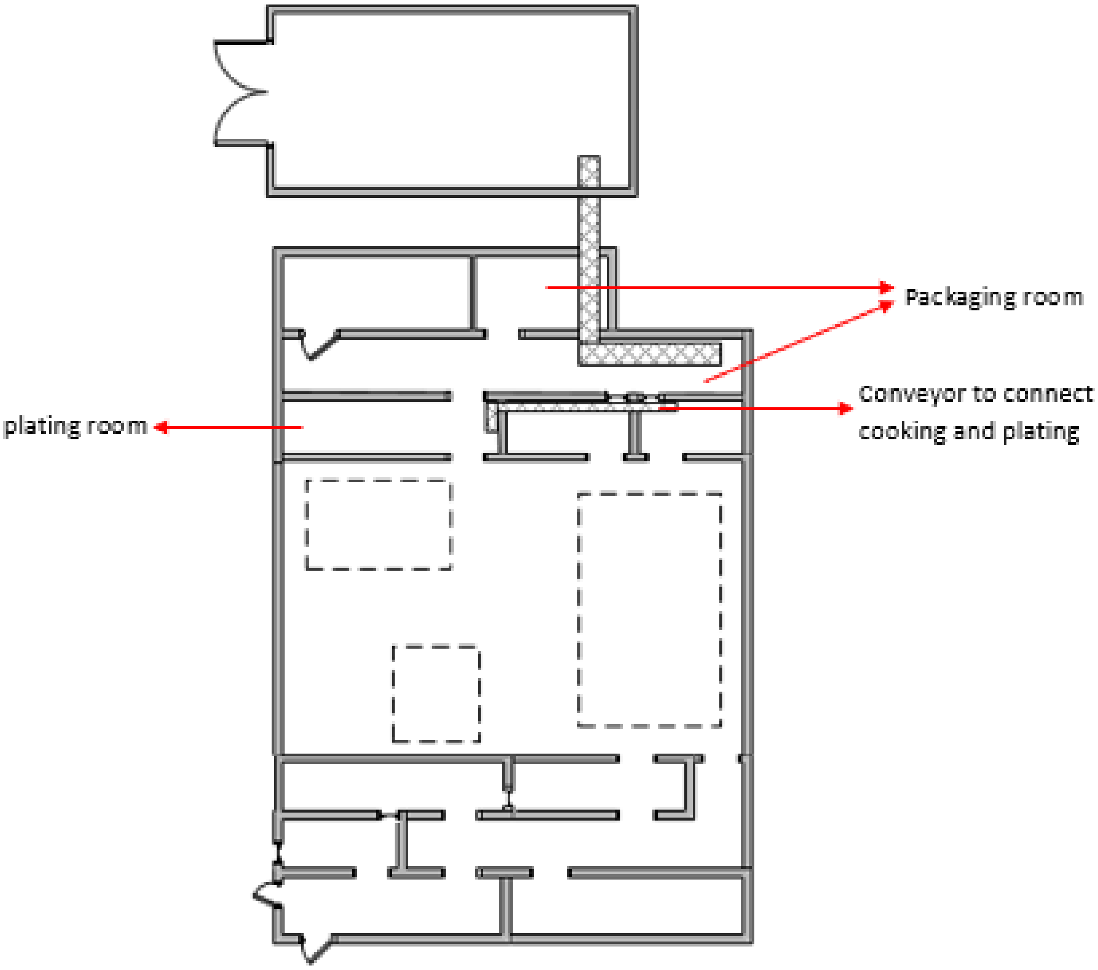

Figure 4.28 New conveyor design for storage expansion

CHAPTER 5
ANALYSIS

This chapter will discuss the analysis that has been made based on the result of data processing result. Moreover, there is also analysis that made based on the discussion with the supervisor from PT.ICS, associated with the other problem which may occur in applying the solution.

5.1 Existing Work Process

The facility planning did not become the priority for the company when building the factory. Yet, only some parts of the process are back and forth which make the production flow not efficient. Moreover, most of the production process is done manually because of the factory still new. This makes the production process time is really depended on the worker productivity.

