QUALITY ANALYSIS FOR DEFECT AND DEFECTIVE COMPONENT PARTS ON PRINTED CIRCUIT BOARD (PCB) USING DMAIC APPROACH

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DECLARATION

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TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF ABBREVIATIONS

AOI	Automatic Inspection
AXI	Automated X-Ray Inspection
DB	Daughterboard
DC	Daughtercard
DMAIC	Define, Measure, Analyze, Improve, Control
FNI	Final Inspection
ICT	In Test Circuit
MB	Motherboard
PCB	Printed Circuit Board Assembly
PCBA	Printed Circuit Board
SMA	Surface Mount Assembly
SMC	Surface Mount Component
SMD	Surface Mount Devices
SMT	Surface Mount Technology
SMT SMTT	Surface Mount Technology Top
SMT SMTB	Surface Mount Technology Bottom
QC	Quality Control
WW	Worked week

KUALITI ANALISIS TERHADAP BAHAGIAN KOMPONEN YANG CACAT DAN ROSAK PADA PAPAN LITAR BERCETAK (PCB) DENGAN MENGGUNAKAN PENDEKATAN DMAIC

ABSTRAK

Dalam kehidupan seharian kita, segala-galanya dari peranti kawalan jauh dan kenderaan mempunyai komponen elektronik. Papan litar bercetak (PCB) dibuat daripada gentian kaca, garisan tembaga dan bahagian logam lain dan papan ini diadakan bersama-sama dengan epoksi dan terlindung dengan topeng pateri. Aliran proses pemasangan papan litar bercetak (PCBA), PCB yang belum diletakkan komponen akan didaftarkan dengan memberikan nombor siri bagi setiap PCB di DOM penghasilan yang diletakkan di hadapan setiap 'Bay' sebelum dimulakan. Untuk mencapai proses terakhir iaitu Pemeriksaan Akhir (FNI) akan berlaku banyak kecacatan dan kerosakan. Produk yang mengalami kecacatan boleh dibaiki semula manakala produk yang rosak akan dilupuskan kerana tidak lagi boleh digunakan. Oleh itu, masalah ini akan mempengaruhi kadar pengeluaran dan permintaan pelanggan. Sebagai tindak balas, pengumpulan data diperoleh untuk menganalisis data dalam kaedah yang lebih cekap dan memperoleh kadar kegagalan pada kecacatan yang ditemui dalam pengeluaran produk. Data akan dipilih mengikut jenis dan menapis data yang diperlukan sahaja untuk mengkhususkan penyelidikan demi mencari punca utama yang paling penting. Pendekatan DMAIC digunakan untuk menganalisis data yang Menentukan, Mengukur, Analisis, Meningkatkan dan Mengawal. Ciri-ciri papan dikaji seperti menganalisis jenis produk, model PCB, stesen, bay, jenis kecacatan dan kerosakan dan juga komponen. Analisis data membolehkan seseorang menjawab soalan, menyelesaikan masalah, dan memperoleh maklumat penting. Alat statistik dan analisis digunakan untuk mencari punca utama dan mencadangkan penyelesaian untuk mengatasi masalah. Oleh itu, adalah perlu untuk mengetahui faktor utama kerosakan komponen atau bahagian-bahagian mekanikal dan juga solusi untuk mengurangkan atau menghentikan kecacatan dan kerosakan.

QUALITY ANALYSIS FOR DEFECT AND DEFECTIVE COMPONENT PARTS ON PRINTED CIRCUIT BOARD (PCB) USING DMAIC APPROACH

ABSTRACT

In our daily lives, everything from our remote control devices to our vehicles includes electronic components. A printed circuit board (PCB) is made with fiberglass, copper lines and other metal parts, this board is held together with epoxy and insulated with a solder mask. Printed circuit board assembly (PCBA) process flow, the raw PCB will be registered by giving a serial number for each PCB at DOM Birthing which is placed at the front of each Bay before it is starting to be processed. To reach until final process which is Final Inspection (FNI) there will be many defects and defective occur. Defect product can be rework while defective product will be becoming scrap products which are no longer can be used. Thus, this problem will affect the production rate and customer demand. As a countermeasure, data collection is obtained to analyze data in more efficient methods and obtained the failure rates on the defects encountered in the production line. Data is being sorted and filter to narrow the research in order to find the most crucial root cause. DMAIC approach is used in order to analyze the data which is Define, Measure, Analyze, Improve and Control. Characteristic of the boards is studied in order to analyze the variety of product, PCB model, station, bay, defect, and defective type and also component. Data analysis allows one to answer questions, solve problems, and derive important information. Statistical and analytical tools are used to find the root cause and propose a solution to countermeasure the problems. Hence, it is necessary to find out the root cause of the rejection of the components or mechanical parts and also the remedy to reduce or if possible put a stop to the defects and defectives.

CHAPTER 1

INTRODUCTION

1.1 Overview

Manufacturing printed circuit boards is a complex task, there are several probabilities to accidentally introduce a defect or defective into the product. Precise and correct standards must be observed when it comes to populating the board with components, as well, an improper selection of solder or reflow temperatures can result in poor wetting or solder bridging, either of which spells disaster for a circuit. Some of these defects may be detected during the initial testing of the devices.

In Printed Circuit Board (PCB) industry there is the Manufacturing Engineering department that monitors the first pass yield of the products every day. First pass yield means that the Printed Circuit Board Assemblies (PCBAs) pass all the seven inspection stations in the production line with only one process loop. When the PCBAs pass all the station in a single loop, the amount of the board those are needed to be reworked will be reduced. Rework process takes a lot of time and needs extra materials and components. In that case, preventive action has been applied to reduce the amount of rework. Manufacturing engineering department keeps improving the quality of the process to produce the PCBA. All the process which can consume time and cost to produce the PCBAs should be avoided.

1.2 Background Research

In recent years, the PCB is produced by Surface Mount Technology (SMT) in production system and provided more quality circuit board layout capability. Production of PCB is on both side of board and leads to change the inspection method from manually which is human eye measurement and inspection to computer-aided inspection [1]. Automatic Inspection (AOI) has two categories which are bottom and top inspection. It can detect any defect or defective on the boards such as solder problems, missing components and more. This system is very efficient in every assembly step of production line due to fast and accurate inspection while meeting customer demands. This is because it can inspect automatically by using computer and

image detection technology immediately to the Surface Mount Devices (SMD) on the circuit boards.

In PCB industries, the most common defect and defective occurred during production is due to soldering that affects the components on board. Solder paste printing is a very crucial process in surface-mount by using the stencil to paste the solder onto the board to supply tin alloy for the solder joint. A stainless-steel stencil with designated apertures is used in stencil printing process to transfer solder paste onto the board. A squeegee is moved along the stencil surface and the solder paste will pass through the apertures in the stencil as shown in Figure 1.1 [2]. From the company's point of view, printing process that contributed a higher number of defects can affect the PCB quality [3].

In conclusion, soldering problems are caused by improper parameter settings during paste stencil printing, component placement, the solder reflow process or combinations thereof in surface mount assembly (SMA). According to industrial reports, total soldering defects related to the stencil printing process amounted from 50% to 70% [2]. The problem is caused by several factors including the stencil design, the constituents of the solder paste, product configuration, and the stencil printer and its printing parameters.

