Multitask Anti-Dust Cleaner

by

Mohd Zaki Al Hafiz bin Rosli

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Mechanical Engineering)

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Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

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Approved by,

(Dr Ahmad Majdi b Abd Rani)

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgement, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MOHD ZAKI AL HAFIZ BIN ROSLI

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ABSTRACT.

This report basically discusses the progress research done and basic understanding of the chosen topic, which is Multitask Anti-Dust Cleaner. The objective of this project is to introduce a new method in cleaning the SMT facilities especially in electronic production line. Nowadays, most of the electronic company use an air gun to blow the dust from the SMT devices. But, this new method, it use a concept of suctions technique rather than blowing method. The challenge of this project is to determine the suitable material to build up the prototype and the way to testing the prototype. The testing should be done in order to determine the suitable materials that need to use and the functionality of the prototype.

This report also contains the materials selection for this project and some materials analysis. The analysis mostly bases on the characteristics of the material and its behavior. The analysis based on the literature review of this project.

The aim of this project is to introduce a new cleaning method and increase worker efficiency and increase the productivity. Other than that, by done this project, the dust problem in production area can be reduce. When the project was done, hopefully the aim can be achieved.

CHAPTER 1
INTRODUCTION.

1.1 BACKGROUND OF STUDIES.

SONY has helped developed discerning Malaysians who have come to expect quality, integrity and reliability in audio/visual equipment. Sony's cutting-edge technology brings sights and sounds, expectations and experiences into the home as well as the office.In line with Malaysia's VISION 2020, our future will focus on the dynamic digital era with even sharper cutting-edge technology. The future is filled with exciting promises for continuous and rapid growth.The company produces electronic components for the lighting products that are mostly used by original equipment manufacturer sector such as automotive, communication and computer industries.

In order to produce a high quality of product, especially the PCB, the dust problem still remains the major problem. The dust may came from various sources such as human hair, shoes, materials used, clothes and many others.

For this day, they use the method where they use an air gun to remove the dust from the SMT feeder. But, this method is not very effective because the dust will remain on that feeder. They also use a devices call 'shower' to prevent the dust from entering the production line. But as long as the system use a blow method, the result will remain the same. The dust will remain on and still have.

The research doing by researcher before, suggest that to prevent the dust from entering the production line, by improve the maintenance system for the air conditioning system, improve the entrance system, and reduce/limit the outdoor activity during working hour by enforcing no outdoor activities during the working hour specially for the workers on production line. The reason why the dust need to prevent from the SMT facilities is, **a)**to increase the quality of the production. **b)**to reduce the dust pollution in the working area. **c)**to prevent workers from serious illness caused by dust. **d)** to increase the worker productivity

1.2 PROBLEM STATEMENT.

1. At the electronic industry, the main problem is the dust pollution. Through my experienced during internship program at SONY, they also faced the same problem. It is because, the dust will reduce the quality of the product. Other than that, it also effect to the workers health. So, many workers can not do their work effectively because had some illness. Expose too long to the dust pollution also can cause the serious illness to the workers. At SONY especially, they use an air gun to remove the dust from SMT facilities. Although the facilities can be clean by using this method, the negative factor is the dust will still remain in the working area. Therefore, this project will aim to design a prototype of the dust cleaner to reduce the dust as much as possible. So it can increase the product quality and workers commitment. Rather than that, the workers health also can be increase.

2. Other than that, the workers productivity also decreased because they need to walk for a some distance to send the feeder to the feeder maintenance room. Other than decreased the worker productivity, it also increased the amount of work that the operator must do.

3. For this task, the difficulty found in collecting the distribution data for dust pollution in the specific area called TV-AUTO MOUNT DEPARTMENT. It is because the company never collect the dust pollution data. Then, the dust distribution data in the production area cannot be define. The company just informed that the production reached the maximum level in the April and December.

4. The other difficulty by doing this project is, the company cannot give the permission to use their facilities. In this project, the JUKI trolley need to be use. Without that trolley, the project cannot be done. The company cannot give the trolley because the rules and regulations of the company said, everything in the company can not be bring out from the company area.

1.3 OBJECTIVES AND SCOPE OF STUDY.

The main objectives of this project are:

- **To develop a multitask anti-dust cleaner.**
- **To remove the dust from the feeder efficiently.**
- **To increase workers productivity.**

The scope of work for this project is by doing an analysis the main contributor to the dust in the working area. Once the research have done, then the prototype of dust cleaner will be design and testing. After that, if the prototype need an improvement, the improvement will be done. And then, the prototype will testing again. Next, the investigation whether the trolley can give the benefit after the implementation.

Due to the difficulty to get the trolley, then the fabricating work have to be done. The trolley maybe not as exactly as the real trolley used by the company. It maybe difference in dimensional. But, the important thing, the cleaner devices can be put on the trolley.

CHAPTER 2
LITERATURE REVIEW.

2.1 Implementation of dust control system using management and planning tools (MPT).

The significance of DCS(Dust Control System) in an electronic industry.

DCS is essential for controlling the IAP in the electronics industries on the basis of three main reasons:

1. controlling the quality of products (i.e. electronic components);
2. maintaining the performances of machines; and
3. avoid the effects on worker's health.

In term of products, dust pollution can affect their performances (reliability) and quality. Electronic products (components) such as integrated circuit (IC), capacitors, transistor, resistor and voltage regulator are sensitive with uncontrolled dust environment. **Oyebisi (2000)** reported that the dust and particulates (spore and fungus) can have an affect on the performances of these electronic components. He reported that when a ceramic capacitor was enclosed in a fungous environment, the percentage change in the capacitance value was up to 167.75.