On the other hand, some of the processes have low capacity compare to other. This creates a bottleneck which sometimes makes the production process of certain product stop. Moreover, the half finish product will fill up the storage. Storage becomes an important aspect of the factory, it determines how much the company can produce and how many products need to sell. It became one of the reasons PT.ICS want to build another storage.

5.2 Tools Design

In order to reduce the production time, the tool can be used to help the worker. The tool that users can be bought or made, depending on the needs. When the tools that needed are high quality and high number in quantity, it is better for a company to buy from a vendor. Unless the company has a worker that can produce the tool with desired specification and quality.

The tool designs from chapter 4 are a rough design which hopefully can reduce the production time in PT.ICS. Hence, it is clear that the tool designs have a lot of deficiency and ineffectiveness. The materials of the product have not thought thoroughly, the materials that have been chosen are aluminum and steel. The consideration in choosing the material only the ability of the material to not poison the food and able to withstand the load. On contrary, the tool materials actually need to consider the weight and the surface part. The weight of the tool should be light enough so the worker can operate it easily, moreover, the surface of the grip should be rough, so the worker hand not slip when using the tool. Even more, the durability of the tools also needs to become a consideration, in order to reduce the cost when comparing the buying or making cost and the usability benefit. Consequently, the production or buying process of the tools need to be calculated. It is important for the company to reduce the price of the tools as low as possible but still considered the desired quality.

On top of that, the design that has been shown in chapter 4 have not used any specific method which calculates the slope, height, etc. Therefore, a further study about the tool design needs to be conducted to be able to get the most effective and efficient tools to use. The design is important because it can fulfill the user or worker needs, which can increase production process efficiency, durability, and reduce the production cost.

5.3 Worker Habit

Changes can be hard for some people, it makes people need to adapt and leave their old habit. But in order to develop and evolved, a company needs changes which will affect the worker inside the company. Sometimes, when a company tries to develop, their worker become the obstacle. Some company fire the one that fails to adapt and changes with other in order to develop, some other choices to wait and fail to develop the company.

In PT.ICS, most of the workers are high school graduate. High school graduate worker has the tendency to have a chat with other while working and lazy when doing their job. Based on the information from the production supervisor in PT.ICS, the worker needs to be seen to work properly. This can become a problem in company development because even the company applied changes but the worker did not do it properly, the changes will not work.

After consulting with the production supervisor, the method that will take is using Closed Circuit TV (CCTV). With this method the supervisor can observe the worker while they work anytime, the cost of the CCTV has been considered by the company and got accepted. The CCTV installation place will be each corner of the room with the highest viewpoint. Moreover, in order to make the worker can cooperate with company changes, the worker needs to get some training. Some benefit of training the workers are (authenticityconsulting,2018):

1. Increased job satisfaction and morale among employees
2. Increased employee motivation
3. Increased efficiencies in processes, resulting in financial gain
4. Increased capacity to adopt new technologies and methods
5. Increased innovation in strategies and products
6. Reduced employee turnover

5.4 Inefficient Solution to One Another

In chapter 4, there are two solutions that would make them not efficient if both of the solutions are applied compare if only one of the solutions applied. Even though in total using both of solutions will be better, but, finding solutions for the problem would be even better.

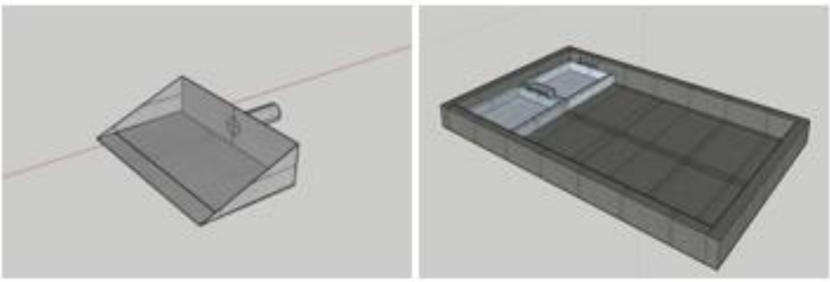

Figure 5.1 Solution for reducing processing time in PT.ICS

As can be seen in the figure above the first solution that is given in chapter 4 is creating smaller tray to reduce the time for placing the product in the cooking tray. The second solution is creating a tool to increase the speed of moving the product to storage tray in plating room. The problem is the designed tool have a deficiency which makes the worker need to move the two rows of the product before using the tool because the tool will hit the tray’s wall if it is not done. Hence, applying the first solution will increase the amount of product that needs to handle manually before the tool can be used.

