INDUSTRIAL PRACTICE REPORT

PT. DJARUM SKM GRIBIG

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INDUSTRIAL ENGINEERING PROGRAM

FACULTY OF INDUSTRIAL TECHNOLOGY

UNIVERSITAS ATMA JAYA YOGYAKARTA

2018

APPROVAL

The industrial practice report which is written basen on the industrial practice at PT. Djarum SKM – Gribig during the period at December 18, 2017 until January 27, 2018 by:

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Telah selesai melakukan kerja praktek di perusahaan kami mulai dari Tanggal 18 Desember 2017 sampai dengan 24 Januari 2018 di perusahaan kami dengan hasil baik.

Demikian surat keterangan ini, harap dipergunakan sebagaimana mestinya.

Hormat kami,

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ACKNOWLEDGEMENT

Praise God for His love and grace for the industrial Practice in PT Djarum can be completed smoothly and reporting industrial Practice can be completed.

The purpose of the Job Training implementation is one of the obligatory academic requirements filled in Industrial Engineering University of Atma Jaya University Yogyakarta. Other than that, the purpose of the Job Training implementation is to introduce student atmosphere of the working world as a candidate in Industrial Engineering graduate.

Completion of Practice Report preparation did not escape the assistance and motivation and participation from all parties, for it with all humility the authors express their gratitude to:

1. PT Djarum as a company that has received the author to be able carry out the Job Training.
2. Mr. Martono and Mrs. Christy as adviser in the field.
3. Mr. Agus, Mr. Eko, Mr. Hasta, Mr. Adrian, Mr. Jony, Mrs. Fitri and many other people who help the writer to finish the industrial practice in PT Djarum.
4. All employees / workers of PT Djarum during the implementation of the Work Practice accept the presence of authors in their work environment.
5. Mrs. DM. Ratna Tungga Dewa, S.Si., MT as the supervisor of Industrial practice.
6. Elizabeth Natalia G. and Sarah Yohana as colleagues work in industrial practice.
7. All parties who have helped up to the series of practical work can resolved.

The writer is aware of the preparation of this report is still far from perfect. Therefore, the writer strongly expects the existence of criticism and constructive suggestions from reader.

Writer hope this report can be useful not only for the writer, but also for the company and expand the knowledge of the reader.

Yogyakarta, May 10, 2018

Ryan Setiawan

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PRELIMINARY

1.1. Background

Industrial Engineering Program, Faculty of Industrial Technology, University of Atma Jaya Yogyakarta (PSTI UAJY) requires all students to carry out industrial practice in accordance with Curriculum in PSTI UAJY. The UAJY PSTI sees practical work as a vehicle or means for students to recognize the atmosphere in the industry as well as to grow, improve, and develop a professional work ethic as a candidate for Industrial Engineering graduate.

Industrial practice can be said as a venue for the simulation of industrial engineering profession. The paradigm that must be invested is that during the practical work students work in companies that choose. Work, in this case includes the activities of planning, design, improvement, implementation and problem solving. Therefore, in industrial practice activities undertaken by students are:

a. Recognize the scope of the company

b. Following the work process in the company continuously

c. Perform and perform tasks assigned by supervisors, supervisors or field supervisors

d. Observe system behavior

e. Compile reports in written form

f. Carry out the practical work exams

1.2. Aim

Things to be achieved through the implementation of this Industrial Practice are:

a. Practicing self-discipline.

b. Exercise ability to interact with subordinates, coworkers, and bosses within the company.

c. Train the ability to adapt to the work environment.

d. Directly observe the company's activities in producing and running a business.

e. Complete the theory acquired in lectures with existing practices in the company.

f. Add insight into production systems and business systems.

1.3. Place and Time of Industrial Practice

This Industrial Practice is held in December 18, 2017 until January 27, 2018 at PT. Djarum part SKM - Gribig, Sub District Besito, Kudus District. In this Industrial Practice the author is placed in the Department of Pre-Process and Materials Preparation SKM (Cigarette Hand Cigarettes) Gribig Kudus.

CHAPTER 2

COMPANY OVERVIEW

2.1. Brief Company History

PT Djarum is a company that produces cigarettes in Indonesia. This company started from a small clove cigarette factory which was established on 21 April 1951. This factory is located on Bitingan Baru street No.28 or which is now named A. Yani Street No.28, Holy. This factory is owned by the founder of PT Djarum named Oei Wie Gwan. Within 9 months, Oei Wie Gwan patented the brand and the name Djarum. Djarum name is inspired by the needle that is on the gramophone.

Djarum initially had only 10 workers. Jobs ranging from clove and tobacco mixing are done manually with small capacity machines. Oei Wie Gwan himself rolled up a kretek cigarette in the factory area when not selling cigarettes on the streets of Kudus. Cigarettes from Djarum's hand rolls have different characteristics because of consistency in consistent quality and taste.

Oei Wie Gwan died in 1963, and the Djarum company continued to run under the leadership of his two sons. Michael Bambang Hartono and Robert Budi Hartono led and developed Djarum until now.

In 1969, Djarum began exporting its cigarette products abroad. In the same year, Djarum marketed Djarum Filter, the first brand manufactured using a machine, followed by the Djarum Super brand introduced on April 21, 1970. Djarum is currently headed by Victor Hartono, who is the grandson of Oei Wie Gwan. Djarum launches a branded mild cigarette L.A. Lights on April 21, 1999 and Djarum Black on April 21, 2000. In 2012 Djarum issued cigarettes Djarum Super Mild or MLD and Djarum Black Mild.

In addition to the world of cigarettes, Djarum is also known actively involved in the world of badminton. Djarum has produced world-class players such as Liem Swie King and Alan Budi Kusuma. In addition, since 1998 the Djarum company has also controlled most of BCA's shares. To Bakti to society and environment, Djarum has a special institution that is Djarum Foundation which is engaged in education, social, culture, and environment.

Oei Wie Gwan died in 1963, and the Djarum company continued to run under the leadership of his two sons. Michael Bambang Hartono and Robert Budi Hartono led and developed Djarum until now.

2.2. Organizational structure

Organizational structure is the composition and relationship between each division or position in an organization or company in carrying out its operational activities.

The existing organizational structure in PT. Djarum part SKM Gribig can be seen in the figure 2.1. below.

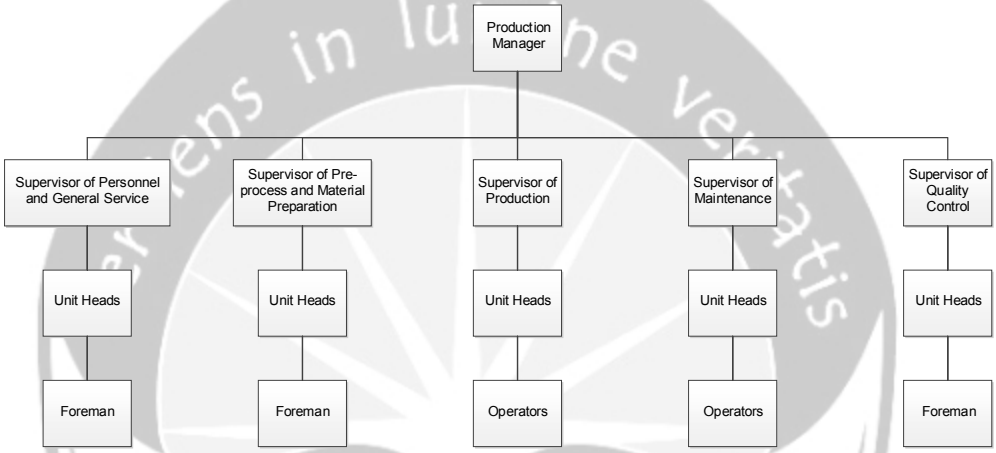

Figure 2.1. Organizational Structure PT Djarum SKM Gribig

Duties, authority and position of the structure of each organization of PT. Djarum SKM Gribig can be explained as follows.

2.2.1. Supervisor of Personnel and General Service

a. Personnel tasks:

i. Activities of personnel, security, employees.

ii. Absentee of employee or worker.

iii. Manage the administration of medical or BPJS employment.

b. Task section GS (General Service)

i. environmental Hygiene

ii. Supply beverages and cigarette for office employee

2.2.2. Production manager

Has several tasks:

a. Carry out production policies in production or order.

b. Ensure that production planning work.

c. Determine the production strategy

d. Determine the amount and material requirements needed for production.

2.2.3. Production Supervisor

Has several responsibilities:

a. Responsible for conduct monitoring or supervision activities directly to the Head Unit under it.

b. Responsible in the fulfillment of targets or levels of quantity, quality and production scheduling that have been determined by mutual agreement.

c. Responsible in fulfilling the quality standards of the products produced in accordance with the needs and delivery schedule of production.

d. Responsible for work safety and environmental hygiene standards (regularity / tidiness of work environment).

e. Responsible for coordinating solid teamwork.

f. Responsible for reporting periodically to his / her supervisor for his / her work along with problem analysis, corrective actions on the matter and the time limit for the estimation of the problem resolution in a concise, and concrete manner.

Authority:

a. Authority in disciplining his subordinates according to the rules / regulations in the company.

b. The authority to stop and manage the operation of production machinery to achieve the production results in accordance with the needs of customers and the fulfillment of the production delivery deadline.

2.2.4. Head Unit

Has several tasks, among others:

a. Plan activities and costs

b. Carry out activities and costs

c. Controlling activities and costs

d. Improve activities and costs

2.2.5. PPMP Supervisor (Pre-Process and Material Preparation)

Have some responsibility that is:

a. Responsible for organizing production process activities of supporting materials (Foil, filter, sweet CTP, OPP cutsheet) according to the needs of production process based on work plan.

b. Responsible for the availability of materials to be used in the production process.

2.2.6. Foremen

Has the task of coordinating subordinate workers, controlling the course of the task, providing direction and guidance to the workers, lowering the rejects of consumers and products that are defective in the process, as well as determining the causes of problems and formulating corrective actions. Responsible to Sub Production Department.

2.2.7. Supervisor of Quality Control

Have some duty or responsibility that is:

a. Control the machine-generated product

b. Checking as much as 8x each shift.

c. Blocking or retrieval of defect items.

d. Process control (checking moisture content, pressure drop validation, ventilation, and SD (Deviation Standard) weighing) every 2 hours.

2.2.8. Supervisor of Maintenance

The duties and responsibilities of maintenance are:

a. Doing maintenance machine at PT. a subsidiary of Djarum on Tuesday and Wednesday.

b. Maintenance and machine treatment in SKM Gribig and OASIS.

c. Doing cleaning

d. Replace the parts on the machine.

2.3. Management of The Company

2.3.1. Vision and Mission of The Company

a. Company Vision

Being the biggest in the value of sales and profitability in the Indonesian cigarette industry.

b. Company Mission

PT. Djarum is present to satisfy smokers' cigarette needs.

c. Vision Description

Leadership in the market by producing products that consistently high quality and innovative to satisfy consumers.

Creation of a strong positive image for our company and our products.

Dedicated professional management and competent human resources.

d. Core Values

PT. Djarum has 5 core values in the development of the company. Those values are the focus on the customer, the professionalism, the continuing learning organization, the family, and the social responsibility. Here is an explanation of these values:

i. Focus on the customer

Customer is a very important part in the sustainability of a company, without any customers, without customer interest in the products that the company has produced will be mandatory. PT. Djarum always give priority to the customer always satisfied with the product, by giving the relatively low price even though the profit is decreased, it is overcome by the increase of good result and the amount of sale. In addition, PT. Djarum listens to customers and meets their needs in the best way that can be done.

ii. Professionalism

Professionals in building a company well, starting with the recruitment of potential employees (one of the elements of vitas for the excitement of a company's motion). The company's ability to innovate continuously in line with these demands, PT. Djarum always provide an innovative response to consumers. Professionals in implementing strategies that have been designed with great optimism. With such professionalism everything can be achieved.

iii. Organizations that are constantly learning

With the success gained in the form of awards and innovative products, PT. Djarum is not satisfied, always learn from that success. Not only always judge his own company. Share with other companies share their knowledge. This learning organization's attitude must be balanced with an attitude of openness and mutual trust so that people dare to make changes and experiments without feeling threatened.

iv. One family

Kinship is felt in the environment of PT. Djarum, this looks when on time off, sometimes directors join employees, share stories, joke, it creates fun for employees. This is where the cohesiveness of all levels of management and employees. They are together to advance the company, with the support of a solid organization, as well as the hard work of all employees.

v. Social Responsibility

In terms of social responsibility, for employees, PT. Djarum is very concerned about its employees by providing social security in the form of guarantee health, annual prize, benefits, accident insurance, pension guarantee. PT. Djarum also provides educational scholarships to children of employees so they can continue their education well. Social Responsibility given by PT. Djarum not only to its employees but also to the general public. To carry out this responsibility PT. Djarum does Corporate Social Responsibility (CSR), which is very clear nowadays, namely: Djarum gives 30 billion funds in badminton field development, GOR PT. Djarum Bakti Bangsa, which is used to recruit badminton players who are world-class reliable. In the environmental field of PT. Djarum gives tress for reforestation.

2.3.2. Employment

Number of employees in PT. Djarum currently approximately 75000 people, spread across several departments in PT. Djarum. Matters relating to employment at PT. Djarum Gribig Kudus is organized as follows:

i. Manpower Recruitment

Procedures and conditions stipulated in the recruitment of labor at PT. Djarum among others:

1. Fill out the form. Intended to obtain complete information and data from prospective employees.

2. Following the psych test

3. Interview. In this interview is usually assessed about appearance, speech, education and so forth.

4. Medical examination. This is done to prevent the possibility of obtaining employees who suffer from a disease that can disrupt the work process.

ii. Employee Hours

Regulation of employees working hours at company PT. Djarum part SKM Gribig has been regulated in accordance with government regulations. Here is the division of working hours PT Djarum SKM Gribig:

1. Shift 1: 06.00 - 14.00 WIB

Break hours are self-managed by employees with a duration of rest for 1 hour.

2. Shift 2: at 14.00 - 22.00 WIB

Break hours are self-managed by employees with a duration of rest for 1 hour.

3. Shift 3: 22.00 - 06.00 WIB

Break hours are self-managed by employees with a duration of rest for 1 hour.

For dinner, employees get catering and employees are not allowed to leave the factory in order to maintain the security of each employee.

The working day of PT. Djarum Gribig Kudus is Monday-Friday. If the demand for cigarettes is low is usually applied a mini shift on the day Saturday and Sunday so

that at 12.00 pm all employees have finished working. On Saturdays and Sunday the employee can go to work depending on the demand for cigarettes. Working hours on Saturdays and Sundays are different from normal shifts. For employees of non-shift working hours are as follows:

1. Monday - Friday:

Working from 07.00 - 16.00 WIB with rest hours at 12.00 - 13.00 WIB.

2. Saturday

Working from 07.00 - 12.00 WIB.

iii. Employee welfare

The Company provides a variety of useful facilities for employee benefits. This facility is provided with the aim of improving employee morale. The following are the facilities provided by the company:

1. Holiday allowances and other benefits
2. Boarding house for employees
3. Cafeteria
4. Small Mosque
5. Car and motorcycle parking spaces
6. Bus for shuttle employees
7. Etc.

Employee of PT Djarum is not only given in material form but also in the company's attention to the safety of its employees. This is a matter of great concern because the safety of work will affect the productivity and image of the company. PT. Djarum has paid attention to the safety of its employees, this can be seen from the work equipment provided by the company to employees. Work equipment provided consists of masks, earplugs, gloves, safety shoes, safety helmets, etc. However, not all employees are given work equipment, only employees who have a high working risk are getting it. In case of work accidents, it will be seen first what the cause and for the cost will be borne by the company.

iv. Facilities

In PT Djarum also provided medical and beverages. For Panelists (master) is given a health injection every month. Panelists are the ones who are tasked with tasting

cigarettes from the R & D department. For workers in the manual tobacco section is given pure cow's milk in order to neutralize tobacco that is inadvertently inhaled by the mothers and to improve health. There is also a company doctor for employees who are sick.

PT. Djarum provides several facilities, namely:

1. Sports Venue

PT. Djarum provides badminton field facilities, volleyball court, tennis court, basketball court, fitness center, jogging track, etc.

2. Vehicles

For Manager, Senior Manager, and Director level get car service facility from PT. Djarum during that position.

3. Education Scholarship

For employees of PT. Djarum who already married get scholarship right from PT. Djarum for elementary and high school level.

2.3.3. Marketing

Marketing of PT. Djarum is not only in the country but has expanded abroad. For products marketed in the country, PT. Djarum already has distributors spread across the western and central part of Indonesia. For products marketed abroad, PT. Djarum has marketed to Malaysia, Singapore, Arab, India, America, and Europe. PT. Djarum also has a company in Brazil where most of the workers are Indonesians assigned to Brazil. In order to improve its services, PT. Djarum already has branches all over Indonesia whose branch of marketing office mostly located in Java Island.

CHAPTER 3

REVIEW OF ENTERPRISE SYSTEM

3.1. Business Process of the Company or Department

Business process is a series of activities between parts within a company.

The business process of PT Djarum can be seen in the figure 3.1 below.

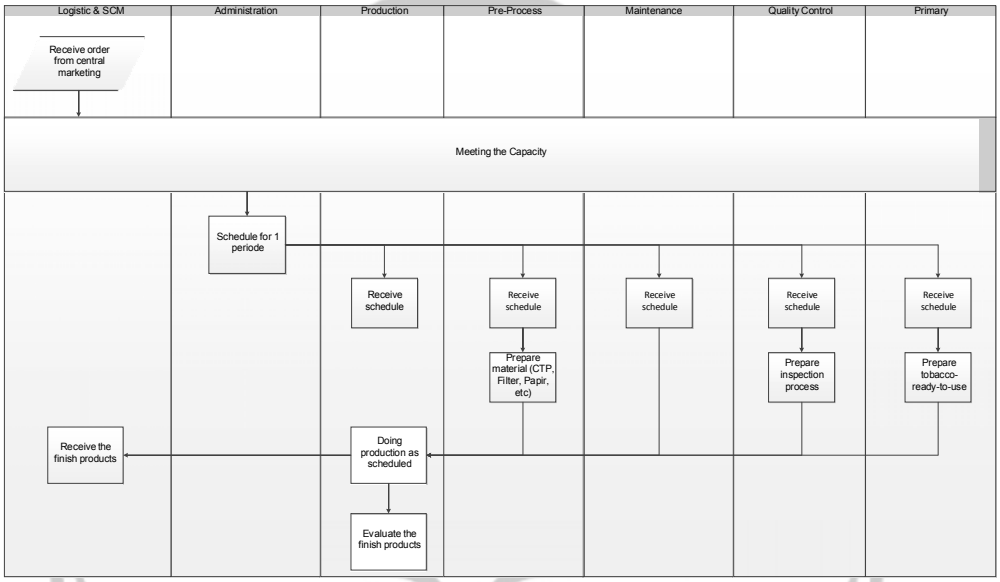

Figure 3.1 Business Process of The Company

3.2. Product Generated

Products that produced by PT Djarum Gribig is Cigarette. There are a lot of cigarette, such as LA Bold, Djarum Coklat, Super 16, MLD, etc. There also produced many kinds of cigarette for export product. The product that produced by PT Djarum can be seen in table 3.1.