In the electronic production area, there are contains many machines(SMT machines) that will used to insert the electronic components onto the board. Each machines have many sophisticated components and very sensitive to the dust particles. If the machines was affected by the dust particles, the machines performance will reduce and increase the maintenance cost for the machines. The investigation by **Hata *et al.* (2000)** represented the functional relations among mechanical components and evaluated a possibility to apply it for failure analysis. Their results showed that the dust particles affected the function (performance) of the components such as roller, ball bearing and sensor.

The workers also have the risk from the air pollution, particularly when they are working continuously in uncontrolled dust pollution environment. They will be exposed to the critical diseases such as skin or lung cancer, asthma and eye problems (cataracts and pterygia) (**Bascom *et al.*, 1995**). As a result from these ailments, productivity of the workers will be reduced and treatment cost will escalate (**Niemela *et al.*, 2002**).

Therefore, there is a need to have an effective and efficient DCS for controlling the IAP especially on the production floor.

The implementation of dust control system using MPT can be divided into 3 phases:

1.Phase 1

- Identifying dust the dust counting point.
- Initial data collection.
- Data analysis.

2.Phase 2

- Relation diagram.
- Tree diagram.
- Prioritization matrices.

3.Phase 3

- Evaluation of DCS
- Improvement achieved for the case study of the company by implementing the DCS

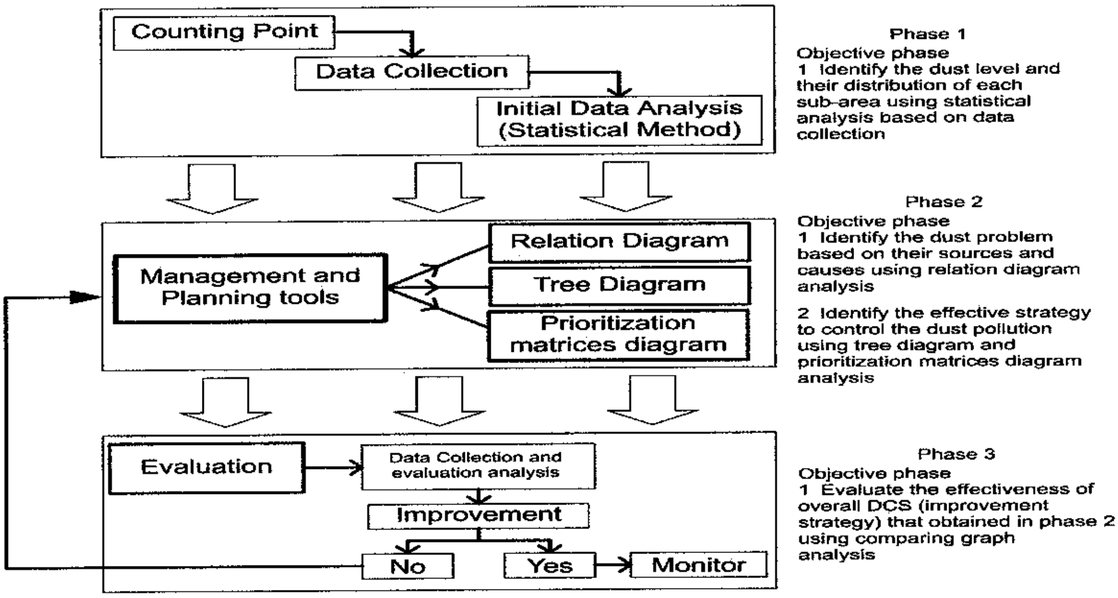


Figure 1:Management and Planning Tools Phases

In the phase 3,the evaluation of effectiveness of the improvement strategies implemented was considered. The result gathered in the phase 1 was compared with the result in this stage.

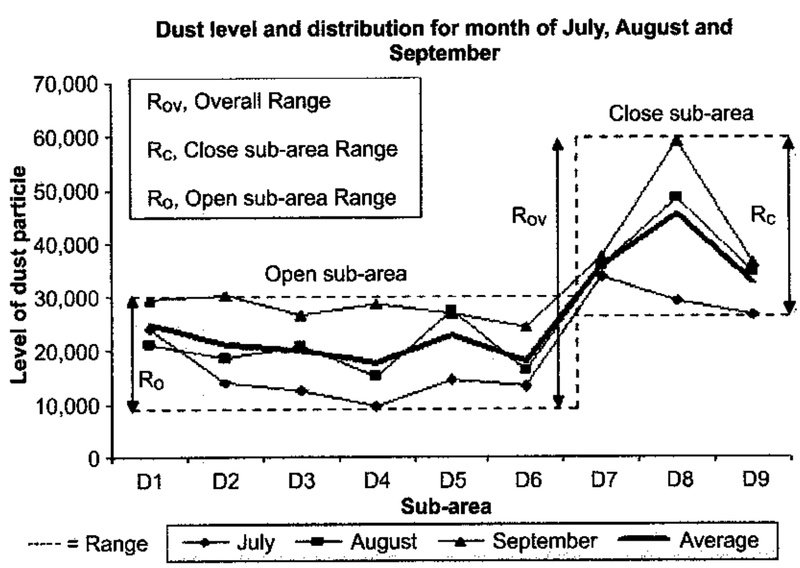


Figure 2:Dust level and distribution for July, August, and September

The impact of the improvement strategies are discussed by comparing the level and distribution of dust pollution before and after implementing the improvement strategies. For this, the comparison is made between the value of $R_{c\text{-}o}$ (difference of range value for close and open sub-area) and R_{ov} (overall range value for sub-areas) before and after the strategies are implemented.