5.5 Benefit Analysis

From the changes that have been given to PT.ICS, there would be some benefit that PT.ICS will get. The benefits that can get by PT.ICS is increased in production speed, reduce the number of workers, and reduce the potential risk of a worker getting injured because of work. The number of the workers can be reduced by reducing the process time needed or redesign a workstation to remove unnecessary tasks which can be done by one person or helping tool.

In wrapping table, the average time per worker on the current workstation design is 12.38 second, 1 batch of taking the dough is 10 doughs. Hence there is additional 1.24 second in dough wrapping process to take the dough from dough maker. With this design, the time needed to take the dough is reduced by 60%. Moreover, it reduces the production process time of dough wrapping by 7%, which means the company can reduce the worker in dough wrapping station by 1 person (14-person x 7%).

In scallop forming, the old workstation design needs three persons to operate the machine. With the new design, the machine can be operated by one operator and table to place the plastic container. Hence the number of the worker reduce by two.

In the whole process of frying the scallop, 77% of the time, the worker is idle. Calculating from the data above, it can be concluded that one person can handle up to three stoves and still have time for idle. Moreover, the stove that they use is already in a bad condition. Broken frying handle lead in high taking out scallop time. The normal fryer has a handle to take out things that fried in the stove, but because the handle is broken, the scallop took out using a spatula. The other task is preparing the scallop before frying, the total time to take and prepare 8 trays scallop is 13.7 minutes, on the other hand, the process time to fry the scallop is 57.6 minutes. Hence by using the available time, the worker can do another job, such as put the scallop and kekian into boil and steam room.

Because of the deficiency of the tool that used in platting room, the first 40 product need to handle manually. Hence, the total of process time using plating tool for one tray (800 pieces) is 356 second, and the plating process time without a tool is 1040 second. Moreover, the worker that trying the tool is have not adjusted to it. With a tool to help the worker, it reduces the process time by almost 60%. Thus, because of the total number of workers are four persons, it can be reduced by two persons. Even though the scallop process cannot use this particular tool, but the other products can use it. The reason is that the only scallop that needs to go through the process which reduces the oil content and put into scallop container, which makes the scallop not lined up with each other.

Table 5.1 Total number of workers reduced

no	workstation	number of workers reduced	explanation
1	wrapping table	1	process time reduced by 7% X number of workers (14)
2	scallop forming	2	redesign the workstation into 1 operator
3	frying room	1	the worker who need to take the scallop is substitute by the one in the shifting tray table
4	platting room	2	the job can be done faster by the help of the tool
total		**6**	

In PT.ICS, because the workers are high school graduate, the wage per person is low. In average the worker got paid Rp 1,250,000 per month, and every year paid thirteen times including the bonus. This is done by the company to reduce the cost of labor and to increase the economic condition around the factory. In a year, by reducing six workers, the company can save Rp 97,500,000. Moreover, because some workstation design in the factory are not considering the ergonomic aspect and got a redesign, the probability of injury risk because of working are reduce.

5.6 Conveyor Placement Design

There are several problems in the PT.ICS design, first, the uphill and downhill conveyor have a higher risk to drop the product. When the worker fails to place the product in right position, it is often to happen for the product to fall (And,1993). Second, when the conveyor path is uphill, it means the distance needed increase and the electric power is increased because it needs more energy. That means it will need more cost in buying and running the conveyor

In this design, the packaging and plating room is switch position. The old plating room is used as the packaging part and the vacant room are used to seal the package. Moreover, there is additional conveyor to connect the boiling and steaming room, frying room, and new plating room. It seems to need more cost than before, but because the work is done now can be directly put into conveyor it reduces the needs of increasing number of worker. While the first design needs to increase their work to move the product to the conveyor.