The production process are started from the primary department which process the tobacoo and give the flavor to the tobacoo by using flavor machine then the primary department will send the flavoured tobacoo to the secondary department. The Pre-process department will prepare the core-tipping paper or CTP that use to wrap the tobacoo and give a sweet flavor or any other flavor based on the type of the cigarette by using sweetening/mentholizing machine. The Pre-process department also produce the filter of the cigarette using acetate tow with automatic filter machine. The Pre-process department will send or distribute the filter and

CTP to the secondary department. In the secondary department, the flavoured tobacoo, cigarette filter, and CTP will be assembly or combine using paper and glue by using maker machine, this process will produce the cigarette. After the cigarette are produced, the it will be collect and pack in packer machine the the finished product will be store in the warehouse. The operation process chart can be seen in figure 3.2

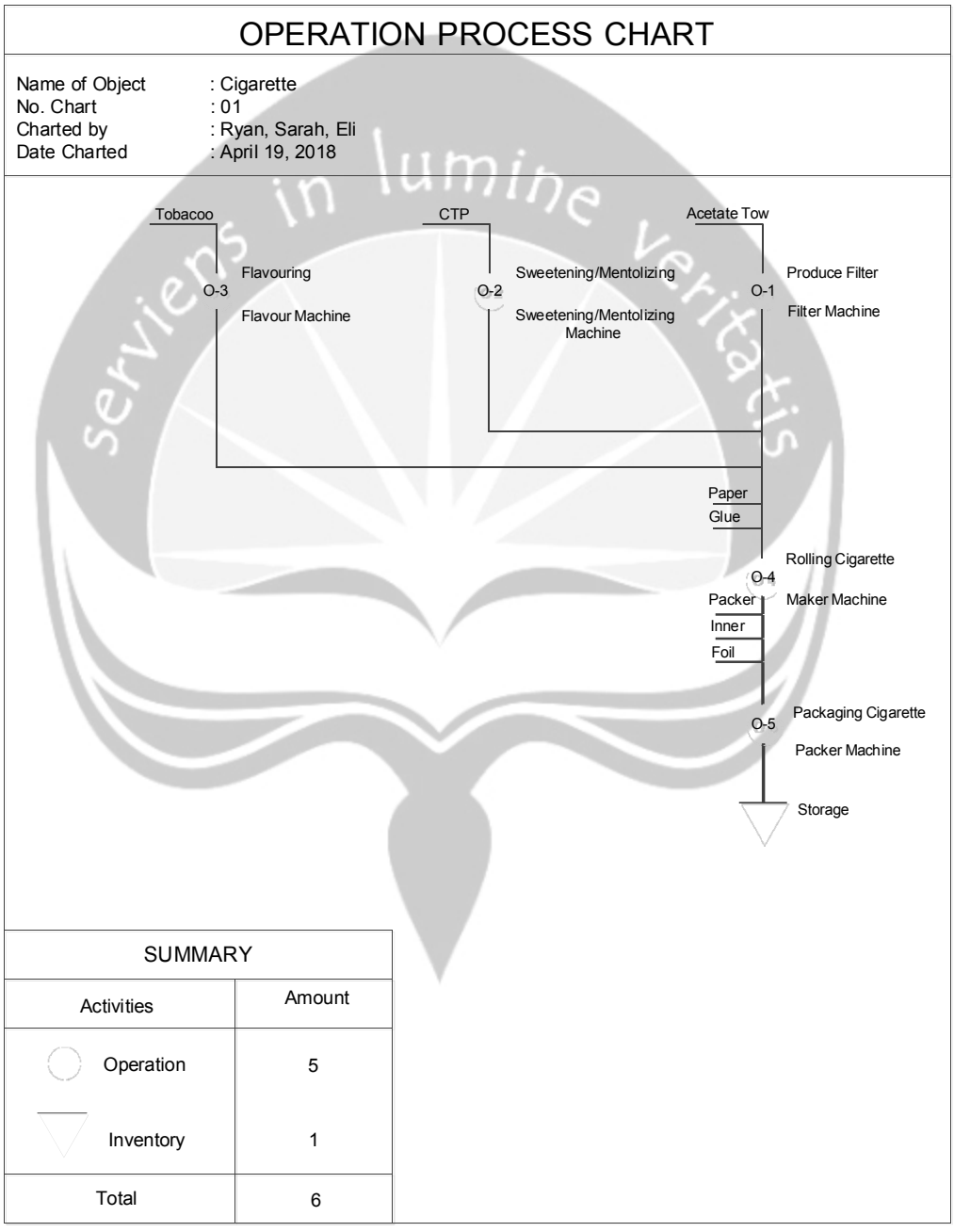

Figure 3.2 Operation Process Chart

Table 3.1. Product of PT Djarum

No.	Product Name	Product Picture
1	Djarum Super Mild	
2	Djarum Super 12	
3	LA Lights	

Table 3.1. Product of PT Djarum (Cont'd)

4	Djarum 76	
5	LA BOLD	

3.3. Production Process

3.3.1. Production Resources

There are some resources that PT Djarum use in Production process and runs the business.

a. Materials

Materials is all resources that PT Djarum processed by machine or man that become an end product. Supporting materials and supply for non-production activity in PT Djarum are also materials component

b. Man

Man is an important component in production process. In SKM(Sigaret Kretek Mesin) Gribig PT Djarum, almost all of the production process used automated machine. Workers or Man component have a role to plan, operate, and mechanic in production process.

c. Methods

Methods in techniques or process that used for inspect a quality of the product, maintain the production process, etc. These methods are done by workers or using machine supporting.

d. Money

Money or capital in this term are funds that the company use for buying the materials, workers salary, pay for tax, etc.

e. Machine

Machine is also important component in production process. In SKM(Sigaret Kretek Mesin) Gribig PT Djarum, all the production process are done by semi-automatic machine. Starting form supply the filter rod, tobacco and processing to end product is done by the machine.

3.3.2. Raw Materials

The raw materials that PT Djarum used are come from many suppliers. These raw materials will be processed become Work in Progress and End product. There are raw materials for finished blend tobacco, raw materials for cigarette filter, cigarette packaging, etc.

a. Filter Rod

Filter Rod are produced by KDF(filter maker machine name) Department using KDF Machine which semi-automated machine.

These are raw materials for producing the filter rod:

i. Acetate Tow

Acetate tow is made from acetate flakes and have a shape like very thin cotton fiber. This material are the main materials for producing filter rod. Acetate tow is imported from Japan, Germany, and United States.

ii. Hotmelt

Hotmelt is made from non-volatile thermoplastic materials that has a square shape and colored yellowish. This material are use for glue the edge of plug wrap.

iii. Triacetine

Triacetine have the shape of white solvent that use for hardening and make the acetate tow elastic.

iv. Inner Glue

Inner glue is a solvent that use for glue the acetate tow with plug wrap. Inner glue is made from triacetine and acetate tow.

v. Plug Wrap

Plug wrap is wrapping the filter, which has a shape of white paper. There are two kinds of plug wrap, porous and non-porous.

b. Cigarette

Cigarette are produce by secondary department using semi-automated machine. The materials use for produce cigarette is:

i. Cigarette Paper

Cigarette paper is a paper which wrap the finished blend tobacco.

ii. Cork Tipping Paper(CTP)

Cork tipping paper is a paper that use for wrap the filter rod of the cigarette. CTP has many flavors depends on the products. CTP will pass sweetener process in pre-process KDF department.

iii. Glue

Glue is use for glue the paper, CTP paper, aluminium foil, inner frame, etiket, or bandrol. There are two kinds of glue that use in production process:

- Glue for making the cigarette or in maker machine is used for glue the edge of the cigarette paper, and CTP paper.
- Glue for packaging process is use 8065 glue that use for glue the etiket paper and inner frame.

3.4. Production Facilities

SKM Gribig PT Djarum has 2 main plant or manufacturing place, Primary and Secondary. In the primary, the main activity is producing and mixing the tobacco and another chemical substance to make finished blend tobacco. This primary plan will supply the finished blend tobacco to the secondary plant. The primary plant and secondary plant are in the different place, so to supply the finished blend

tobacco secondary plant by using conveyor. This conveyor is connected the two plants and the finished blend tobacco will be collected in KAB department. Actually, KAB is the name of the machine that they use for distributing the tobacco trough a pipe, but all the workers usually called this department by the machine that they use.

The machine in secondary plant will receive the tobacco and processing it to become a cigarette or end product. In the secondary plant, there are semi-automated machine which all the process IS maintain just by 2 or 3 persons.

In semi automated machine, the tobacco materials will be received directly in the machine, because the materials are transported by KAB machine and the filter also received directly from KDF department trough a pipe. But also, there are some old machine which still need a lot of workers to operate. This old machine usually used for export product, because export product usually produces many kinds of product and has high flexibility in small production quantity. This old machine need manual material handling to insert the cigarette and other materials needed.

Every material needed that comes from supplier are received by the main warehouse which located in Oasis and distributed to all of the company's plants. At SKM Gribig the received material is stored in the primary Warehouse and distributed to the inventory buffer located on each production floor. The transfer of this material is carried out in different ways, depending on the size or type of material, as follows:

3.4.1. Manual Handling

Manual handling is done by workers without using machine. This is usually done to move items that are not too heavy and in small quantities. Manual handling is usually done when the worker will replace paper material on the machine, move or inserting the cigarette from the maker machine to the packer machine, etc. Some manual handling has been facilitated with robot arms or machine that positioning or adjusting the height of items that will be handle, so that workers do not have to bend while taking the goods, in this case PT Djarum also emphasizes the ergonomic aspect at the manual handling of WIP or work in progress product.

Manual handling also still occurs in the final product in the staple division at the Warehouse location although the weight of the product is very heavy, which is between 15-27 kg. In the staple section of this warehouse the worker must move the finished goods down from each production floor which transported to the warehouse by conveyor and handled manually to the pallet and arranged in the Warehouse. Manual handling is still done because the use of automation or machine will require substantial investment.

3.4.2. Mixed Material Handling

Mixed handling is the handling of goods or materials with the help of machine. Mixed material handling is done to move goods that are quite heavy or in a lot of quantity. Transfer from truck to Warehouse, distribution of goods to each production floor, etc. This transfer is usually done by using handlift, forklift or electric handlift.

Forklifts usually use for move goods from the truck into the primary warehouse or the handling of machines and other heavy items. And material handling using handlift or electric handlift is usually done when moving small items in large quantities or commonly done to move goods from inventory buffer to the machines area.

CHAPTER 4

REVIEW OF STUDENT OCCUPATIONS

4.1. Scope of Work

On the industrial practice in PT Djarum, the work is done in the secondary plant, SKM Gribig. In this industrial practice the work is done in the PPMP office (Pre-Process and Material Preparation) that located in Secondary Plant of SKM Gribig. The following is the layout or layout of the workspace during industrial practice by Figure 4.1.

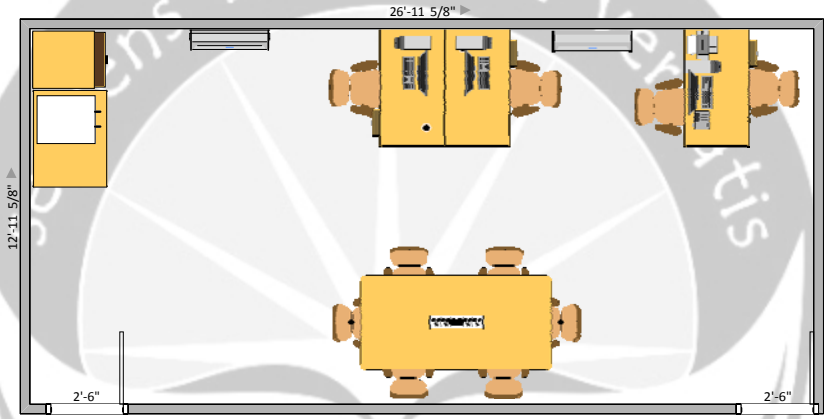

Figure 4.1 Layout of PPMP Office

The author is given a place at an open meeting table which is also commonly functioned as a multipurpose table. Working hours of non-shift workers on Monday to Friday are 07.00 to 16.00 WIB and for Saturday is 07.00 to 12.00 WIB.

On the implementation of practical work in PT Djarum, the author was given the task by Mr. Martono as the field supervisor to make observations on the packaging division in the staple part of finished goods warehouse. This observation aims to determine the productivity of staple workers who are considered less productive and the work depends only on the output of the machine. Workers in the staple section is also works manually and has a heavy workload on work that needs to be done ergonomic analysis of the worker posture.

This project purposes are to analyze the productivity of each worker in the staple process. the other purpose is to analyze the workload of worker in this department to know is the number of current worker is optimum or not. And the last purpose is to analyze the RWL(recommended weight limit) of the end product that can be lift by the worker and the ergonomics analysis with the proposed workstation design.

4.2. Job Responsibilities and Authority

In the implementation of practical work in PT Djarum authors are given the task to observe the work processes that occur in the packaging division of staple in finished goods warehouse. There are several authorizations given by the company to the author during the industrial practice in PT DJarum:

a. Authors are allowed to use the PPMP office (Pre-Process and Material Preparation) as the place to do the task.

b. Authors are allowed to ask workers in the field to collect information and store data that is allowed by the field supervisor.

c. Authors are allowed to perform observations and data collection.

4.3. Work Implementation Methodology

In doing project work, the authors make work steps for the research done to succeed and achieve the goal. The figure 4.2 and 4.3 is a Research Flow Diagram created by the author:

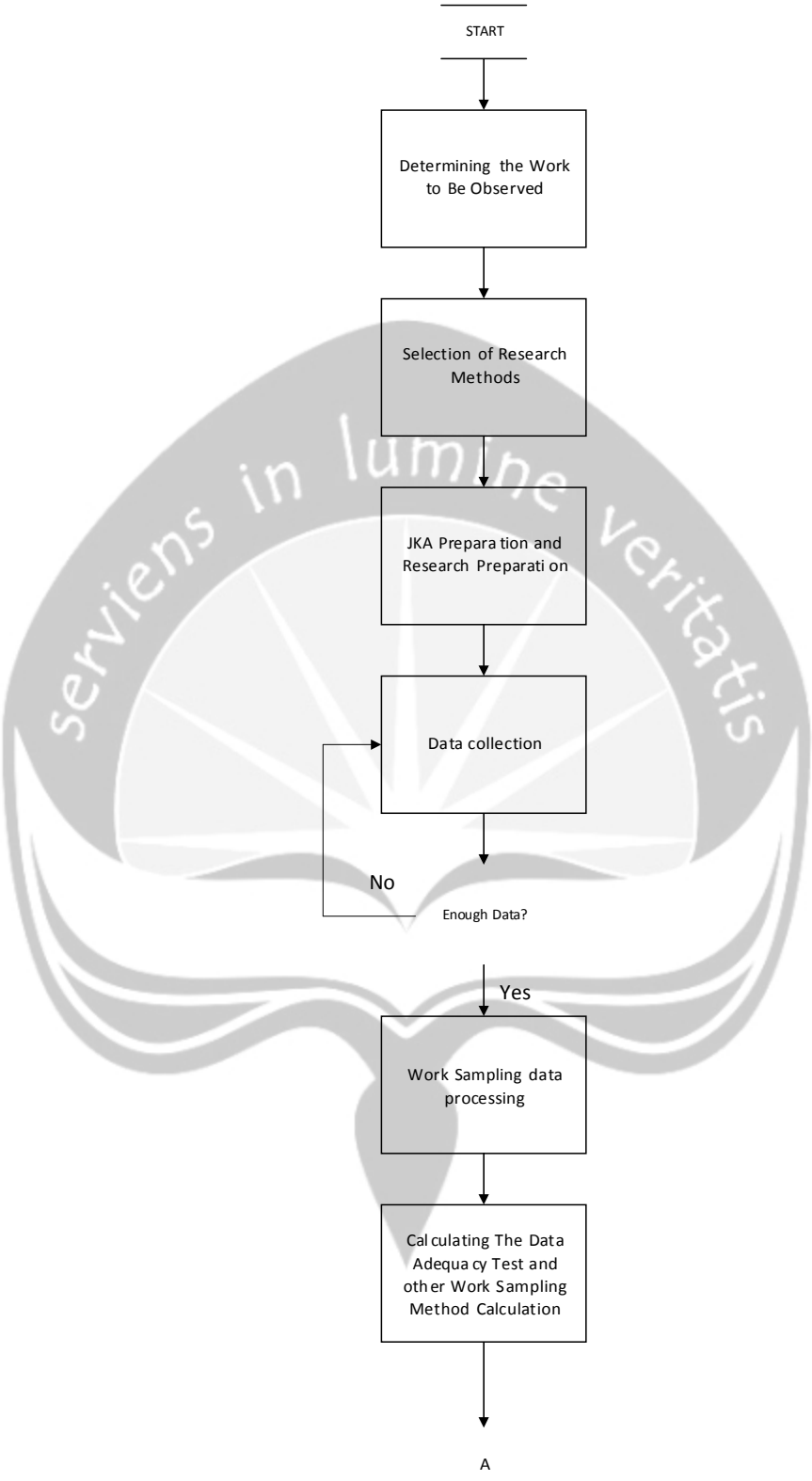

Figure 4.2 Research Flow Diagram

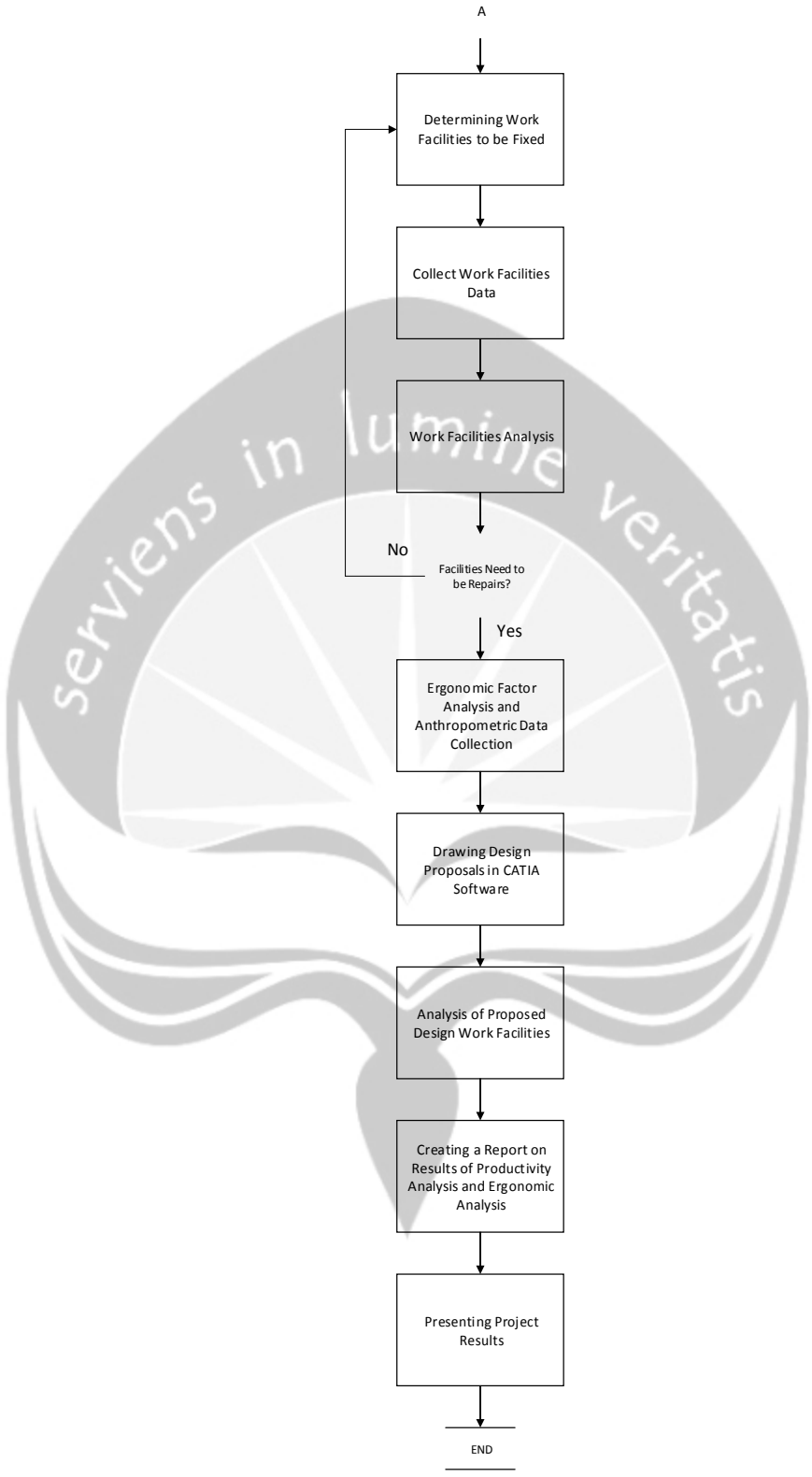

Figure 4.3 Research Flow Diagram(Cont')

There are many divisions and work processes undertaken at SKM Gribig. In Project determination, this project is focused to observe the processes that occurred in the staple section packing division. This work process is chosen because of the observations and data obtained in the field, this work is very dependent on the output of the machine where when the machine is damaged, staple parts do not have goods that can be processed or done, so this work is considered less productive and analysis needs to be done. In addition, the work in this section still uses manual handling and is at risk of working accidents.

After choosing the work to be done observations, then choose the research method that will be used to do this project. After determining the method of research, then began to make the creation of the observation sheet (random visit schedule) and other research preparation. After preparation is complete, then begin to observe and collect data for the project. Data collection was done on shift 1 which started at 06.00 until 14.00 WIB. Data processing done after all the data required is collected, if the data obtained is still not sufficient, the author will make a re-observation until the data obtained enough.

During the observation, observation of the work process that occurs and based on the data obtained is needed, it can be seen whether the work process needs to be improved. When the selected work facility is fixed, then the data retrieval for the repair of the work facility will be done. Data on initial facility dimensions, worker posture, etc. will be collected for working on this project. The data obtained will be analyzed using predetermined ergonomic methods. Once the necessary data in the repair of the work facility has been obtained, the authors will draw the proposed design results in the CATIA software. From this design, the authors can analyze the design facilities and find out whether the design results can reduce the risk of work accident or not.

After analysis of productivity and ergonomic analysis of the work process has been completed, the next process is created a report that will be used for reports of practical work. The presentation of the results of practical work and projects that have been done during practical work in PT Djarum is required to evaluate the project result.

4.4. Working Result

4.4.1. Data and Discussion

a. Productivity Analysis Using Work Sampling

Here is the data that collected on the work process of packing staple parts in finished goods warehouse. The data collection is done on shift 1 that is at 06.00 until 14.00 WIB. The data collection of goods that processed in the staple process can be seen in the table 4.1. below.

Table 4.1. Table Frequency Box Processed At Staple Work

Frequency Table Goods that can be process in Staple division Shift 1									
No	Saturday, 30 December 2017			Tuesday, 2 January 2018			Wednesday, 3 January2018		
	Hour	*Box*/ Hr	*Box*/10 Min	Total	*Box*/Hr	*Box*/10 Min	Total	*Box*/Hr	*Box*/10 Min
1	06.00-06.29	19	3.166	0	0	0	0	0	0
2	06.30-06.59			0			0		
3	07.00-07.29	168	28	0	0	0	110	168	28
4	07.30-07.59			0			58		
5	08.00-08.29	226	37.666	57	77	12.833	170	215	35.833
6	08.30-08.59			20			45		
7	09.00-09.29	112	18.666	90	248	41.333	46	146	24.333
8	09.30-09.59			158			100		
9	10.00-10.29	139	23.166	67	182	30.333	76	196	32.666
10	10.30-10.59			115			120		
11	11.00-11.29	149	24.833	75	95	15.833	99	179	29.833
12	11.30-11.59			20			80		
13	12.00-12.29	164	27.333	181	256	42.667	106	171	28.5
14	12.30-12.59			75			65		
15	13.00-13.29	241	40.1667	190	312	52	219	359	59.833
16	13.30-14.00			122			140		
Average			25.375			24.375			29.875
Average/minutes			2.654166667						

Based on observations made, in table 4.10. can be seen the average box processed by staple parts workers per minute. At 06.00 to 07.00 only a few items that can be processed in staple workstation, because at the turn of shift 3 to shift

1, the machine still has not produced goods on that time. On observation in next days, no items can be processed in the staple section at 06.00 until 07.00 WIB, so the workers become very unproductive.

