ANALYSIS OF BROKEN PIN DEFECT ON MODULE DUAL MC CU IN ENDTEST PROCESS

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***Abstract*— PIN in semiconductors is an acronym for "Positive-Intrinsic-Negative". This refers to the three-layer structure of some semiconductor components such as PIN diodes, which consists of a positive layer (P), an intrinsic or uncharged layer (I), and a negative layer (N). Pins have a variety of functions, in this case the pin is a component in semiconductors that functions as a connector from one component to another. Broken pins are failures that often occur in the Dual MC Cu module in the EndTest process, almost every load there must be broken pin damage, because this module uses sensitive needle pins compared to pins in other modules. There are several factors that affect broken pins, namely; a few wrong pin testing positions, adapters that are too strong in pressure, and from the previous process. This study was conducted to analyze the factors and prevent damage done to the EndTest process caused by broken pins in order to minimize the damage that occurs. This research uses the Fishbone Method and Pareto Chart. This research can analyze the failure, can find the aspects involved in the main failure, and find the causes of product defects in the EndTest production process.**

Keyword: Pin, Broken, EndTest

I. INTRODUCTION

PT. Infineon Cegled Hungary operates in the electronics sector, specifically focusing on the production of semiconductor modules. The production process is very complex, involving sophisticated equipment and integration with IoT systems, resulting in efficient production. Various processing stations are used to make modules commonly used in electric vehicles, large windmills and electric helicopters. Among these processes, the EndTest procedure involves both visual and non-visual assessments. Visual inspection requires a thorough inspection of the completed module, assessing elements such as the base plate, frame, cover, PINs, and rivets. In contrast, non-visual testing is performed by machines and includes dynamic electrical, ISO, and static electrical evaluations.

Before starting the production process (initial run), IPCQ (In Process Quality Control) carries out checks to ensure compliance with the details specified in the Aufrag paper (a document containing relevant data about the task in progress). Next, the machine is configured, and the adapter is adapted to the module requirements. Once configuration is complete, the module is loaded into the machine for three non-visual tests. Once complete, the module undergoes a visual inspection and is then placed in a tray for storage. From September 2023 to November 2023, many product failures occurred in the pin section caused by various sources. Based on the conditions above, the author chose to carry out a final assignment entitled "Analysis of Broken Pin Defects in the Dual MC Cu Module in the EndTest Process Using the Fishbone and Pareto Chart Method at PT Infineon Technologies Cegled Hungary". In this method the author did not take the entire data but only sampling data only because it is not permitted to collect such data.

So this table is an example of the reasons for the failure experienced by the author, here it is not the entire data but only sample data due to limitations in data collection.

Table 1. Data sample of Broken Pin

ECONO DUAL MODULE					
BEFORE			AFTER		
MONTH	WEEK	UNIT	MONTH	WEEK	UNIT
SEPTEMBER	1	15	JANUARY	1	
	2	17		2	
	3	9		3	
	4	15		4	
OCTOBER	1	12	FEBRUARY	1	
	2	5		2	
	3	10		3	
	4	6		4	
NOVEMBER	1	13	MARCH	1	
	2	15		2	
	3	9		3	
	4	5		4	

So the total number of failures obtained by the author was 56 in September, 33 in October, 42 in November, and the total failure in those 3 months was **131 pcs.**

II. METHOD

A. Fishbone Diagram

This research aims to analyze the causes of a problem. In this research, the tool used to analyze the problem is root cause analysis. Root cause analysis is used to determine the initial cause of the problem. The method used in root cause analysis is the fishbone diagram. Where the fishbone diagram can identify several problems that underlie these obstacles to decision making. The results of this research can be seen atdecision making five problems that underlie hampered decision making. [1]

Fishbone analysis is an approach used to provide more detailed analysis to find the root causes of existing problems, non-conformities and gaps. [2] Root of the problem analysis and fishbone diagram, it is possible analyze in detail the causes of the failure of the broken pin.In the end, you can find a solution to each of these problems. Technologies will look for each problem for the root of the problem, and the answers will be given right on target so that it is hoped that this can be minimized and obstacles to decision making will be implemented.

