Improvement Yield Production to Increase Productivity for Model Light-2

Final Project

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Abstract— Production yields one of the processes that need to control in manufacturer process to know the productivity of production. Production yield without control will negatively impact productivity and increase production costs. There are several reasons why production yield may not achieve the target, affecting costs due to elements such as Man, Method, Material, Machine, and Environment. To identify and address these issues, we will use the 4M+1E tools and capability statistics to analyse the problems and determine their origins and solutions. According to the analysis results using 4M+1E from the data (summary yield production, log data from the end-tester, component datasheets, schematics, and bench tests), we can identify the root causes of the problems. By comparing the data readings using distribution charts, we can determine the results. Based on the study of the manufacturing process using 4M+1E and capability statistics, it was concluded that the decrease in yield performance was caused by the machine test limit specification. Additionally, changing the machine test limit increased yield productivity, achieving a 99.99% success rate. This change was identified through an ECN and monitored over two months of production.

Keyword: Yield Production, Capability Statistics, ECN.

I. INTRODUCTION

Production is an important component responsible for creating products in a manufacturing setting, and various production types are employed by global manufacturers. The production assembly, the type selected for this project, involves creating products using manpower, materials, and machines. It is essential to control the quality and output during production to achieve the target output outlined in the schedule plan. However, during production, problems can arise due to many variables related to the 4M+1E factors [6].

Production yield aims to control production parameters, determining whether the yield meets the target. Initially, the yield target must be established in the early stages of production. Meet the yield target is essential for achieving company profits and ensuring good quality, which, in turn, has a positive impact on the company's rating and customer satisfaction.

Production yield is to control and monitoring production process at manufacturer, which is in the production yield have target to kept achieved. In this case production yield can't achieved the target due to defect occur at model Light-2 based on summary yield 2022. Average Passed yield is 96.52% and Rejected is 3.48%. effect for low production yield is low productivity and cost impact (Loss Scrap Increase) [8].

Based on current analysis low production is due to high value on the End-Tester which is based on FA analysis found PCBA resistor is high value compare with the OK units. And temporary do changed the component of PCBA (Resistor), but every month NG was increase.

Analysis had done before but can't solved the problem, decided to bring again this problem became as final project. And tools that use for analysis is 4M+1E and capability statistic. from those tools hope can give better solution for the problem happen. [4].

II. METHOD

Project carry out used the Yield production Monitoring, 4M Methodology and Capability Statistic.

Other than that, I use fishbone diagram which is this tool to find out the root cause of the problem happened. From this do the process mapping by using 4M+1E (Method, Machine, Material, Man & Environment) and Capability statistic.

A. Yield Production Monitoring

Yield Production refers to the effectiveness of a manufacturing process in producing acceptable products without defects. It is a key performance indicator that measures the proportion of good units produced out of the total units started in production. Yield production is essential for evaluating the efficiency and quality of the production process.

First Pass Yield (FPY):

- **Definition**: First Pass Yield (FPY) is the percentage of products that pass all quality inspections and tests without any rework or repair on the first test.
- **Calculation**: It is calculated by dividing the number of good units produced on the first attempt by the total

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number of units started in production, then multiplying by 100 to get a percentage.

- **Important**: FPY is an important metric as it indicates the effectiveness of the production process in producing defect-free products the first time through, which helps in reducing costs and increasing efficiency.

Last Pass Yield (LPY):

- **Definition**: Last Pass Yield (LPY) is the percentage of products that pass the final tests, including those that may have undergone rework or repair.
- **Calculation**: It is calculated by dividing the number of units that pass the final inspection by the total number of units started in production, then multiplying by 100 to get a percentage.
- **Important**: LPY provides a broader measure of the production process's effectiveness, accounting for the overall yield including any corrections or rework that were necessary to produce acceptable products.

B. Capability Statistics

Capability statistics are metrics used to evaluate how well a manufacturing process can produce products within specified limits or tolerances. These statistics provide insights into the process's ability to produce defect-free products consistently. They are critical for quality control and continuous improvement actions in manufacturing.

Tools for Capability Analysis:

1. Control Charts:

Control charts are graphical tools used to monitor the stability of a process time by time. They help identify trends, shifts, or any unusual variations in the process.

2. Histograms:

Histograms are bar charts that represent the frequency distribution of data. They help visualize the spread and central tendency of the data, indicating how well the process meets specifications.