After a holiday like on Tuesday 2 January 2018, the machine needs a longer adjustment or setup than usual, because the new engine is restarted when shift 1 begins. This leads to a pullback in production time, causing staple workers to be not productive from 6 am to 8 am. While on a normal day or when the engine continues to run 24 hours before, production began to run smoothly around at 07.00.

Based on these observations, the frequency of items that can be processed at most is at 13.00 to 14.00. At that hour, shift 1 workers spend the rest of the production targets available for 1 shift. At this time can be categorized as busy working hours, because there are 241 to 359 boxes that must be processed in staple jobs. If on average, at 13.00 to 14.00 there are 5 items that should be stamped by the workers every minute. The data of process time every work element can be seen in the table 4.2. below.

Table 4.2. Time table of each work element

Time table of each work element					
No.	Staple the goods (Secon)	Positioning the goods in the warehouse (Secon)	Fix the defect packing (Secon)	Take the pallet or handlift (Secon)	Stick the lot paper (Secon)
1	4	84	6	14	12
2	5	94	14	7	6
3	6	98	6	11	10
4	6	66	8	12	8
5	4	53	5	7	5
6	4	81	4	7	4
7	9	96	5	14	5
8	4	100	4	5	5
9	3	101	7	16	12
10	4	114	8	10	6
11	4	72	5	14	5

Table 4.2. Time table of each work element (Cont'd)

12	3	99	9	14	11
13	4	105	11	6	8
14	5	78	7	9	10
15	7	110	6	15	5
16	4	64	5	8	5
17	3	99	6	12	5
18	4	102	4	13	7
19	3	79	8	20	6
20	4	88	6	14	9
Avg	4.5	89.15	6.7	11.4	7.2

From the measurement of time of each work element, it is found that the average for doing stapling activities of goods is 4.5 seconds. To perform activities positioning goods in the warehouse area, workers need an average time of 89.15 seconds. The average time required to perform the repair activity of packing or duct tape that defect takes an average time of 11.4 seconds. In giving lot paper, workers need an average time of 7.2 seconds.

Table 4.3. Result of Data Processing of Work Sampling

Productivity Analysis														
Shift 1		Other	Staple the goods	Positioning the goods	Fix defect packing	Pick Pllet or Handlift	Stick Lot Paper	Idle	Break	End of Shift	Total Observation	Total Observation without Other Element	Productivity *	productivity (%)
Monday, 8-01-2018	P. 1	18	15	5	0	4	3	20	13	1	79	65	0.69	69.23
	P. 2	18	20	3	0	2	1	21	13	1	79	65	0.67	67.69
	P. 3	27	8	11	0	1	0	13	18	1	79	60	0.78	78.33
	P. 4	38	7	5	0	1	0	10	18	0	79	61	0.83	83.60
Tuesday, 9-01-2018	P. 1	70	49	14	1	12	3	52	50	4	255	201	0.74	74.12
	P. 2	69	61	18	0	5	3	39	56	4	255	195	0.8	80
	P. 3	103	28	13	0	6	2	55	48	0	255	207	0.73	73.42
	P. 4	85	42	14	0	3	2	57	48	4	255	203	0.71	71.92
Wednesday, 10-01-2018	P. 1	67	52	18	0	13	1	47	55	2	255	198	0.76	76.26
	P. 2	68	74	11	0	4	1	42	55	0	255	200	0.79	79
	P. 3	90	47	30	0	11	4	41	30	2	255	223	0.81	81.61
	P. 4	125	39	13	1	5	1	41	30	0	255	225	0.81	81.77
Total / Element		778	442	155	2	67	21	438	434	19		1903		
Average												158.58	0.764	76.41

*Productivity = Total Productive observation/total observation - (break+end of shift)

The result of data processing in work sampling method can be seen in the table 4.3. above. There are several work elements observed during the observation process. Other is an activity undertaken by workers outside the staple area of finished goods warehouse. The four workers took turns working on the process of stapling and packing process in the export section, this is based on the agreement of previous workers so that workers can take rotates and not only work in one work area. Other work elements also consist of jobs such as reading shift schedules, briefings, giving lubricants to conveyors, etc. All activities outside the breaks conducted or included in "others" work elements, researchers assume as productive job. Activities staple of items, position goods in the warehouse, fix the packing, take the pallet / handlift, giving lot is the main work element that must be done by staple worker. These work elements are included in productive jobs.

Shift finished is an activity where there is no more goods produced by the production section on shift 1. After the shift is finished, the workers have no other job anymore so that all their work has been completed and leave the staple area. By the time when the shift is finished and the break is not included in the observations made by the researcher, so the amount of data that has the activity is excluded from the actual observation amount. So the number of observations is the result of total idle activities, productive activities, and other activities / other.

Idle is a time when workers are not doing anything or idle activities. Workers are not productive when no items can be processed in the staple work process.

Table 4.4. Data Adequacy Test Results

Data Adequacy Test		
	Average Productivity	N'
Workers 1	0.732075829	228.7367
Workers 2	0.755641026	202.1123
Workers 3	0.777925449	178.4189
Workers 4	0.791018391	165.1207
Average	0.764165174	

In the data suffieciency test result in table 4.4., the researcher chose the confidence level of 95% so that it has the price k = 2. And the level of accuracy used is 8% which means the data obtained can deviate by 8% from the actual completion time. The data adequacy test is searched using the average

productivity of each worker. At worker 1 obtained the result of N 'equal to 228,7 whereas value of N equal to 464 so that data is enough. The second worker has a N value of 202.1 and a N value of 460, so that the data is sufficient. For worker 3 has a value of N 'of 178.4 and a value of N of 490, so that the data is enough. In worker 4 has a value of N 'of 165 and a value of N of 489 so that the data is enough.

The uniformity test also need to conduct as the test to know is the data received are uniform or not. The uniformity test resul can be seen in table 4.5. until table 4.6. and the graph figure in the figure 4.4 until figure 4.7.

Table 4.5. Result of Calculation of UCL and LCL

Average Productivity of the Workers = 0.76		
Average total pengamatan = 158.5833		
Upper control Limit		
UCL	0.861743085	
	86.17430847	%
Lower control Limit		
LCL	0.658256915	
	65.82569153	%

Table 4.6. Results of Data Uniformity Test

No.	Workers	Productivity in day-		
		1	2	3
1	Workers 1	69.23077	74.12935	76.26263
2	Workers 2	67.69231	80	79
3	Workers 3	78.33333	73.42995	81.61435
4	Workers 4	83.60656	71.92118	81.77778
LCL		65.82569	65.82569	65.82569
UCL		86.17431	86.17431	86.17431

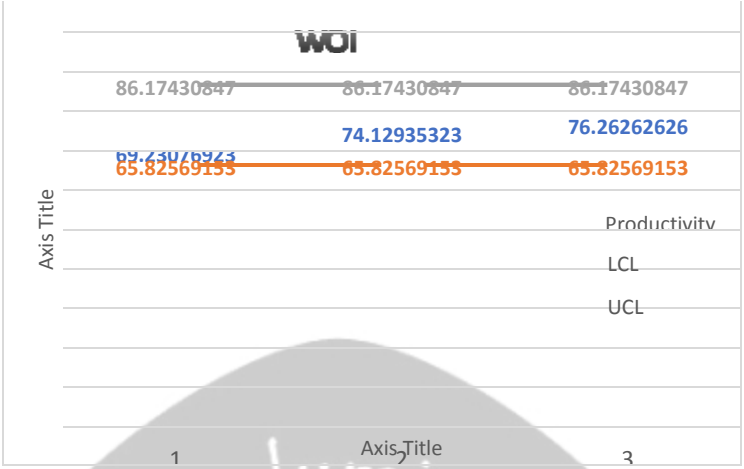

Figure 4.4 Graph of Data Uniformity Test Results of Worker Data 1

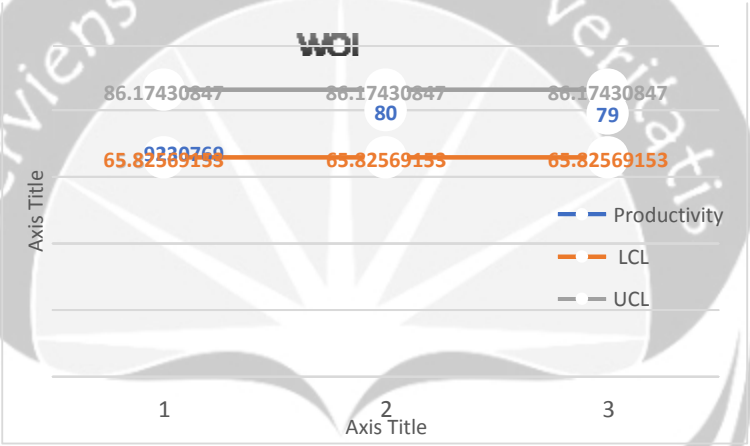

Figure 4.5 Graph of Data Uniformity Test Results of Worker Data 2

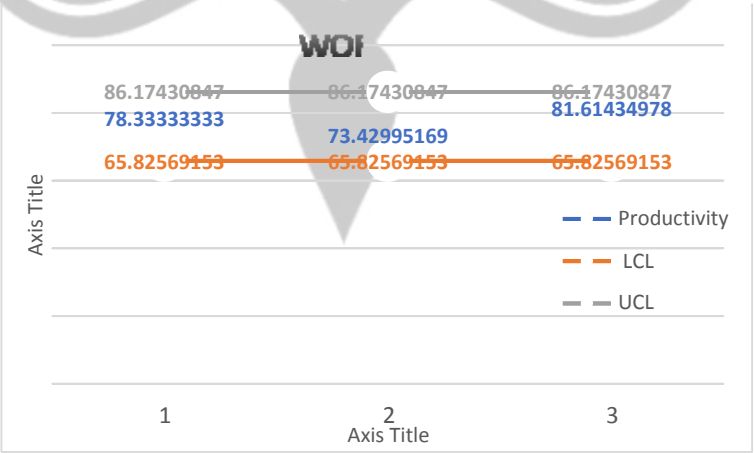

Figure 4.6 Graph of Data Uniformity Test Results of Worker Data 3

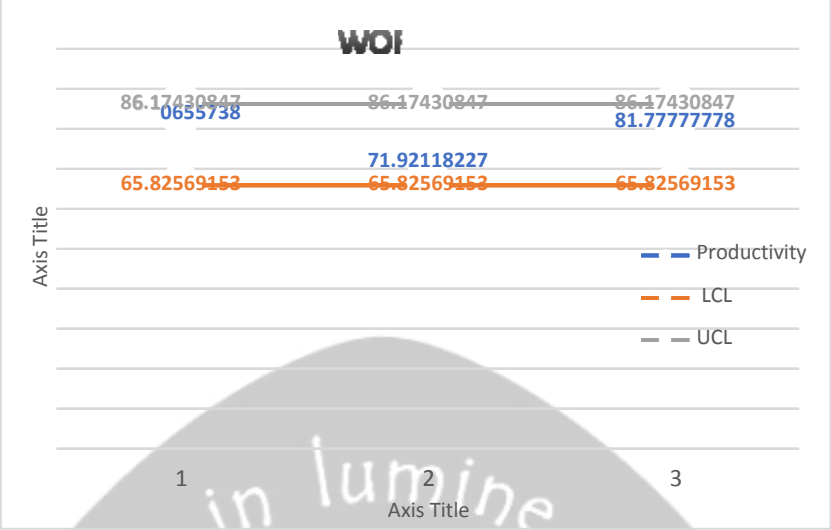

Figure 4.7 Graph of Data Uniformity Test Results of Worker Data 4

From result of calculation and data processing got UCL result equal to 86,17 and LCL equal to 65,82. From the data uniformity test results, the data obtained entirely between the upper quartile limit and the lower quartile limit so that it can be said that the data has been uniform and still within the control limits. The data obtained entirely is data obtained from the same population.

Skill			Effort		
+0.15	A1	Superskill	+0.13	A1	Excessive
+0 13	A2		+0.12	A2	
+0.11	B1	Excellent	+0.10	B1	Excellent
+0 08	B2		+0 08	B2	
+0 06	C1	Good	+0 05	C1	Good
+0 03	C2		+0 02	C2	
0.00	D	Average	0 00	D	Average
−0 05	E1	Fair	−0 04	E1	Fair
−0.10	E2		−0 08	E2	
−0 16	F1	Poor	−0.12	F1	Poor
−0 22	F2		−0 17	F2	
Conditions			**Consistency**		
+0 06	A	Ideal	+0 04	A	Perfect
+0 04	B	Excellent	+0.03	B	Excellent
+0.02	C	Good	+0 01	C	Good
0 00	D	Average	0 00	D	Average
−0.03	E	Fair	−0.02	E	Fair
−0.07	F	Poor	−0.04	F	Poor

Figure 4.8 Westinghouse adjustment factor

Table 4.7. Adjustment Factors *Westinghouse*

Faktor Allowance Westinghouse Average Workers									
Working elements	Skill	Score	Effort	Score	Condition	Score	Consistency	Score	Total Allowance
Staple the goods	D	0	D	0	D	0	D	0	1
Positioning the goods in the warehouse	D	0	C2	0.02	C	0.02	D	0	1.04
Fix the defect packing	D	0	D	0	D	0	D	0	1
Take the pallet or handlift	D	0	C2	0.02	D	0	D	0	1.02
Stick the lot paper	B2	0.08	D	0	C	0.02	D	0	1.1
Other	D	0	D	0	D	0	D	0	1

The adjustment factor can be seen in table 4.7. is given to the workers to determine the fairness and unfairness of the worker in doing his work. The method of adjustment factor used is the Westinghouse method that can be seen in the figure 4.8. In this method there are adjustment factors such as skills, effort, working condition / condition, and consistency. Assessments were made for the average of all workers who were in the staple process during the observations made. Assessment of the adjustment factor is given for each work element so that later can be calculated the normal time and standard time of each work element performed by staple worker.

The result of total adjustment for the goods staple is 1, because the adjustment factor is fair. The activity of positioning goods in the warehouse is given a score of 0.02 on the business and working conditions because the condition of the workers perform each job positioned the goods in the warehouse is quick and the workers know the existing places well. Other factors in positioning activities are given a score of 0 or fair, so the total score for this activity is 1.04. The activity of correcting

the defect packing is given a reasonable adjustment factor so that the total adjustment factor is 1. The activity of taking the pallet is given a score of 0.02 because the worker takes the pallet with a good enough effort and the other factor is given a score of 0 or fair, so the total adjustment factor is 1.02. The activity gives the lot paper given a score of 0.08 on the skills because the workers do this job well. Working conditions when giving the lot notes were scored 0.02 because of its available board as a place to stick lot paper, it will make the workers easily to find the proper lot paper. The result of the total fator adjustment obtained on the job of giving the lot paper is 1.1. and the last activity is the other has a reasonable adjustment factor and the total score is 1.

Factor	Job Example	Equivalent Load	Allowance	
A. Energy released			Male	Female
1. Can be ignored	Working at the desk, sitting down	No load	0.0-6.0	0.0-6.0
2. Very light	Work at the table, stand up	0.00-2.25 kg	6.0-7.5	6.0-7.5
3. Lightweight	Shoved lightly	2.25-9.00	7.5-12.0	7.5-16.0
4. Medium	Hoeing	9.00-18.00	12.0-19.0	16.0-30
5. Weight	Swinging a heavy hammer	18.00-27.00	19.0-30.0	
6. Very heavy	Shouldering loads	27.00-50.00	30.0-50.0	
7. Unbelievably heavy	Bear heavy sacks	Above 50 kg		
B. Work attitude				
1. Sit down	Working sit, light		0.00-1.0	
2. Stand on two legs	Body upright, supported by two legs		1.0-2.5	
3. Stand on one leg	One leg working on the controller		2.5-4.0	
4. Lie down	On the side, back or front of the body		2.5-4.0	
5. Bending	The body is bent on both legs		4.0-10.0	
C. Work Motion				
1. Normal	Swinging a heavy hammer		0	
2. A bit limited	Limited swing from the hammer		0-5	
3. Hard	Carry heavy loads with one hand		0-5	
4. Only for limited limbs	Working with hands overhead		5-10	
5. All limbs are limited	Working in mines		10-15	
D. Eyestrain			Good Lights	Bad Lights
1. Dijointed view	Read measuring instrument		0	1
2. Almost continuous view	Meticulous work		2	2
3. Continuous view with changing focus	Check for defects on the fabric		2	5
4. Constant view with fixed focus	A very thorough examination		4	8
E. Workplace temperature conditions	(temperature degree celcius)		Normal Fatigue	Excessive
1. Frozen	Below 0		Above 10	Above 12
2. Low	0-13		10-0	12-5
3. Medium	13-22		5-0	8-0
4. Normal	22-28		0-5	0-8
5. High	28-38		5-40	8-100
6. Very high	Above 38		Above 40	Above 100
F. Atmosphere				
1. Good	Well ventilated room		0	
2. Enough	Bad ventilation, odors		0-5	
3. Not good	Toxic dust, or non-toxic but numerous		5-10	
4. Bad	Harmful odors that require to use breathing apparatus		10-20	
G. Good environmental conditions				
1. Clean, healthy, bright with low noise			0	
2. The work cycle repeatedly between 5-10 seconds			0-1	
3. Repetitive work cycle between 0-5 seconds			1-3	
4. Very noisy			0-5	
5. If influencing factors can degrade quality			0-5	
6. Feel the vibration of the floor			5-10	
7. Exceptional circumstances (sound, cleanliness, etc.)			5-15	

Figure 4.9. Allowance factor

Table 4.8. Table Allowance Factor of workers

Works Element	Allowance (%)									
	Ener-gy released (TK)	Wo-rk attitude (SK)	Working Movement (GK)	Eye Fatigue (KM)	Workplace Temperature Situation (KSH)	The Atmosphere (KA)	Environmental Situation (KL)	Individual needs (KP)	Total Allowances (%)	Allowance *(allowance)*
Staple the goods	24	1.75	2.5	0	0	0	0	1.25	29.5	0.295
Positioning the goods in the warehouse	15.5	1.75	0	0	0	0	0	1.25	18.5	0.185
Fix the defect packing	9.75	1.75	0	0	0	0	0	1.25	12.75	0.1275
Take the pallet or handlift	15.5	1.75	0	0	0	0	0	1.25	18.5	0.185
Stick the lot paper	0	1.75	0	0	0	0	0	1.25	3	0.03
Other	0	0	0	0	0	0	0	1.25	1.25	0.0125

The allowance factor for the worker is using some factor in figure 4.9 and the writer analyze each element's allowance factor. The allowance factor in the table 4.8. is given to the worker so it can give the workers the opportunity to do the things that must be done. Giving allowance factors and adjustment factors are provided for work to be fair (fair) both from the management side and from the manual worker side. The greatest allowance is given to the working elements of the goods staple, because in this work the workers need more labor and lift the heavy loads. Stapling goods activities have a considerable allowance factor on the energy released so given a score of 24. Staple goods activities are given a allowance of 0.2875. The activity of positioning the goods is given the allowance factor of 0.1725. Correcting the defect packing has a leeway factor of 0.115. Taking pallet or handlift has allowance factor of 0.1725. And the activity of giving lot paper is given the allowance factor of 0.0175. Other activities are not given a allowance factor or equal to 0 because the researcher did not observe directly the process of the activity.

Workers perform all work activities by standing so that all allowance factors of work attitude given a score of 1.75.

By all the calculation and analysis before, the work sampling process will be continued to the calculation of Waktu Baku or standard time of every work element that can be seen in the table 4.9. below.

Table 4.9. Results Work sampling process

Data Processing Work Sampling											
Company:		PT Djarum SKM Gribig				Total visit:			1903		
Job:		Staple Workers in Packing Process				Total Time Observation:			1070 min		
Name:		Workers 1,2, and 3									
No	Work-ing ele-ments	To-tal Acti vity	OI U	%produ ctive activity	Produc tive time	Cy-cle time	p	Time Nor mal	Allowa nce (a+1)	Stand ard time	WB (sec on)
1	Staple the goods	442	14 20	23.22	271.7 499	0.19 14	1	0.19 14	1.295	0.24 8	14.8 7
2	Positio ning the goods in the wareho use	155	15 5	8.14	95.29 69	0.61 48	1.0 4	0.63 94	1.185	0.75 8	45.4 62
3	Fix the defect packin g	2	2	0.105	1.229 637	0.61 48	1	0.61 48	1.127 5	0.69 3	41.5 92
4	Take the pallet or handlift	67	67	3.52	41.19 285	0.61 48	1.0 2	0.62 71	1.185	0.74 3	44.5 88
5	Stick the lot paper	21	21	1.10	12.91 119	0.61 48	1.1	0.67 63	1.03	0.69 7	41.7 95
6	Other	778	77 8	40.88	478.3 29	0.61 48	1	0.61 48	1.012 5	0.62 3	37.3 5

From the result of data processing of job sampling, can be done the calculation of standard time for each work element. The standard time for the work of stapling items is 14,87 seconds. The job of positioning goods in Warehouse is 45,462 sec. Correcting a defect packing takes 41.59 seconds. The work of picking up a pallet or handlift has a standard time of about 44,588 seconds. The paper giving job has

a raw time of 41,795 seconds. And another job or Other has a standard time of 37.35 seconds.

b. Workload Analysis

Workload analysis is use to analyze the workload of each workers in the staple process and can be consideration for the next decision. To calculate the workload analysis, the performance rating and allowance must be determined before. The performance rating and allowance of the workers can be seen in the tabel 4.10. until table 4.12. below.