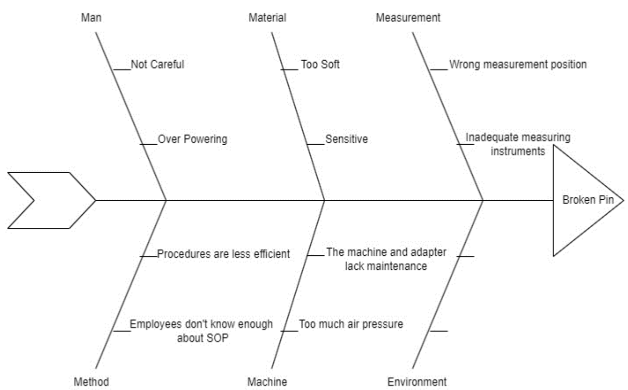

Figure 1. Fishbone Diagram of Broken Pin

Table 5 below shows an overview of opinions and root causes of failures that occur in the process :

Table 2. Root Cause Description

Problem Category	Possible Root Cause	Discussion	Root Cause?
MAN	Not Careful	There is a test every 4 months regarding employee accuracy	Y
	Over Powering	A briefing before starting work	N
MATERIAL	Too Soft	There will be an increase in the quality of materials	N
	Sensitive	There will be an increase in the quality of materials	N
MEASURE MENT	Wrong Measurement Position	The gauge will be adjusted	Y
	Inadequate Measuring Instruments	Measuring Instrument that are no longer suitable for use will be replaced or refurbished	N
METHODE	Procedures are Less Efficient	Update procedure every year	Y
	Employees don't Know Enough About SOP	SOP will be update with wprds that are easy for employees to undestand	N
MACHINE	The Machine and Adapter Lack Maintenance	Machine maintenance time will be increased	Y
	Too Much Air Pressure	The air pressure will be adjusted depending on the item	Y

B. Pareto Chart

Pareto chart is a quality control analysis tool in the form of blocks and graphs that illustrate the comparison of data. Pareto charts can be used to select problems to find out the most dominant main problems. By getting the most dominant main problem in product damage, it can be a further source of information to be further examined and prioritized with the aim of improving the highest level of damage. [3]

Pareto charts contain bar graphs and line graphs. Bar graphs show data classifications and values, while line graphs show cumulative amount of data. Data classification is sorted from left to right from highest rank to the lowest rank. [4]

The opinion of the author is that combining the Pareto chart and fishbone is more appropriate to apply to risk-based audits which find findings with a high risk level of more than five, so there is a need for priority mapping so that the audit process is more precise goals and risks are handled more quickly. [5]

Pareto diagrams are used to identify the dominant types of defects that occur in the production process. The bar graph shown in the pareto diagram presents the problems in order of occurrence. The table shows data on the type of defect, the amount of scrap and the percentage of the defect. The following is sample data for 3 months obtained by the author :

Table 2. Failure Sample Data By the Author

Part Of Defect	Unit	Percentage
Baseplate	196	41.61%
Pin	166	35.24%
Frame	52	11.04%
Rivet	39	8.28%
Terminal	15	3.18%
Lid	3	0.64%
Total	471	100.00%

Table 3. Failure Sample Data On the Pin By Author

Type Defect Pin	Unit	Percentage
Broken Pin	131	78.92%
Scratched Pin	12	7.23%
Short Pin	7	4.22%
Burnt Pin	5	3.01%
Incorrect Pin	4	2.41%
Silicone On Pin	3	1.81%
Long Pin	2	1.20%
Less Pin	1	0.60%
Glue On Pin	1	0.60%
Total	166	100.00%

Based on table 3 above, the pin is a part that experiences many failures after the baseplate. and in table 4 there are 9 types of defects on pins, the type of defect that often occurs in the last 3 months is broken pins with a total of 131 lots of defects (78.92%). Meanwhile, the types of defects with the fewest are less pin 1 lot (0.60%) and glue on pin 1 lot (0.60%). The total failure in the last 3 months was 166 lots. Figures 11 and 12 show the Pareto diagram of defect types, number of failures, percentages, and the most dominant causes of defects on pins.