Table II.
The range between initial stage (Phase 1) and evaluation stage (Phase 3)

Before and after implement Range values	Before (^{B}) Range value, R^B	After (^{A}) Range value, R^A	Improvement percenta
Overall sub-area (R_{ov})	R^B_{ov} 49,207	R^A_{ov} 9,757	80.2
Close sub-area (R_c)	R^B_c 32,382	R^A_c 8,000	75.3
Open sub-area (R_o)	R^B_o 20,651	R^A_o 7,703	62.7
Variance close and open sub-area ($R_{c\text{-}o}$)	R^B_{c-o} 11,731	R^A_{c-o} 297	97.5

Figure 3:Value of dust distribution before and after implementation.

2.2 Implementation of air gun to clean the feeder.

In the electronic company such as SONY, they use an air gun to remove the dust from the feeder. After the production in the workstation completed, the worker at the workstations will send all the feeders to the feeder maintenance room. In the feeder maintenance room, the worker in that department will use an air gun to remove the dust at the feeder. Other than that, they also will check up the feeder to make sure all the feeder is in good conditions. If they found any damage at the feeder, they will repair the feeder, After that, all the feeders will be placed at the feeder storage area. Using an air gun to clean up the feeder is not efficient enough to remove the dust from the feeder. It is because, after the feeder was cleaned, they will placed the feeders at the feeder storage area. The storage area is in the open area. And the chance to feeder affected by the dust is increase since they stored in the open area. The are that the feeders stored after cleaning process shown in the figure below.

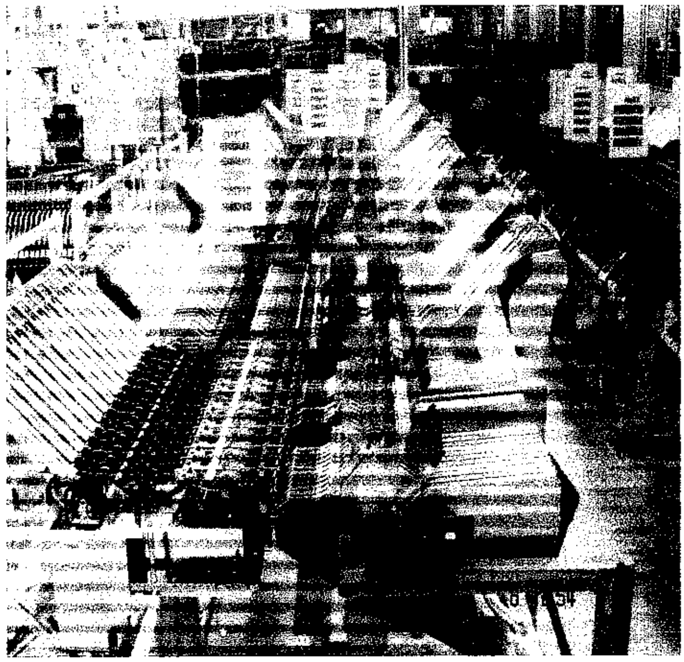


Figure 4:Feeder Storage Area in SONY TV Auto Mount Department

2.3 Working Area and Worker Route.

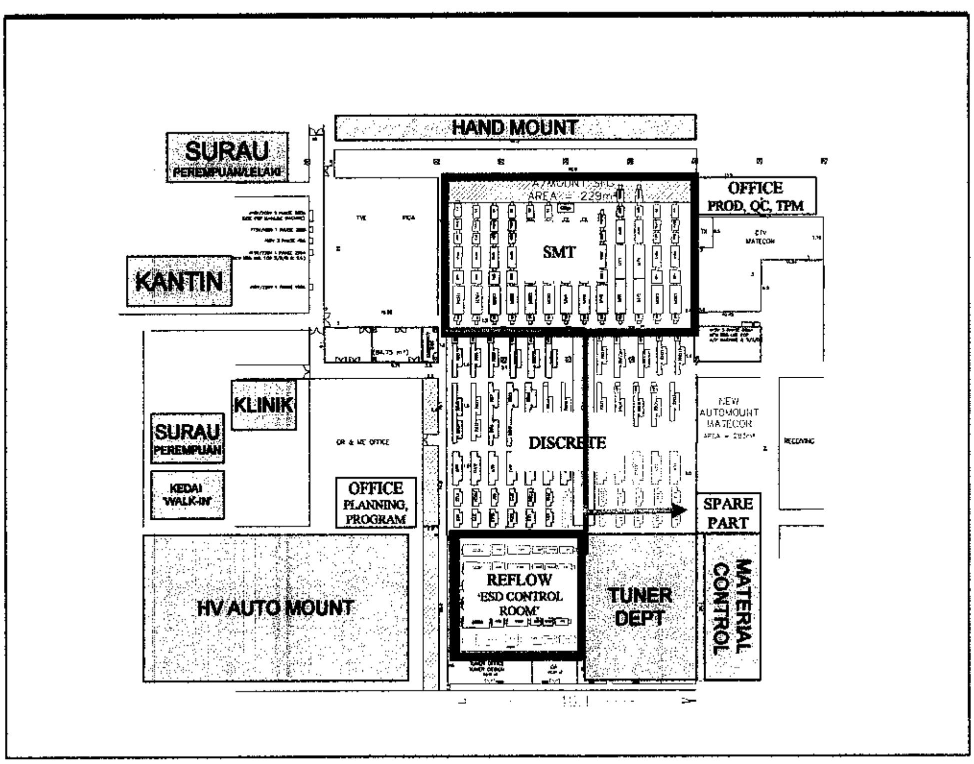


Figure 5: SMT block area

From the figure 5, the working area is concentrate on the "red block", which is glue area at above and reflow area at the bottom. The different of both are can be distinguished by its technology level. Reflow area have the relatively higher technology machine used compared to the glue area, in order to mount the chips components on the PWB tightly, machines at glue area will use glue dispenser to "stick" the chips components but machines at reflow area will use solder paste to replace the glue dispenser. Beside that, machines in reflow area are also higher technology than machines in glue area where it can mount the chips components on PWB more faster, chips components that can be mount also smaller. Because the reflow mount the chips more faster, than, the process to change the feeder is more rather than any other area.