3. Pareto Charts:

Pareto charts identify the most significant factors contributing to a problem using the Pareto principle (80/20 rule). They help prioritize areas for improvement.

4. Process Capability Plots:

Process capability index (Cp, CPK, Pp, PPK) along with the process data and specification limits. They provide a visual representation of the process performance.

5. Fishbone Diagrams (Ishikawa):

Fishbone diagrams identify potential causes of problems by categorizing them into major factors (Man, Machine, Method, Material, Environment). They help in root cause analysis.

6. 4M+1E Analysis:

This method analyzes factors such as Man, Machine, Method, Material, and Environment to identify and address issues affecting process capability.

C. Engineering Change Notice (ECN):

Engineering Change Notice (ECN) is a formal document used to propose, describe, and implement changes to a product or system's design, parts, materials, specifications, or production processes. The ECN process is crucial for maintaining product quality, compliance, and continuous improvement in manufacturing and engineering.

D. Data Collection

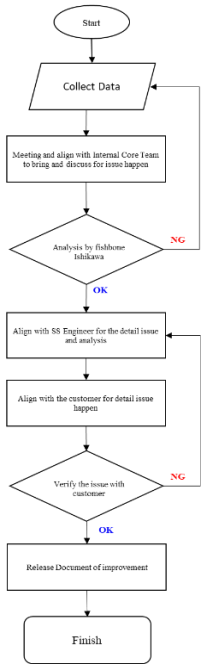

Figure 1. Flow Chart of Project

The established process plan includes a flowchart, which will also be used for the fishbone diagram. The flowchart provides an overview of the process from start to finish, outlining each step to be followed for this project.

III. RESULTS AND DISCUSSION

1. Production Yield

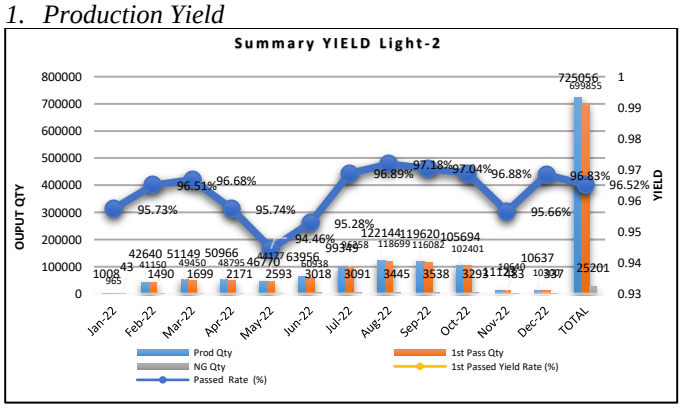

Figure 2. Pareto Chart Production Yield

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Pareto chart data helps to discern the details of what transpired on the production line. By analyzing graphs or Pareto charts, one can understand the production output, Pass Qty, and NG Qty, enabling the calculation of Pass % and Reject %. As evident in the Pareto chart, the average Pass rate is only 96.50%, with a Reject rate of approximately 3.5% [6 & 9].

TABLE I
PRODUCTION YIELD DATA

Month	Prod Output	1st Pass Output	NG Qty	Pass Yield	NG Rate
Jan	1008	965	43	95.73 %	43%
Feb	42640	41150	1490	96.51%	3.5%
Mar	51149	49450	1699	96.68%	3.3%
Apr	50966	48795	2171	95.74%	4.3%
May	46770	44177	2593	94.46%	5.5%
Aug	122144	118699	3445	97.18%	2.8%
Sep	119620	116082	3538	97.04%	3.0%
Oct	105694	102401	3293	96.88%	3.1%
Nov	11123	10640	483	95.66%	4.3%
Dec	10637	10300	337	96.83%	3.2%
Total	**725056**	**699855**	**25201**	**96.52%**	**3.5%**

2. Distribution & Box Plot data Production data

The second step in data collection is to obtain details based on summary data, which revealed that NG failures occurred in the End-Tester for ID.3 Check Pin. Distribution data and box plots were generated to examine the value readings from the log data of the End-Tester. The readings indicated values exceeding the upper limit specification. The ID.3 specification sets the Lower Specification Limit (LSL) at 1.63V and the Upper Specification Limit (USL) at 1.67V. The readings show a marginal deviation, slightly exceeding

the upper limit, based on sampling data from 526 DUTs, including both OK and NG units.

