Streamlining Quality, Efficient Process, Batch Lot Optimization Through Value Stream Mapping and Lean Sigma integrating Elite Inline Repair System

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ABSTRACT

The buildup of batch lot units (units with defects) has been a chronic problem in production, leading to significant rejection rates and time loss, which in turn cause inefficiencies in the workflow. The root of this issue lies in the lack of efficient process (MUDA`s) process automation and the reliance on manual traceability, which compromises data accuracy and contributes to the seven types of waste—waiting, transporting, processing, inventory, motion, defects/rework, and overproduction—as identified by the MUDA methodology.

A comprehensive strategy employing value stream mapping and a lean-sigma approach was adopted. Central to this strategy is the in-house developed Elite Inline Repair System, which has been instrumental in resolving the seven MUDA wastes in terms of speed and data accuracy. Process improvement and system automation have not only enhanced the manufacturing process by reducing defects and saving costs but also improved data accuracy and speed of work. The Elite Inline Repair System stands as a testament to the efficacy of integrating system automation with lean manufacturing principles to achieve a more streamlined, efficient, and cost-effective production process.

1. 0 INTRODUCTION

The accumulation of batch lot units—units identified with defects—has emerged as a significant challenge on production process. This issue has led to increased rejection rates, time loss, and inefficiencies within the workflow. The underlying problem is rooted in the absence of efficient process, system automation and an over-reliance on manual traceability. Such practices have compromised data accuracy and contributed to the seven types of waste as identified by the MUDA methodology: waiting, transporting, processing, inventory, motion, defects/rework, and overproduction. The need for a solution that can seamlessly integrate into the workflow, enhance data accuracy, and eliminate these inefficiencies is evident. The Elite Inline Repair System, developed in-house, presents a promising approach to resolving these issues by employing lean sigma principles and the MUDA elimination approach to improve the process workflow. The effectiveness of this system in transforming the production landscape necessitates a thorough examination of its impact on operational excellence and efficiency.

1.1 Problem Statement

The production process has faced a formidable challenge over the period of 2020-2023: the significant accumulation of 80,000 batch lot units identified with defects. This issue has escalated into a critical concern, leading to substantial quality issues during the reprocessing of units and incurring financial losses totaling PHP 8,800,000 due to scrap PCBs. An exhaustive analysis utilizing Value stream mapping and the lean sigma approach has identified the core problems and implement preventive actions.

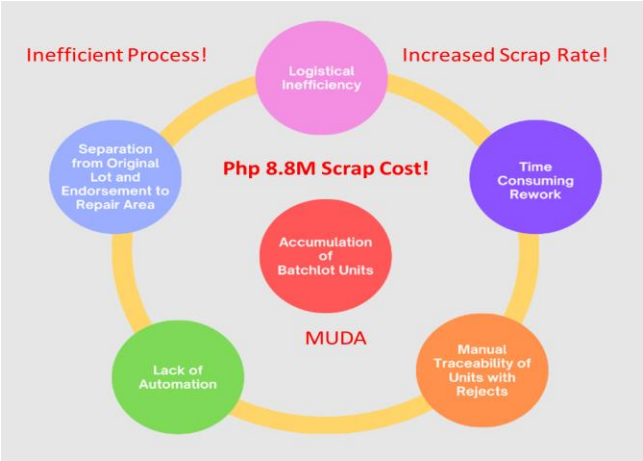


Fig 1. Factors Contributing to the Buildup of Batch Lot Units

These issues have severely impeded the ability to uphold

Fig 2. Factors Contributing to the Buildup of Batch Lot Units using MUDA Approach

consistent quality standards and optimize production efficiency. Consequently, it is crucial to address these concerns to enhance the operational workflow and guarantee the delivery of high-quality products. The resolution of these problems is not only essential for maintaining product integrity but also for ensuring the sustainability and competitiveness.

1.1.1 Project Objective

The primary objective of this study is to demonstrate the application of value stream mapping techniques and process automation to prevent the accumulation of defective batch lot units on production lines. This approach aims to enhance overall productivity, efficiency, cost impact, and workflow smoothness, as well as ensure on-time delivery and optimal space utilization. Additionally, it seeks to reduce unit scrappage and improve product quality by eliminating the manual recording of defective batch lot units and increasing data accuracy.