All the feeders from reflow ,SMT ,and discrete area will be send to the feeder maintenance room after the production completed. The workers need to gathered all the feeders from the machine, and follow the path to sending the feeders. This will reduce the worker productivity and increase the amount of work that the operator must do. The route of operator need to walk was shown in the figure above.

CHAPTER 3
METHODOLOGY.

3.1 PROJECT IDENTIFICATION.

Work that are going to be conducted for this project:

1. **Project topic selection**

   This crucial stage is to make sure that the topic chosen is feasible with the scope of studies and time frame given. Preliminary research and interview with lecturer were conducted for each scope of work.

2. **Project Planning**

   Defined scope of work is outlined along the given time frame to keep track with planned activities and to ensure that the project will be finished in the time frame and it goes smoothly without any delay.

3. **Literature Study**

   Information gathered are mostly from journal, internet, library and interview with respective supervisor who is well exposed in this area and able to clarify problems and uncertainty. Research by individuals on related topic serves a practical reference for basic understanding.

4. **Project work 1**

   Based on the schedule and planning, the project is done gradually. First stage is to prepare the data and prototype specifications. And then, find the suitable materials to build up the prototype.

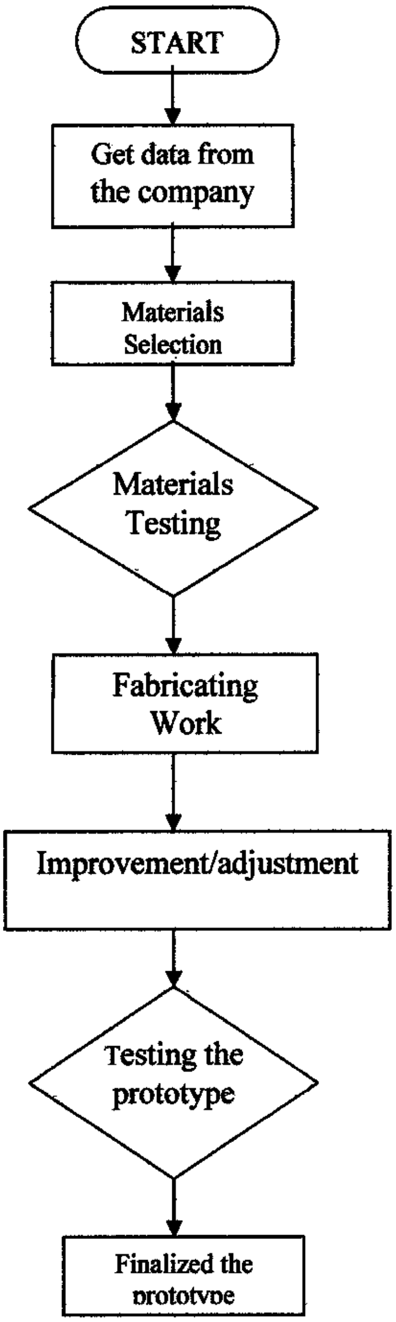
5. **Fabrication**

   The fabricating work include modeling the prototype, and build up the prototype. To fabricate the prototype, several ways will use, such as welding metal and glued metals using epoxy.

6. Testing and Improvement

It is to determine any part that maybe do not work properly and also determine the part that need an improvement. After known the part that need to be improve, the improvement work then need to be done. This to make sure the prototype can work properly and do not have the problem.

Figure 6:Details Flow Chart of Procedures for the Project



3.2 GANTT CHART.

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Research about materials that need to use.														
2	Testing on materials														
4	Do fabricating work														
5	Do the testing.														
6	Doing an improvement to the prototype														
7	Testing the prototype														
8	Doing an adjustment to the prototype														
9	Prototype finalized.														

Process

4. RESULT AND DISCUSSION.

4.1 General Characteristics of Nonferrous Metals and Alloys

Table 1 : General Characteristics of Nonferrous Metals and Alloys

Material	**Characteristics**
Nonferrous alloys	More expensive than steels and plastics, good corrosion resistance; high-temperature applications.
Aluminium	**High strength-to weight ratio, high thermal and electrical conductivity; good corrosion resistance; good manufacturing properties**
Magnesium	Lightest; good strength to weight ratio
Copper	High electrical and thermal conductivity; good manufacturing properties
Superalloys	Good strength and resistance to corrosion at elevated temperatures; can be iron,cobalt and nickel base alloys
Titanium	Highest strength to weight ratio of all metals; good strength and corrosion resistance at high temperature.
Refractory metals	High strength at high temperature.
Precious metals	Gold, silver, and platinum; generally good corrosion resistance

The table shown the characteristics of various of nonferrous metals and alloys. It shown he general characteristics of each materials and based on the characteristics, the suitable material o use in the project will be select. And the material selected for this project is aluminum.

The important factors in selecting aluminum are their strength to weight ratio, resistance o corrosion by many chemicals, high thermal and electrical conductivity, nontoxicity and ease f formability and of machinability. Plus, they are also nonmagnetic. Most aluminum alloys can e welded with relative ease.