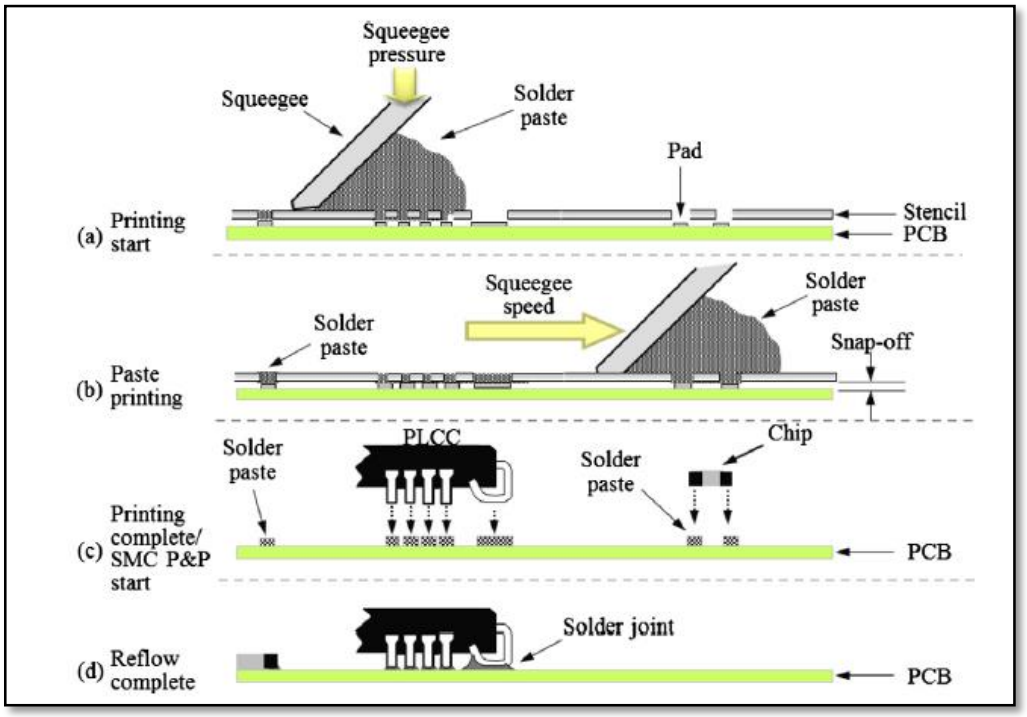

Figure 1.1 Solder printing process [2]

The problem that always on PCB is the occurrence of solder-ball defects underneath electronic components assembled as printed circuit boards (PCBs) that will contribute to failures of electronic systems containing the affected PCBs. Furthermore, design issue also has a higher number of defective problem that affects the production rate. Design issues divided into several problems such as tombstoned, void, insufficient solder, missing solder and short or bridging solder.

The first step to finding a solution to make improvements was to understand the assembly process and to identify all features that could potentially cause PCB defects and could be measured [4].

Moreover, in manufacturing of PCB final inspection (FNI) station also play an important role in order to sustain the production yield. The company goal for FNI station is 99%. Getting below the targeted goal will affect the production capacity and the shipping process. This will cause a time delay in shipping as an increase in defects and defectives means more time to be depleted on scrap and rework and an increase in the total man-hours 22 and cycle time and inventory carrying cost as the board has to be re-routed.

Small components placement and chassis assembly usually will cause missing, bent, scratch or dented. This defective cause cannot be rework unless it will be scraped away. Nevertheless, solder problem on PCB can be rework and undergo the second loop of process. There are several test process on the printed circuit board assembly which is Automatic Inspection (AOI), Automated X-Ray Inspection (AXI), and In Test Circuit (ICT) prior to board functional test. This is the best and overall cost-effective to detect problem on PCB. The earlier defects are found, the most cost-effective the process is shown in Figure 1.2 [5]:

Coverage	AOI	AXI	ICT
Placement	• Extra parts • Missing • Tombstone • Billboard • Misalignment • Orientation • Missing Non-Electric • Bypass Caps, L's • Inverted • Polarity	• Extra parts • Missing • Tombstone • Billboard • Misalignment • Bypass Caps, L's	• Missing • Tombstone • Inverted • Polarity

Solder		• Shorts • Opens • Insufficient • Poor wetting • Marginal joints • Voids • Solder balls	• Shorts • Opens
Electrical	• Wrong part	• Wrong part	• Wrong part • Dead/Bad part • Cold solder • PCB short/open • Continuity • Part functionality • Values/Tolerances • Bent leads

Figure 1.2 Type of defect and defective in each test [5]

1.3 Problem Statement

In one batch of production, there are higher numbers of defects and defectives include various types of defects and defectives occurred. After knowing the defects and defectives, data for 3 need to be review and analyze using statistical tools to see the trend of problem within the months to find the root cause. Therefore, the data will be used as an analysis to improvise defects and to see what when wrong and come out with countermeasures.

1.4 Objectives

The main objectives of this project are:

- To identify quality problems of defect and defective.
  - Done by collecting data from the electronic company.
- To analyze selected data using statistical tools and techniques.
  - By using the control charts, DMAIC approach, 5 Whys, Pareto chart, check sheet and Cause and Effect diagram.
- To develop a solution and countermeasure.
  - Doing further analysis by using other tools.

1.5 Scope of Work

At the beginning of this project, process flow of PCB is observed and the present printing operation is inspected and analyzed. This project is focusing on one model only which is the APEX model. Then, the data collection of PCB production for 3 months which is July, August and September in year 2018 will be analyzed by using statistical tools to see the relationship between the trend and result that limit to higher stations and bay. Therefore, by using control charts, DMAIC, 5 Whys, Pareto chart, check sheet and Cause and Effect diagram to solve the quality related problems and increase quality of the products to come out a final proposal in quality analysis for defect and defective component parts on PCB.

CHAPTER 2

LITERATURE SEARCH

2.1 Introduction

Based on studies, PCBA is an important part of the manufacturing process, in which SMT is a crucial method used to directly attach the surface mounted components (SMCs) onto the pads of the PCB. SMT assembly consists of three consecutive process steps: solder paste stencil printing, component placement, and solder reflow. Then, it will go through an inspection station to identify any defects occur. If soldering failures occur, the defective boards are sent to rework stations for defect correction [2].

2.2 Research Variable

Statistical methods are used in planning, designing, collecting data, analyzing, and reporting of the research findings. There are two types of variables which is an understanding of quantitative and qualitative variables and the measures of central tendency as shown in Figure 2.1 [6].

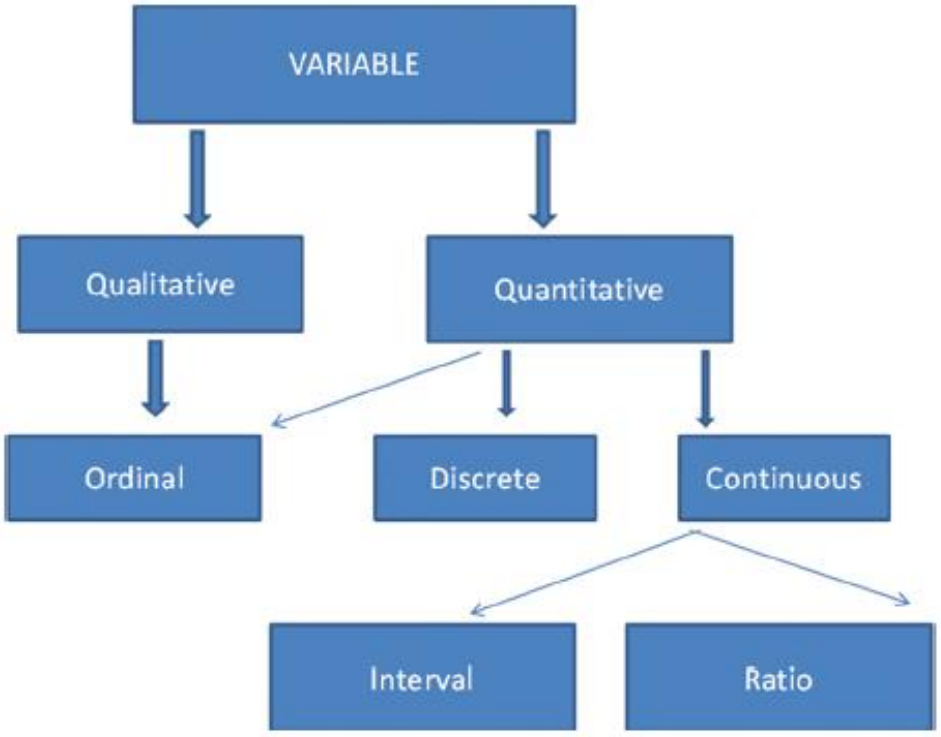

Figure 2.1 Classification of variable [6]