1.1.2 Scopes and Limitations

The Inline Repair System Project was strategically deployed at Gruppo EMS Business Unit 2, specifically within the Ink Jet Printer Assembly line. The deployment took place over a period stretching from November 6, 2023, to March 22, 2024. It is important to note that this deployment represents only Phase 1 of the overarching project.

Two production line was selected from manufacturing based on their history of high defect rates and low productivity.

- Line 18: SMT PCB assembly line
- Line UB: Backend assembly line

As we progress, the scope will expand to include comprehensive integration within all SMT and BE lines, enhancing our repair and reprocessing capabilities across the entire production spectrum.

1.1.3 Understanding the Problem

Initial data were collected to assess the performance of the selected production lines, including defect rates, process inefficiencies, and customer feedback.

In-depth interviews were conducted with production line operators, supervisors, and quality control personnel to identify the root causes with process simulation of overall productivity inefficiency, cost impact, delivery delays, space consumption, unit scrappage, and quality issues. Value stream maps were created to visualize the flow of materials and information, identify bottlenecks, and uncover non-value-added activities.

Observational studies were conducted to analyze work processes, identify wasteful movements, and quantify cycle times for each production step.

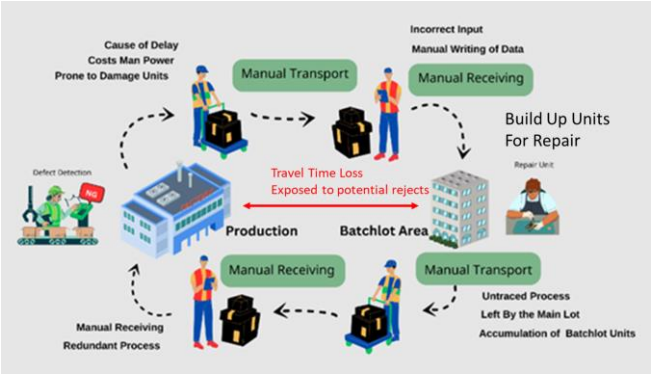


Fig 3. Flow for Repairing units with rejects.

The buildup of defective or NG (non-good) units within a production line can create significant challenges, often resulting in increased expenses, operational delays, and the waste of resources.

Maintaining a real-time process log is essential for recording data, similar to other assembly processes, especially when issues arise that require further investigation. However, the Elite system focuses exclusively on PCB assembly traceability and is not integrated into the inline repair of NG

units. Traditionally, unit repairs are conducted away from the production line, which can lead to units being separated from their original batch.

2.0 REVIEW OF RELATED WORK

Not Applicable.

3.0 METHODOLOGY

To identify possible improvements, a detailed review of the current Process and System Flow is conducted using the MUDA approach and the Lean Sigma principle. Data collection and analysis are now essential for directing the decision-making process. The first priority is to avoid the unnecessary accumulation of batch-lot units by carefully monitoring and controlling them.

3.1 Define Phase – Define the problem

Each production process was analyzed to identify its primary function and any unnecessary features or activities. The costs associated with defects, rework, and inefficiencies were quantified, and potential cost savings from process improvements were estimated. Cross-functional teams were formed to brainstorm ideas for process improvements, cost reduction, and defect prevention. Existing product designs were analyzed to identify opportunities for simplification, standardization, and error-proofing.

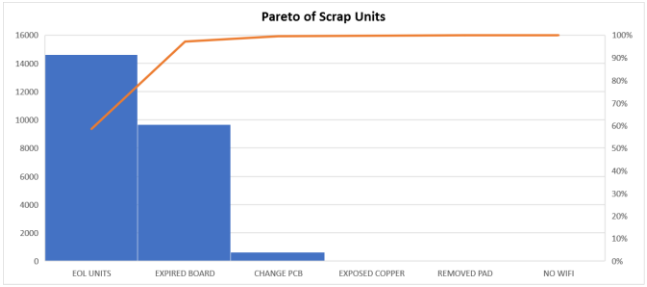
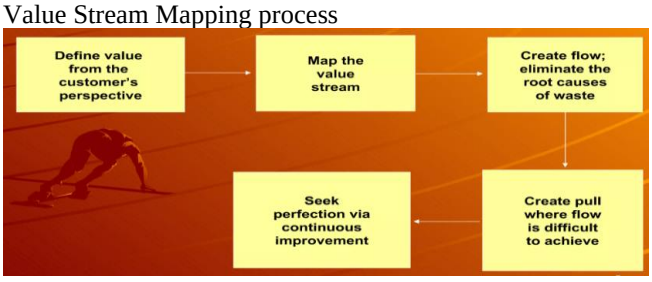