Table 2:Properties of Selected Aluminum Alloys

Alloy	Ultimate tensile strength(Mpa)	Yield strength (Mpa)	Elongation in 50mm(%)
1100(A91100)	90	35	35-45
1100	125	120	20-9
2024(A92024)	190	75	20-22
2024	470	325	19-20
3003(A93003)	110	40	30-40
3003	150	145	16-8
5052(A95052)	190	90	25-30
5052	260	215	14-10
6061(A96061)	125	55	25-30
6061	310	275	17-12
7075(A97075)	230	105	16-17
7075	570	500	11

Based on all the tables, the aluminum have a wide variety of desireable properties, such as strength, toughness, hardness, and ductility. It also can resist to high temperature, creep, and also low oxidation. Other than that, it also high strength to weight and stiffness to weight ration. It can be heat treated to impart certain desired properties. And lastly, the cost to buy the aluminum alloy is less than other comparison materials.

4.2 Productivity in the Production Line.

BEFORE PROTOYPE IMPLEMENTED.

Table 3:Productivity Units Before Implemented Prototype

UNITS PRODUCED/SHIFT(PIECES)	75	100	115	90	80	125
LINE	S7	S8	S9	S10	S11	S12
PRODUCTIVITY(UNITS/LABOR HOUR	6	8	10	8	7	10

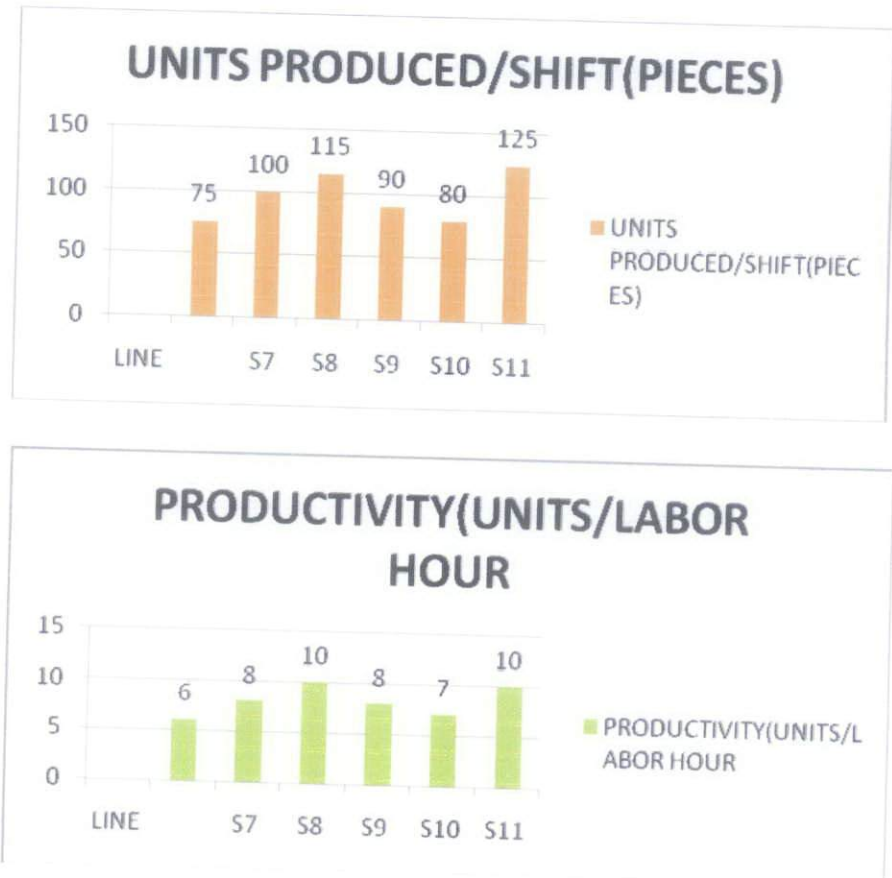


Figure 6:Graph of Productivity Performance Before Implemented Prototype

AFTER PROTOTYPE IMPLEMENTED.