The defects need to be diagnosing correctly hence Pareto chart and Cause-Effect Diagram has been used to identify and classify the reasons that are responsible for defective PCB. Root cause analysis is used as an analytical tool that can be used to perform the review and understanding the defects [7]. Pareto analysis is a major contribution to major rejection percentage to identify the defects. Pareto shows all defects and related percentage while Cause and Effect diagram is necessary to find out actual reasons for the defects for analysis purpose. Both are used to identify and evaluate different defects and causes for these defects in production [7].

Understanding processes so that defects can be improved by means of systematic approach requires knowledge of the seven basic quality control (QC) tools, which are used in problem identification. These tools are largely quantitative and help answer the questions associated with them [8].

- Process flowchart – What is done?
- Pareto analysis – Which are the big problems?
- Cause and effect analysis – What causes the problem?
- Histogram – What does the variation look like?
- Check sheet/tally sheets – How often does it occur?
- Scatter diagrams – What are the relationships between factors?
- Control charts – Which variations are to be controlled and how?

Moreover, the ‘5 Whys' techniques is another approach to root cause analysis because it narrows the scope for improvement even further by insisting that risk control efforts that focus on one root cause for each cause[9].

Next, one of the case studies on PCB is presented on Six Sigma quality improvement through DMAIC approach [10]. DMAIC is a closed-loop process that eliminates unproductive steps, focuses on new measurements, and applies technology for continuous improvement [3]. DMAIC approach is implemented in manufacturing line process to define problem, measure important data, analysis the problem, suggest improvements and control the improvements to solve the problems. The key of processes to use DMAIC approach is shown in Table 2.1.

Table 2.1 Key steps of six sigma using DMAIC approach

Six Sigma steps	Key processes
Define	-Define the requirements and expectations of the customer -Define the project boundaries -Define the process by mapping the business flow
Measure	-Measure the process to satisfy customer's needs -Develop a data collection plan -Collect and compare data to determine issues and shortfalls
Analyze	-Analyzes the causes of defects and sources of variation -Determine the variations in the process
Improve	-Improve the process to eliminate variations -Develop creative alternatives and implement an enhanced plan
Control	-Control process variations to meet customer requirements -Develop a strategy to monitor and control the improved process -Implement the improvements of systems and structures