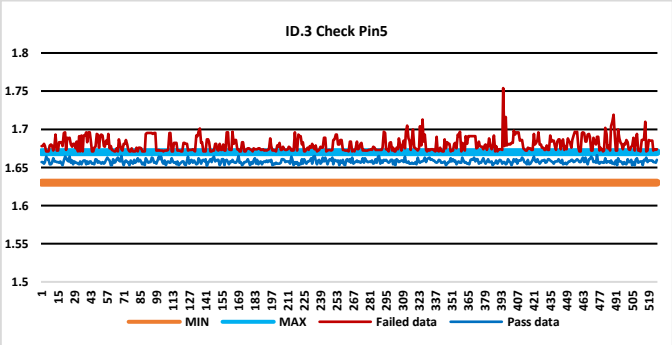

Figure 3. Distribution Chart Production Data

The distribution diagram DUT OK and NG data from a sampling of 526 DUTs. According to the distribution diagram and box plot readings, the DUT NG borderline exceeds the upper limit spec.

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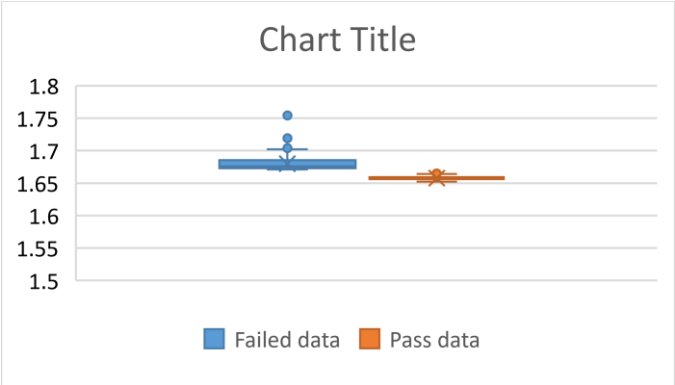

Figure 4. Box Plot data Production data

The Box Plot diagram DUT OK and NG data from a sampling of 526 DUTs. According to the distribution diagram and box plot readings, the DUT NG borderline exceeds the upper limit spec.
Histogram and Box Plot diagram can use for analysis data to see the differences between OK and NG data.

A. Analysis

1. Analysis (Fishbone Diagram)

Based on the collected data, a problem was identified in the End Tester process, where testing failed on ID3.CheckPin5. Further analysis is needed using the 4M+1E approach to identify the root cause.

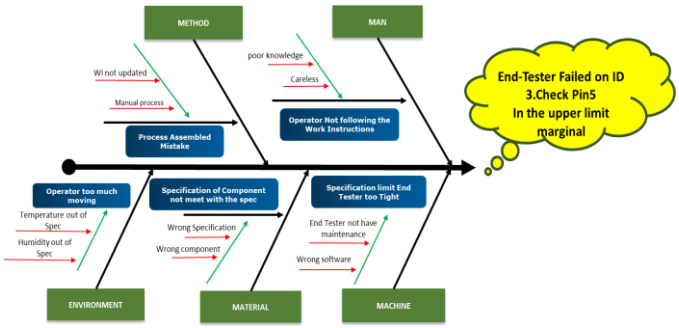

Figure 5. Fishbone Diagram

After finishing the mapping using the fishbone diagram, the next step is to verify the possible causes. The purpose is to identify which possible causes have a higher frequency, allowing us to focus more on determining the most significant cause for this problem. Based on the table and Pareto chart, it is indicated that the two most probable causes have frequencies.

exceeding 40% (Refer to internal document). The first one is the specification of the component does not meet the required specifications (57%), and the second one is the specification limit of the End Tester too tight (75%).

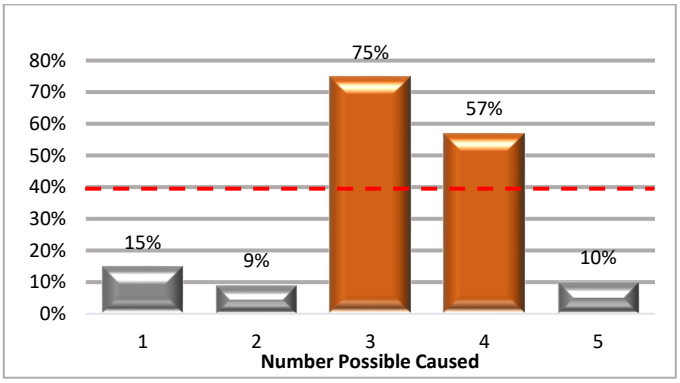

Figure 6. Pareto of Verification Possible Caused

The frequency of possible causes is identified on a scale of 1-100 occurrences, indicating that possible causes have been identified at various times. Based on the occurrence percentage, two of them meet the target outlined in the internal document, with a specification exceeding 40%.