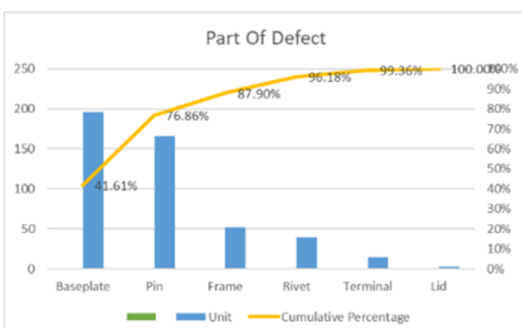

Figure 2. Pareto Chart Sample Data On Module Failure

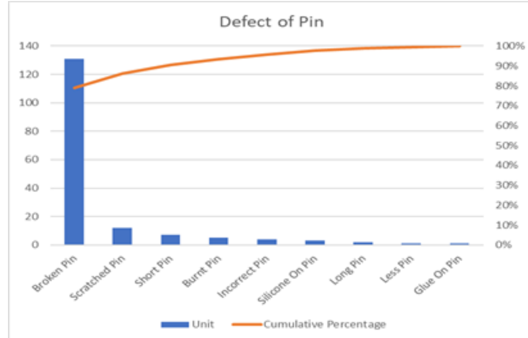

Figure 3. Pareto Chart Sample Data On Broken Pin Failure

Based on figure 12, the types of defects that occur the least are less pins and glue on pins with a percentage of 0.60%. Meanwhile, the most dominant type of defect that occurs in the production process is Broken Pin which is caused by various kinds of problems with a percentage of 78.92% of the total defects. This value is quite large so it must be overcome so that the production process can run smoothly and have good product quality. This condition shows that the control process carried out needs to be optimized considering that Broken Pin is included in the critical defect category. The results of this Pareto diagram analysis are used to determine top level events at the analysis stage using the FishBone method. Therefore, it is necessary to carry out further analysis using FishBone to find out the root of the problem, as well as proposed improvements so that the production process can be controlled and eliminate defective products.

C. Flow Chart

In completing the project "Broken Pin Defect Analysis on the Dual MC Cu Module in the EndTest Process Using the Fishbone and Pareto Chart Method", there are several stages required. The steps that need to be taken are as follows:

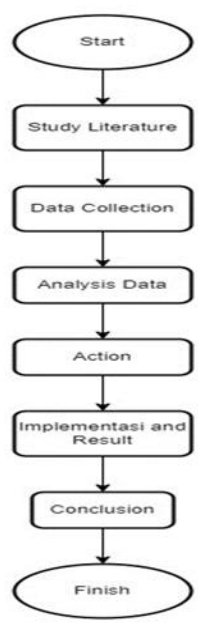

Figure 4. Flowchart Activity Analysis

A flowchart is a diagrammatic representation of steps to solving a given problem. Although it can also be used for other things such as the analysis of the problem or documentation of a process. [8] Here the writer uses a flowchart as an analysis for the activities to be carried out.

1. Study Literature

Study Literature is the initial phase in a research where researchers look for information related to the problem they want to research. This process includes searching for relevant library data, reading and reviewing the information found, taking notes, and analyzing the research materials that have been collected.

2. Data Collections

Data collection is an important stage in the research or decision-making process, because the quality of the data obtained will affect the validity and reliability of the analysis and conclusions produced. The collection of data on damaged pins is a summary of previous reject data, data collected from the first month of my internship and up to now the latest data. This data will be a reference to see whether the Fishbone diagram and Pareto diagram methods used are successful in reducing defects or not.

3. Analysis Data

The use of Pareto charts and fishbone diagrams was used in data analysis to identify the total number of broken pin failures as well as the main factors that had the most significant influence on broken pin failures in the EndTest process.

