ANALYSIS OF V-CHECK DEFECTS IN THE FINAL INSPECTION PROCESS

Final Project

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2026

STATEMENT OF AUTHENTICITY OF FINAL PROJECT

I, the undersigned, certify that the contents of part or all of my Final Project entitled: " Analysis of V-Check Defects in the Final Inspection Process " is my **own work, completed without the use of materials that are not permitted,** and **is not the work of other parties which I acknowledge as my own work.** All references cited or referred to have been written in full in the bibliography. If it turns out that my statement is not true, I am willing to accept sanctions in accordance with applicable regulations.

Batam, 29 July 2026

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Approval sheet

The Final Project Proposal is structured to fulfill one of the requirements for obtaining a degree
Bachelor of Associate Engineer (AMd.T.)
in
Batam State Polytechnic

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ANALYSIS OF V-CHECK DEFECTS IN THE FINAL INSPECTION PROCESS

Abstract

Product quality is a critical factor in maintaining customer satisfaction and improving company competitiveness. In the final inspection process, a V-check alarm detected by Camera 7 indicates defects that reduce inspection efficiency and machine performance.

This study aims to identify the root causes of V-check defects and propose improvements to reduce defect rates. The methods used include defect data collection, root cause analysis using 7 QC tools, fishbone diagram analysis, and improvement testing through lighting optimization and camera parameter adjustment.

The results show that defects are categorized into false defects and true defects. False defects are mainly caused by improper camera settings and insufficient lighting, while true defects are caused by unclear product markings such as gray color, unclear codes, and incorrect polarity orientation.

After implementing improvements, the defect rate decreased significantly, indicating that lighting optimization and camera calibration are effective in improving inspection performance.

KSeywords: Defect Reduction, Camera Calibration, Final Inspection, Root Cause Analysis

Foreword

All praise and thanks go to God Almighty who has given His mercy and grace so that the writer can complete this Final Project Report entitled "Analysis defects v-check in camera 7 on final inspection machine". This Final Project Report is prepared to fulfill one of the requirements for obtaining a Bachelor of Associate Engineer (AMd.T.) Degree in Manufacturing Electronics Engineering Study Program at the Batam State Polytechnic.

The preparation of this final project report, of course, could not be separated from the direction and guidance of various parties. Therefore, the authors express respect and gratitude to all those who have helped me in the process of working on this final project:

1. To families who provide support in the form of enthusiasm and material support.
2. Mr. Ahmad Riyad Firdaus, S.Si, MT, Ph.D as Deputy Director of Academic Affairs at Batam State Polytechnic.
3. Mr. Muhammad Arifin, S.Si., M.Sc. as Chair of the Manufacturing Electronics Engineering Study Program at the Batam State Polytechnic.
4. Mr. Vivin Octowinandi, S.Tr.T., M.Sc as the Advisor who has provided a lot of input and guidance in completing this proposal.
5. Mrs. Widya Rika Puspita, S.Pd., M.Si., Ph.D. as Industrial Internship Coordinator for the Electronics Manufacturing Engineering Program at Batam State Polytechnic.
6. Mr. Budiana, S.Si., M.Si as Faculty Advisor
7. All Lecturers of the Batam State Polytechnic Electrical Engineering Department who have provided knowledge during lectures.
8. Management of PT. Panasonic Industrial Device Batam which has provided the opportunity for the author to conduct research.
9. Mr. Yuliyanto, S.T. was the Maintenance Engineering Manager Capacitor Department at PT. Panasonic Industrial Device Batam.
10. Mr. Hermanto Sembiring Leader of Electrical Engineering has guided the author while collecting data at PT. Panasonic Industrial Device Batam.
11. To classmates from college majors who have been together until graduation.
12. Mr. Ibrahim as a mentor who has shared a lot of knowledge during the internship.
13. All parties that the author has not mentioned who have helped and provided support in completing this Final Project Report.

The author realizes that there are still deficiencies in the writing, preparation, and production of this Final Project Report, therefore the author hopes for criticism and suggestions for improvement in the future. Thus, the author compiled this Final Report as well as possible, hopefully, it can bring benefits to all parties, especially the writer.