Table 4: Productivity Units After Implemented Prototype

UNITS PRODUCED/SHIFT(PIECES)	85	108	123	112	92	137
LINE	S7	S8	S9	S10	S11	S12
PRODUCTIVITY(UNITS/LABOR HOUR	7	9	10	9	8	11

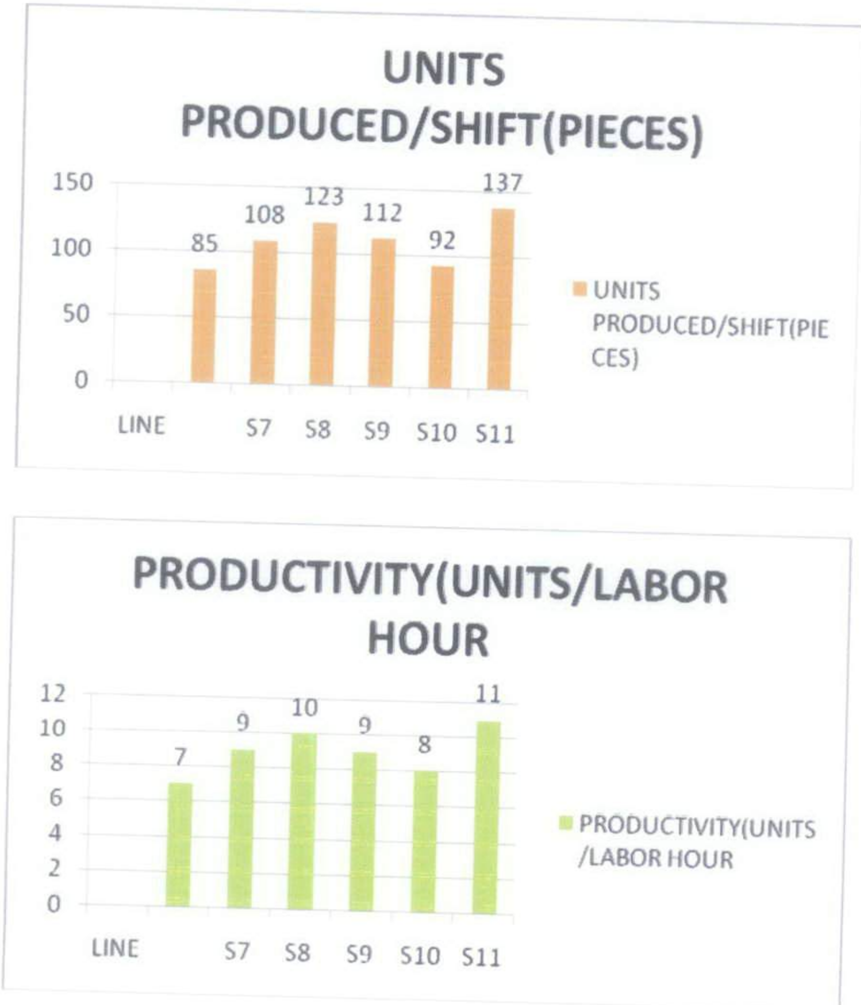


Figure 7: Graph of Productivity Performance After Implemented Prototype

Graphical Analysis.

From the graph shown, the productivity for line increase with the implementation of the prototype. This is because, when the prototype was implemented, it reduce the walking path of the operator. So, the worker will have more time at their workstation.

As an example, line S7 is produce for business board type. Before the prototype implemented, the units produced/shift is 75 pieces/shift and the productivity is 6 units/labor hour. When the prototype implemented to the line, the units produced/shift was increase to 85 pieces/shift; additional 10 boards after implementation and the productivity is 7 units/labor hour. By implemented the prototype, the worker can produce more board in the line S7.

The productivity increase because, the worker simply have more time on their workstations. Before the prototype implemented to the line, after each machine cycle end, they need to go to the feeder maintenance room to clean off the feeder, which is wasting production time.

4.3 Total Operation Time and Takt Time.

BEFORE PROTOTYPE IMPLEMENTED.

Table 5:Processing Time in One Workstation Before Implementation.

Unloading	Sending Feeder	Cleaning Feeder	Loading	Sending To Production Line	Insert Qty	Total Operation Time	Actual Tact Time	Standard Tact Time (s)	Var (+/
500	30	900	120	30	20	1780	89	100	3

***The units in each table box is in second**

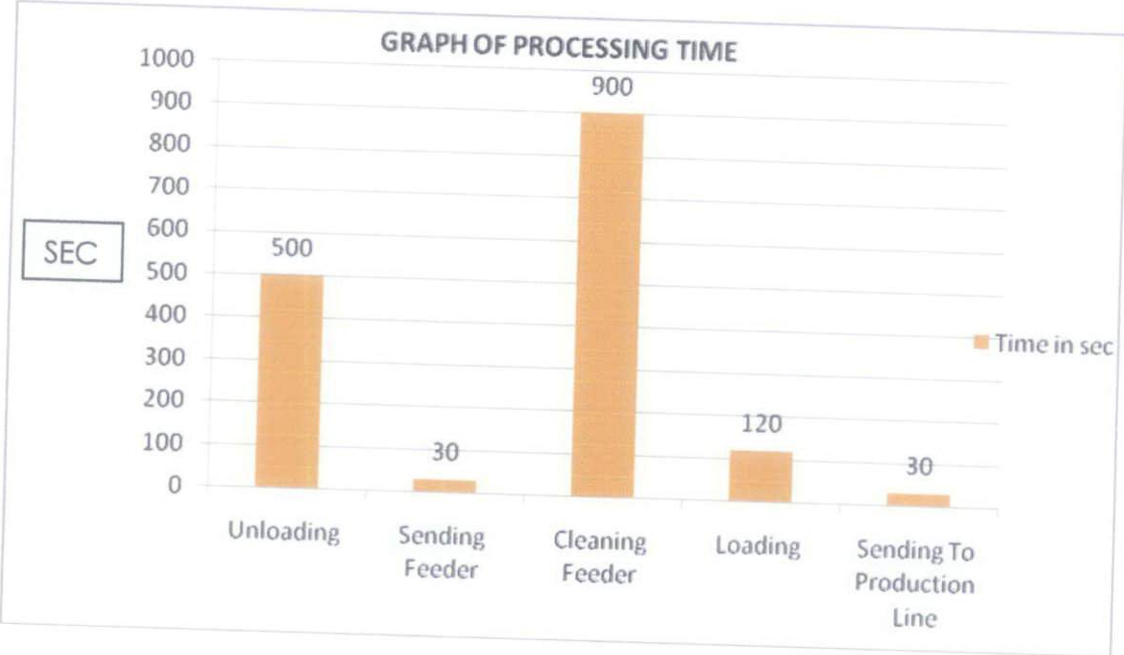


Figure 8:Graph of Processing Time

AFTER PROTOTYPE IMPLEMENTED.

Table 6: Processing Time in One Workstation After Implementation.