TABLE II
POSSIBLE CAUSED ACCORDING TO FISHBONE DIAGRAM

No	Possible Caused	Frequency	%	Remarks
1	Operator Not Following the Work Instructions	15	15%	Not verified
2	Process Assembled Mistake	9	9%	Not verified
3	Specification limit End Tester too Tight	75	75%	Verified
4	Specification of Component does not meet with the spec	57	57%	Verified
5	Operator too much moving	10	10%	Not verified

2. Analysis (Material)

The first step involves checking and validating the material, as the frequency of occurrence for the material issue is 57%. To investigate the connection of this problem with the material, the initial step is to check and refer to the schematic of the PCBA. Based on the schematic, the issue with ID.3 CheckPin5 is affecting the connection to the PCBA component, specifically the (R3) resistor component.

To validate the status of the material as either OK or NG, a thorough examination involving visual inspections, X-Ray scans, and offline tests with a Multimeter is conducted. The objective is to ensure the integrity of PCBA components by checking for issues such as component breakage, solder non-wetting, and compliance with specified criteria. Following visual inspections through a microscope and X-Ray scans, along with the examination of resistor components using a Multimeter, no anomalies were detected. Furthermore, the results of soldering were deemed acceptable in accordance with IPC A-610 Class-2 standards [9].

According to Table IV highlight the difference of both DUT OK and NG. which is to analysis by comparison 10 DUT and individual resistor measurement between OK and NG units. based on the result 10 DUT NG is slightly higher borderline on upper of limit, and for the resistor value between OK and NG samples still within of specification accordance data sheet provided by supplier [7].

TABLE III
COMPARISON OK & NG (RESISTOR AND DUT)

No	Unit OK		Unit NG	
	R3 (kΩ)	Reading ET (1.63~1.67)	R3 (kΩ)	Reading ET (1.63~1.67)
1	2.202	1.661	2.276	1.686
2	2.191	1.656	2.238	1.672
3	2.196	1.657	2.262	1.681
4	2.194	1.656	2.288	1.690
5	2.195	1.656	2.238	1.673
6	2.187	1.654	2.251	1.677
7	2.193	1.655	2.254	1.677
8	2.196	1.657	2.295	1.692
9	2.193	1.655	2.259	1.681
10	2.197	1.657	2.237	1.672

In BOM provided customer mentioned that description of component R3 is **RMPC16-222 J TP.** Refer to the datasheet component specification is 2.2kohm +/- 5%. Which is LSL: 2090 ohm & USL 2310 ohm.

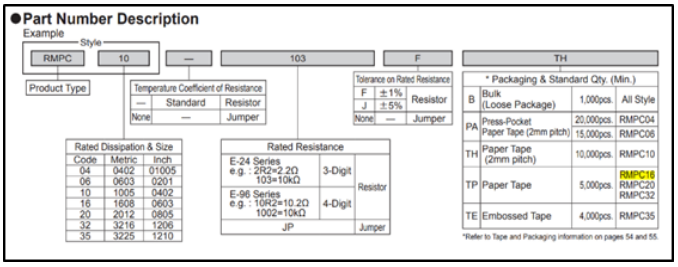

Figure 7. Data sheet Component

3. Analysis (Machine)

The second step involves checking and validating the machine (2 End tester), as the frequency of occurrence for the machine issue is 75%. To investigate the connection of this problem with the machine, the initial step is to check and refer to the schematic of the End tester. Based on customer suggestion to do maintenance on the End-Tester to make sure condition of Tester in good condition.

The maintenance there is some changing for consumable parts, is like pin probe and connector. Which those parts are included in list changing for the maintenance period and for other items is only check that the condition is still follow the specification.

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According to the analysis Table V having comparison 20 DUT before and after maintenance, which is there is 20 units DUT for comparable between before and after maintenance, based on the results DUT within of specification and there is not a big difference reading value. Look at the distribution charts also there is not a big difference, purpose of distribution charts is to make easy look on the data, which is before and after all are within the specification for both ET No.1 and ET No.2 [10].