Batam, 12 January 2026

Reza Danuarta.

Analysis of V-check Defect in the Final Inspection Process

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Received on dd-mm-yyyy | *Revised on dd-mm-yyyy* | *Accepted on dd-mm-yyyy*

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The Final Inspection process plays a critical role in ensuring that electronic components meet quality standards before shipment. At PT Panasonic Industrial Devices Batam, Camera 7 frequently generated false defect detections during the V-check inspection process, resulting in unnecessary product rejection and reduced inspection efficiency [1], [2].

This study aims to identify the root causes of V-check defects and evaluate the effectiveness of corrective actions in improving inspection performance. A combination of qualitative and quantitative approaches was employed through direct observation, historical production data analysis, Fishbone Diagram, Root Cause Analysis (RCA), and inspection performance evaluation. The analysis identified inappropriate camera parameter settings and unstable lighting conditions as the primary causes of false defect detection. Corrective actions included product code registration, camera parameter optimization, camera recalibration, and the installation of a black cover to improve lighting stability [3], [4].

Experimental results showed that inspection accuracy increased from *78% to 95%* after register code optimization and from *77% to 93%* after lighting improvement. In addition, the number of V-check defects decreased from *14,246 to 5,252 units* in the first experiment and from *13,800 to 3,011 units* in the second experiment. Furthermore, the *Defect Performance Rate* decreased from *97.2% to 77.2%* and from *88.8% to 69.8%*, indicating a significant reduction in false defect occurrences after implementing the proposed corrective actions. These findings demonstrate that optimizing camera parameters and lighting conditions effectively improves inspection reliability, minimizes false defect detection, and enhances the overall stability of the Final Inspection process. [5], [6].

Keywords—Final Inspection, Machine Vision, V-check Defect, Root Cause Analysis, Fishbone Diagram, Defect Performance Rate.

II. Introduction

In Product quality has become one of the primary competitive factors in modern manufacturing industries because it directly influences customer satisfaction, production efficiency, and company profitability. The rapid development of automated inspection technology has encouraged manufacturing companies to adopt machine vision systems capable of inspecting products accurately and consistently without depending entirely on manual inspection. Compared with conventional inspection methods, automated visual inspection offers higher speed, repeatability, and reliability while minimizing human errors during the production process [1], [2].

PT Panasonic Industrial Devices Batam is one of the leading manufacturers of electronic components, producing capacitors, resistors, and inductors for consumer electronics and automotive applications. To ensure that every product complies with quality standards, the company employs an automated Final Inspection system equipped with machine vision technology. In this process, Camera 7 performs visual inspections by evaluating product markings, identification codes, polarity orientation, and other visual characteristics before products are released to the next manufacturing stage [3], [7].

Although machine vision technology significantly improves inspection efficiency, its performance strongly depends on several operational factors, including camera calibration, image processing parameters, illumination quality, and environmental conditions. Any deviation in these parameters may cause the inspection system to incorrectly classify acceptable products as defective or fail to detect actual defects. Consequently, inspection accuracy decreases, leading to increased production losses and lower machine effectiveness [4], [8].

During the period from September to November 2025, the Final Inspection machine experienced a substantial increase in V-check defects generated by Camera 7. These defects negatively affected production performance because many products were rejected despite meeting quality specifications. The excessive number of false defect alarms also increased operator workload, prolonged re-inspection activities, reduced production throughput, and decreased Overall Equipment Effectiveness (OEE). This situation demonstrates that improving machine vision performance is essential for maintaining production stability and achieving manufacturing targets [5], [9].

Previous studies have reported that inspection accuracy in machine vision systems is influenced by multiple interacting factors, including sensor sensitivity, lighting intensity, image contrast, camera positioning, and algorithm configuration. Systematic identification of these contributing factors is therefore necessary before effective corrective actions can be implemented. Among various quality improvement tools, the Fishbone Diagram (Ishikawa Diagram) is widely recognized as an effective approach for identifying and categorizing root causes of manufacturing problems involving human, machine, method, material, environment, and management factors [6], [10].