Table 4.10. *Performance Rating* 4 Workers Bagian Stapel

Work-ers	Skill	Score	Effort	Score	Condi tion	Score	Consist ency	Score	Perform ance Rating	Informa tion
P1	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	1	Fair
P2	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	1	Fair
P3	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	1	Fair
P4	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	D = 0	1	Fair

Table 4.11. Allowance(Allowance) 4 Workers Bagian Stapel

Work ers	Energy release d (TK)	Work attitu de (SK)	Worki ng Move ment (GK)	Eye Fatigue (KM)	Workp lace Temp eratur e Situati on (KSH)	The Atmos phere (KA)	Environ mental Situation (KL)	Individual needs (KP)	Total Allowan ce (%)
P1	24	1.75	0	0	0	0	0	1.25	27
P2	24	1.75	0	0	0	0	0	1.25	27
P3	24	1.75	0	0	0	0	0	1.25	27
P4	24	1.75	0	0	0	0	0	1.25	27

Table 4.12. Average Productivity of 4 Workers

Workers	Average Productivity
P1	0.732075829
P2	0.755641026
P3	0.777925449
P4	0.791018391

i. Workers 1

Workload = (%productive x *Performance Rating*) x (1 + *allowance*)

Workload = (0.73 x 1) x (1 + 27%)

= 0.93

= 93%

ii. Workers 2

Workload = (%productive x *Performance Rating*) x (1 + *allowance)*

Workload = (0.75 x 1) x (1 + 27%)

= 0.95

= 95%

iii. Workers 3

Workload = (%productive x *Performance Rating*) x (1 + *allowance)*

Workload = (0.77 x 1) x (1 + 27%)

= 0.98

= 98%

iv. Workers 4

Workload = (%productive x *Performance Rating*) x (1 + *allowance)*

Workload = (0.79 x 1) x (1 + 27%)

= 1.00

= 100%

The performance rating is based on the Westinghouse adjustment table. All workers have the right skills, effort, working conditions, and consistency, so the performance rating is 1 or fair. The allowance factor of each worker is based on actual work conditions. The power released is quite large because the load raised is 21kg in average or included in heavy work. Worker's attitude is to stand on two legs. The movement of workers is normal and free. The eye fatigue of workers has a score of 0 because workers do not always concentrate on one object continuously. Normal place temperature. The atmosphere and environment are quite good. Allowance for personal needs of men is given an average score of 1.25%.

From the calculation results, the workload of each worker, namely worker 1, worker 2, worker 3, and workers 4. The first worker has a productivity percentage of 73%

and workload of 93%. The second worker has a 75% percentage and a workload of 95%. The third worker has a percentage of productivity of 77% and workload of 98%. The fourth worker has a productivity percentage of 79% and workload of 100%. From the calculation of the workload, it can be concluded that the workers have enough workload and no need for reduction or addition of the number of workers. 4 Workers who rotate like this have an optimal level of productivity and have enough workload.

c. Data and Analysis of Initial Workstation

The dimension and weight of the end product of PT Djarum can be seen in the table 4.13. below.

Table 4.13. Dimension of the *Box* or Products of PT Djarum

No	Brand	*Box dimension* (mm)			Real Box Dimension (mm)			Weight (kg)
		Length	Width	Height	Length	Width	Height	
1	LA BOLD 20	410	450	560	410	450	580	27.85
2	BLACK SERIES 16	390	485	520	390	485	530	17.85
3	LA LIGHT 12	330	385	440	330	385	450	20.95
4	MLD 12	330	385	440	330	385	450	21.1
5	BLACK 12	330	385	440	330	385	450	20.65
6	BOLD 12	350	410	480	350	410	495	27.35
7	SUPER 16 R2	390	485	520	390	485	530	25.85
8	SUPER 16 R1	365	420	475	365	420	495	15.75
9	DC 12	375	384	513	375	384	530	15.85
10	76 GOLD 12	375	384	513	375	384	530	15.55
11	DIS 16	365	420	475	365	420	485	20.45
12	76 GOLD 16	365	420	475	365	420	485	20.55
AVERAGE		364.5833	417.75	487.5833	364.5833	417.75	500.8333	20.8125

From the observation and measurement of the box or product dimension that must be processed in the staple work process, the result is that the average dimension of each box so or real is 364.5x417.75x500.83 and the average weight of the box is 20.8 kg. Average usage is done because the box or the existing product has a variety of sizes, so the use of dimensions in the analysis or design requires simplification so that to tolerate the existence of dimensions that are too large or small then selected the average dimension of the box or existing products.

The following table(table 4.14.) is a dimension of the initial work facility:

Table 4.14. Table Initial Work Facility Dimension

Initial Work Facility Dimension	Dimension (cm)
Horizontal Length Conveyor	495
Conveyor Width	70
Conveyor Max Height	70
Conveyor Min Height	50
Conveyor Aisle	53
Conveyor Thickness	8
Pallet Dimension	115x115x15

Early work facility Redefined on CATIA software with the aim to analyze ergonomic posture using RULA and know the dimensions of the initial facility in detail. Initial work facilities were also given mannequin 5 and mannequin 95 as an illustration when there were workers who had body dimensions with a 5th or 95th percentile. The RULA analysis was performed for both the mannequins. The figure of initial workstation by using CATIA software can be seen in figure 4.10 until figure 4.13 below.

In the 95th percentile mannequin, RULA analysis was performed. Suppose the worker does the job statically or >4 times per minute. The results of the RULA analysis of the mannequins at the initial work facility had a RULA score of 7 which would require investigation and change now. Wrong enough wrist positions, too heavy loads, poor arm and neck position make the RULA score poor enough.

When the 95th percentile mannequin performs the same activities and postures, but the work is done <4 times per minute, the RULA score is 6 for which further investigation is needed and requires immediate change. A bad score lies in the wrist posture that moves beyond its symmetry angle.

In mannequin with the 5th percentile RULA analysis was performed with CATIA software. When workers do static work or> 4 times in one minute, the results of a RULA score of 7 indicating that the posture has a high risk and requires investigation and change at this time. The score is quite bad because of the position of the forearm, the load is too heavy, the wrist position, and the weight of the muscle is quite heavy. When the 5th percentile mannequin was analyzed in the same position, but the intermittent activity or <4 times per minute, the results obtained RULA score of 6 which means need further investigation and changes immediately. Then it can be concluded that the body position is too bent and cause high RULA score obtained from the analysis using CATIA software. The result of the RULA analysis can be seen in figure 4.14 until 4.17.

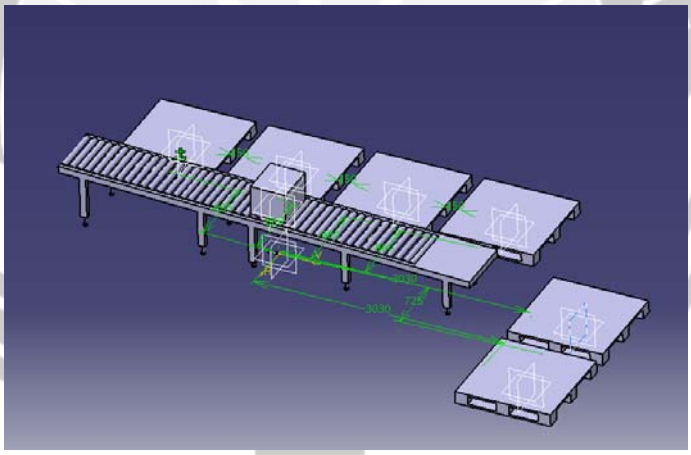

Figure 4.10 3D view of the Initial Workstation Using CATIA

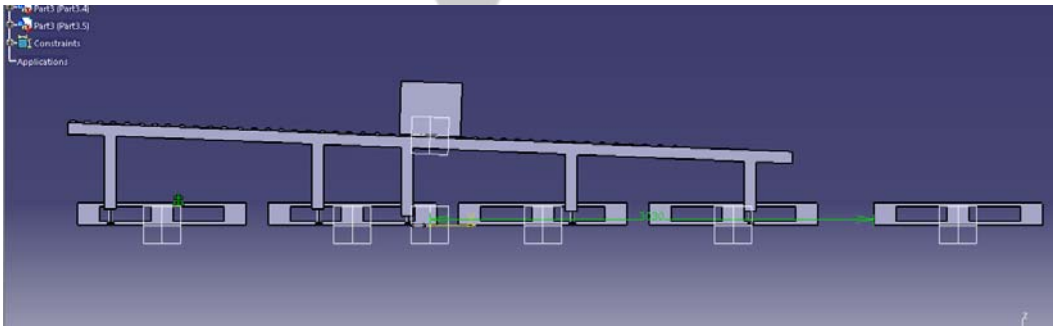

Figure 4.11 Side View of the Initial Workstation Using CATIA

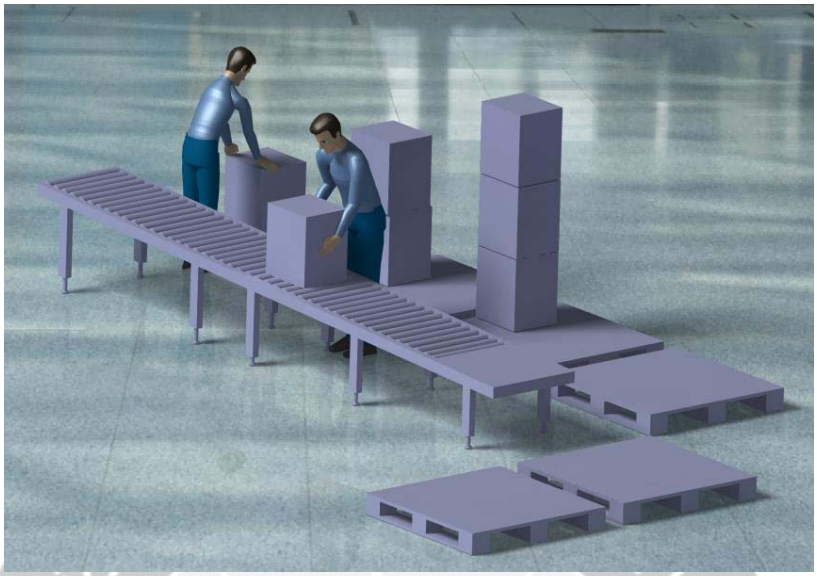

Figure 4.12 3D View of Initial Workstation and Mannequin Percentile 95 and Percentile 5

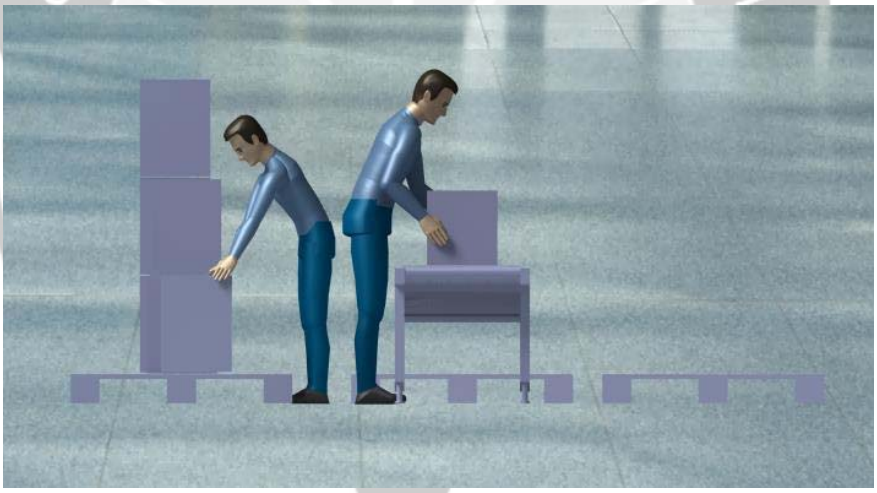

Figure 4.13 Side View of Initial Workstation and Mannequin Percentile 95 and Percentile 5

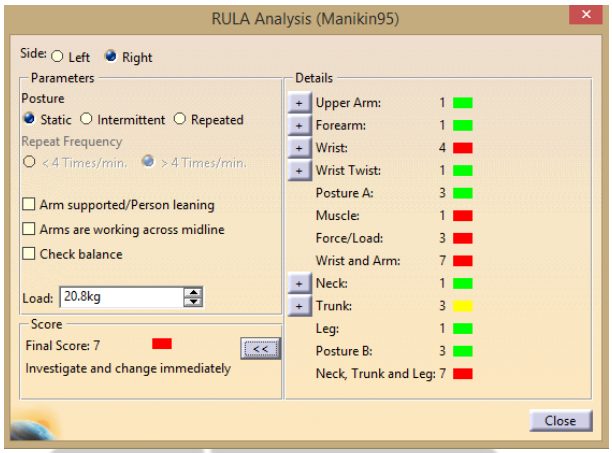

Figure 4.14 RULA Analysis of Mannequin with 95th Percentile Using CATIA (*Static*)

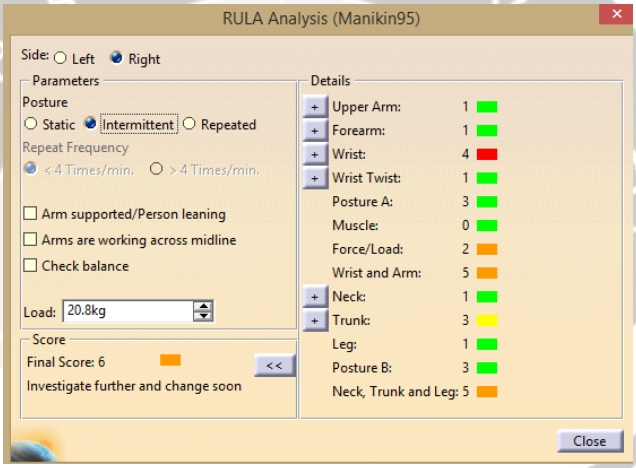

Figure 4.15 RULA Analysis of Mannequin with 95th Percentile Using CATIA (*Intermittent*)

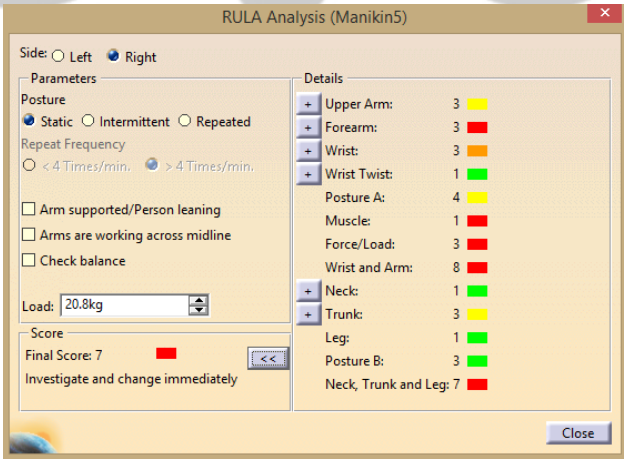

Figure 4.16 RULA Analysis of Mannequin with 5th Percentile Using CATIA (*Static)*

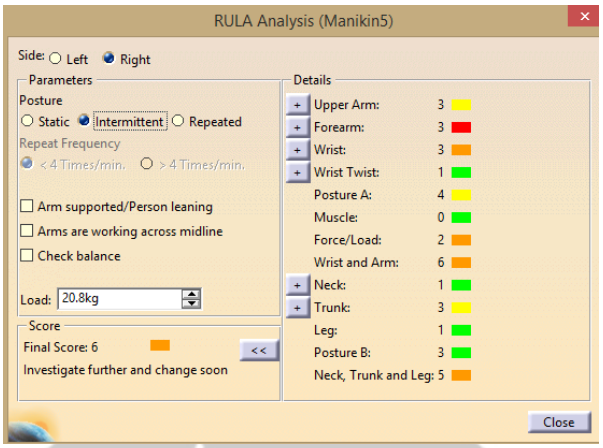

Figure 4.17 RULA Analysis of Mannequin with 5th Percentile Using CATIA (*Intermittent)*

d. Analysis of Workers When stacks Box in the first pile

The picture of workers when doing the staple job in the first pile can be seen in figure 4.18 and 4.19. In the posture of the neck, workers move the neck by 0 to 20 degrees. The body bends to lift and place the box on the pallet for 20 to 60 degrees. The position of the worker's body while lifting slightly twisted and tilted when the worker will take the goods on the conveyor. Workers stand with two straight legs these neck, trunk, and legs analysis can be seen in figure 4.20. The weight of the box raised ranges from 15-27 kg as can be seen in figure 4.21. The upper arm lifts between 45 to 90 degrees when positioning the goods. The arm sometimes lifts sideways as it will pick up the items on the conveyor. The lower arm works between 60 and 100 degrees. The palm of the hand moves beyond 15 degrees up or down and rotates when lifting the box as can be seen in figure 4.22. The handle on the box can be easily held tightly as can be seen in figure 4.23. Work is done more than 4x per minute during busy working hours as can be seen in figure 4.24. From the REBA analysis results obtained REBA score of 10 and it can be concluded that the posture at work has a high risk and requires further research or change. The result of analysis can be seen in figure 4.25.

Figure 4.18 Workers Put The Box From Conveyor

Figure 4.19 Workers Stacks The Box in the First Pile

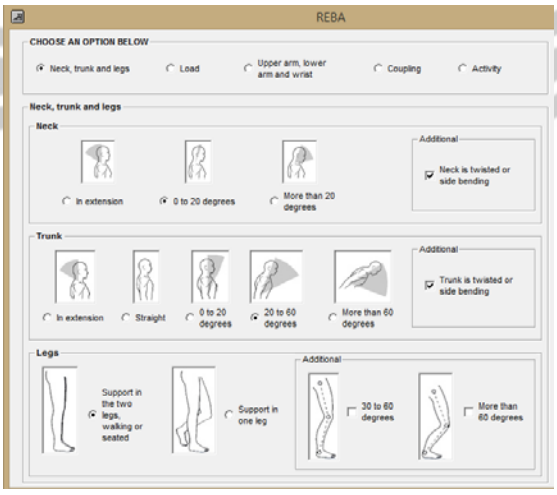

Figure 4.20 REBA Analysis Using ERGOFELLOW Software (*Neck,trunk, and legs*)

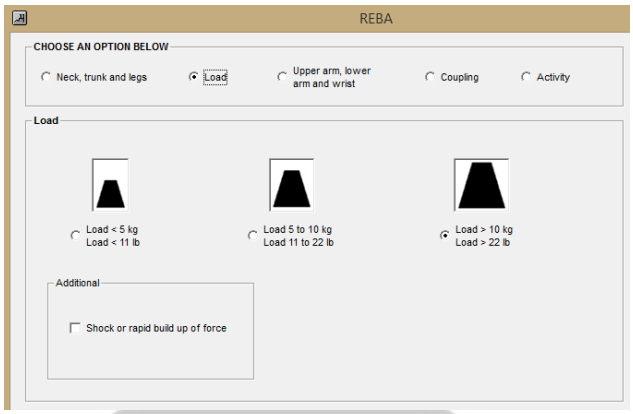

Figure 4.21 REBA Analysis Using ERGOFELLOW Software (*Load*)

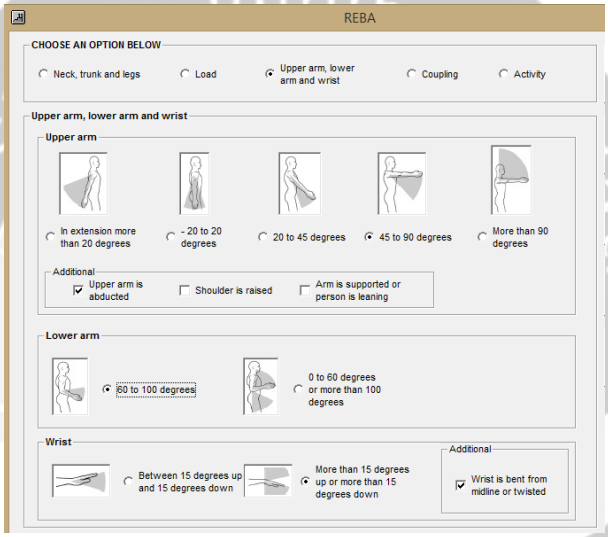

Figure 4.22 REBA Analysis Using ERGOFELLOW Software (*Upper arm, lower arm, and wrist*)