TABLE IV
COMPARISON DUT BEFORE AND AFTER MAINTENANCE

No	End Tester 1		End Tester 2	
	Before Maintenance	After Maintenance	Before Maintenance	After Maintenance
1	1.660	1.658	1.658	1.656
2	1.659	1.658	1.658	1.657
3	1.659	1.658	1.658	1.658
4	1.659	1.658	1.659	1.658
5	1.660	1.658	1.657	1.657
6	1.659	1.658	1.658	1.658
7	1.659	1.657	1.659	1.658
8	1.659	1.657	1.657	1.658
9	1.658	1.657	1.656	1.658
10	1.659	1.657	1.659	1.660
11	1.659	1.657	1.658	1.658
12	1.658	1.657	1.659	1.658
13	1.659	1.657	1.657	1.658
14	1.658	1.657	1.658	1.658
15	1.658	1.657	1.658	1.658
16	1.658	1.656	1.658	1.658
17	1.658	1.657	1.659	1.658
18	1.658	1.655	1.658	1.658
19	1.658	1.658	1.658	1.658
20	1.658	1.657	1.658	1.658

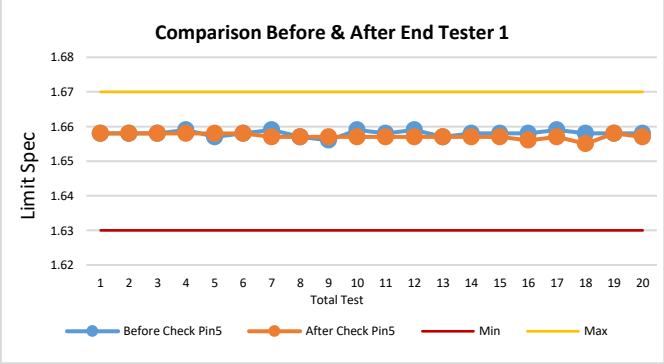


Figure 8. Distribution Chart Comparison ET-1

The distribution chart comparison before and after maintenance from End Tester No.1, result indicated that not much different between before and after. However, the maintenance needs to be done periodically according to the schedule of maintenance.

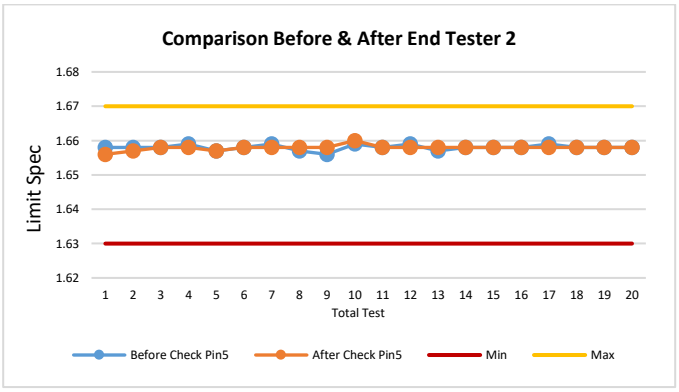


Figure 9. Distribution Chart Comparison ET-2

The distribution chart comparison before and after maintenance from End Tester No.2, result indicated that not much different between before and after. However, the maintenance needs to be done periodically according to the schedule of maintenance.

To further deep analysis to do bench test to comparison result of reading between End Tester and Bench Test. Based on the bench test result found a small difference value.

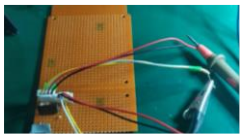
Processs	Picture Process	Remark
1. Collect 30 Unit After Test from End Tester	--	
2. Insert DUT to Prototype of Bench JIG test		--
3. Give Power Input 3.3V to Power Input Circuit		PSU INPUT : 3.3VDC 1A MULTIMETER : 3.3041V
4. Collect Voltage Value from multimeter		--

Figure 10. Work Instruction process of Bench testing

According to the analysis table V, the customer requested a bench test. The figure no. 10 is a table matrix used to validate the results of the End tester. The objective is to compare the data from the End tester with the data from the bench test through three looping of the test.

In Addition, bench test with 3 times looping, the purpose is to see the consistency of test using bench test, make sure there is no data jump out of specification between 1st test until 3rd test, to show the data reading can refer to the distribution charts which is reading is consistent.