CHAPTER 3

METHODOLOGY

3.1 Methodology flow chart

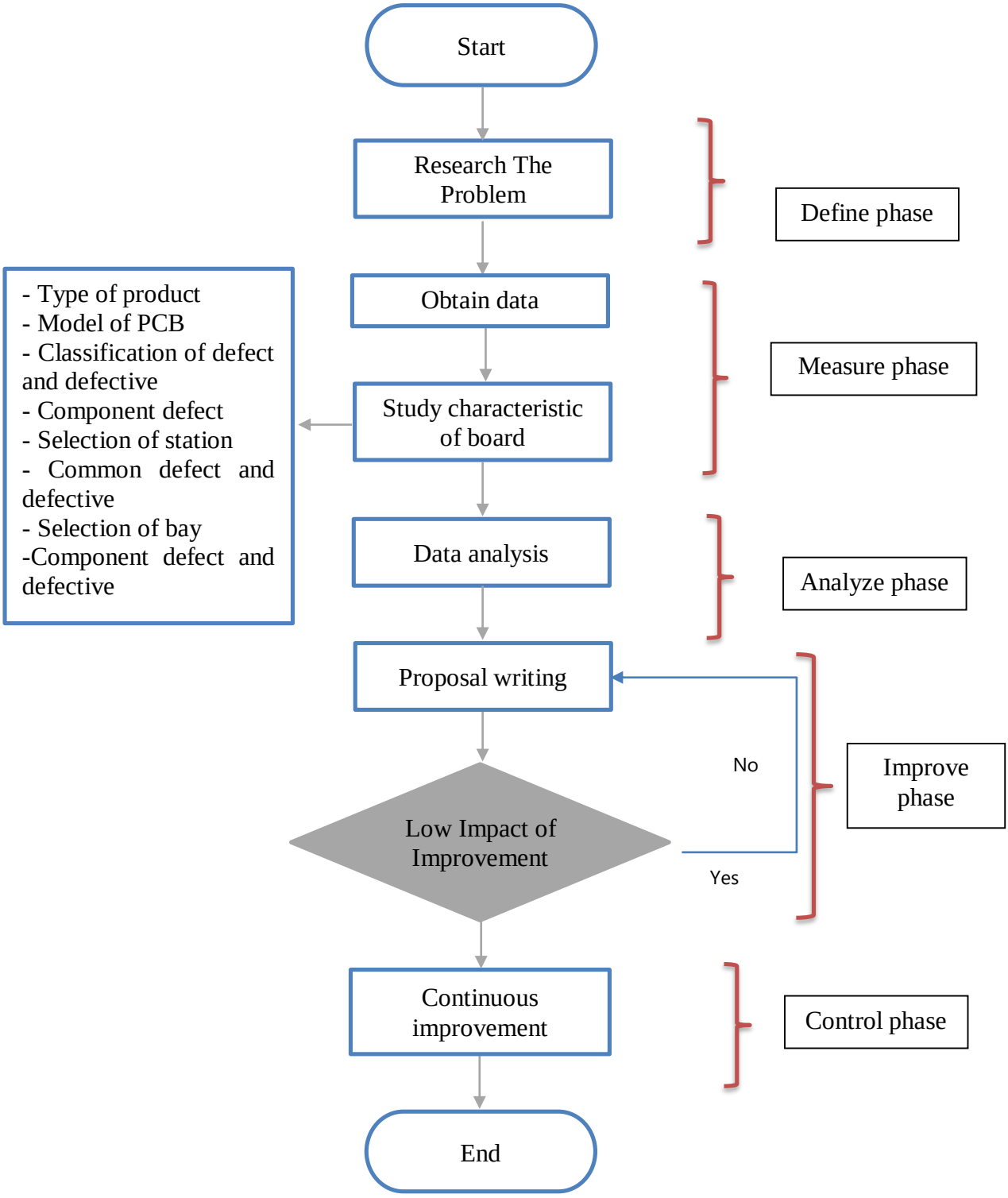

Figure 3.1 Research flowchart

3.2 Flowchart of the process by using DMAIC approach

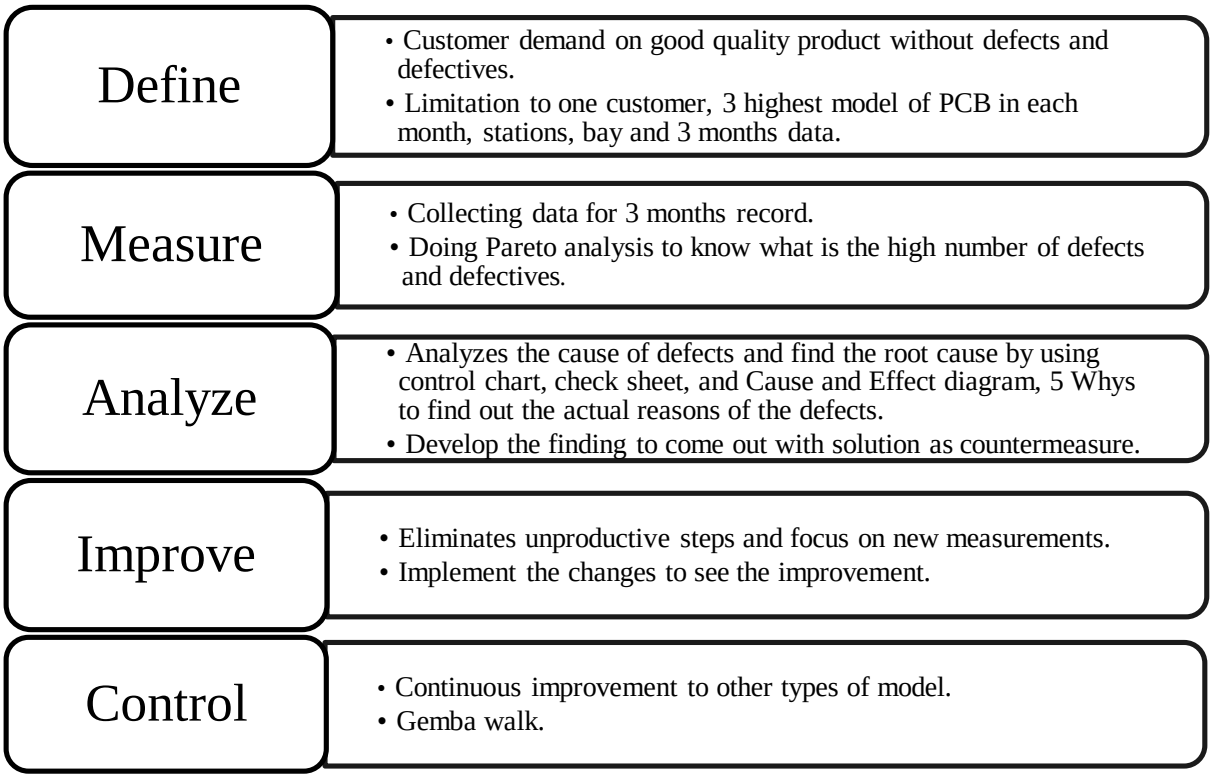

Figure 3.2 DMAIC approach

3.2.1 Define phase

In PCB production, customer demand for good quality product without defects and defectives that will contribute to wastage. The barrier for the company to produce good quality is the defect and defective that cause from soldering process, machine or technical error. To find the root cause of the defect and defective, data information is needed to identify patterns and relationships. Furthermore, the whole process of PCB production is being studied in Figure 3.3. The purpose is that data collected over time will show a trend. Then, the trend will allow seeing when a failure occurred. In this stage, it needs to understand what type of product, type of model PCB, stations, bay, product defect and defective and also component. Detailed manufacturing process flow of PCB is studied.

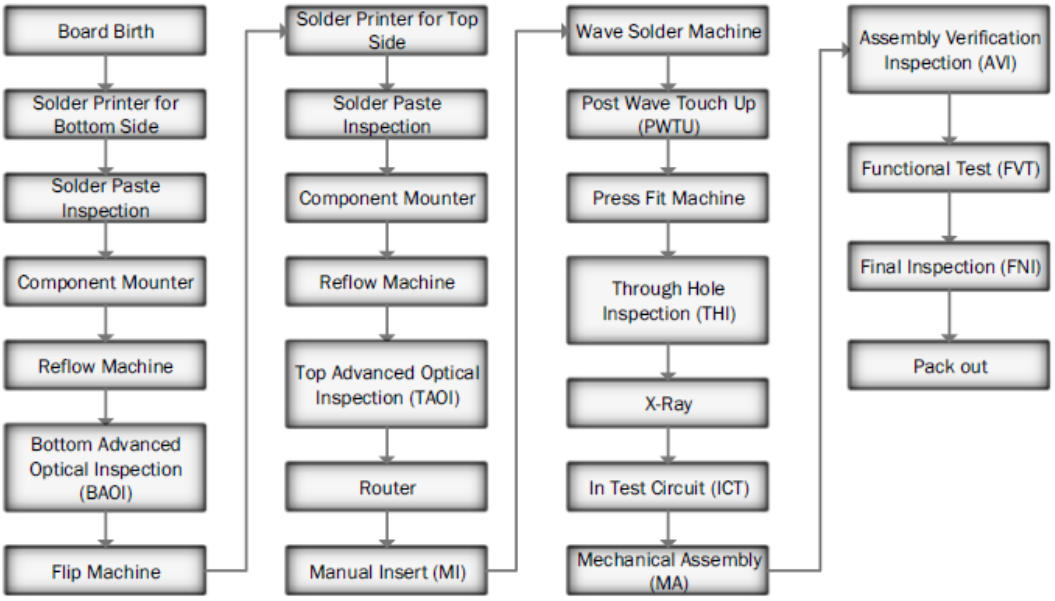

Figure 3.3 Process Flow of Printed Circuit Board (PCB)

3.2.2 Measure phase

Data collection of PCB production is obtained from company to be review and analyze. This is measured by collecting data for 3 months which is July, August and September in year 2018. The data is sort to the highest model that contribute to defect and defective by doing Pareto analysis to see the trend. Pareto chart is a bar chart that plots non-numerial or qualitative categories to their respective frequency. Besides, it is a tool for identifying the most significant problems to help prioritize improvement efforts.

3.2.3 Analyze phase

The information will be analyzed by using control chart, Cause and Effect diagram, 5 Whys and check sheet to find the root cause. The cause and effect diagram support the brainstorming and logically organizes potential inputs for a specific problem or effect besides a starting point for countermeasure identification. Another tool is 5 Whys which is used to explore in depth the potential causes of a problem. Moreover, control chart is historical process data to identify a recent period of predictability and stability. Lastly, develop the finding to come out with solution for countermeasure.

3.2.4 Improve phase

The first step towards improvement is standardization where there is no standard, there can be no improvement. Next, eliminate unproductive steps and focus on new measurements which is the components of a good standard.

3.2.5 Control phase

To meet customer requirements, continuous improvement to sustain and make it part of the culture. In Lean Management, the process performance must be monitor by doing Gemba Walk. Evaluate the results and look for other ways to apply the learning to similar problems/processes across the organization. Begin the cycle again by setting a new target condition.

CHAPTER 4

RESULT

4.1 Classification of Printed Circuit Board (PCB)

PCB is classified according to monthly results for defects and defectives, product classification, stations and bay classification, defects and defectives type and component defect. In this project, PCB is only focusing on ECBU (APEX) workcell.

Table 4.1 List of Workcell

Workcell
Cisco
Cisco UABU
Cisco SRGBU (ASR1K)
Cisco ECBU (APEX)
Cisco DCBU (Equator)
Cisco BACKPLANE (BP)
Cisco CORBU/INSBU
Cisco SSEBU
Cisco EBBU

4.2 Classification of Product Type

In this industry of PCB production, they produced many boards for variety of uses in electrical and mechanical components such as:

1) Laptop
2) Computer
3) Plane
4) Radio
5) Cellphone

PCB has several types which are single-sided (one copper layer), double-sided (two copper layers) or multi can be -layer (outer and inner layers of copper). For the multi-layer of PCB, they are divided into motherboard (MB) daughterboard (DB) and daughtercard (DC). Apart from that, they also have 64 APEX Models of PCB with different features.