Table 5.2 Profit for using conveyor to replace one worker

no	name	Price/quantity
1	machine price	Rp 5,449,000
2	number of machines	10
3	electricity price (kwh)	Rp 1,467
z	Electricity needed (Kw)	0.5
5	working hour per day	7
6	maintenance	Rp 2,724,500
7	worker wage	Rp 1,250,000
profit per year		**Rp 6,576,940**
profit per machine life time (10 years)		**Rp 65,769,398**

Profit per machine lifetime =

$$(worker\ wage\ x\ annual\ wage\ x\ number\ of\ worker)$$
$$-(machine\ price\ x\ number\ of\ machine)$$
$$-(electricity\ price\ x\ electricity\ needed\ x\ working\ hours\ per\ day)$$
$$-(maintenance\ x\ 10)$$

The profit of using conveyor to replace one worker is Rp 6,576,940 per year, with maximum of Rp 65,769,398 if the conveyor able to work for average conveyor lifetime. The conveyor maintenance is 5% of conveyor price. While it seems costly, but by doing that it gives higher change for conveyor to keep operating in maximum performance for 10 years.

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CHAPTER 6
CONCLUSION AND SUGGESTION

Chapter conclusions and suggestions are explained about the conclusions that can be taken in this study. A section in this conclusion also discusses conformity with the objectives to be achieved in this research. In the Suggestions section is discusses suggestions or recommendation provided for future research.

6.1 Conclusion

The conclusions in this study should be in conformity with the research objectives described previously. The conclusions in this study were obtained from the development process, testing, and calculation. Here is a conclusion from facility planning in PT.ICS.

1. The working environment in the factory are affected by the design of the workstation. Creating a good design with considering the ergonomic aspect can help the worker to work easier and safer. Moreover, the workstation that considering ergonomic aspect would have faster processing time due to the worker can do the task easier. It also reduces the risk of the worker getting hurt because of work, which can be a problem for the company.
2. Creating efficient workstation design means remove the unnecessary things in the workstation while the production process is running. The unnecessary things are varied, it can be movement, repeating process, too many worker (which lead to too low workload). By using motion time study, it is possible to detect which part are unnecessary or taking too much time and can get reduced. Hence, it is possible to create a new design that have less unnecessary things and the process time can be reduce. The result of the reduced process time can be reduced number of worker or increase number of productivities.
3. The solution may help PT.ICS to reduce numbers of workers approximately six persons, which can save Rp 97,500,000 a year.

4. Using automatic machine such as conveyor can increase the working speed and reduce in cost, if using conveyor can reduce one worker, it can save Rp 6,576,940 per year.
5. The designs of the tools are not effective yet, because there is no calculation in designing the tool.

6.2 Suggestion

1. Make sure to get permission to take video of the production process to increase the data validity and accuracy.
2. Calculating all the process time, hence as the result it possible to do line balancing to increase the production output.
3. If it necessary to create the tool, create some automatic or semi-automatic tool.

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ATTACHMENT

Wrapping process adequacy test

no	**taking flour sheet**	**put the dough**	**wrap the dough**	**put wrapped dough to tray**	**bring wrapped dough to shifting tray**
1	4.8	2.3	14.3	1.6	1.6
2	4.5	2.3	14.6	1.7	1.7
3	4.8	2.2	14.4	1.7	1.8
4	4.5	2.2	14.2	1.7	1.6
5	4.9	2.2	14.4	1.7	1.6
6	4.8	2.3	14.7	1.7	1.6
7	5.0	2.0	14.6	1.6	1.7
8	4.7	2.3	14.3	1.6	1.9
9	4.8	2.2	14.9	1.8	1.8
10	4.9	2.3	14.3	1.7	1.7
avg	4.8	2.2	14.5	1.7	1.7
std	0.2	0.1	0.2	0.1	0.1
adequacy data	**1.6**	**2.6**	**0.4**	**2.5**	**4.5**