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TABLE V
COMPARISON END TESTER & BENCH TESTING RESULTS

No	End Tester Results	Bench Testing Results		
		1st Testing	2nd Testing	3rd Testing
1	1.655	1.649	1.649	1.649
2	1.657	1.650	1.649	1.650
3	1.660	1.654	1.654	1.655
4	1.654	1.647	1.647	1.647
5	1.666	1.659	1.658	1.659
6	1.656	1.650	1.650	1.650
7	1.654	1.647	1.647	1.647
8	1.659	1.651	1.652	1.652
9	1.657	1.650	1.650	1.659
10	1.657	1.659	1.659	1.659
11	1.666	1.659	1.659	1.659
12	1.653	1.650	1.646	1.646
13	1.658	1.650	1.651	1.651
14	1.666	1.653	1.654	1.654
15	1.666	1.653	1.653	1.653
16	1.659	1.653	1.653	1.653
17	1.662	1.655	1.655	1.655
18	1.655	1.649	1.649	1.649
19	1.658	1.651	1.651	1.651
20	1.663	1.653	1.656	1.656
21	1.658	1.651	1.652	1.652
22	1.662	1.655	1.656	1.656
23	1.666	1.653	1.653	1.653
24	1.658	1.651	1.651	1.651
25	1.661	1.654	1.648	1.654
26	1.656	1.650	1.650	1.650
27	1.662	1.655	1.656	1.655
28	1.666	1.648	1.661	1.666
29	1.659	1.652	1.652	1.652
30	1.658	1.651	1.651	1.651

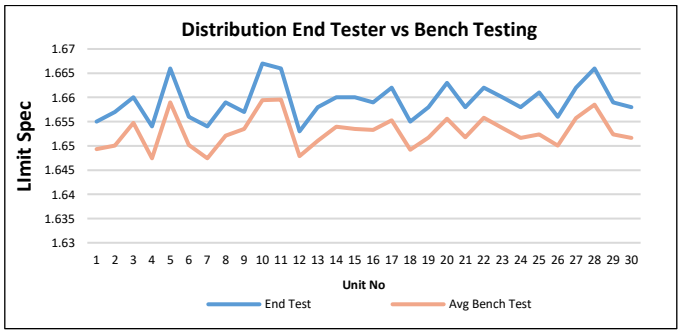

Figure 11. Distribution charts comparison ET & BT

To visualize the differences between the End tester results and Bench test results, create distribution charts comparisons. Based on the analysis, there is a small offset in the End tester, with slightly higher voltage readings compared to the bench testing.

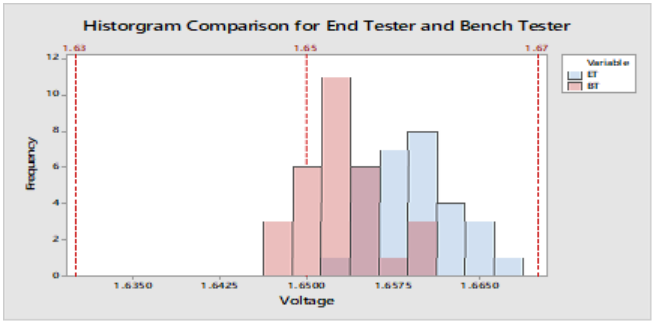

Figure 12. Histogram Comparison

To visualize the differences between the End tester results and Bench test results, create histogram charts comparisons. Based on the analysis, there is a small offset in the End tester, with slightly higher voltage readings compared to the bench testing.

B. Result

1. Production Result after implementation change limit End Tester

Based on the detailed result analysis already review and confirm that in End tester have slightly higher voltage reading compared to bench tester. Due to the configuration of DC supply at End tester improvement is decided to open the test limit to improve productivity at production. To carry out the process change customer will issue ECN.

ECN to carry out the process changes, based on the ECN document the test limit before is 1.63~1.67 after 1.63~1.70.