4.3 Total Number of Defects and Defectives in July, August and September

Table 4.2 Total number in July, August and September

Month	Total Number
July	3058
August	3592
September	2813

Table 4.2 shows a total number of defects and defectives PCB in July, August and September. August has a higher number among three months which is 3592.

4.3.1 Total Number and Percentage of Final Assembly in July, August and September

4.3.1(a) Total Number and Percentage of Defective in July

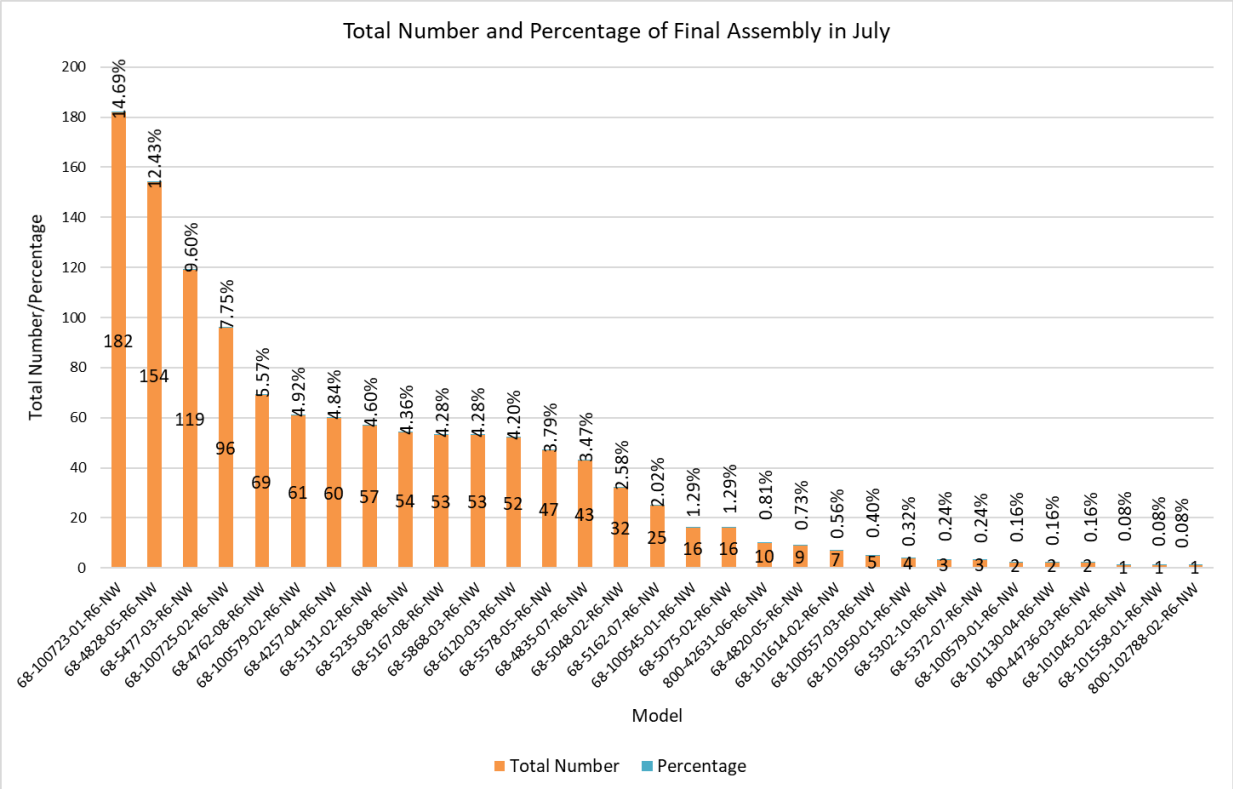

Figure 4.1 Total number and percentage of final assembly in July

Top three higher total number in July is 68-100723-01, 68-4828-05 and 68-5477-03 due to defective on PCB from Figure 4.1. Thus, higher of percentage in July caused by critical machine in production line and further investigation needs to be done.

4.3.1(b) Total Number and Percentage of Defective in August

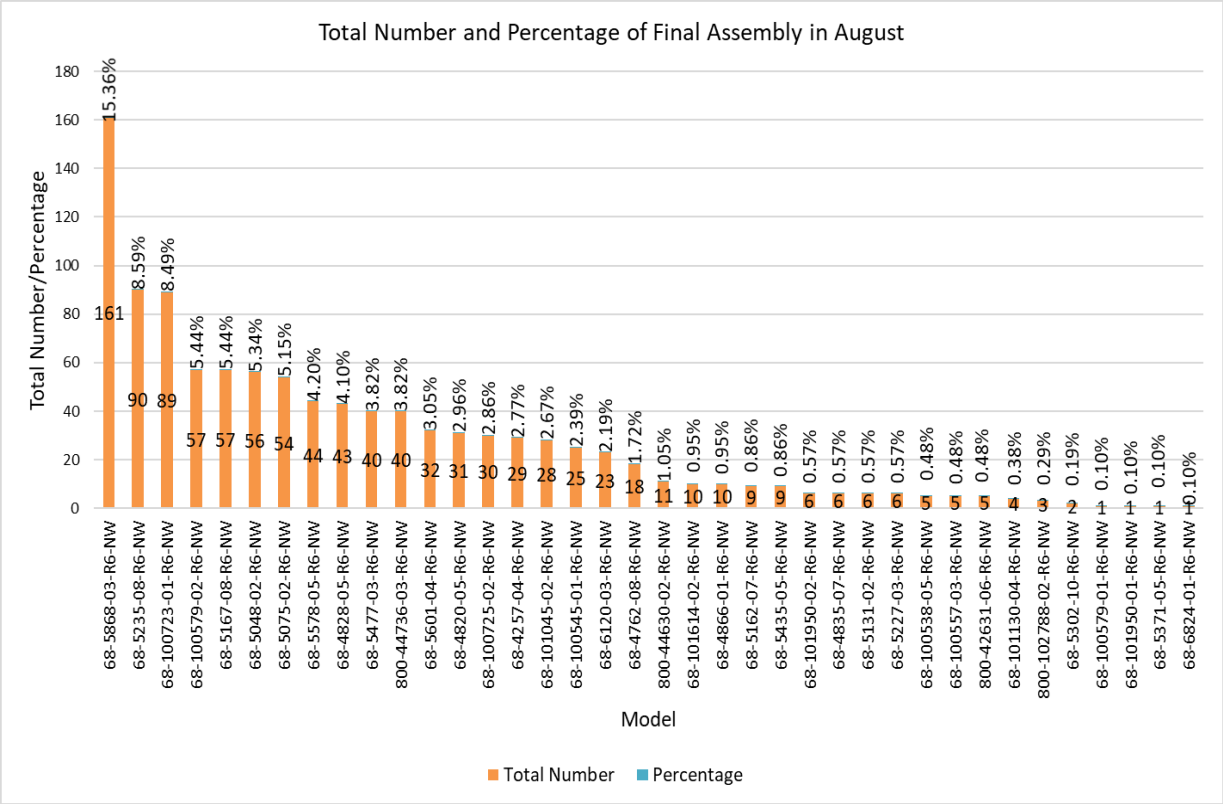

Figure 4.2 Total number and percentage of final assembly in August

Top three higher total number in August is 68-5868-03, 68-5235-08 and 68-100723-01 due to defective on PCB from Figure 4.2. Thus, higher of percentage in August caused by critical machine in production line and further investigation needs to be done.