Average time to take flour sheet

taking flour sheet (second)		
no	**worker 1**	**worker 2**
1	4.9	4.6
2	4.9	4.7
3	4.6	4.8
4	4.7	4.6
5	4.9	4.7
6	4.5	4.7

taking flour sheet (second)		
no	worker 1	worker 2
7	4.9	4.7
8	4.6	4.9
9	4.7	4.6
10	4.6	5.0
average	4.7	4.7
total average		**4.7**

Average time to put the dough

put the dough (second)			
time	worker 1	worker 2	worker 3
1	2.2	2.4	2.5
2	2.4	2.1	2.1
3	2.4	2.3	2.4
4	2.2	2.3	2.4
5	2.3	2.5	2.2
6	2.3	2.4	2.1
7	2.3	2.3	2.3
8	2.3	2.1	2.2
9	2.2	2.2	2.2
10	2.1	2.2	2.3
average	2.3	2.3	2.3
total average			**2.3**

Average time to wrap the dough

wrap the dough (second)	
time	worker 1
1	14.4
2	14.3
3	14.0

wrap the dough (second)	
time	**worker 1**
4	14.4
5	14.0
6	14.8
7	14.7
8	14.1
9	14.9
10	14.8
average	**14.4**

Average tie to put wrapped dough on tray

put wrapped dough on tray (second)			
time	**worker 1**	**worker 2**	**worker 3**
1	1.6	1.6	1.6
2	1.8	1.6	1.7
3	1.7	1.7	1.8
4	1.8	1.6	1.6
5	1.5	1.7	1.7
6	1.7	1.5	1.8
7	1.6	1.7	1.7
8	1.7	1.8	1.6
9	1.7	1.5	1.6
10	1.7	1.8	1.6
average	1.7	1.7	1.7
total average			**1.7**

Average time to bring wrapped dough to shifting tray

bring wrapped dough to shifting tray (second)			
time	**worker 1**	**worker 2**	**worker 3**
1	1.6	1.8	1.7
2	1.6	1.8	1.9
3	1.9	1.9	1.8
4	1.8	1.7	1.6
5	1.8	1.8	1.7
6	1.9	1.7	1.8
7	1.8	1.9	1.7
8	1.7	1.8	1.7
9	1.8	1.9	1.7
10	1.8	1.7	1.8
average	1.8	1.8	1.8
total average			**1.8**

Average time to platting with hand

platting with hand (second)										
time	**worker 1**	**worker 2**	**worker 3**	**worker 4**	**worker 5**	**worker 6**	**worker 7**	**worker 8**	**worker 9**	**worker 10**
1	1.0	1.4	1.1	1.2	1.3	1.3	1.3	1.4	1.1	1.1
2	1.1	1.1	1.1	1.0	1.5	1.2	1.4	1.1	1.4	1.5
3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.2	1.3
4	1.4	1.0	1.3	1.2	1.5	1.2	1.1	1.2	1.4	1.5
5	1.5	1.0	1.3	1.0	1.2	1.1	1.5	1.2	1.4	1.4
6	1.2	1.1	1.3	1.0	1.3	1.1	1.5	1.2	1.3	1.2
7	1.4	1.5	1.3	1.3	1.3	1.2	1.3	1.1	1.3	1.2
8	1.4	1.2	1.3	1.4	1.4	1.2	1.2	1.2	1.2	1.2
9	1.0	1.4	1.1	1.0	1.1	1.1	1.4	1.4	1.3	1.2
10	1.5	1.5	1.2	1.3	1.1	1.4	1.4	1.3	1.2	1.1

platting with hand (second)										
time	worker 1	worker 2	worker 3	worker 4	worker 5	worker 6	worker 7	worker 8	worker 9	worker 10
average	1.3	1.2	1.2	1.2	1.3	1.2	1.4	1.2	1.3	1.3