Based on these considerations, this research analyzes the dominant causes of V-check defects occurring in the Final Inspection process using the Fishbone Diagram and Root Cause Analysis (RCA). Furthermore, corrective actions involving optimization of vision processing parameters, camera recalibration, and lighting improvement are evaluated to determine their effectiveness in reducing false defects and enhancing machine vision performance. The findings of this research are expected to provide practical recommendations for improving inspection reliability, reducing unnecessary product rejection, and increasing production efficiency in automated manufacturing systems [3], [5], [10].

III. Method

This study employed an applied research approach to investigate the root causes of V-check defects occurring during the final inspection process at PT Panasonic Industrial Devices Batam. The research combined qualitative and quantitative methods to obtain comprehensive information regarding defect occurrence and machine performance. [3], [6], [10].

The overall research methodology consisted of four main stages: problem identification, data collection, root cause analysis, implementation of corrective actions, and evaluation of improvement effectiveness. The workflow was designed to ensure that every improvement activity was based on actual production data and validated through measurable inspection performance indicators [1], [5], [11].

In this study, Performance Rate refers to the Defect Performance Rate, which measures the proportion of products identified as inspection defects during the Final Inspection process. Unlike the Performance component in the Overall Equipment Effectiveness (OEE) framework, lower values of this indicator represent better inspection performance because they indicate fewer false defect detections [6], [10].

A. Process Flow

The research flow adopted in this study is illustrated in *Figure 1*. The process began by identifying the increasing number of V-check defects detected by Camera 7 during the final inspection process. Historical defect data and direct observations were subsequently collected to determine the characteristics of inspection failures. Root Cause Analysis using the Fishbone Diagram was then conducted to classify possible causes into six major categories: Man, Machine, Method, Material, Environment, and Management. Based on the identified dominant causes, corrective actions involving camera parameter optimization and lighting improvement were implemented. Finally, inspection performance before and after improvement was evaluated using defect data and Overall Equipment Effectiveness (OEE) indicators [5], [6], [10].

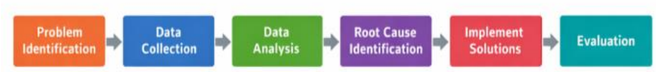

Figure 1. Flowchart

B. Fishbone Diagram

The Root Cause Analysis (RCA) was carried out using the Fishbone Diagram, also known as the Ishikawa Diagram. This analytical method systematically classifies potential causes of a problem into several major categories, enabling researchers to identify the dominant factors affecting machine performance. Compared with conventional troubleshooting approaches, the Fishbone Diagram provides a structured visualization of cause-and-effect relationships and facilitates collaborative discussion among engineers and production personnel [6], [10].

No.	**Potential Root Cause**	**Current Control/ Validasi**	**Root Cause Y / N**
1. Man	1. The operator did not follow work procedures.	1. procedures available on every machine.	N
	2. Human error during machine setup	2. Operators rarely perform SOP setup of the machine before running	N
2. Machine i	1. Brightness and contrast are not suitable on the product	1. parameters do not meet the product criteria, so the camera cannot detect properly.	Y
	2. Inadequate machine calibration	2. Every time cleaning and changing lots are done, the camera sensor is calibrated.	N
	3. Lighting on the final inspection product	3. lack of lighting on components passing through camera 7	Y

3. Method	1. Complex inspection procedures	1. lack of operator literature regarding the procedure	N
	2. Ineffective sampling inspection	2. Insufficient sampling during the final inspection process	N
4. Material	1.Dust contaminated material	1.Dusty material from the molding machine	N
	2.Material condition is not good	2.poor resin quality	N
5.Environment	1.Insufficient lighting	1.lighting in the machine area is lacking	N
	2.Limited Inspection Space	2.sufficient and adequate work area for operators	N
6.Management	1.Lack of supervision from PA Production	1.Loose supervision of operators and machines	N
	2.poor preventive maintenance planning	2. Routine and well-planned maintenance planning	N

Table 1. Fishbone Validation

The analysis indicated that Machine and Environment contributed most significantly to V-check defects. Incorrect brightness and contrast parameters reduced the ability of Camera 7 to distinguish product markings, while inadequate lighting generated reflections and inconsistent image contrast. Consequently, these conditions increased the occurrence of false defects during the inspection process [3], [4], [5].