4. Action

After product analysis and pin fracture failure are obtained, action is then taken to minimize or even prevent failure. In this analysis, we will check the pin lever adapter, the wind pressure applied to the pin, and the position of the pin on the adapter.

5. Implementation and Result

Implementation related to pin break failure refers to concrete steps or actions taken in response to the problem. This includes changes implemented in the production process, use of better materials, design modifications, stricter maintenance, employee training, or other actions planned based on analysis and findings regarding the causes of pin breakage.The results of these implementations can then be evaluated to see whether they succeeded in reducing the incidence of pin breaks. This evaluation involves using measurement or monitoring methods to see whether the number of broken pins has decreased, whether improvements or actions taken have been effective, and whether there has been an improvement in overall performance or quality.

6. Conclusion

Pin breakage is a critical issue that significantly impacts the quality, reliability, and functionality of certain processes or products. In-depth analysis, utilizing Pareto charts and fishbone diagrams, has pinpointed specific factors such as excessive pressure, weaker materials, or fragile designs as contributors to pin fractures.To address this issue, a series of corrective actions were implemented during the analysis phase. These actions involved refining production processes, altering materials, revising designs, and enhancing maintenance and employee awareness. Post-implementation, there have been noticeable improvements. The incidents of broken pins have markedly decreased, indicating enhanced product quality and overall process reliability.

The success of these measures in mitigating pin breakage is evident. However, continuous efforts to sustain and enhance performance, along with vigilant monitoring of potential triggers for pin breakage, remain crucial for ensuring ongoing improvements and upholding superior product quality in the long run.

III. RESULT AND DISCUSSION

A. *Corrective Action*

Based on previous analytical observations, there are 3 errors that often result in broken pin failure, namely:

1. The machine and adapter lack maintenance
2. Wrong position when measuring the pin
3. Too much air pressure

These three errors are the errors that cause the greatest percentage of broken pin failures compared to other errors.

Table 5. Item Checking and Setting

Item Check and Setting	
1.	Adapter Pin
2.	Vacuum Pressure

Table 6 above is the check item and setting the item. Based on observations of broken pin failures after checking the pin adapter, it was found that in the pin holes in the adapter there was dirt such as dust, copper, pieces of broken pins.

So I took action to clean the holes using Iso Propyl Alcohol (IPA) and an Air Blow Gun. and after that I checked the air pressure on the adapter, if the pressure is right according to the standard and type of module then the adapter is ready for use but if the pressure is too weak or strong then the adapter should not be used and repair it immediately. After cleaning and checking the adapter, the adapter is then reinstalled and ready to be used.

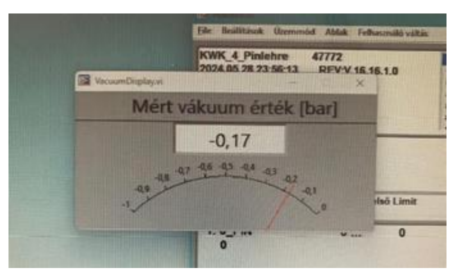

Figure 1. Vacuum Value for Dual Module

The image above is the vacuum pressure value for the Dual module. If the vacuum value is less than that or weak, it can cause measurement delays and make the module unreadable when the pin is installed on the adapter.

Meanwhile, if the vacuum value is more than that or is too strong, it can cause the module to be pulled and difficult to remove from the adapter, causing the pin to break when the module is removed. So if the vacuum pressure weakens or strengthens, immediately report it to the technician because I am not allowed to adjust the vacuum pressure myself.

The vacuum value has a tolerance if the value does not match the picture above. So the maximum tolerance is +10 and the minimum is -15 or -20 for Dual modules and ordinary operators cannot set this vacuum value, so if the vacuum value does not match the module, then the technician will set the vacuum value.

B. *Preventive Action*

In this sub-chapter the author will explain what preventive measures are taken to prevent the recurrence of broken pin failures.