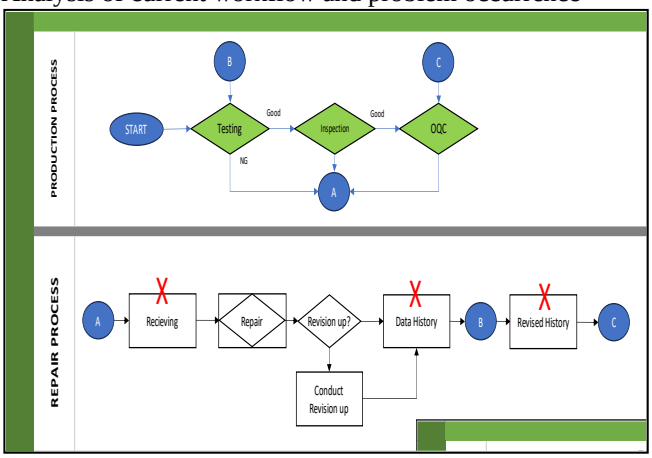
Fig 4. Pareto of Scrap units on batch lot

3.2 Measure Phase – Measure the problem

Value Stream Mapping process



Analysis of current workflow and problem occurrence



Value Stream Mapping vis-vis Current and Desired State

Current State	Gap	Desired State
1.Accumulated PCB units rejects 2. Longer Repair time 3. Longer waiting time to transport units to repair area 4. No proper traceability 5. Unproductive repair personnel	1.Increased scrappage 2. Inefficient process 3. Too many MUDA 4. Poor productivity 5. Affects Work Discipline	1. Produce more with less cost 2. Lean process 3. Error proofed process 4. Faster report and repair units' traceability 5. Inspired productive workforce

3.3 Analyze Phase – Analyze the problem

Value Stream Mapping Analysis

The current process and method of operation are contributing to an increase in the scrapping of PCB units for repair. Due to the manual tracking and recording, the rejected units have piled up, preventing the repair operator from identifying which unit should be repaired first, the type of rejection, and the assigned batch lot.

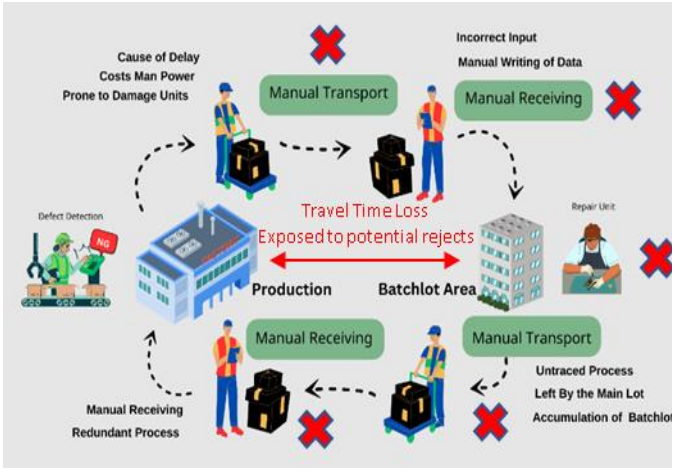
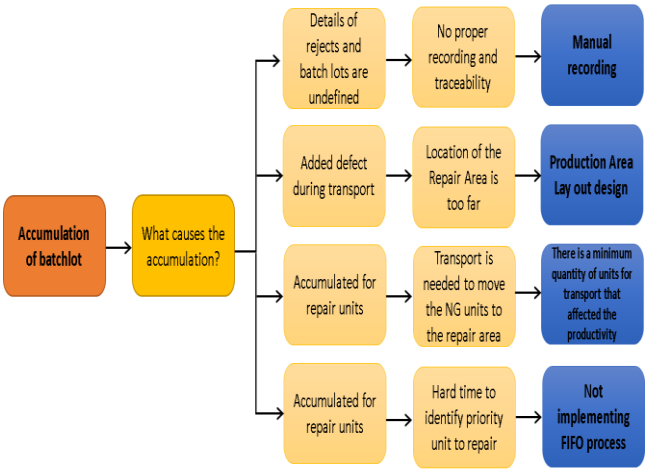