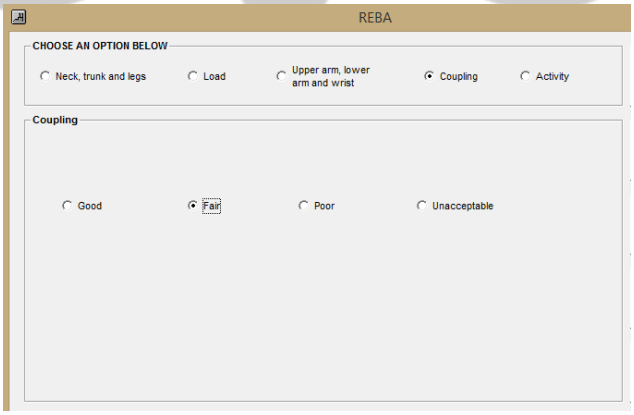

Figure 4.23 REBA Analysis Using ERGOFELLOW Software (*Coupling)*

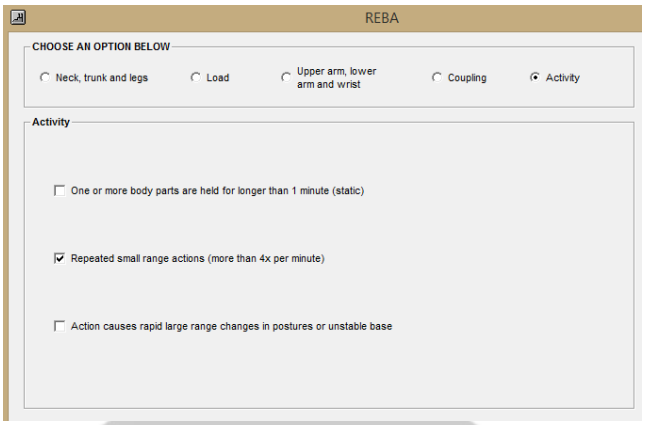

Figure 4.24 REBA Analysis Using ERGOFELLOW Software (*Activity*)

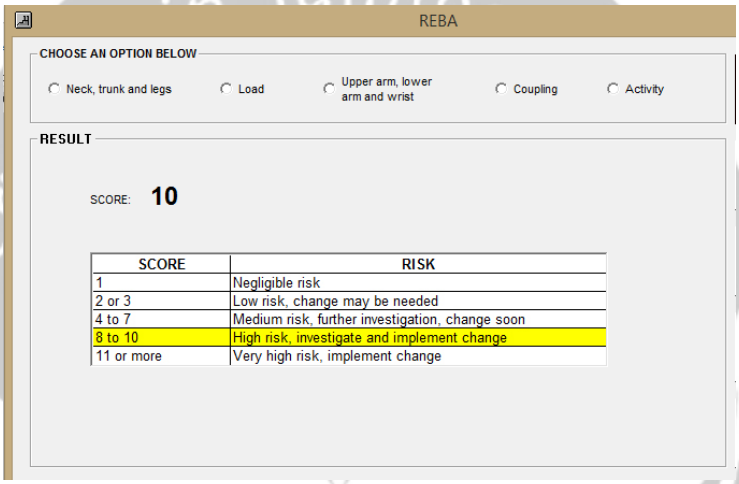

Figure 4.25 REBA Analysis Using ERGOFELLOW Software (*Result*)

d. Analysis of Workers When stacks Box in the Second pile

The picture of workers when doing the staple job in the second pile can be seen in figure 4.26 and 4.27. Workers posture while doing staple work process has a head position between 0 to 20 degrees. The position of the body is slightly bent between 0 to 20 degrees and sometimes the workers leaning sideways or twisting the body to pick up and place the goods, The position of the worker's feet standing upright on two legs. The analysis of neck, trunk, and legs can be seen in figure 4.28. The position of the upper arm of the worker moves from 45 to 90 degrees and the worker lifts the forearm to the side or abduction thus increasing the addition of the score on the upper arm. In the lower arm, the worker moves between 60 and 100 degrees while holding or lifting boxes. Wrist positions that range more than 15 degrees up or down. The wrist also spins as the worker pushes the box or arranges

the box on the pallet this analysis can be seen in figure 4.30. The handle on the box can be easily held tightly as can be seen in figure 4.31. Work is done more than 4x per minute during busy working hours as can be seen in figure 4.32. From the REBA analysis results obtained REBA score of 10 and it can be concluded that the posture at work has a high risk and requires further research or change. This analysis result can be seen in figure 4.33.

Figure 4.26 Figure Workers Put The Box From Conveyor

Figure 4.27 Figure Workers Stacks The Box in the Second Pile

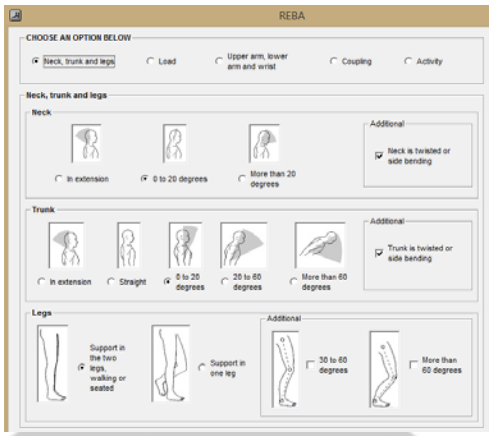

Figure 4.28 REBA Analysis Using ERGOFELLOW Software (*Neck, trunk, and legs*)

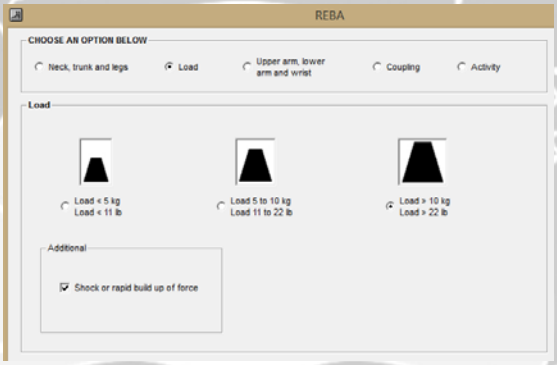

Figure 4.29 REBA Analysis Using ERGOFELLOW Software (*Load*)

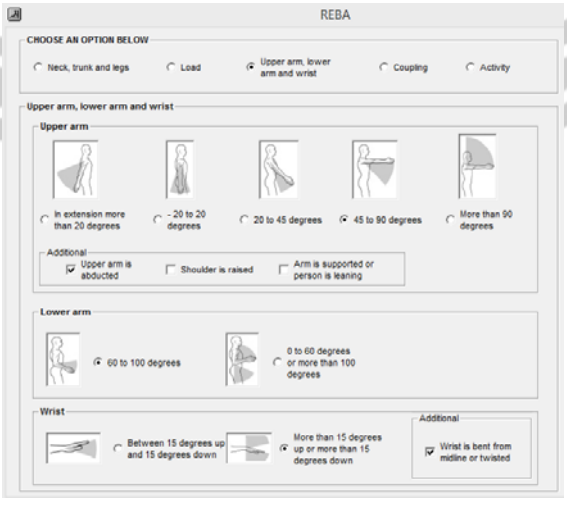

Figure 4.30 REBA Analysis Using ERGOFELLOW Software (*Upper arm, lower arm, and wrist*)

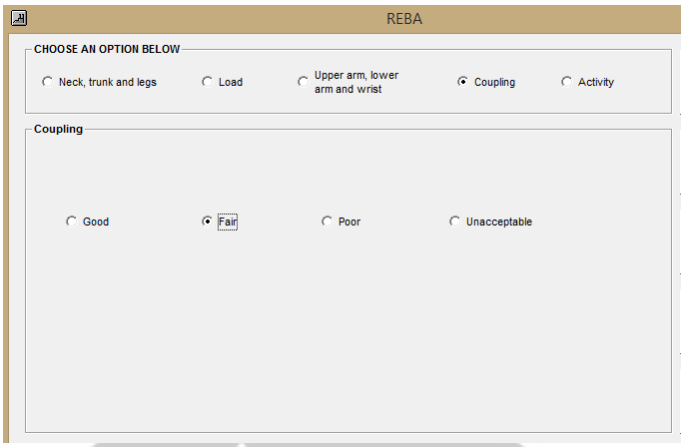

Figure 4.31 REBA Analysis Using ERGOFELLOW Software (*Coupling*)

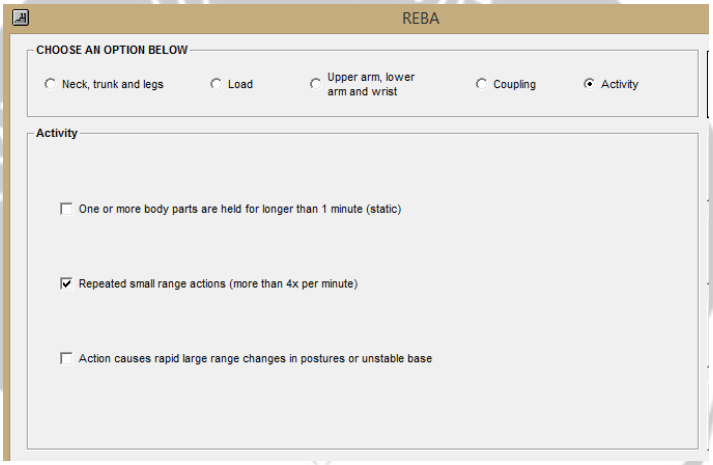

Figure 4.32 REBA Analysis Using ERGOFELLOW Software (*Activity*)

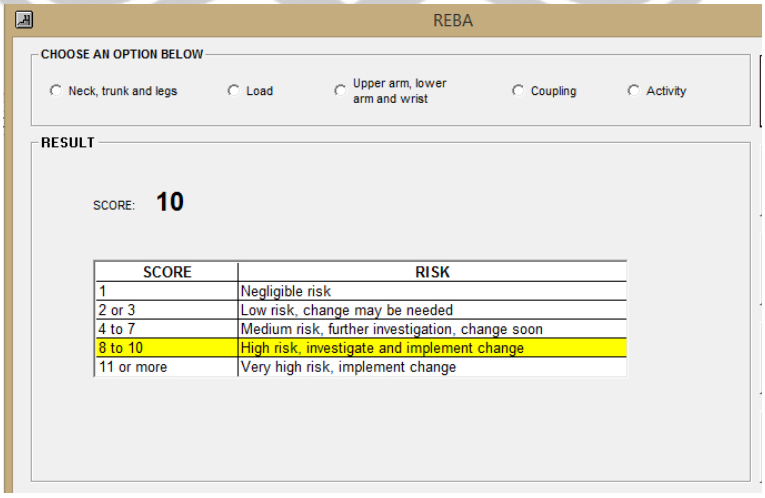

Figure 4.33 REBA Analysis Using ERGOFELLOW Software (*Result*)

e. Analysis of Workers When stacks Box in the Third pile

The picture of workers when doing the staple job in the third pile can be seen in figure 4.34 and 4.35. On the worker's posture while doing the top staple box work, the position of the worker's head is slightly raised as it lifts the goods (in extension). Workers turn their heads to see the position of the placement. The position of the worker body is slightly bent between 0 to 20 degrees and the worker's body is also slightly twisted while moving the goods. The position of the worker's feet rests on two upright legs. These analysis can be seen in figure 4.36. Workers do the work by lifting boxes weight between 15 to 27 kg and it takes shock or pounding power when lifting goods, because the box should be positioned on a high enough pile as can be seen in figure 4.37.

The posture of the upper arm of the worker when carrying the item-lifting activity is between 45 to 90 degrees and the forearm of the infected worker is abducted. The bottom arm of the worker moves between 0 to 60 degrees or more than 100 degrees. Workers' palms move more than 15 degrees up or down and wrists twist. This upper arm, lower arm, and wrist analysis can be seen in figure 4.38. The handle on the box can be easily held tightly as can be seen in figure 4.39. Work is done more than 4x per minute during busy working hours. This activity is repeated over 4x per minute as can be seen in figure 4.40. From the results of REBA analysis conducted, the worker's body posture REBA score of 11 which means that the posture has a very high risk and requires immediate change of work facility. The result of the analysis can be seen in figure 4.41.

Figure 4.34 Figure Workers Put The Box From Conveyor

Figure 4.35 Figure Workers Stacks The Box in the Third Pile

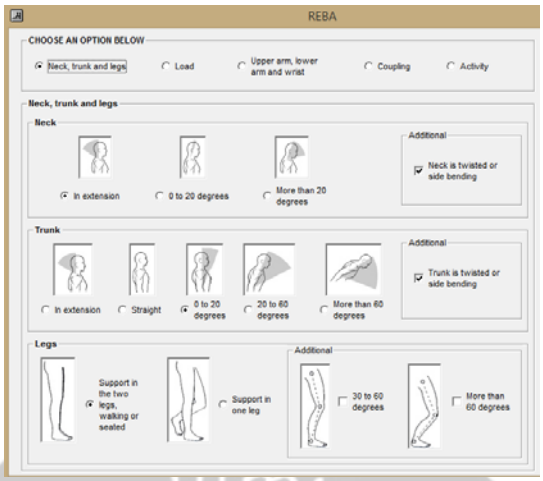

Figure 4.36 REBA Analysis Using ERGOFELLOW Software (*Neck, trunk, and legs*)

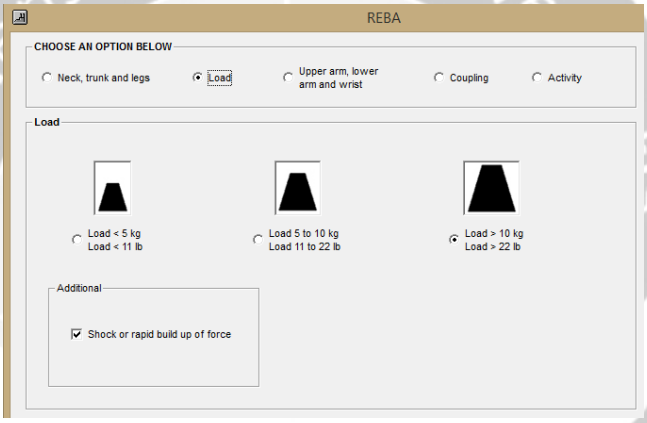

Figure 4.37 REBA Analysis Using ERGOFELLOW Software (*Load*)

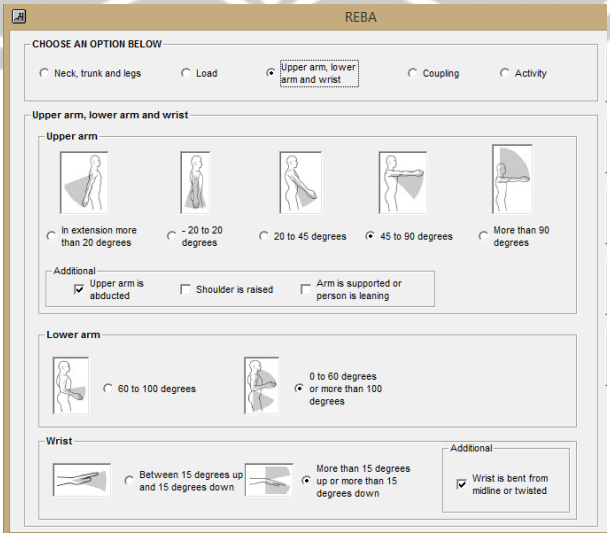

Figure 4.38 REBA Analysis Using ERGOFELLOW Software *(Upper arm, lower arm, and wrist)*

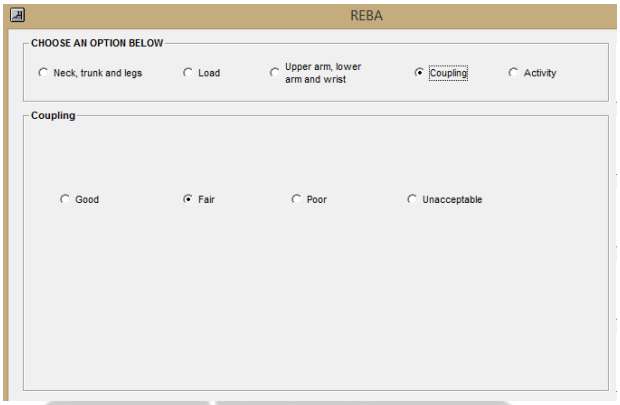

Figure 4.39 REBA Analysis Using ERGOFELLOW Software *(Coupling)*

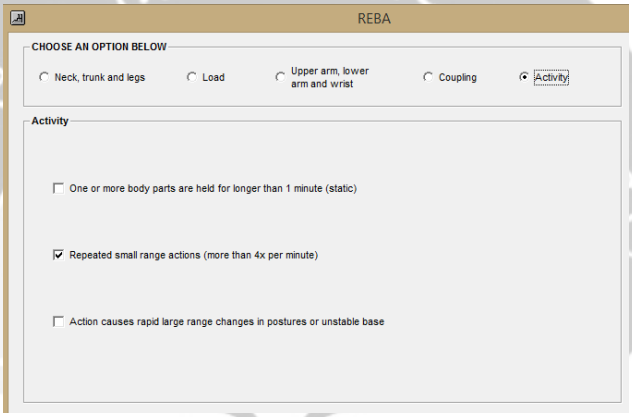

Figure 4.40 REBA Analysis Using ERGOFELLOW Software *(Activity)*

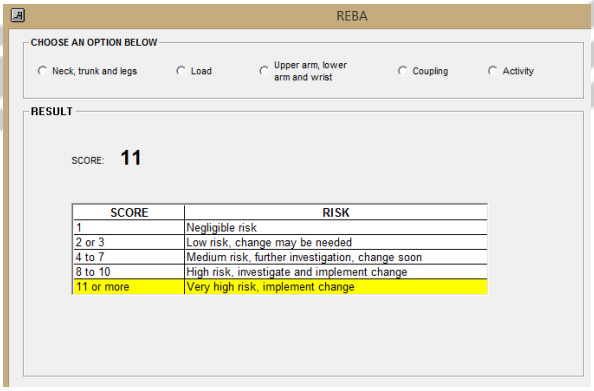

Figure 4.41 REBA Analysis Using ERGOFELLOW Software *(Result)*

f. Ergonomics Analysis and Proposed Workstation Design

Anthropometri figure can be seen in figure 4.42 and the anthropometri dimension data for Indonesian people can be seen in the table 4.15.

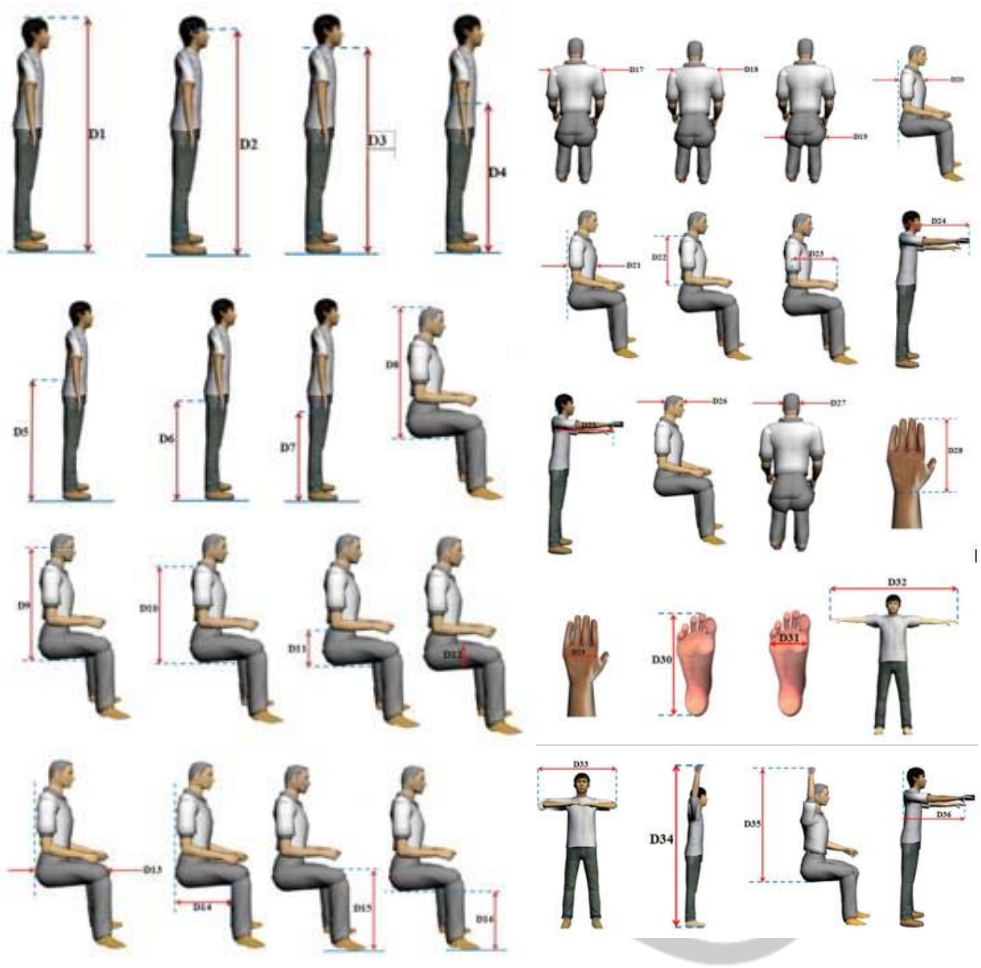

Figure 4.42 Anthropometri Dimension Figure (sources: http://antropometriindonesia.org/index.php/detail/sub/3/4/0/dimensi_antropometri)

Table 4.15. Anthropometri Data of Indonesian People

Dimension	Information	5th	50th	95th	SD
D1	Height body	160.06	169.14	178.22	5.52
D2	Height eyes	149.22	158.34	167.46	5.54
D3	Height shoulders	132.07	140.74	149.4	5.27
D4	Elbow height	98.43	105.15	111.87	4.08
D5	Hips height	86.45	94.16	101.87	4.69

Table 4.15. Anthropometri Data (Cont'd)

D6	Height of bone	65.95	73.38	80.8	4.52
D7	height fingertips	62.39	71.89	81.39	5.77
D8	Height in a sitting position	72.24	83.21	94.17	6.67
D9	High eyes in a sitting position	60.18	72.61	85.05	7.56
D10	Shoulder height in a sitting position	47.84	64.24	80.63	9.97
D11	Elbow height in sitting position	23.87	32.16	40.46	5.04
D12	Thigh thickness	12.51	19.5	26.49	4.25
D13	Knee length	47.81	53.31	58.8	3.34
D14	Popliteal length	31.36	39.55	47.75	4.98
D15	Knee height	47.57	54.98	62.39	4.5
D16	Popliteal height	37.49	43.97	50.44	3.94
D17	Wide side of shoulder	35.93	45.44	54.95	5.78
D18	Shoulder width	30.06	37.28	44.5	4.39
D19	Hip width	29.7	36.82	43.95	4.33
D20	Thick of bottom	18.79	22.04	25.29	1.98
D21	Thick of stomach	15.4	25.63	35.86	6.22
D22	Upper arm length	24.48	35.41	46.33	6.64
D23	Forearm length	19.49	45.71	71.93	15.94
D24	Long ranges of hands forward	42.99	70.52	98.05	16.74
D25	Long shoulder-grip hand forward	49.02	61.52	74.03	7.6
D26	Head length	7.8	18.89	29.97	6.74
D27	Head width	13.18	17.92	22.65	2.88
D28	Hand length	14.1	19.06	24.02	3.01
D29	The width of the hand	7.66	12.28	16.9	2.81
D30	Length of legs	18.79	24.83	30.88	3.67
D31	Legs Width	7.25	9.73	12.2	1.5
D32	The length of the arm stretch to the side	132.86	168.32	203.78	21.55
D33	Long elbow span	67.91	85.45	102.99	10.66
D34	Height of hand grip up in a standing position	161.99	205.19	248.38	26.26
D35	Height of grip up in a sitting position	97.81	124.77	151.73	16.39
D36	Length of hand grip forward	55.39	72.19	88.99	10.21

The anthropometric dimensions used in table 4.15. and Figure 4.42 above are obtained from the website http://antropometriindonesia.org/index.php/detail/artikel/4/10/dataantropometri. The site is a site containing Indonesian anthropometric data collected from various sources such as ITB, ITS, UNDIP, UBAYA, UAJY and Educational institutions or researchers who have anthropometric data on measuring Indonesian people. The data taken are data from the Indonesian anthropometry from the age of 21 years to 47 years. Age 21 is taken because it anticipates the existence of workers who have 21 years of age, and 47 years is the maximum age or the oldest that can be selected on the anthropometry data in the site. Workers in the staple section have varying ages, ranging from 23 years to over 50 years of age. The tribe of the anthropometric data used is all the tribes in Indonesia, so the dimensions can be used for all types of tribes that exist. The sexes used are male, because all manual workers of the staple or packing section are male.