ıg	Sending Feeder	Cleaning Feeder	Loading	Sending To Production Line	Insert Qty	Total Operation Time	Actual Tact Time	Standard Tact Time (s)	Varian (+/-)
	30	30	120	30	20	710	35.5	100	-64.5

***The units in each table box is in second**

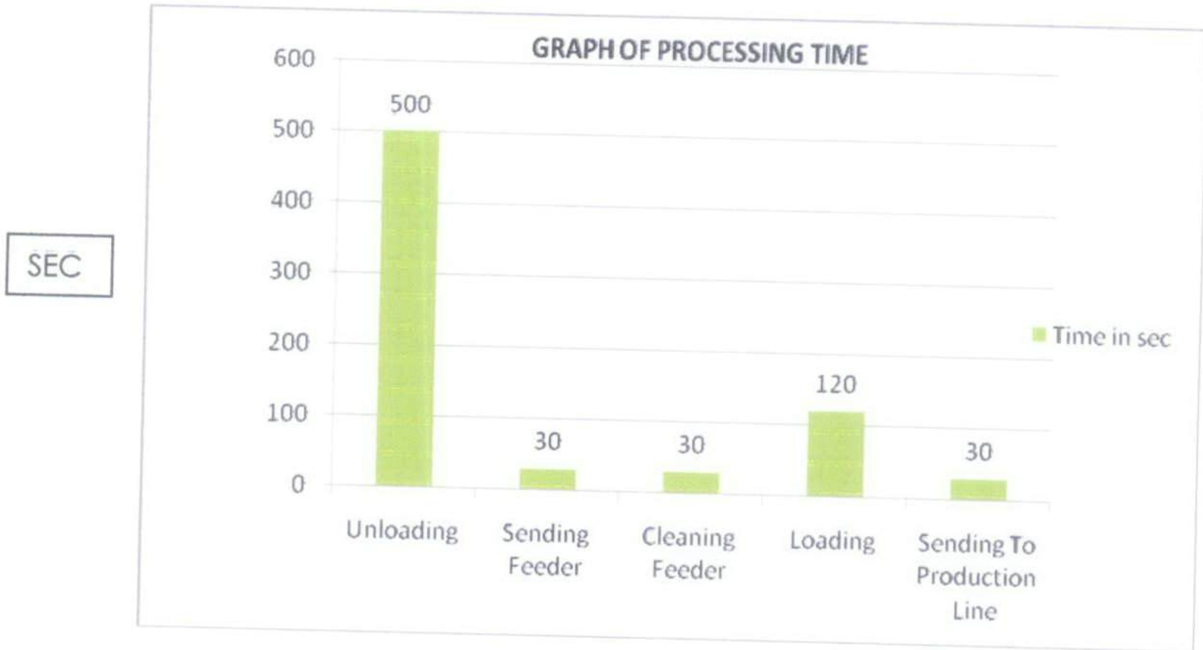


Figure 9:Graph of Processing Time After Implementation

Graphical Analysis.

From the graph, it shown that the most time lost is during cleaning the feeder. Before the prototype implemented, the time taken to clean the feeder is 900sec. It took a long time to clean the feeder because the worker need to send the feeder to the feeder maintenance room to clean it. By implemented the prototype in the line, the worker did not have to send the feeder to feeder maintenance room. And this can reduce the wasting time to send the feeder. The time taken to clean the feeder is just only 30second after the prototype implemented.

The takt time calculated based on the total operation time and the quantity of board inserting into the machine for work cycle. Assume the total operation time=x and quantity of board inserting into the machine=y;

Takt time=x/y

Takt time before implementation=1780seconds/20pc

=89seconds.

Takt time after implementation=710seconds/20pc

=35.5seconds.

4.4 Prototype Working Sequence.

1.Put the feeder into the prototype.

2.Close the prototype door.

3.Switch on the power for 15 seconds.

4.After 15 seconds, turn off the switch.

5.If the operation just about to start, simply takeout the feeder from the prototype.

The function to seal the prototype is to make sure there are no dust can be enter into the prototype. The prototype will be switch on for about 15 seconds to remove the dust from the feeder. But, the timer on the circuit can be adjustable whether to increase or decrease the time. It depends on the feeder size. If the feeder have big size, so the time taken to clean the feeder will be longer than the small one.

After the cleaning process, the feeder can be take out from the prototype to check whether the feeder is in good condition or need to be repair. If the feeder need to be repair, then that time the worker need to send that particular feeder to the feeder maintenance room. The picture of the prototype is shown below:

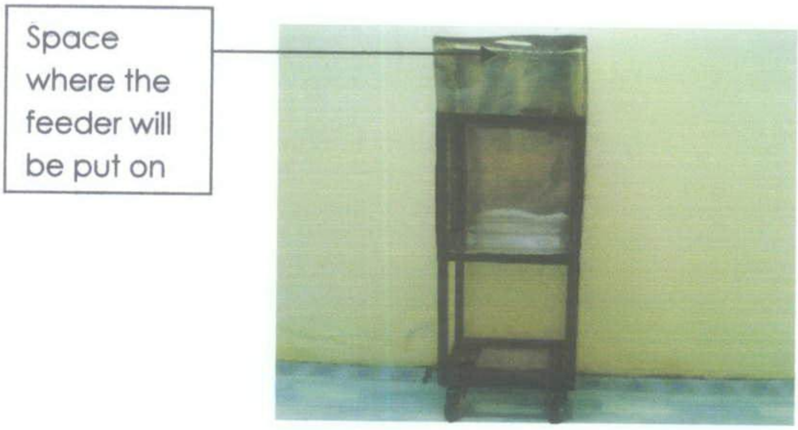


Figure 10:Front view of the prototype.

In the figure 10, the labeled area is the space where the feeder will be put on. The prototype was designed for the small feeder because the small feeder was used the most during production.