Fig 5. Shows problem incurs by each process on repairing units with defect

Further analysis was conducted using Fault Tree Analysis

Fig 6. Shows problem root causes



3.4 Improve Phase – Solve the problem

Solution Tree Analysis

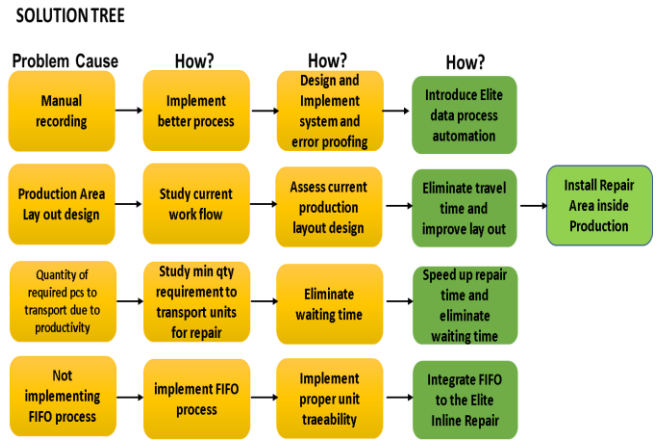


Fig 7. Shows the analysis and formulation of the solution

Analysis and developing error proofing solution – Lean Sigma. System improvement and process automation development – In house Elite System and integrate with Lean Sigma (Zero Defect Process) was developed and integrated into the process.

The deployment of the ELITE Inline Repair System begins with an extensive planning stage. This initial phase involves a collaborative effort among Production Leads, Quality Engineers, Process Engineers, Equipment Engineers, System Developer and Customers to ensure the project aligns with their joint objectives. A trial run is carried out during this stage to assess the system's performance against the plan. User Acceptance Testing (UAT) is performed with users to confirm that the application meets all the specified requirements and matches the expectations set during the planning stage. Following the successful trial run, the results are presented to senior management and the customer. Training sessions are then held for the Production Team, QA Team, and Engineering Support. Upon receiving customer approval, the system is rolled out on selected lines to monitor performance data.

Elite Inline Repair System program design

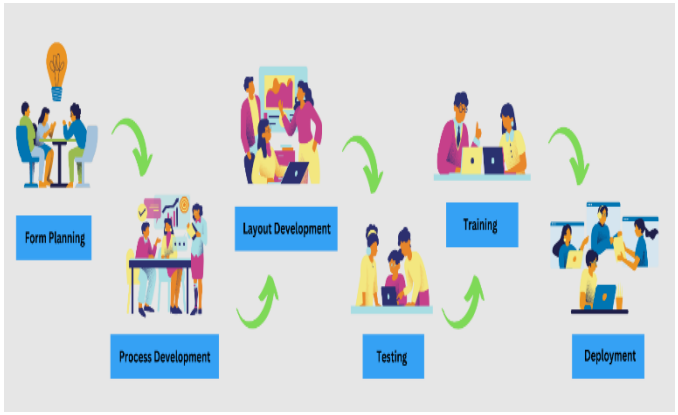
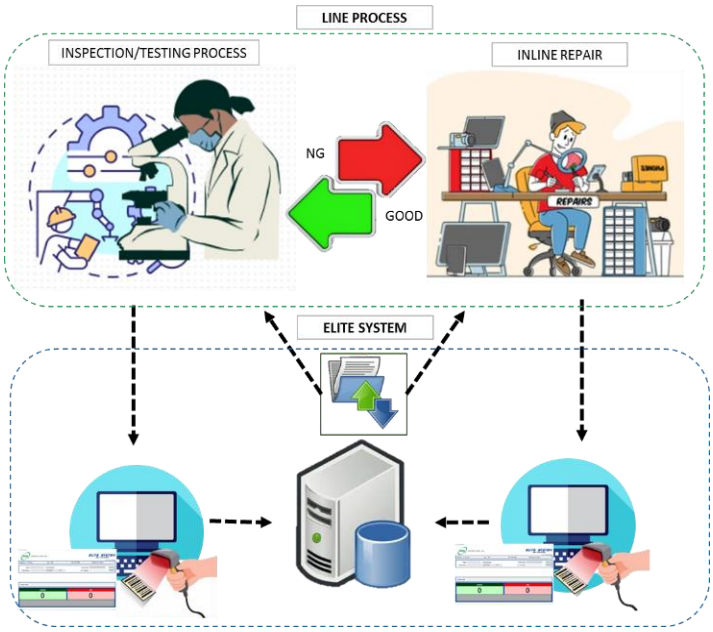