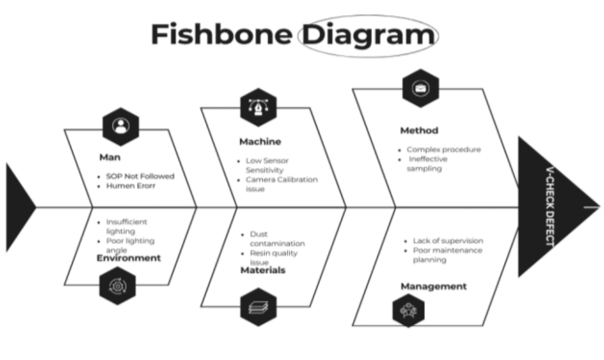

Figure 2. Fishbone Diagram

C. *Improvement Implementation*

Following the Fishbone analysis, two corrective actions were implemented to eliminate the dominant causes of V-check defects.

No.	**Potential Root Couse**	**Correctives Action**
1. Machine	1. Adjusting the brightness parameters and codes according to product standards.	1. Entering the brightness parameter with the correct value of 40 Hz and registering the code on the product according to the product's needs.
	2. Lighting on the final inspection product at camera 7	2.Increasing the lighting on the final inspection product at camera 7 by adding a cover and coating it with black stickers. Before using the cover, the incoming light was 20 Hz; after installing the cover coated with black stickers, the incoming light is 40 Hz and more focused on the capacitor product.

Table 2. Corrective Action

The first improvement involved optimizing the vision processing parameters stored in the Camera 7 controller. Brightness, contrast, image threshold, and product registration parameters were adjusted according to the actual product specifications. Camera recalibration was then performed to improve image recognition accuracy and reduce incorrect rejection caused by parameter mismatch [3], [5].

The second improvement focused on optimizing the lighting system around Camera 7. Increasing the lighting on the final inspection product at camera 7 by adding a cover and coating it with black stickers. Before using the cover, the incoming light was 20 Hz; after installing the cover coated with black stickers, the incoming light is 40 Hz and more focused on the capacitor product. A black cover and black sticker were installed to minimize excessive light reflection entering the camera sensor. These modifications improved image contrast, reduced glare, and enabled the camera to distinguish product markings more consistently. After implementation, the inspection system exhibited improved stability and a considerable reduction in false defect occurrences [4], [5].

D. Performance Rate Analysis (OEE Perspective)

To evaluate the effectiveness of the implemented improvements, machine performance was assessed using the Overall Equipment Effectiveness (OEE) method. OEE is one of the most widely used performance indicators for measuring manufacturing productivity because it combines machine availability, operational performance, and product quality into a single evaluation metric [1], [9], [12].

The Performance Rate was selected as the primary indicator because V-check defects mainly influence inspection throughput and production efficiency.

The theoretical production quantity was calculated using

$$Theoretical\ Production = \frac{Operating\ Time}{Cycle\ Time}$$

The Performance Rate was determined by

$$Performance = \frac{Actual\ Production\ Output}{Theoretical\ Production} \times 100\%$$

where:

- Operating Time = actual machine operating time (seconds)
- Cycle Time = standard inspection cycle time (seconds/product)
- Actual Production Output = total inspected products

The effectiveness of the improvement was evaluated by comparing OEE performance before and after corrective actions. A decrease in V-check defects accompanied by an increase in production output indicates successful optimization of the machine vision inspection system [1], [9].