Average time to platting with hand (cont.)

platting with hand (second)											
time	worker 11	worker 12	worker 13	worker 14	worker 15	worker 16	worker 17	worker 18	worker 19	worker 20	worker 21
1	1.2	1.0	1.2	1.3	1.1	1.3	1.2	1.0	1.2	1.2	1.1
2	1.3	1.4	1.0	1.3	1.2	1.1	1.3	1.3	1.2	1.5	1.2
3	1.2	1.0	1.4	1.4	1.5	1.4	1.3	1.0	1.1	1.5	1.2
4	1.4	1.1	1.0	1.4	1.2	1.4	1.4	1.4	1.5	1.0	1.1
5	1.3	1.3	1.3	1.2	1.2	1.4	1.4	1.1	1.3	1.4	1.0
6	1.4	1.3	1.4	1.2	1.3	1.4	1.3	1.5	1.3	1.5	1.2
7	1.5	1.2	1.3	1.3	1.2	1.4	1.0	1.1	1.3	1.3	1.2
8	1.3	1.1	1.1	1.4	1.1	1.2	1.2	1.4	1.1	1.0	1.1
9	1.1	1.4	1.2	1.5	1.2	1.4	1.5	1.4	1.5	1.1	1.5
10	1.3	1.2	1.1	1.1	1.3	1.4	1.4	1.3	1.3	1.5	1.5
average	1.3	1.2	1.2	1.3	1.2	1.3	1.3	1.3	1.3	1.3	1.2
total average											**1.3**

Average time to platting with tool

platting with tool (second)											
time	**worker 1**	**worker 2**	**worker 3**	**worker 4**	**worker 5**	**worker 6**	**worker 7**	**worker 8**	**worker 9**	**worker 10**	**worker 11**
1	0.5	0.4	0.5	0.5	0.4	0.3	0.5	0.3	0.3	0.5	0.4
2	0.5	0.4	0.3	0.5	0.5	0.5	0.4	0.3	0.4	0.5	0.4
3	0.3	0.4	0.3	0.4	0.4	0.3	0.5	0.3	0.4	0.4	0.3
4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4
5	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.5	0.3
6	0.4	0.3	0.4	0.5	0.5	0.5	0.5	0.3	0.4	0.5	0.4
7	0.4	0.4	0.4	0.3	0.5	0.5	0.3	0.5	0.5	0.4	0.4
8	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.5	0.3	0.4	0.3
9	0.4	0.4	0.5	0.4	0.4	0.3	0.4	0.3	0.4	0.4	0.3
10	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.3	0.4	0.5
average	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Average time to platting with tool (cont.)

platting with hand (second)											
time	**worker 12**	**worker 13**	**worker 14**	**worker 15**	**worker 16**	**worker 17**	**worker 18**	**worker 19**	**worker 20**	**worker 21**	**worker 22**
1	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.3	0.5
2	0.3	0.4	0.5	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.5
3	0.4	0.3	0.3	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4
4	0.4	0.4	0.4	0.3	0.4	0.4	0.5	0.5	0.4	0.5	0.4
5	0.5	0.3	0.4	0.4	0.5	0.3	0.4	0.4	0.4	0.5	0.4
6	0.5	0.5	0.3	0.5	0.4	0.3	0.5	0.3	0.5	0.4	0.3
7	0.4	0.4	0.4	0.3	0.5	0.5	0.4	0.4	0.5	0.5	0.5

platting with hand (second)											
time	**worker 12**	**worker 13**	**worker 14**	**worker 15**	**worker 16**	**worker 17**	**worker 18**	**worker 19**	**worker 20**	**worker 21**	**worker 22**
8	0.5	0.3	0.4	0.4	0.5	0.3	0.4	0.4	0.4	0.3	0.4
9	0.4	0.5	0.4	0.4	0.5	0.5	0.4	0.3	0.5	0.3	0.5
10	0.4	0.4	0.3	0.3	0.5	0.4	0.3	0.4	0.3	0.5	0.5
average	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
total average											**0.4**