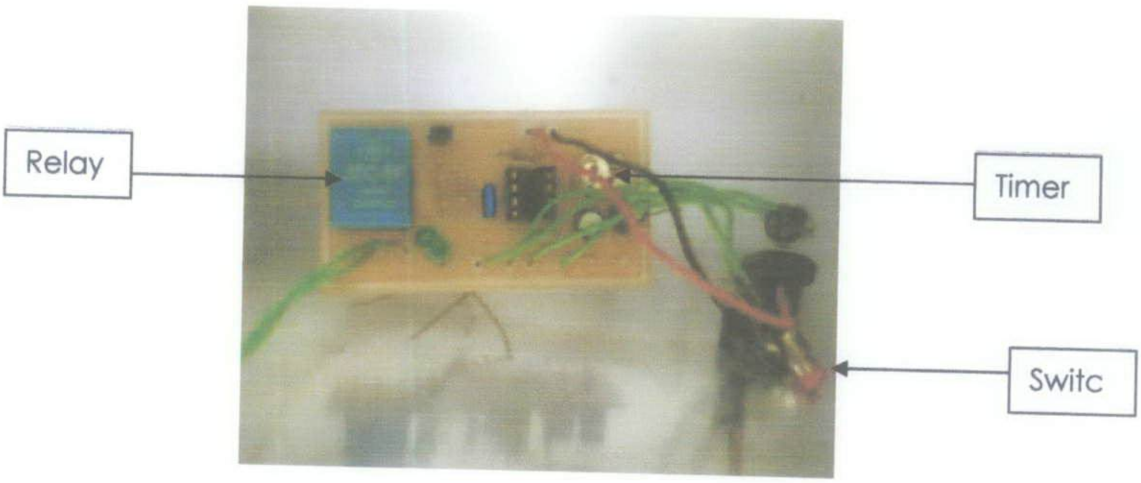


Figure 11:Timer circuit.

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. When the switch open, the relay will go into the normally close mode. Then, after 15 seconds, the relay will go into the normally open mode and made the suction fan stop operating.

The timer function to control the sequence of the process. In this prototype, the timer can be setup from minimum 15 seconds to 100 seconds. It depends on the size of the feeder. Because the prototype was designed to operating for small feeder, the timer in this prototype was set to 15 seconds.

4.5 AutoCAD Drawing of the Prototype.

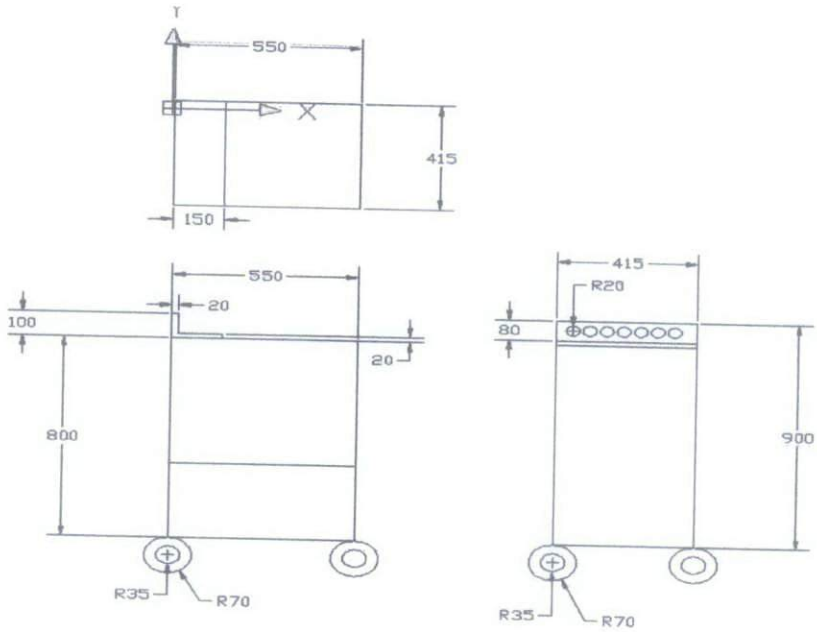


Figure 12:Prototype AutoCAD Drawing

The figure 12 shown of the AutoCAD drawing for the prototype. It shows the dimensions of the prototype. The drawing was divided into 3 dimensions view which is the front view, top view and side view of the prototype. The small hole;20cm radius, used to hold the feeder during in the prototype. The circle that is 35cm inner radius and 70cm outer radius is the wheel of the prototype. The wheel can be lock to make sure the prototype will still in the layout.

CHAPTER 5.CONCLUSION AND RECOMMENDATIONS.

5.1 CONCLUSION.

After the implementation of the prototype, it proved that the worker efficiency and productivity were increase. The units produced per/shift increased after the prototype was implemented. The increment of the productivity is because, it reduce the walking path of the operator and the worker have more time in their workstations to do the work.

The total takt time and total processing time also reduced after the prototype was implemented. Before the implementation, the total processing time for one workstation is 1780seconds and the total takt time is 89 seconds. But, after the implementation, the total processing time reduced to 710 seconds and the total takt time reduced to just only 35.5 seconds.

So, it proved that by implemented the prototype at the workstations, it can increase the productivity of the workers in each workstations. Also , by implementation of the prototype, the total processing time and total takt time were reduced dramatically.

5.2 RECOMMENDATION.

1. The aluminum cover should be best replace by the Perspex. Since the cost to buy the Perspex in this project, so the aluminum sheet was used.

3.Put the timer on the prototype, to avoid the working from forget to switch off the power after turned it on.

4.Increase the size of the prototype, so more feeder can be placed at the workstations.

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