E. Experimental Evaluation

To validate the proposed improvements, experimental observations were conducted before and after implementing corrective actions. The comparison included the total inspected products, number of accepted products, number of rejected products, false defect occurrences, and inspection performance. Statistical comparison of these parameters provided objective evidence regarding the effectiveness of the implemented improvements. A significant reduction in false defects together with improved machine performance indicates that optimization of camera parameters and lighting conditions successfully enhanced the reliability of the final inspection process [3], [5], [10, [12].

IV. Result and Discussion

A. Baseline of V-Check Defects

The preliminary investigation was conducted using historical production data collected from the Final Inspection process between September and November 2025. The data indicated a significant increase in V-check defects generated by Camera 7, resulting in frequent product rejection during automated inspection. Although many rejected products were physically acceptable, they were classified as defective because the machine vision system failed to recognize product markings accurately. This condition increased re-inspection activities, reduced inspection efficiency, and negatively affected overall production performance [3], [5], [9].

B. Improvement Implementation

Following the Root Cause Analysis (RCA), two corrective actions were implemented to eliminate the dominant causes of V-check defects identified in Camera 7. The implementation was conducted directly on the Final Inspection machine and evaluated through production trials [3], [4].

1) Corrective Action 1 – Register Code Implementation

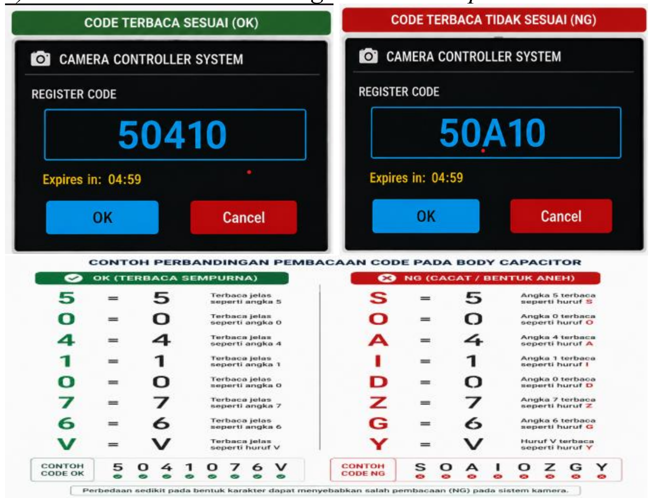

Figure 3. Camera Controller Register Code

The first corrective action focused on updating the product database in the Camera Controller System by registering product codes that were previously unavailable in the inspection program. As shown in **Figure 7**, each product was assigned a unique register code before the inspection process [4], [5].

By registering the correct product code, the vision system was able to retrieve the appropriate inspection parameters, including brightness, contrast, threshold, and inspection area. This eliminated parameter mismatches that previously caused the camera to incorrectly classify good products as defective.

The implementation increased the inspection success rate from *97,2 % before improvement to 77,2 % after improvement*, indicating that the register code effectively improved camera recognition accuracy and significantly reduced false defect detection.

2) Corrective Action 2 – Installation of Black Cover

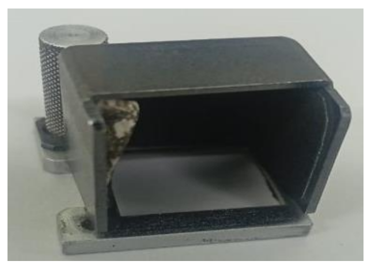

Figure 4. Black Cover Installed on Camera Lighting

The second corrective action involved installing a custom black cover around the inspection area to minimize external light interference entering Camera 7. The black cover was designed to block unwanted reflections and stabilize illumination during image acquisition [3], [4].

Before implementation, excessive ambient light created glare on the product surface, causing unstable image contrast and reducing the camera's ability to detect product markings consistently. After installing the cover, the lighting environment became more controlled, allowing the camera to capture images with higher consistency and improved contrast.