By using the anthropometry data above, the writer proposed some dimension of the workstation in table 4.16. below.

Table 4.16. Dimension of Proposed Workstation

Function	Anthro-pometric Dimen-sion	Per-centile	Percen-tile Score	Allo-wance Score	Total (mm)	Information
Distance between pallets	TPR (Thick of Sto-mach)	95	35.86	0.14	360	The use of 95th percentile is due to anticipate the presence of workers with a 95th percentile or large stomach thickness doing the job, where the worker will tie the items in the pallet with the rope that surrounds the item. Allowance is provided to facilitate the calculation and to design the proposed work stations.
High maximum of conveyor	TPL (hip height)	95	101.87	4.13	1060	The 95th percentile is used so that workers who have a height of 95th percentile, can lift the goods with good posture, without bending. Allowance given aims to increase the movement of the goods in the conveyor, because the difference in maximum and minimum conveyor height from the initial workstation has a difference of 20cm and is considered sufficient

Table 4.16. Dimension of Proposed Workstation (Cont'd)

High minimum of conveyor	TPL (hip height)	5	86.45	0.55	870	Use of the 5th percentile is used so that workers who have short posture, can still lift the goods comfortably without difficulty in taking the goods from the conveyor
Distance between conveyor and pallet	LBH (shoulder stand width)	95	54.95	10.05	650	The use of the 95th percentile due to anticipate the presence of workers who have wide shoulders feel narrow and lack of areas of motion in work.
Height Machine for the First pile	TPL (hip height) – height of the pallet	50	79.16	21	1001.6	The use of the 50th percentile is used so that the machine can still be used comfortably by the person having the 5th percentile and the 95th percentile, the 21cm clearance given to the third pile, the worker can still have good posture.
Higher Machine for Second stack	TPL (hip height) - (heigth of the pallet + box height)	50	29.0767	21	500.76	The use of the 50th percentile is used so that the machine can still be used comfortably by the person having the 5th percentile and the 95th percentile, the 21cm clearance given to the third pile, the worker can still have good posture.
Engine Height for Third pile	TPL (hip height) - (pallet height+ (2 * box height))	50	-21.007	21.066	0	The use of the 50th percentile is used so that the machine can still be used comfortably by the person who has the 5th percentile and the 95th percentile, 21.06667cm slack is granted so that in the third pile, the worker can still have good posture.

TPR or thickness of the stomach is used because the observations made, workers have difficulty to do binding activities before positioning goods in the warehouse. The distance between pallets narrow enough to make the workers can not pass the empty space between the pallet and need the help of other workers to tie the rope. Using the thick dimensions of the 95th percentile stomach, workers can easily engage in binding activities.

The maximum conveyor height is the highest distance between the initial conveyor and the floor. High dimension of this maximum conveyor used hip height with 95th percentile. High conveyor minimum used anthropometry data by using hip anthropometric data percentile 5. Percentile 5 is chosen so that workers who have short posture still can easily do staple process of goods. The difference between the maximum height dimension and the minimum height of the conveyor is

accompanied also by the leeway so that the box or the dropped item can still run smoothly on the conveyor.

The distance between the conveyor and the pallet is used in the anthropometric dimension of shoulder width standing with the 95th percentile. The use of this dimension is done so that the workers can freely perform pivot activities or rotation of the body using the foot, so that the work posture rotate the body can be avoided.

For the height of the elevator pallet machine to be used, the height can be adjusted to the worker's hips height by the 50th percentile, this is done so that all workers who have average posture or percentile 5 and 95th percentile can still use it comfortably without feeling too high. Engine height at second stack, using height dimension of hips minus height of pallet and box height so that height of start and altitude machine when there is 1 stack of goods remain according to worker hip height. Machine height when there is 2 pile box above pallet still have 21 cm height above the desired height of the hip, so that the height of the conveyor increases, the first and second stack machines require a high penalty of 21 cm inserted in the looseness. This 21cm dimension is used so that when the workers do the staple work barnag the top most or the third pile can still have good posture.

The figure of proposed workstation that built using CATIA software can be seen in the figure 4.43 until 4.45. At the proposed work facility, the researcher advises to improve the conveyor and pallet or pallet dimensions. Improvement of worker posture can be done by using a tool called Pallet lift table or pallet lifting machine. This machine can adjust its height based on the load on it. By using this machine, the palette can be lifted to adjust to the height of the worker's hip so that workers can place the box without having to bend or feel too high. The height of the pallet will change when there is enough stuff on it so that the height position of the pallet in each pile will be different. Workers can staple or move goods in a good position.

The height of the conveyor is also changed, because at the initial work facility, the conveyor's height is very low and the worker needs to bend to pick up the goods. Workers with a height with a 95th percentile can only lift the box from the conveyor with a bent position. When workers have to stack boxes in the third pile, the worker needs to stamp his energy while heating the box in order to reach an empty position on the pallet, this is a deficiency in the initial work facility.

The distance between the pallets which is only about 15 cm makes the workers need the help of other workers when will tie the goods before positioning the pallet in the warehouse. Pallet or pallet is arranged based on the length of conveyor and space available in the work area. This also becomes an obstacle that needs to be considered in the next work facility change.

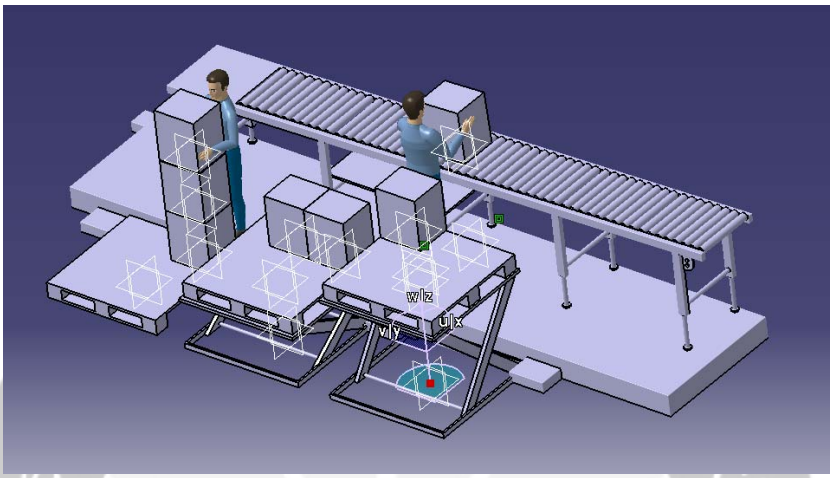

Figure 4.43 Proposed Workstation Using CATIA in 3D

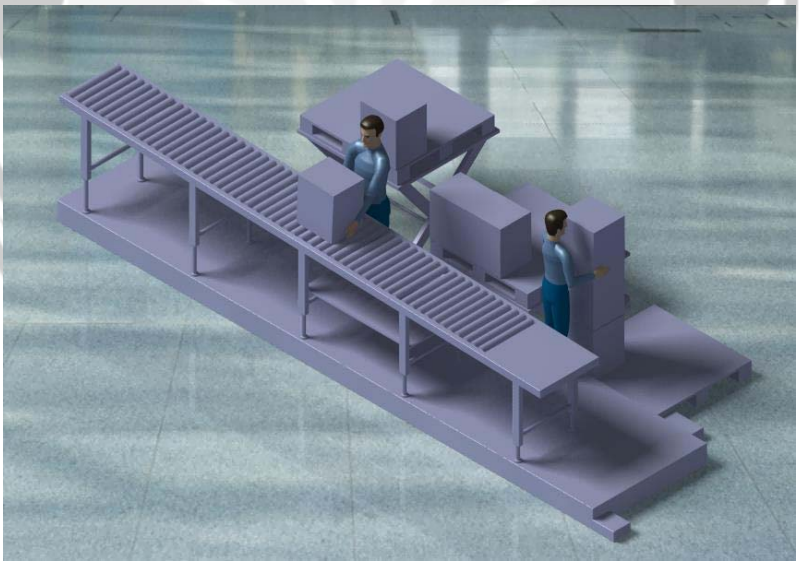

Figure 4.44 Proposed Workstation Using CATIA in 3D (*rendered)*

Figure 4.45 Side View of Proposed Workstation CATIA

The result of RULA analysis using CATIA software on mannequin95 or mannequin with 95th percentile got result of score 3, this result obtained if worker lift a load <4 times / minute (intermittent). The worst posture is in the load removed or loaded. The RULA analysis of 95th percentile mannequin scores 6 indicating that investigation is needed or further studies and changes are immediate. This is because the worker is allowed to do posture or work repeatedly> 4 times / minute (Static).

The results of RULA analysis on Mannequin percentile 5 show a RULA score of 3. From the scores obtained, further investigation is required, and changes may be required. This score is quite good when compared with the results of RULA analysis at the initial facility that has a score of 6. This result is obtained by using the lifting frequency> 4 times / minute. The results of the 5th percentile mannequin analysis by using the frequency of rapture activity <4 times / min has a RULA score of 6. This means that further investigation is required and requires immediate changes. The difference in scores between when workers perform the lifting frequency strongly affects the results of RULA score. The figure of RULA analysis of each mannequin using CATIA software can be seen in the figure 4.46 until 4.49.

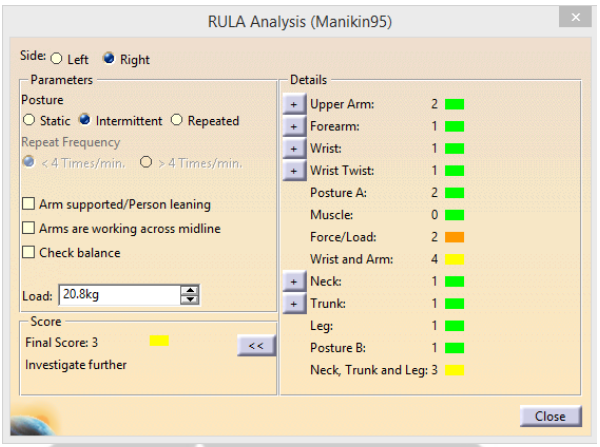

Figure 4.46 RULA Analysis of Mannequin with 95th Percentile Using CATIA(*Intermittent*)

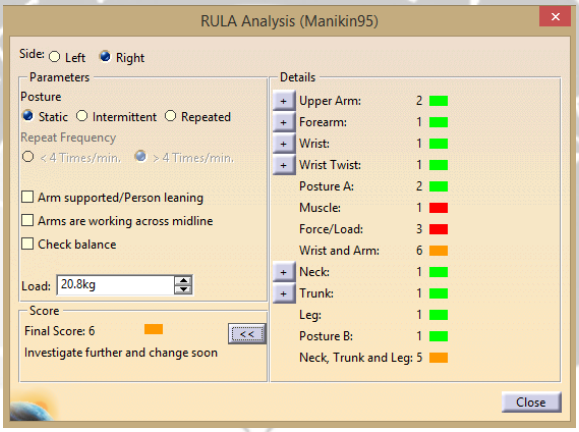

Figure 4.47 RULA Analysis of Mannequin with 95th Percentile Using CATIA(*Static*)

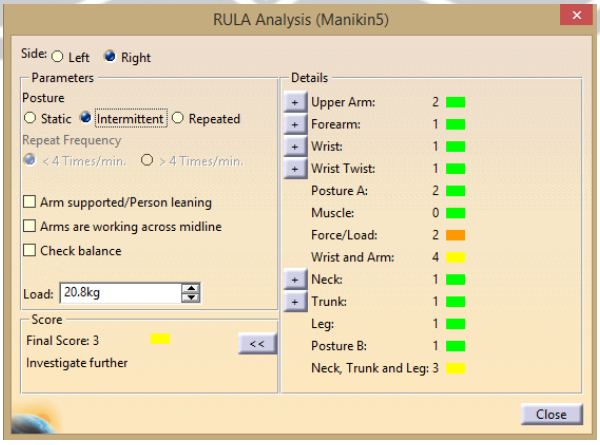

Figure 4.48 RULA Analysis of Mannequin with 5th Percentile Using CATIA (*Intermittent*)

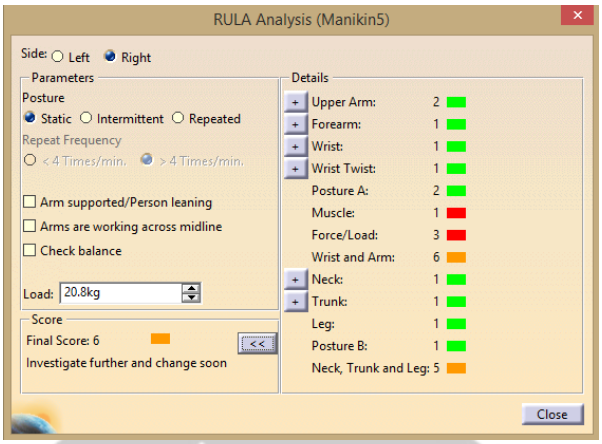

Figure 4.49 RULA Analysis of Mannequin with 5th Percentile Using CATIA (*Static*)

REBA analysis is performed on mannequins that have been made in CATIA software. This analysis is done by using ErgoFellow software using some working posture data. Work posture used is the worst work posture that can be done by mannequin. The position of the mannequin head is between 0 and 20 degrees. The position of the body of the permanent worker can remain upright because of the height of conveyor and pallet in accordance with the height of the hips and in the appointment does not require bending work posture. Both workers' legs remain upright while doing the work. Box loads raised by workers over 10kg. This neck, trunk, and legs analysis can be seen in figure 4.50. The load that the worker must be lift is more than 10 kg as can be seen in figure 4.51.

The position of the upper arm of the worker can move between 45 to 90 degrees when it will push the box or put the box on the pallet. The upper arm also lifts or experiences abduction when lifting a large enough box. The worker's underarm moves between 60 and 100 degrees. The wrist moves 15 degrees up or 15 degrees down and rotates while performing some work activity. The analysis of upper arm, lower arm, and wrist can be seen in figure 4.52. Box holds included in fair category as can be seen in figure 4.53. Activity is repeated and can be more than 4x per minute when the worker is in peak hours as can be seen in figure 4.54. Obtained a score of REBA analysis results of 7 which means that the job has a medium-term risk, requires further investigation, and changes immediately. This is obtained because the body position is still pelru bent when will push the box on the pallet far enough distance from the range. In addition, repeated movements of

more than 4x per minute have contributed quite a lot to the scores obtained. The result of this analysis can be seen in figure 4.55.

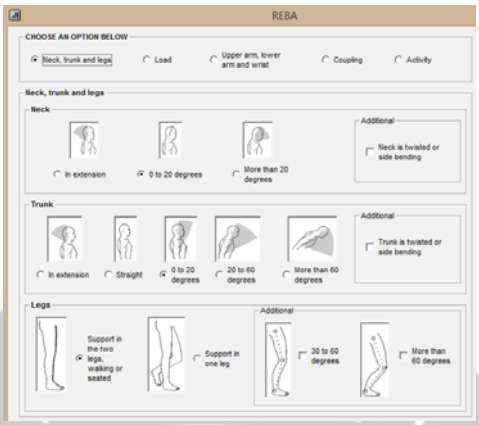

Figure 4.50 REBA Analysis Using ERGOFELLOW Software (*Neck, trunk, and legs*)

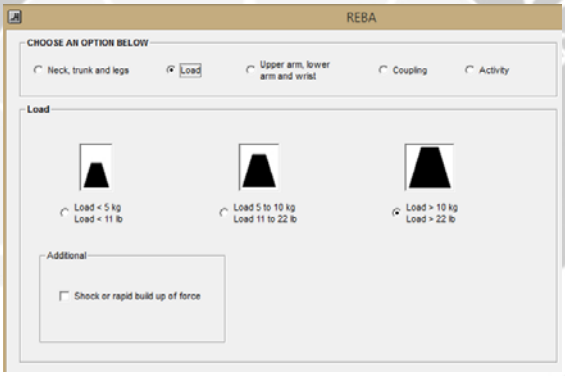

Figure 4.51 REBA Analysis Using ERGOFELLOW Software (Load)

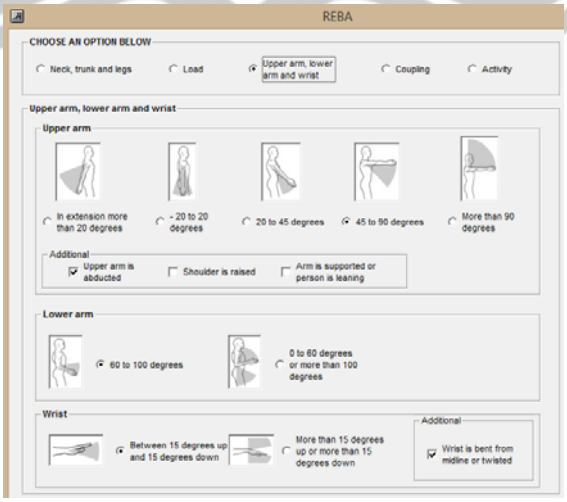

Figure 4.52 REBA Analysis Using ERGOFELLOW Software (Upper arm, lower arm, and wrist)