4.3.1(c) Total Number and Percentage of Defective in September

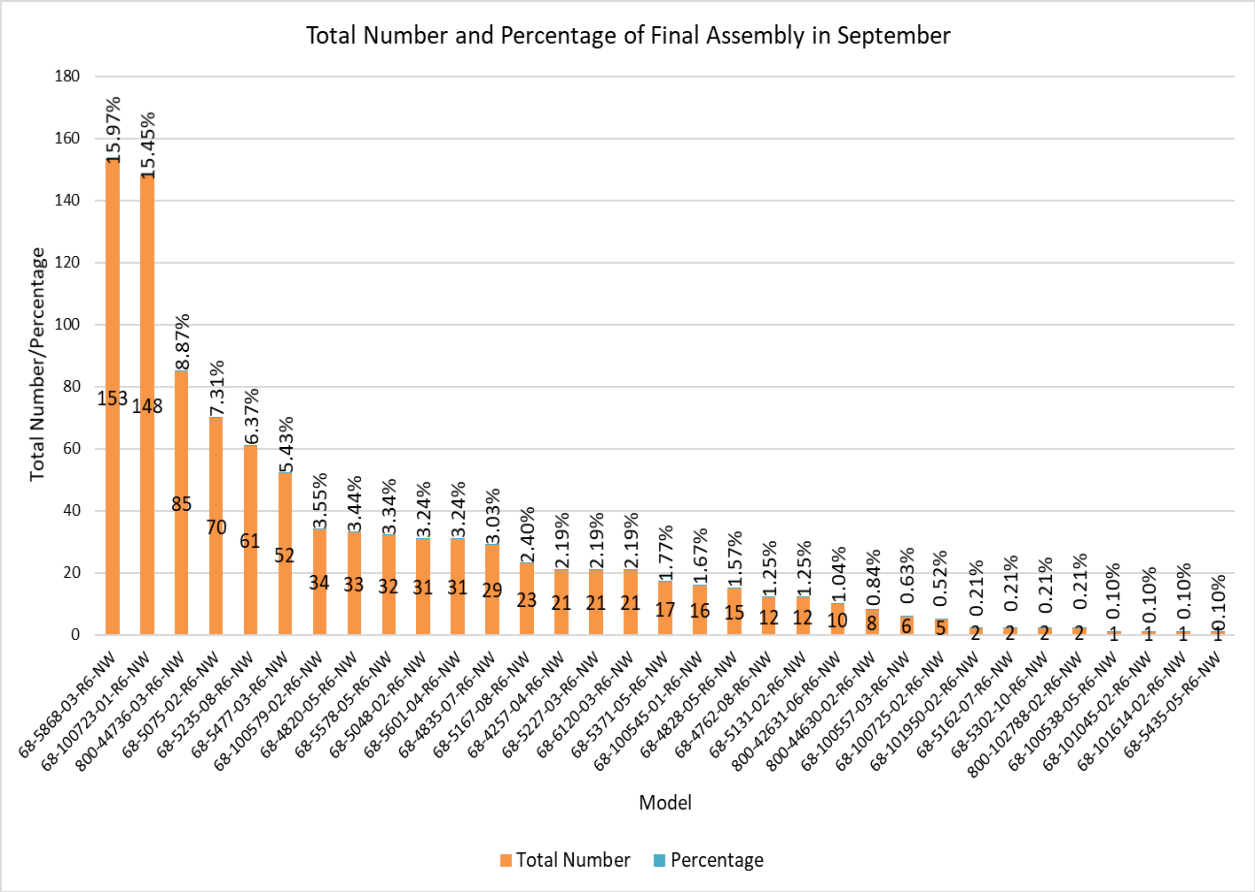

Figure 4.3 Total number and percentage of final assembly in September

Top three higher total number in September is 68-5868-03, 68-100723-01 and 800-44736-03 due to defective on PCB from Figure 4.3. Thus, higher of percentage in September caused by critical machine in production line and further investigation needs to be done.

4.3.2 Total Number and Percentage of PCBA in July, August and September

4.3.2(a) Total Number and Percentage of Defect in July

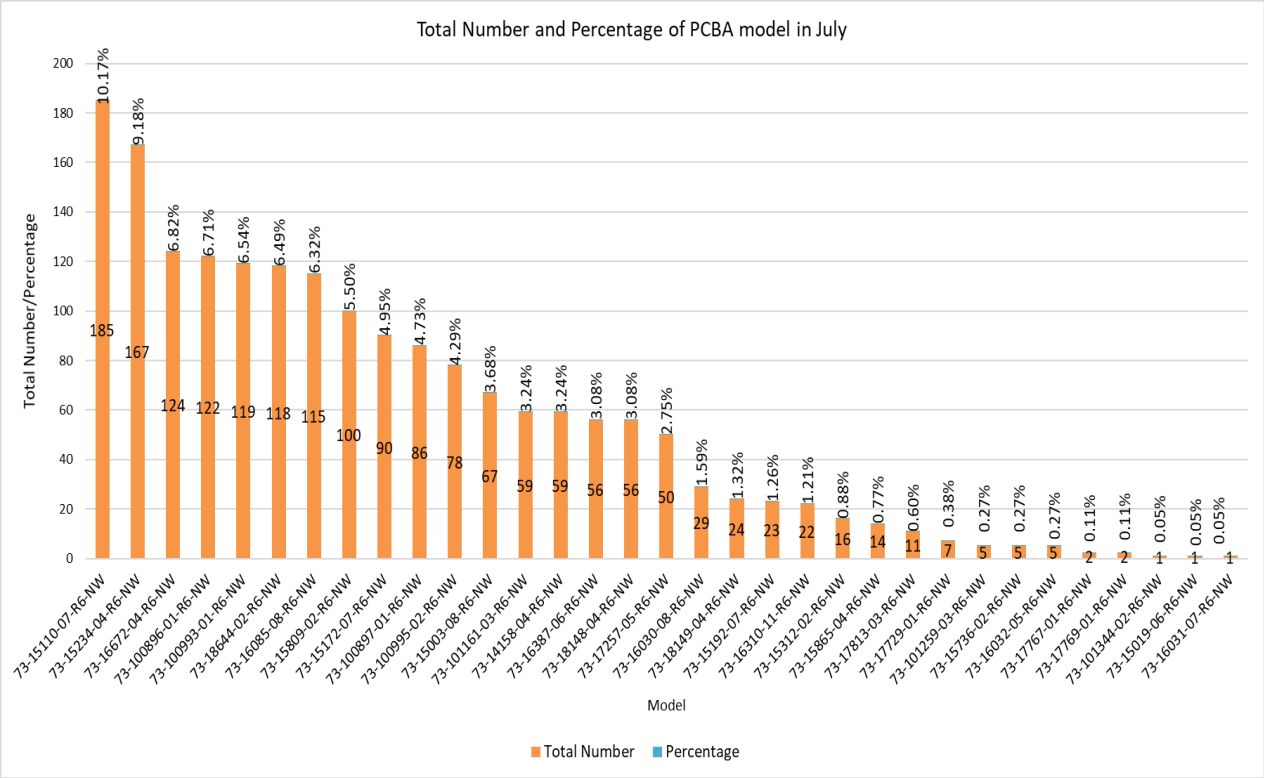

Figure 4.4 Total number and percentage of PCBA in July

The top three higher total number in July is 73-15110-07, 73-15234-04 and 73-16672-04 due to defect on PCB from Figure 4.4. Thus, higher of percentage in July caused by critical machine in production line and further investigation needs to be done.