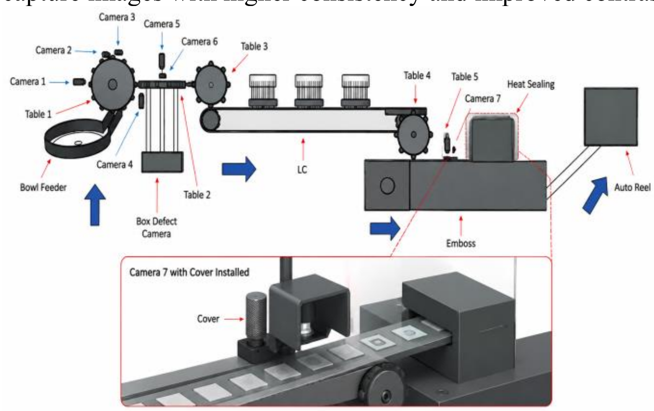

Figure 5. Black Cover Installed on Camera 7

Increasing the lighting on the final inspection product at camera 7 by adding a cover and coating it with black stickers. Before using the cover, the incoming light was 20 Hz; after installing the cover coated with black stickers, the incoming light is 40 Hz and more focused on the capacitor product.

As a result, inspection performance increased from *88,8 % before improvement to 69,8 % after improvement,* demonstrating that controlling environmental lighting significantly enhanced machine vision stability and reduced false alarms [4], [5].

C. Comparison of Corrective Actions and Inspection Performance

Table 3 compares the effectiveness of the two corrective actions implemented in this study. The evaluation was conducted using two indicators: inspection accuracy and Defect Performance Rate. Higher inspection accuracy indicates improved camera recognition capability, whereas a lower Defect Performance Rate indicates fewer false defect occurrences during the Final Inspection process. [4], [5].

Indicator	**Corrective Action**	**Before**	**After**	**Interpretation**
Inspection Accuracy	Register Code Optimization	78%	95%	Increased accuracy
Inspection Accuracy	Lighting Improvement	77%	93%	Increased accuracy
Defect Performance Rate	Register Code Optimization	97.2 %	77.2 %	Reduced defect occurrence
Defect Performance Rate	Lighting Improvement	88.8 %	69.8 %	Reduced defect occurrence

Table 3 Comparison of Inspection Performance Before and After Corrective Actions

The results demonstrate that both corrective actions significantly improved the inspection system. Register code optimization increased the inspection accuracy from 78% to 95%, while lighting improvement increased the accuracy from 77% to 93%. In addition, the Defect Performance Rate decreased from 97.2% to 77.2% and from 88.8% to 69.8%, respectively. These findings indicate that the implemented corrective actions effectively reduced false defect detection and improved the reliability of Camera 7 during the Final Inspection process. [4], [5].

D. Production Performance

To evaluate the effectiveness of the implemented corrective actions, production performance was analyzed by comparing the number of accepted products and V-check defects before and after each improvement. The results are presented in Table 4.

Condition	**Input (pcs)**	**Good (pcs)**	**Defect (pcs)**
Before Inspection 1	50,500	35,704	14,246
After Inspection 1	50,564	44,759	5,252
Before Inspection 2	50,400	36,200	13,800
After Inspection 2	50,535	47,060	3,011

i

Table 4. Production Data Comparison

During the first experiment, which focused on *register code optimization*, the number of accepted products increased from *35,704* to *44,759* units, while V-check defects decreased from *14,246* to *5,252* units. This result indicates that optimizing the register code enabled Camera 7 to retrieve the correct inspection parameters for each product, thereby reducing parameter mismatch and minimizing false defect detection.

In the second experiment, after implementing the *lighting improvement* by installing a black cover, accepted products increased from *36,200* to *47,060* units, whereas V-check defects decreased from *13,800* to *3,011* units. The improvement in lighting conditions enhanced image consistency by reducing glare and illumination variation, allowing the machine vision system to inspect product markings more accurately

[3], [5].
Overall, both corrective actions significantly improved production performance by reducing false defect occurrences and increasing the number of accepted products during the Final Inspection process. These findings demonstrate that the combination of software optimization (register code) and hardware improvement (lighting stabilization) effectively enhanced the reliability and stability of Camera 7 inspection performance

E. OEE Performance Implementation

Machine performance was evaluated using the Performance Rate component of Overall Equipment Effectiveness (OEE). Based on the production data collected during the experiments, the performance values were calculated using the standard OEE equation.