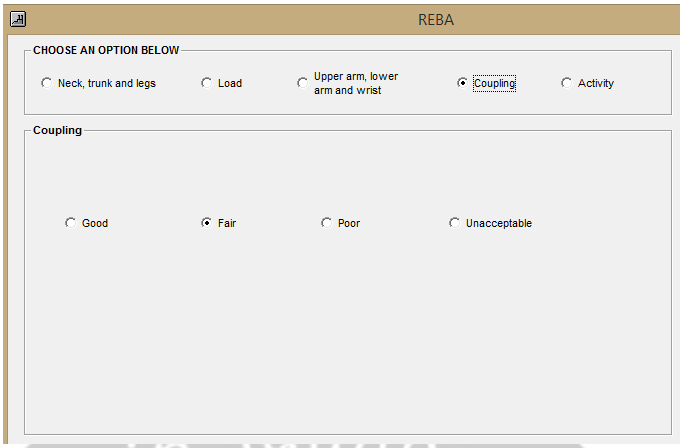

Figure 4.53 REBA Analysis Using ERGOFELLOW Software *(Coupling)*

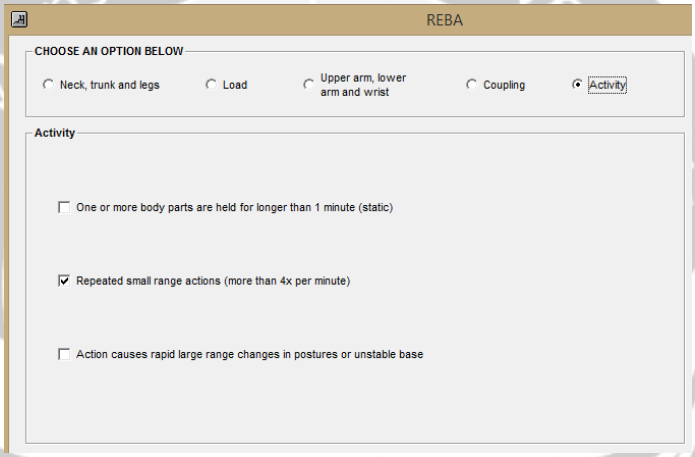

Figure 4.54 REBA Analysis Using ERGOFELLOW Software *(Activity)*

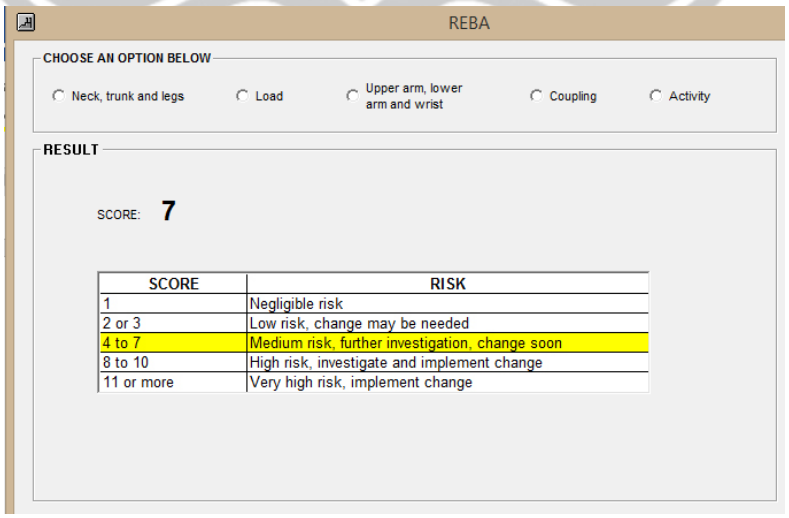

Figure 4.55 REBA Analysis Using ERGOFELLOW Software *(Result)*

g. RWL(Recommended Weight Limit) Analysis in Initial Workstation

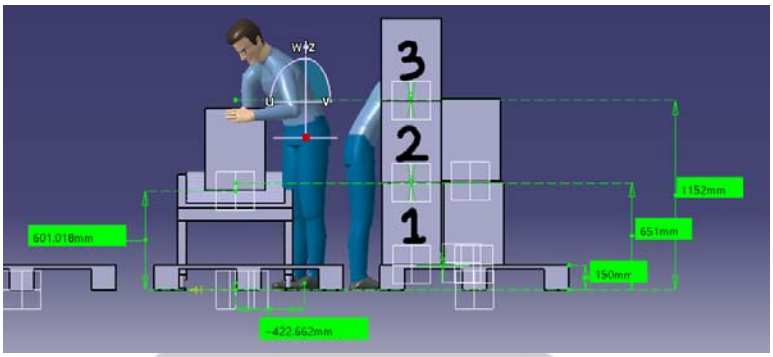

Figure 4.56 RWL*(Recommended Weight Limit)* Analysis in Initial Workstation

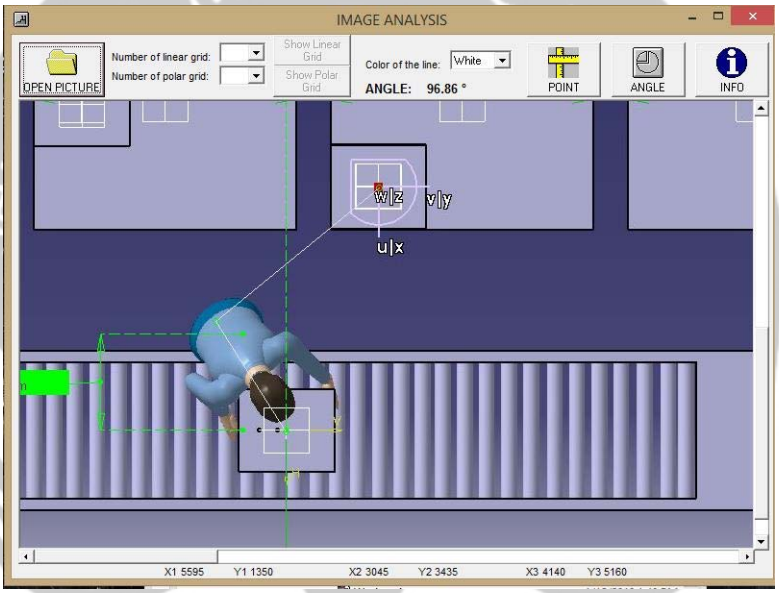

Figure 4.57 Work Angle Analysis in Initial Workstation Using ERGOFELLOW Software

Figure 4.56 and figure 4.57 are the data that will be use for RWL *(*Recommended Weight Limit) analysis with using CATIA and Ergofellow software.

Table 4.17. Table RWL(*Recommended Weight Limit*) Calculation Using ErgoFellow *Software* In Initial Workstation

Stack-	H(cm) origin	V(cm) origin	H(cm) destination	V(cm) destination	D(cm)	A(˚)	F	C	L(kg)	RWL Origin(kg)	RWL Destination(kg)	LI origin	LI destination
1	42.2	60.1	42.2	15	45.1	96.86	0.72	1	20.8	5.948	5.106	3.497	4.074
2	42.2	60.1	42.2	65.08	4.98	96.86	0.72	1	20.8	6.467	6.568	3.216	3.167
3	42.2	60.1	42.2	115.16	55.06	96.86	0.72	1	20.8	5.832	5.369	3.567	3.874

From the table 4.17. above, the RWL of the origin and the RWL of the destination are known by using the formula below.

H = 42.26 cm (Distance load to the center point of the body)

V = 60.1cm (Distance load to the floor)

D = Distance of vertical displacement of objects

A = 96.86 degree (the angular asymmetry of the body shaped)

F = 0.72 (Frequency 4Lifts / min Taken from the standard time that has been obtained, the frequency of appointments made by workers in the duration ≤2 hours)

C = 1 (Fair, How to hold the load)

L = 20.8 kg (Original item load)

RWL = 23 x (25/H) x [1 – (0.003 x (V – 75))] x [0.82 + (4.5/D)] x [1- (0.0032 x A)] x F x C

LI = L / RWL

In this RWL (Recommended Weight Limit) analysis, the required dimensions are measured using CATIA software. This is done by using the actual activity reference on existing work facilities. the distance between the load to be lifted with the center point of the body or that is located directly at the center of the pedestal or foot (H) of 42.26 cm. The vertical distance between the load center point on the conveyor with the floor (V) is 60.1 cm. The asymmetry angle formed by the body when lifting the load (A) is 96.86 degrees. The frequency of hiring performed by the worker (F) is 4 batches / minute, this figure is obtained from the standard time already obtained in the previous work sampling calculation, the worker has the rotating habits during stapling activities so that the duration of the work lifts about 1-2h, the determination of F is 0.72. Coupling factor or way of holding the load (C) is obtained Fair so that obtained the multiplier of 1.

From the calculation of RWL (Recommended Weight Limit) origin or origin obtained results of 5.948 and RWL destination or destination of 5.106 kg in the first pile. In the second stack obtained RWL origin of 6.467 kg and RWL destination of 6.568 kg. And the result of RWL calculation on third stack origin is 5,832 kg while at RWL destination is 5,369 kg. From these results it can be said that the best load that must be used for the workers to lift the load or do a staple well on all the piles is 5.106 kg.

While the LI (Lifting Index) on stacks 1, 2, and 3 has LI> 1 which can be interpreted that the work of lifting or moving goods with an average of 20.8 kg has a risk of injury in the lower back.

h. RWL (Recommended Weight Limit) Analysis in Proposed Workstation

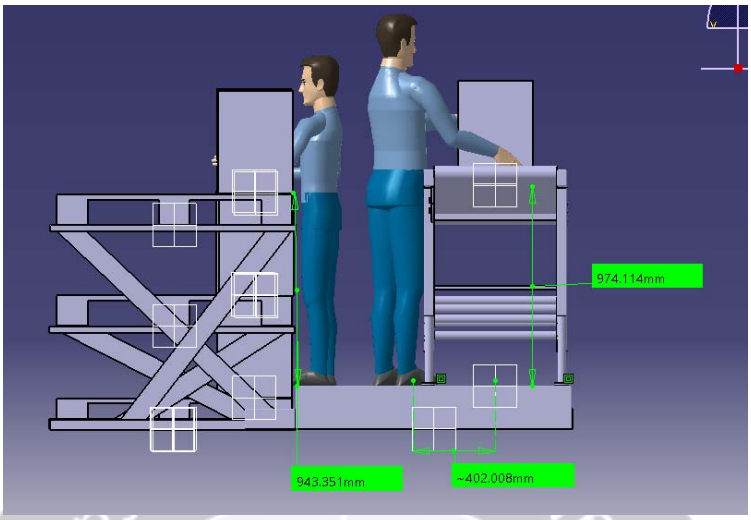

Figure 4.58 RWL*(Recommended Weight Limit)* Analysis in Proposed Workstation

Figure 4.59 Work Angle Analysis in Proposed Workstation Using ERGOFELLOW Software

Figure 4.58 and figure 4.59 are the data that will be use for RWL *(*Recommended Weight Limit) analysis using CATIA and Ergofellow software.

Table 4.18. Table RWL(*Recommended Weight Limit*) Calculation Using ErgoFellow *Software* In Proposed Workstation

Stack-	H(cm) origin	V(cm) origin	H(cm) destination	V(cm) destination	D(cm)	A(˚)	F	C	L(kg)	RWL Origin(kg)	RWL Destination(kg)	LI origin	LI destination
1	40.02	97.4	40.02	94.3	3.1	104.71	0.72	1	20.8	6.416	6.48	3.242	3.21
2													
3													

From the table 4.18. above, the RWL of the origin and the RWL of the destination are known by using the formula below.

H = 40.02 cm (Distance load to the center point of the body)

V = Distance load to the floor (cm)

D = 3.1 cm (Distance of vertical displacement of objects)

A = 104.71 degree (the angular asymmetry of the body shaped)

F = 0.72 (Frequency 4Lifts / min Taken from the standard time that has been obtained, the frequency of appointments made by workers in the duration ≤2 hours)

C = 1 (Fair, how to hold the load)

L = 20.8 kg (Original item load)

RWL = 23 x (25/H) x [1 – (0.003 x (V – 75))] x [0.82 + (4.5/D)] x [1- (0.0032 x A)] x F x C

LI = L / RWL

In the proposed work facility an analysis was performed using dimensions formed on 95th percentile mannequin in CATIA software. After the analysis, the results obtained RWL origin or initial RWL of 6.416 kg and LI (Lifting Index) obtained for 3.2. The height of the three piles can be said the same, because when the proposed machine is used the machine will have different heights adjusting to the number of piles on the amapal, then the height of each pile of goods on the pallet will be the same, so that the difference in height of the conveyor and pallet is only 3.1 cm.

In the result of RWL destination or destination RWL analysis, the result of RWL is 6,48 kg and LI (Lifting Index) is 3,21. And the comparison of RWL in the initial facility and RWL in the final facility are:

Table 4.19. Dimension and RWL Calculation in Proposed Workstation

Initial Working Facility				Proposed Working Facility			
RWL origin	LI origin	RWL destination	LI destination	RWL origin	LI origin	RWL destination	LI destination
5.98	3.497	5.106	4.074	6.416	3.242	6.48	3.21
6.467	3.216	6.568	3.167				
5.832	3.567	5.369	3.874				

Table 4.19. is the resume both of initial and proposed working facility RWL analysis. The selected RWL is the lowest RWL of each work facility, so that the weight of the load can be generalized when the worker does the first, second or third congestion activity without injury or work risk. At the initial facility there is a minimum RWL of 5.106 kg. At the final working facility obtained a minimum RWL of 6.416 kg. From these results it can be said that there is an increase in the burden that can be lifted by workers at the proposed work facility, so that workers can have a greater RWL value compared with previous work facilities.

CHAPTER 5
CLOSING

5.1. Conclusion

At 13.00 to 14.00 there are 5 items that must be stamped by the workers every minute. At that hour can be said as busy working hours.

Based on the productivity analysis using work sampling technique, the average productivity percentage of the four workers was 76.41% and included productive. And From workload analysis, we get the result:

i. Working burden of workers 1: 93%
ii. Working burden of worker 2: 95%
iii. Working burden of worker 3: 98%
iv. Workload of worker 4: 100%

Based on the data obtained, it can be said that the workers have enough workload and optimal. Reduction in the number of workers can make workers very heavy in doing the work because the workload will exceed 100%. But when workers are added, the workers have less workload so that many unemployed workers or lack of workload are owned. So that the activities of placement workers with rotation on schedule as long as researchers make observations, can be said optimal in terms of productivity and workload owned by workers.

From the results of the design done, the results obtained REBA analysis of 7 which means having the risk of intermediate work, further investigation, and changes immediately, this means there is a decrease in the rate of injury due to the initial work facility, obtained the REBA score on the first pile, second and third respectively 10,10, and 11 which means having a high risk of injury, investigation, and change now.

The result of RULA analysis at intermittent load or frequency of appointment <4 times / min also changes that at initial facility have RULA score of 6 which mean need to be investigated and change need to be done immediately, at analysis of RULA in work facility proposal got result of score of RULA 3 which means that the worker's posture needs further investigation for the future and changes may be needed.

The result of RULA analysis at static load or lifting frequency> 4 times / min obtained score result at initial facility equal to 7 or mean need to be investigated and change of work post right now, and at proposal facility got result of score of RULA equal to 6 meaning investigation and change immediately. This means that the lifting frequency more than 4 times / minute still has a high enough risk considering the load to be raised on average is 20.8 kg.

From the result of RWL analysis (Recommended Weight Limit) using ErgoFellow software got minimum RWL result from all calculation at initial work facility = 5,106 kg and LI (Lifting Index) equal to 4,072. At the proposed work facility there was an increase of RWL result which was 6.416 kg and LI decreased to 3,242. Based on these results workers at the proposed work facility can lift a heavier load than the initial work facility due to the difference in RWL yields of 1.3 kg.

5.2. Suggestion

At 06.00 to 07.00 no items can be processed in staple section of finished goods warehouse, so that workers can be diverted to other work so that workers are more productive. And at 13.00 to 14.00 it takes 3 people in the staple process because of the amount of goods that must be processed due to shift change.

Required manufacture of prototype or experimental tool design results, so that the work by using the proposed facility can be analyzed the effectiveness and efficiency obtained from using the design results. So it can be done comparison of the effectiveness and efficiency of the work done by the staple parts workers.

The lifting frequency or the stapling activity should be no more than 4x / min because of the employment risk if the lifting frequency is> 4x / min has a high risk of injury and affects the score of Rapid Entire Body Assessment (REBA) or Rapid Upper Limb Assessment (RULA). And The RWL (Recommended Weight Limit) result can be increased by reducing the worker's body distance with the items to be lifted, reducing the vertical distance of the transfer.

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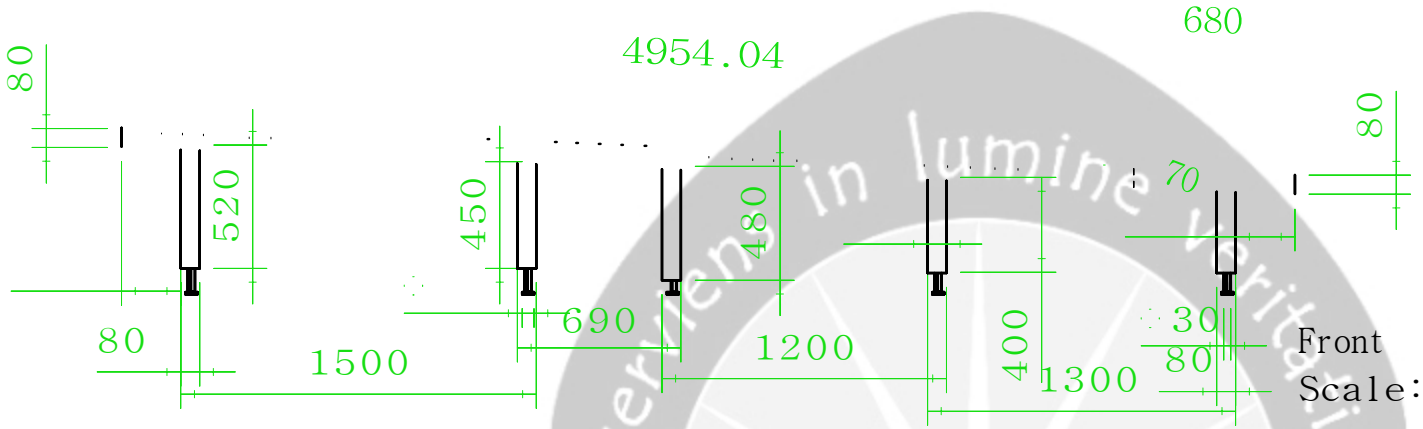

Front view
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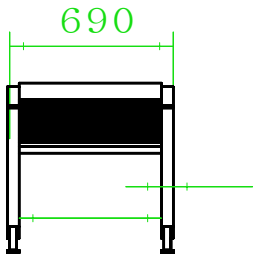
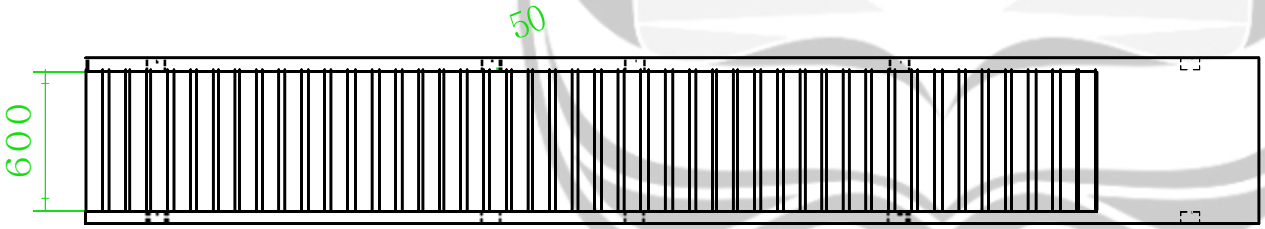


Left view
Scale: 1:30



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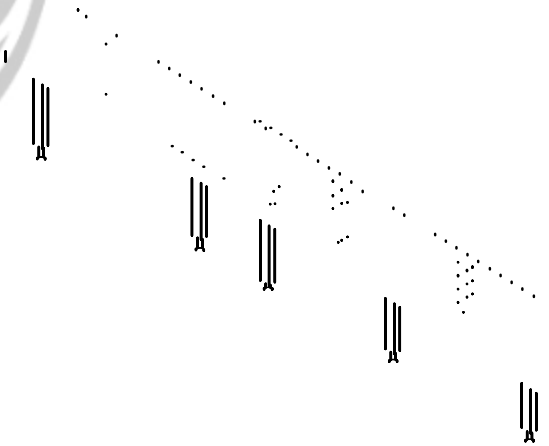
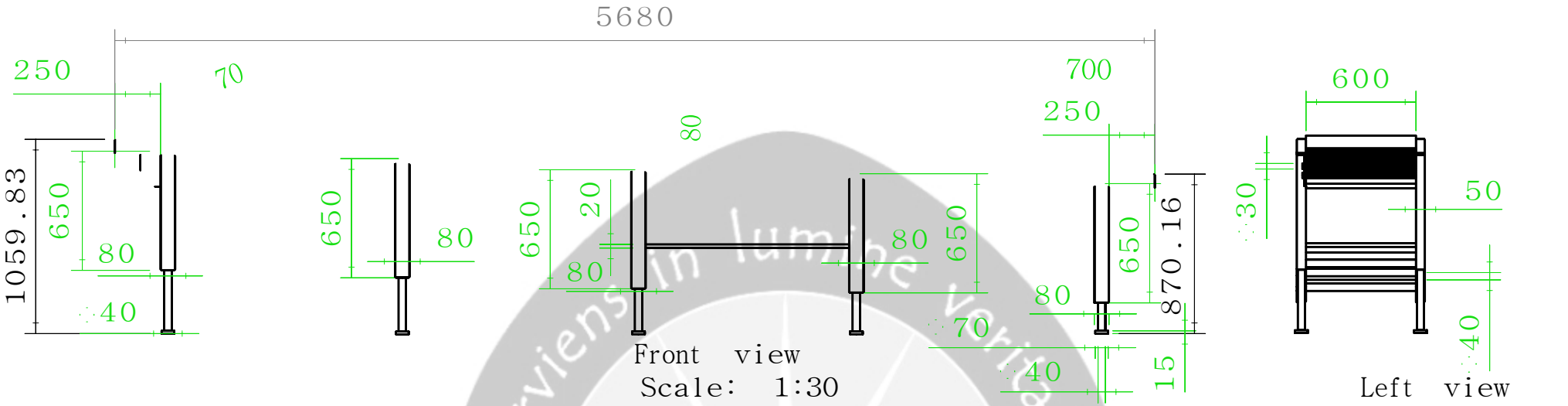