4.3.2(b) Total Number and Percentage of Defect in August

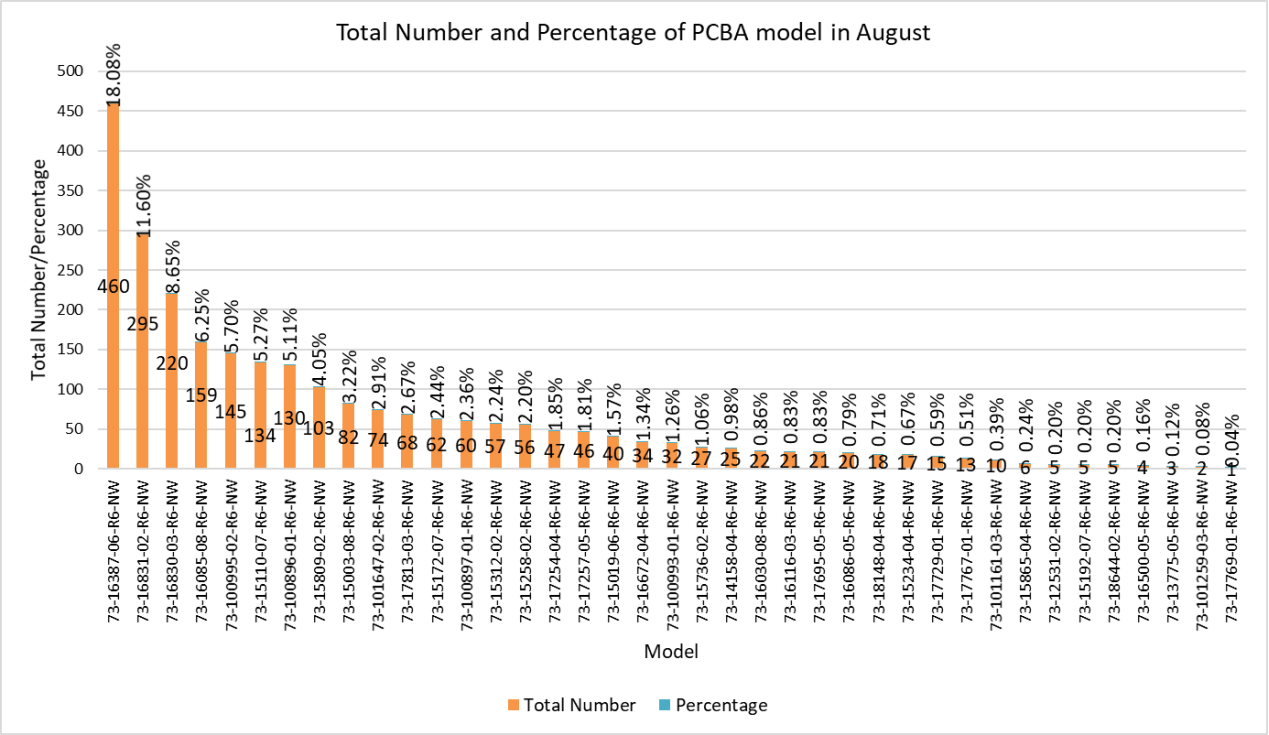

Figure 4.5 Total number and percentage of PCBA in August

Top three higher total number in August is 73-16387-06, 73-16831-02 and 73-16830-03 due to defect on PCB from Figure 4.5. Thus, higher of percentage in August caused by critical machine in production line and further investigation needs to be done.

4.3.2(c) Total Number and Percentage of Defect in September

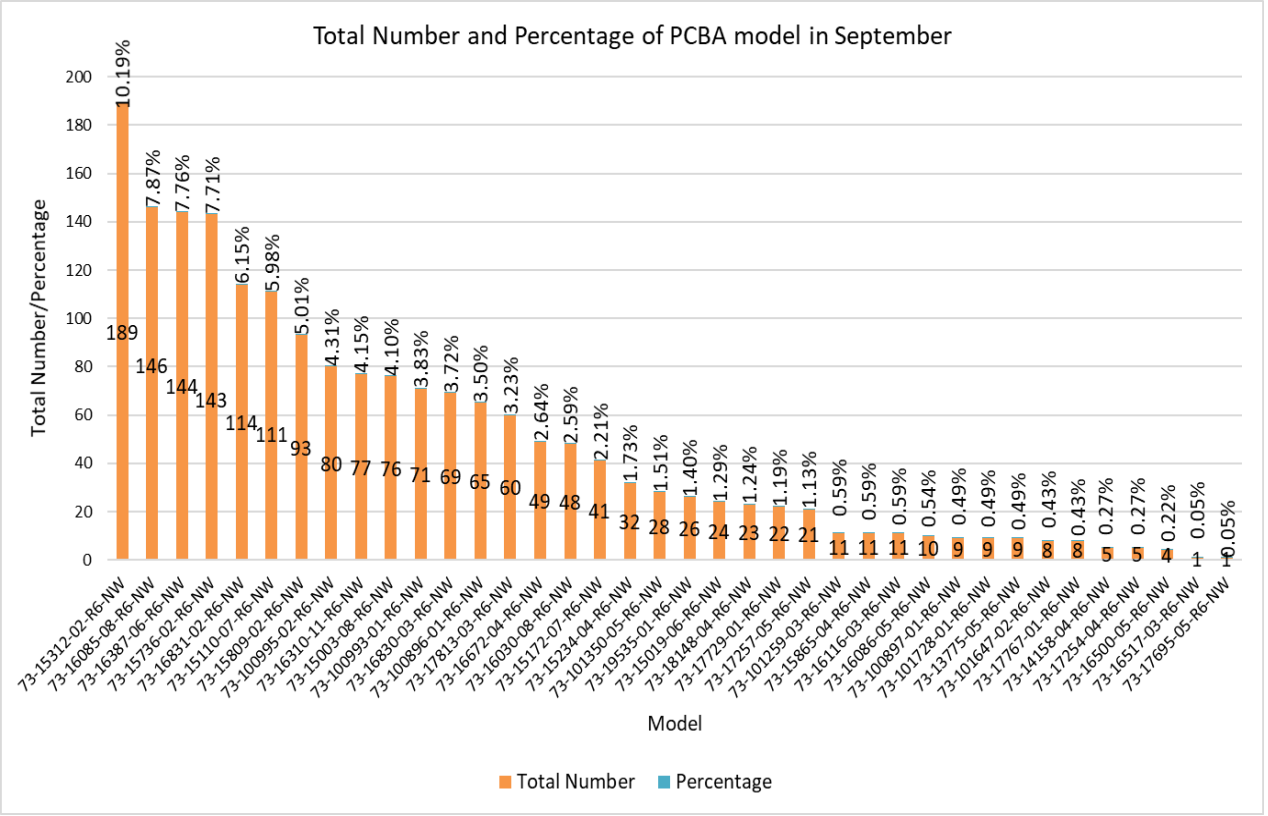

Figure 4.6 Total number and percentage of PCBA in September

The top three higher total number in September is 73-15312-02, 73-16085-08 and 73-16387-06 due to defect on PCB from Figure 4.6. Thus, higher of percentage in September caused by critical machine in production line and further investigation needs to be done.

4.4 Classification of Bay

Bay is the production line that started from process board birth until In Test Circuit (ICT) station. ICT station is a that provides analog and digital power up to the components on the PCB board and identify defects on boards. Each bay produces two to three types of models in a day. Top three higher defectives and defects are observed to find out which bay has a problematic issue.

4.4.1 Defective Number of July

Row Labels	Count of SerialNumber
BAY 19	**177**
Assemble 68 ASSY	1
Assemble MANUAL_ASSY	1
BIRTH Cisco_Birth	170
SMT SMTT01	4
SMT SMTT02	1
BAY 20A	**5**
Assemble 68 ASSY	3
SMT SMTB01	2
Grand Total	**182**

68-100723-01

Row Labels	Count of SerialNumber
BAY 19	**145**
Assemble 68 ASSY	1
Assemble MANUAL_ASSY	1
Assemble Mech Assy1	4
BIRTH Cisco_Birth	135
SMT SMTB01	1
SMT SMTT02	3
BAY 20A	**9**
Assemble 68 ASSY	1
Assemble MANUAL_ASSY	2
Assemble PACE	1
BIRTH Cisco_Birth	4
SMT SMTB01	1
Grand Total	**154**

68-4828-05

Row Labels	Count of SerialNumber
BAY 19	**115**
BIRTH Cisco_Birth	99
SMT SMTB01	9
SMT SMTT01	1
SMT SMTT02	6
BAY 20A	**4**
Assemble 68 ASSY	1
Assemble MANUAL_ASSY	1
BIRTH Cisco_Birth	2
Grand Total	**119**

68-5477-03

Figure 4.7 Defective number in each Bay

Figure 4.7 shows a total number of defective for 3 selected models in July. Most of defectives are cause from birth of PCB in three models.