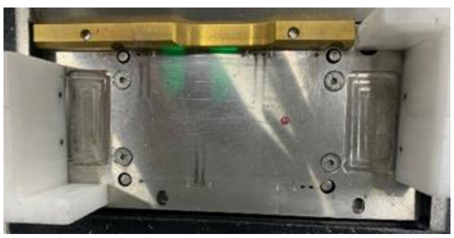

Figure 2. Dirty Adapter Image

If you look closely, there is dirt in the area around the pin adapter hole which can cause the pin to break. This dirt can clog the hole and cause the pin to be measured incorrectly so that the pin will break. Therefore, immediately clean and check the pin adapter. So here are the tools and materials for cleaning the pin adapter :

Table 6. Tools and Materials for Preventive Action

Tools and Materials	Description
Air Blow Gun	to spray air into the holes in the adapter so that traces of dirt or dust can be removed from the holes.
Iso Propyl Alcohol	to clean the hole from dirt after being sprayed by the air blow gun.
Corn Needle	to pry out dirt in the adapter hole that is difficult to remove.
Tissue	for final cleaning when ready to carry out all repairs and cleaning.

So preventive action is the answer to damage caused by wrong measuring meter position and too much air pressure so that the author can almost reduce the failure of broken pins.

C. *Research Result The Data*

The following are the results of before and after sample data sample after corrective action was taken by the author :

Table 7. Data Sample of Broken Pin Before and After

ECONO DUAL MODULE					
BEFORE			AFTER		
MONTH	WEEK	UNIT	MONTH	WEEK	UNIT
SEPTEMBER	1	15	JANUARI	1	4
	2	17		2	1
	3	9		3	2
	4	15		4	1
OKTOBER	1	12	FEBRUARI	1	2
	2	5		2	3
	3	10		3	0
	4	6		4	2
NOVEMBER	1	13	MARET	1	1
	2	15		2	2
	3	9		3	0
	4	5		4	1

Based on the table above, the author has carried out an analysis for approximately 6 months, namely 3 months to find the root of the problem and 3 months to make improvements and find solutions. If you look at the table, there was a lot of damage from broken pins, before there were 131 modules and after the author carried out preventive action and corrective action, the damage became only 19 modules.

1. Total Failure of the Pin (Before)

Table 8. Failure Sample Data On the Pin By Author (Before)

Type Defect Pin	Unit	Percentage
Broken Pin	131	78.92%
Scratched Pin	12	7.23%
Short Pin	7	4.22%
Burnt Pin	5	3.01%
Incorrect Pin	4	2.41%
Silicone On Pin	3	1.81%
Long Pin	2	1.20%
Less Pin	1	0.60%
Glue On Pin	1	0.60%
Total	166	100.00%

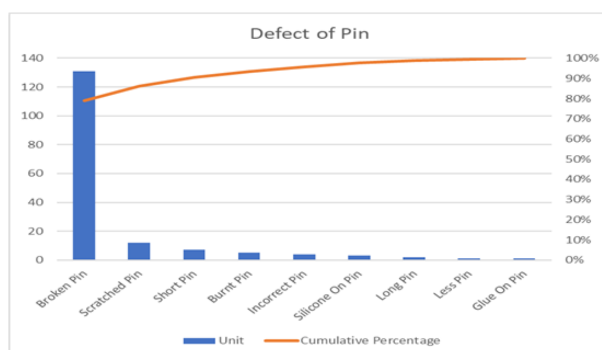

Figure 3. Pareto Chart Sample Data On Broken Pin Failure (Before)

Based on data from September to November in the table and Pareto diagram above, it is known that broken pins cause a bigger problem with pin failures, 78% more than other pin failures.

Defect Percentage Calculation Results Before Improvements :

$$\left(\frac{\textit{Defect Count Before Improvement}}{\textit{Total Unit Product}}\right) \times 100\ \%$$

Percentage Calculation Result :

(15 Load Material x 840 Unit) = 12.600 Unit
Percentage Before Improvement = 131/12.600 x 100 %
Percentage Before Improvement = (0,0103 x 100%)
Percentage Before Improvement = 1.03%
The defect percentage before improvement was 1.03% with a total of 12.600 unit.