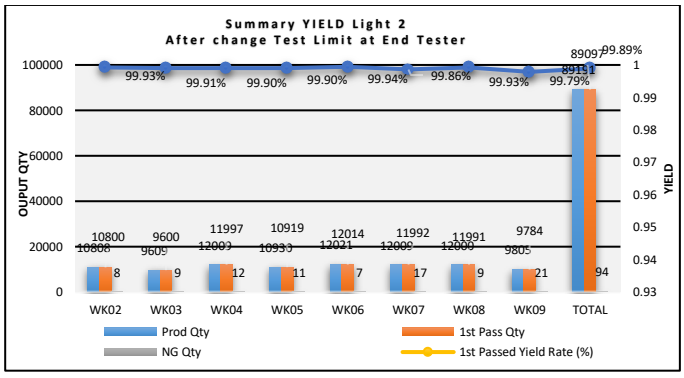

Figure 12. Pareto Chart Production Yield After Improvement

According to the yield monitoring for 2 months, the result of yield was increased before 96.50% then after 99.89% indicated on pareto graph above show from WK02-WK09.

TABLE VI
PRODUCTION YIELD DATA AFTER IMPROVEMENT

Week	Prod Output	1st Pass Output	NG Qty	Pass Yield	NG Rate
02	10808	10800	8	99.93 %	0.07%
03	9609	9600	9	99.91%	0.09%
04	12009	11997	12	99.90%	0.10%
05	10930	10919	11	99.90%	0.10%
06	12021	12014	7	99.94%	0.06%
07	12009	11992	17	99.86%	0.14%
08	12000	11991	9	99.93%	0.08%
09	9805	9784	21	99.79%	0.21%
Total	**89191**	**89097**	**94**	**99.89%**	**0.11%**

IV. CONCLUSION

Based on the Production yield monitoring and analysis using fishbone diagram that has been done, concluded for the obtained testing limits changed it able to improve the productivity. Following on distribution of charts and CPK data from 526 population data, pass data before and after implement ECN the CPK value is >1.33, Which is from population pass data before value on 1.47, which is after implement ECN can achieve better value on 3.35. Implement the new test limit on the End-Tester and monitoring for 2 months production, result of production yield has increased. before change the test limit, the pass yield was 96.50% and reject yield was 3.5% after change the test limit at End Tester, production yield increased to 99.89% and reject yield decrease to 0.11%. the improvement in yield on this project is **3.39%** so productivity can increase and scrap cost also lower due to decrease in rejection [4, 6, 7, 9].

REFERENCES

[1] "KPI (Key performance indicators for manufacturing operations management in the process industry)." Accessed: Feb. 20, 2024. [Online]. Available: https://www.researchgate.net/publication/323131190_Key_performance_indicators_for_manufacturing_operations_management_in_the_process_industry

[2] Prof. Dr. Bakr M. Rabeeh, "Failure Analysis of Mechanical Components Lecture No. 12;", pp 1-3, 2016-2017.

[3] Krzysztof Knop* and Krzysztof Mielczarek, "Using 5W-1H and 4M Methods to Analyze and Solve the Problem with the Visual Inspection Process – case study", *12th International Conference Quality Production Improvement – QPI 2018*, vol. 183, pp. 2-5, 31-July-2018.

[4] "ECN (Engineering Change Notice)" Accessed: May. 15, 2024. [online]. Available: https://mae.ufl.edu/designlab/Lab%20Assignments/EML2322L-Engineering%20Change%20Notice.pdf

[5] IPC-JSTD-001 (Requirement for soldered Electrical and Electronic Assemblies) https://www.ipc.org/, pp. 6-8 "1.13.1.1.1 Temperature" [19 Dec 2023)

[6] "Yield Monitoring and Mapping | Wiley." Accessed: Jun. 07, 2024. [online]. Available: https://acsess.onlinelibrary.wiley.com/doi/epdf/10.2134/precisionagbasics.2016.0089

[7] Md. Golam Mohiuddin, "Production Management," *Production Management*, pp.27-37, Jan. 2024, DOI:10.4324/9781003289050-4.

[8] Datasheet Component RMPC16-222JTP, http://www.kamaya.co.jp/, [21 Dec 2023]

[9] "Yield Analysis and Optimization | ResearchGate." Accessed: May. 07, 2024. [online]. Available: https://www.researchgate.net/publication/228479032_Yield_Analysis_and_Optimization

[10] IPC-A-610 (Acceptability of Electronic Assemblies) https://www.ipc.org/, pp. 53-72 "Soldering Acceptability Requirements" & pp. 161-173 "7 Through-Hole Technology" [19 Dec 2023]

[11] Peihua Qiu, CHAPMAN & HALL/CRC Texts in Statistical Science Series, "Introduction to Statistical Process Control", pp. 105-109, 26-Mar-2024

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