4.4.2 Defect Number in July

Row Labels	Count of SerialNumber
BAY 19	**3**
Assemble PACE	2
SMT SMTT02	1
BAY 20A	**171**
Assemble MANUAL_ASSY	2
Assemble PACE	3
BIRTH Cisco_Birth	7
SMT SMTB01	55
SMT SMTT01	62
SMT SMTT02	42
Grand Total	**174**

73-15110-07

Row Labels	Count of SerialNumber
BAY 19	**2**
Assemble PACE	2
Bay 21	**1**
SMT SMTT01	1
Bay 22	**83**
SMT SMTB01	10
SMT SMTT01	72
SMT SMTT02	1
Bay 23	**3**
SMT SMTB01	3
Bay 28	**77**
Assemble MANUAL_ASSY	2
Assemble PACE	8
BIRTH Cisco_Birth	2
SMT SMTB01	7
SMT SMTT01	58
Grand Total	**166**

73-15234-04

Row Labels	Count of SerialNumber
BAY 19	**14**
Assemble PACE	2
BIRTH Cisco_Birth	3
SMT SMTT01	8
SMT SMTT02	1
BAY 20A	**109**
Assemble MANUAL_ASSY	2
BIRTH Cisco_Birth	4
SMT SMTB01	32
SMT SMTT01	36
SMT SMTT02	35
Grand Total	**123**

73-16672-04

Figure 4.8 Defect number in each Bay

Figure 4.8 shows a total number of defect for 3 selected models in July. Most of defects are cause from SMT of components on bottom side and top side of PCB.

4.4.3 Defective Number in August

Row Labels	Count of SerialNumber
BAY 19	**138**
Assemble 68 ASSY	2
BIRTH Cisco_Birth	132
SMT SMTB01	2
SMT SMTT02	2
BAY 20A	**23**
Assemble 68 ASSY	2
Assemble MANUAL_ASSY	20
SMT SMTT02	1
Grand Total	**161**

68-5868-03

Row Labels	Count of SerialNumber
BAY 19	**84**
Assemble MANUAL_ASSY	2
BIRTH Cisco_Birth	73
SMT SMTB01	1
SMT SMTT01	1
SMT SMTT02	7
BAY 20A	**6**
Assemble MANUAL_ASSY	3
Assemble PACE	1
BIRTH Cisco_Birth	2
Grand Total	**90**

68-5235-08

Row Labels	Count of SerialNumber
BAY 19	**86**
BIRTH Cisco_Birth	86
BAY 20A	**3**
Assemble 68 ASSY	1
BIRTH Cisco_Birth	2
Grand Total	**89**

68-100723-01

Figure 4.9 Defective number in each Bay

Figure 4.9 shows a total number of defective for 3 selected models in August. Most of defectives are cause from birth of PCB in three models.

4.4.4 Defect Number in August

Row Labels	Count of SerialNumber
BAY 19	**1**
SMT SMTT01	1
BAY 20A	**1**
SMT SMTT02	1
Bay 22	**61**
SMT SMTB01	12
SMT SMTT01	24
SMT SMTT02	25
Bay 28	**397**
BIRTH Cisco_Birth	2
SMT SMTB01	393
SMT SMTT01	2
Grand Total	**460**

73-16387-06

Row Labels	Count of SerialNumber
BAY 19	**25**
Assemble PACE	25
Bay 22	**268**
BIRTH Cisco_Birth	2
SMT SMTB01	146
SMT SMTT01	108
SMT SMTT02	12
Grand Total	**293**

73-16831-02

Row Labels	Count of SerialNumber
BAY 19	**1**
BIRTH Cisco_Birth	1
BAY 20A	**215**
Assemble PACE	4
BIRTH Cisco_Birth	6
SMT SMTB01	141
SMT SMTT01	49
SMT SMTT02	15
Grand Total	**216**

73-16830-03

Figure 4.10 Defect number in each Bay

Figure 4.10 shows a total number of defect for 3 selected models in August. Most of defects are cause from SMT of components on bottom side and top side of PCB.

4.4.5 Defective Number in September

Row Labels	Count of SerialNumber
BAY 19	**139**
Assemble 68 ASSY	2
Assemble MANUAL_ASSY	2
BIRTH Cisco_Birth	127
SMT SMTT02	8
BAY 20A	**14**
Assemble 68 ASSY	4
Assemble MANUAL_ASSY	9
SMT SMTT01	1
Grand Total	**153**

68-5868-03

Row Labels	Count of SerialNumber
BAY 19	**135**
BIRTH Cisco_Birth	135
BAY 20A	**13**
Assemble 68 ASSY	7
Assemble MANUAL_ASSY	1
BIRTH Cisco_Birth	3
SMT SMTT01	1
SMT SMTT02	1
Grand Total	**148**

68-100723-01

Row Labels	Count of SerialNumber
BAY 19	**82**
Assemble MANUAL_ASSY	4
Assemble PACE	1
BIRTH Cisco_Birth	61
SMT SMTT01	4
SMT SMTT02	12
BAY 20A	**3**
Assemble MANUAL_ASSY	1
BIRTH Cisco_Birth	2
Grand Total	**85**

800-44736-03

Figure 4.11 Defective number in each Bay

Figure 4.11 shows a total number of defective for 3 selected models in September. Most of defectives are cause from birth of PCB in three models.

4.4.6 Defect Number in September

Row Labels	Count of SerialNumber
BAY 20A	**16**
BIRTH Cisco_Birth	1
SMT SMTT01	13
SMT SMTT02	2
Bay 22	**29**
Assemble MANUAL_ASSY	2
BIRTH Cisco_Birth	2
SMT SMTB01	17
SMT SMTT01	8
Bay 28	**6**
SMT SMTB01	2
SMT SMTT01	4
Bay 83	**136**
Assemble MANUAL_ASSY	6
SMT SMTB01	2
SMT SMTB03	5
SMT SMTT01	29
SMT SMTT02	63
SMT SMTT03	31
Grand Total	**187**

73-15312-02

Row Labels	Count of SerialNumber
BAY 19	**29**
Assemble PACE	4
BIRTH Cisco_Birth	3
SMT SMTT01	9
SMT SMTT02	13
BAY 20A	**101**
Assemble MANUAL_ASSY	1
BIRTH Cisco_Birth	8
SMT SMTB01	13
SMT SMTT01	51
SMT SMTT02	28
Grand Total	**130**

73-16085-08

Row Labels	Count of SerialNumber
Bay 22	**144**
SMT SMTB01	3
SMT SMTT01	132
SMT SMTT02	9
Grand Total	**144**

73-16387-06

Figure 4.12 Defect number in each Bay

Figure 4.12 shows a total number of defects for 3 selected models in September. Most of defects are cause from SMT of components on bottom side and top side of PCB.

4.5 Classification of Station

The station is the flow of printed circuit board manufacture from the birth of board until final inspection (FNI) station. The process flow of PCB is shown in Figure 3.3. Through all the station PCB board will undergo a different process that will contribute different types of defects and defectives.