2. Total Failure of the Pin (After)

Table 9. Failure Sample Data On the Pin By Author (After)

Type Defect Pin	Unit	Percentage
Broken Pin	19	29.23%
Scratched Pin	25	38.46%
Short Pin	5	7.69%
Burnt Pin	7	10.77%
Incorrect Pin	4	6.15%
Silicone On Pin	1	1.54%
Long Pin	1	1.54%
Less Pin	1	1.54%
Glue On Pin	2	3.08%
Total	65	100.00%

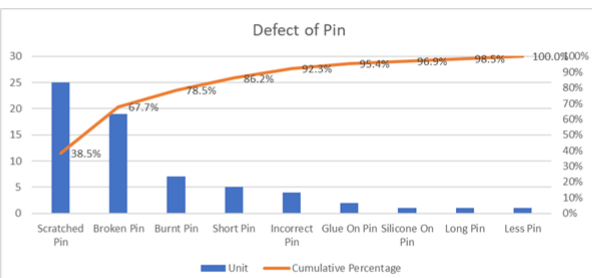

Figure 4. Pareto Chart Sample Data On Broken Pin Failure (After)

Percentage Calculation Results :

Defect Count Before Improvement - Defect Count After Improvement = Result Percentage

Reduced Percentage Of Defects = 78.92% - 29.23%
Reduced Percentage Of Defects = 49.06%

So the author reduced defect failure from 78.92% to 29.23%. So the results of the improvements made by this author to make failures lower are **(78.92% - 29.23%) = 49.06%**

Based on the author's post-repair results, data was collected from September to November for pre-repair failures and from January to March for post-repair performance. The author identified three main causes of broken pin failures: the machine and adapter lack maintenance, incorrect pin measurement positioning, and too much air pressure.

For corrective action, from January to March, the author organized and cleaned the machine items that caused pin damage. Since January, pin failures have significantly decreased, leading to less scrap. While pin failures haven't been completely eliminated, their frequency has been notably reduced.

IV. CONCLUSIONS AND SUGGESTIONS

A. *Conclusions*

Based on the analysis of the final assignment "Analysis of Broken Pin Defects on the Dual MC Cu Module in the EndTest Process Using the Fishbone and Pareto Chart Method at PT Infineon Technologies Cegled Hungary" the following conclusions can be drawn:

1. Pin fracture failure analysis using the Fishbone and Pareto Chart analysis methods is quite effective in determining the factors causing pin fracture failure, making it easier to carry out the analysis. The factor that causes the failure of the pin to break is the wrong measurement position on the pin adapter and the module which is caused by dirt blocking and clogging the hole in the adapter and causing the position to be incorrect, resulting in a broken pin.
2. With exams conducted by the company every three or four months for new and old employees, it also ensures that employees do not forget the work procedures that are carried out and employees can find out how important procedures are when working.
3. After carrying out corrective actions and preventive actions in the analysis of broken pin failures from January to now, broken pin failures have reduced and even in the third week of February and March no broken pin failures occurred (0%). Where two actions are taken, namely, the first is to find the root of the problem. After taking action to find the root cause of the problem, the author immediately takes corrective action.

Next, for the second action, namely corrective action by cleaning and carrying out maintenance on the pin adapter, after carrying out preventive action from January to March in the analysis of broken pin failures, the previous results showed that 131 were damaged and after taking action there were only 19 damaged. So that the data on damage caused to the pins is reduced and allows the company's production to increase.

B. *Suggestions*

The suggestions that the author gives to the company where the author is working on this final assignment are as follows:

1. To reduce the number of broken pin failures in products, checks and maintenance must be carried out on machines that have the potential to frequently cause product scrap.

2. It is important to check the machine parameters, so that there are no problems with broken pin failures or other failures.

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