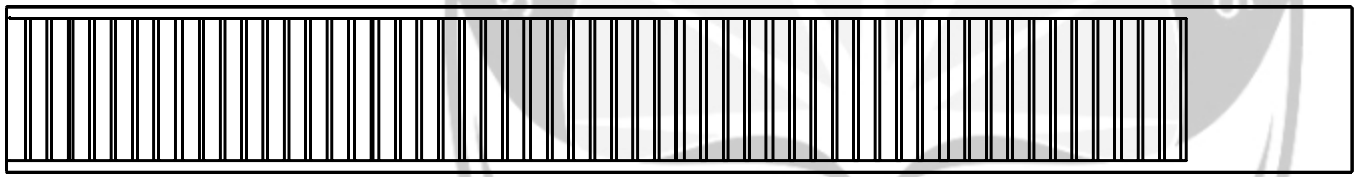
Isometric view
Scale: 1:45

INITIAL CONVEYOR



Front view
Scale: 1:30

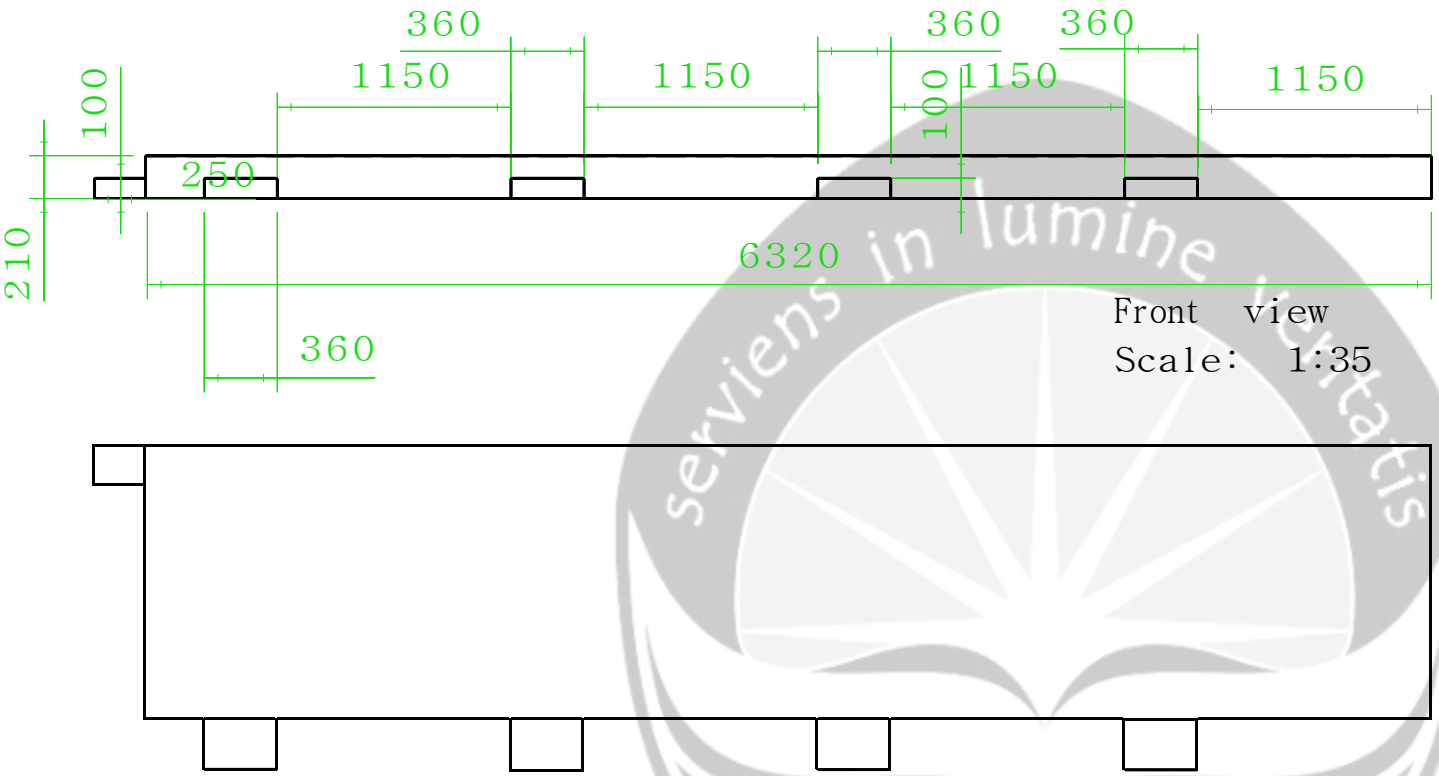
Left view
Scale: 1:30



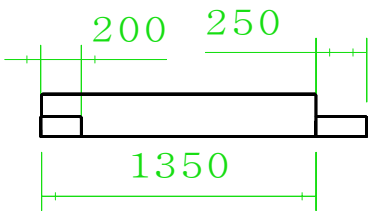
Top view
Scale: 1:30

PROPOSED CONVEYOR

Isometric view
Scale: 1:45



Front view
Scale: 1:35

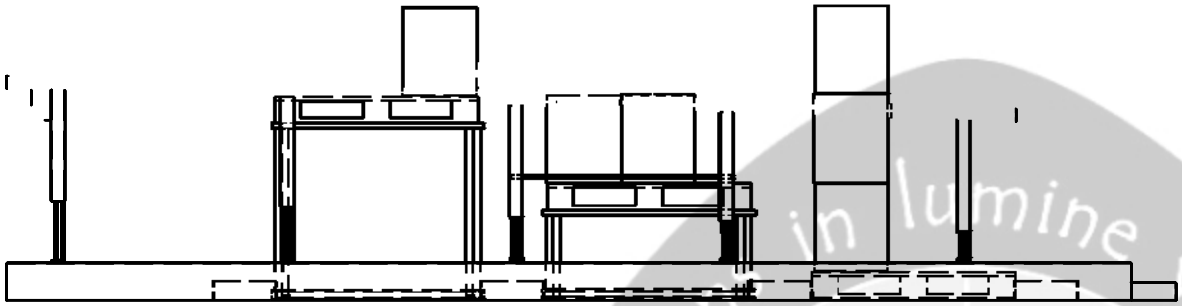


Left view
Scale: 1:35

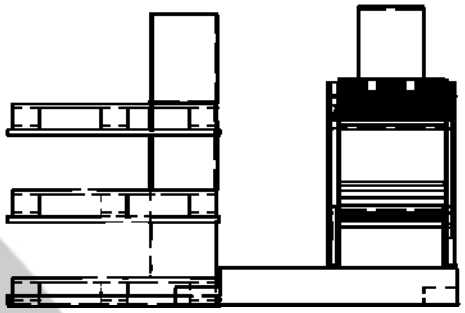
Top view
Scale: 1:35

PROPOSED WORK
FACILITIES BASE

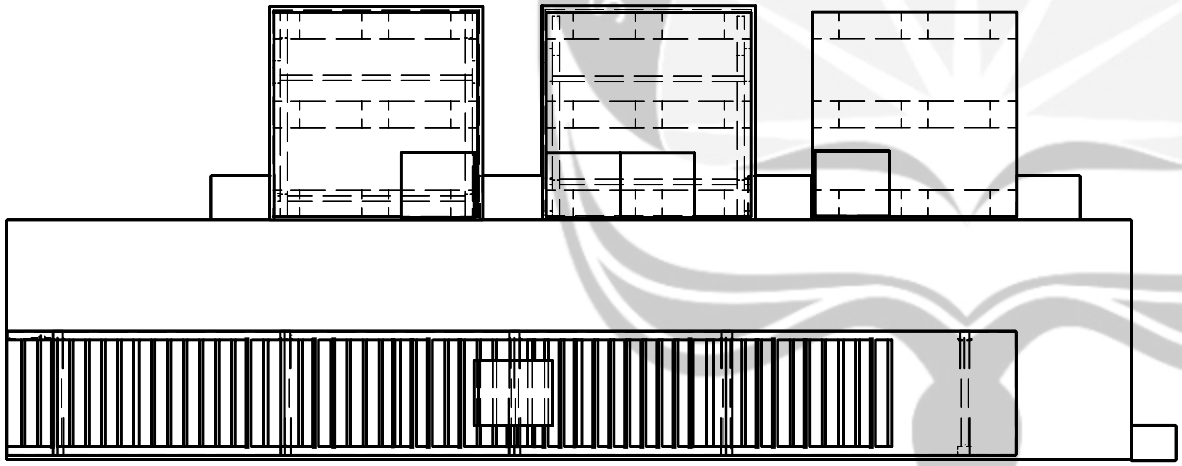
Isometric view
Scale: 1:50



Front view
Scale: 1:40



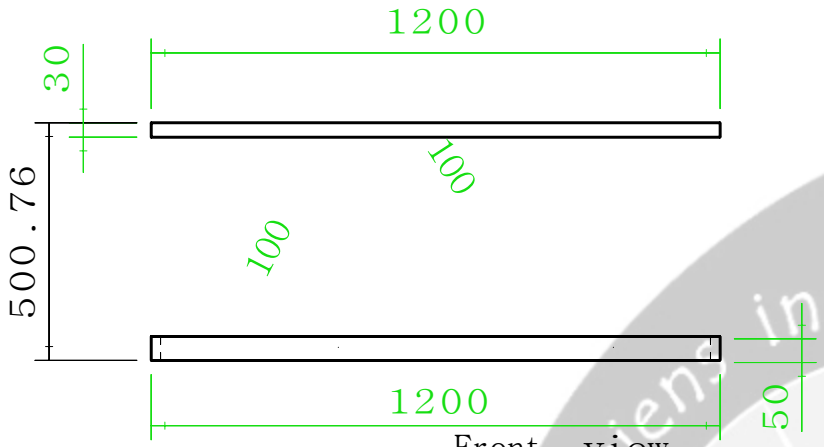
Left view
Scale: 1:40



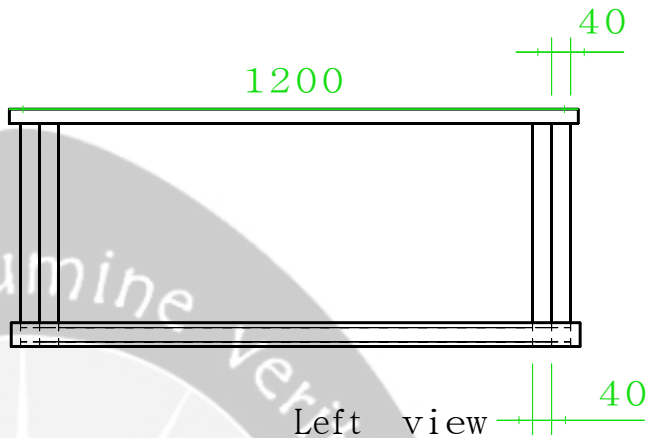
Top view
Scale: 1:40

PROPOSED WORK FACILITIES

Isometric view
Scale: 1:45

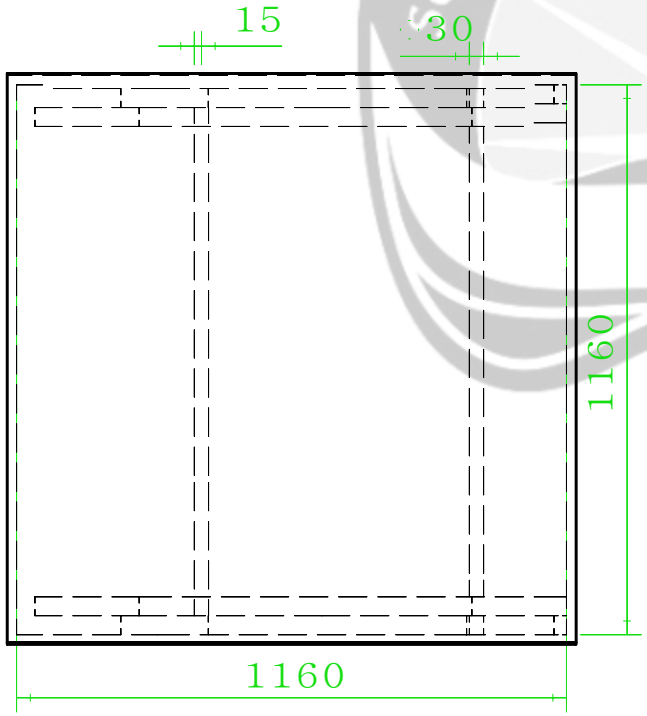


Front view
Scale: 1:15



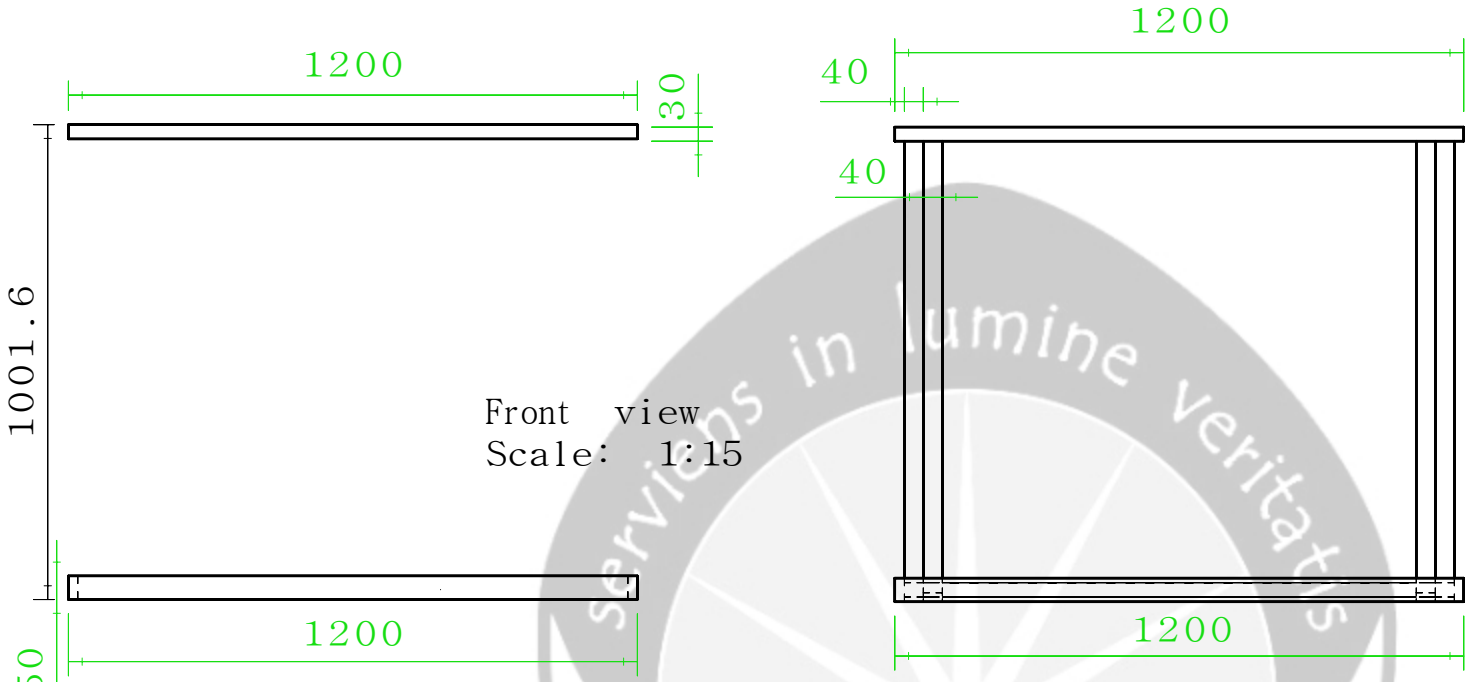
Left view
Scale: 1:15

MACHINE IN 2ND PILE CONDITION



Top view
Scale: 1:15

Isometric view
Scale: 1:15



Front view
Scale: 1:15

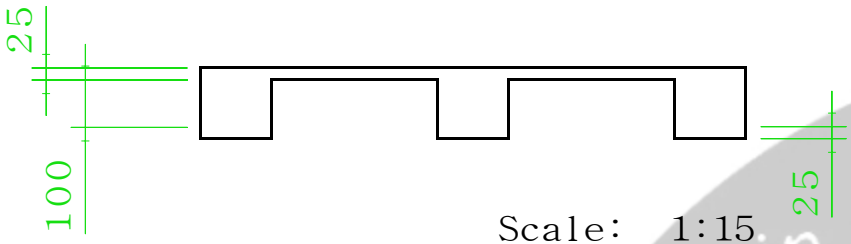
Left view
Scale: 1:15

Top view
Scale: 1:15

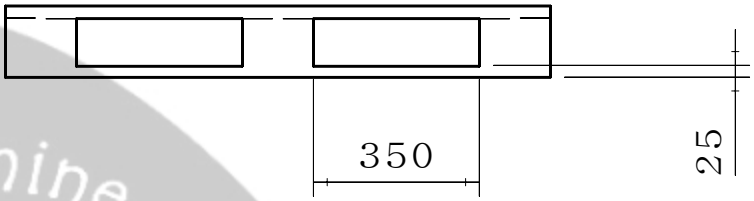
MACHINE IN 1ST PILE CONDITION

Isometric view
Scale: 1:20

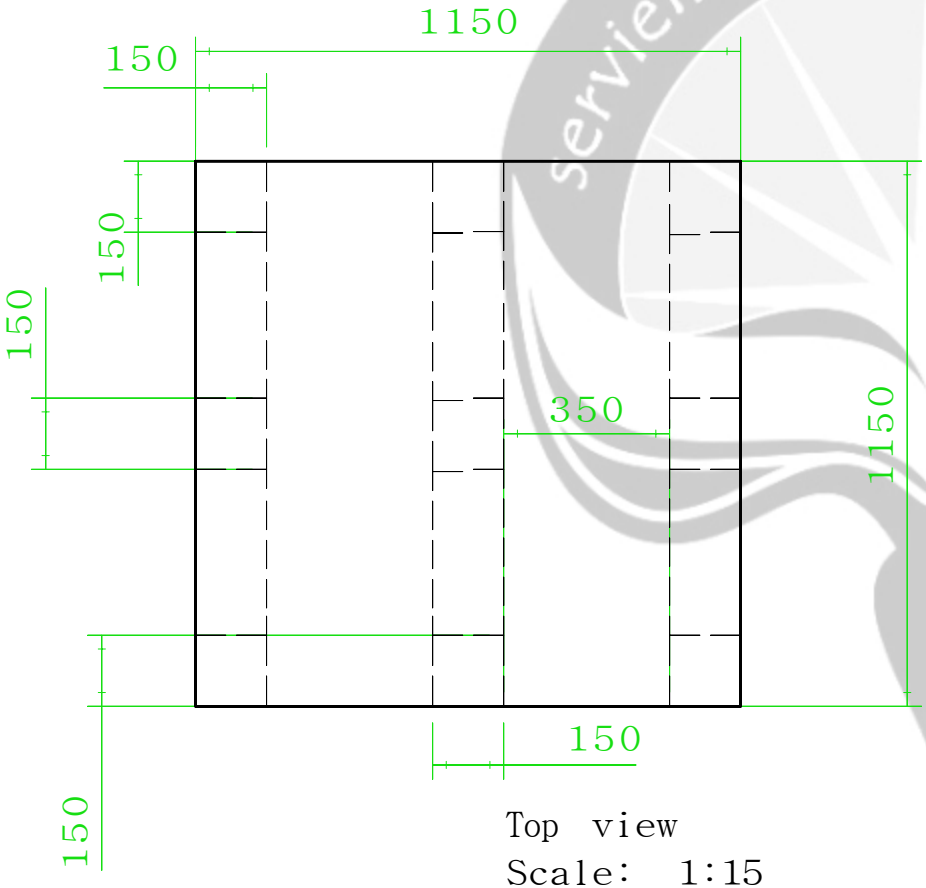
PALLET



Scale: 1:15



Left view
Scale: 1:15



Top view
Scale: 1:15

Isometric view
Scale: 1:20

APPENDIX

Frequency of RWL (*Recommended Weight Limit*)

Frequency Lifts/min (F) ‡	Work Duration					
	≤1 Hour		>1 but ≤2 Hours		>2 but ≤8 Hours	
	V < 30†	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤0.2	1.00	1.00	.95	.95	.85	.85
0.5	.97	.97	.92	.92	.81	.81
1	.94	.94	.88	.88	.75	.75
2	.91	.91	.84	.84	.65	.65
3	.88	.88	.79	.79	.55	.55
4	.84	.84	.72	.72	.45	.45
5	.80	.80	.60	.60	.35	.35
6	.75	.75	.50	.50	.27	.27
7	.70	.70	.42	.42	.22	.22
8	.60	.60	.35	.35	.18	.18
9	.52	.52	.30	.30	.00	.15
10	.45	.45	.26	.26	.00	.13
11	.41	.41	.00	.23	.00	.00
12	.37	.37	.00	.21	.00	.00
13	.00	.34	.00	.00	.00	.00
14	.00	.31	.00	.00	.00	.00
15	.00	.28	.00	.00	.00	.00
>15	.00	.00	.00	.00	.00	.00

Coupling Factor of RWL (*Recommended Weight Limit*)

Coupling Type	Coupling Multiplier	
	V< 30 inches (75 cm)	V ≥ 30 inches (75 cm)
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90

Program Studi Teknik Industri Universitas Atma Jaya Yogyakarta
Lembar Bimbingan Pelaksanaan dan Penyusunan
Laporan Kerja Praktek/ Magang

Nama Mahasiswa : Pygon Sahawan

NPM : 15140438

Perusahaan tempat KP : PT Djarum

Tanggal pelaksanaan KP : 18 Desember 2017 - 24 Januari 2018

Dosen Pembimbing : Brilionta Budi M.

No	Tanggal	Agenda	Tanda Tangan Dosen Pembimbing
1	29/11/17	Penyerahan surat pembimbingan dan Konsultasi persiapan Kerja Praktek	
2	22/12/17	Laporan atau konsultasi penugasan dari perusahaan	
	5/02/18	Laporan pertama setelah pelaksanaan Kerja Praktek dan konsultasi penyusunan laporan	
	7/03/18	Penyerahan draft laporan Kerja Praktek untuk pertama kali	
	14 Mei 2018	Pengesahan laporan Kerja Praktek	