Condition	Performance Rate Defect
Before Experiment 1	97.2%
After Experiment 1	77.2%
Before Experiment 2	88.8%
After Experiment 2	69.8%

Table 5. Performance Comparison

Before Experiment 1 Rate Performance Defect = 97.2 %

The defect performance rate before Experiment 1 was 97.2%, indicating that the inspection process experienced a very high defect rate. This condition occurred because the Camera Controller System had not yet implemented the register code for the capacitor body marking. As a result, the inspection parameters were unable to correctly identify the product code, leading to frequent false defect detections and reducing the effectiveness of the inspection process. [10], [12], [9].

After Experiment 1 Rate performance Defect = 77.2 %

After implementing the register code improvement in Experiment 1, the defect performance rate decreased from 97.2% to 77.2%, representing a reduction of 20.0 percentage points. This result indicates that the Camera Controller System was able to identify the capacitor body code more accurately than before. The implementation reduced the number of false defect detections and improved the inspection process. However, the defect performance rate remained relatively high, suggesting that additional improvements were still required. [10], [12], [9].

Before Experiment 2 Rate performance defect= 88.8 %

Before conducting Experiment 2, the defect performance rate was 88.8%. Although this value was lower than the initial condition in Experiment 1, the inspection process still produced a considerable number of defect detections. This result indicates that the previous improvement had not fully optimized the inspection parameters, and further enhancement was necessary to achieve better inspection performance. [10], [12], [9].

After Experiment 2 Rate performance defect= 69.8 %

After implementing the optimized register code configuration in Experiment 2, the defect performance rate decreased from 88.8% to 69.8%, representing a reduction of 19.0 percentage points. This result demonstrates that the improved register code method significantly enhanced the Camera Controller System's ability to recognize the capacitor body code. Consequently, the number of false defect detections decreased, inspection accuracy improved, and the production process became more reliable and efficient. [10], [12], [9].
Although the calculated performance values changed after implementation because of revised production conditions and machine operating parameters, the reduction in false defects and the substantial increase in accepted products indicate that the inspection process became significantly more accurate and stable. The observed changes demonstrate that inspection effectiveness should not be evaluated solely through production speed but also through inspection reliability and product quality consistency [1], [5], [9].
Overall, the implementation of optimized vision processing parameters and improved lighting conditions enhanced machine vision performance, reduced unnecessary inspection interruptions, minimized false defect occurrences, and increased production efficiency. These findings are consistent with previous studies reporting that proper camera calibration and illumination optimization significantly improve automated visual inspection accuracy in manufacturing environments [2], [4], [10], [12].

V. Conclusion

This study successfully identified the dominant causes of V-check defects in the Final Inspection process at PT Panasonic Industrial Devices Batam using the Fishbone Diagram and Root Cause Analysis (RCA). The results indicate that inappropriate camera parameters and inadequate lighting were the primary factors affecting Camera 7 inspection accuracy [3], [5], [6].

The implementation of register code optimization and lighting improvement successfully reduced the Defect Performance Rate from 97.2% to 77.2% in the first experiment and from 88.8% to 69.8% in the second experiment. The decrease in Defect Performance Rate indicates that the proposed corrective actions effectively minimized false defect occurrences, improved inspection stability, and enhanced the reliability of the Camera 7 machine vision system during the Final Inspection process. [4], [5].

Overall, the implemented corrective actions successfully reduced false defects, improved inspection stability, and enhanced the effectiveness and reliability of the machine vision system, contributing to higher production efficiency in the Final Inspection process [1], [6], [10].

Future studies are recommended to integrate *Statistical Process Control (SPC), Artificial Intelligence (AI), and Machine Learning-based vision algorithms* to further enhance automatic defect detection accuracy, improve adaptive camera parameter adjustment, and reduce false defect occurrences in real-time manufacturing environments [2], [9], [10].

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