Fig 8. Steps in Developing and Deploying the Elite Inline Repair System

With the introduction of the ELITE Inline Repair system, NG (rejects) units can now undergo inline repairs, which prevents them from being separated from the main batch. This eliminates the waiting time, transportation, and potential defects that could arise during separate repair and reprocessing.

This streamlined process enhances efficiency by keeping units within their production flow, reducing the risk of additional defects.

Process integrated Elite Inline Repair system eliminating



manual data recording and traceability.

Fig 9. ELITE Inline Repair System Hierarchy

The table provided below illustrates a comparison between manual and automated processes. It describes the procedures pre-enhancement of the Elite System for repair processes involving batch lot units, contrasting with the post-implementation scenario following the introduction of the Elite Inline Repair System.

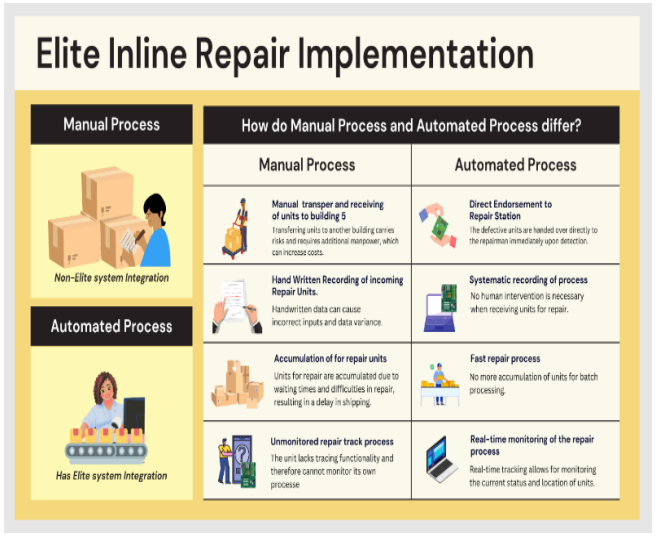


Table 10. Contrast Between Manual and Automated Procedure

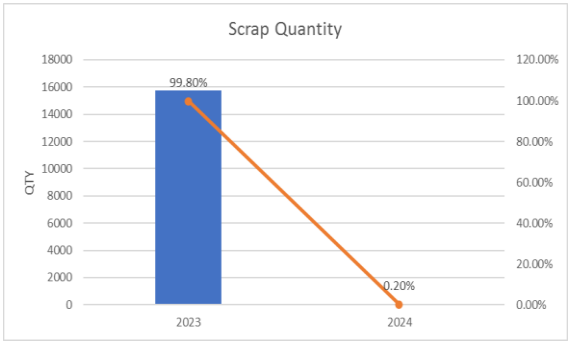
3.5 Control Phase – Maintain the solution

The new procedure and work instruction for the ELITE inline repair system were documented and deployed. Station orientations were conducted to inform operators, technicians, line engineers, group leaders, supervisors, QA, and managers about the implemented system. This system was deployed in November 2023 on SMT Line 18A and Backend Lane UB.

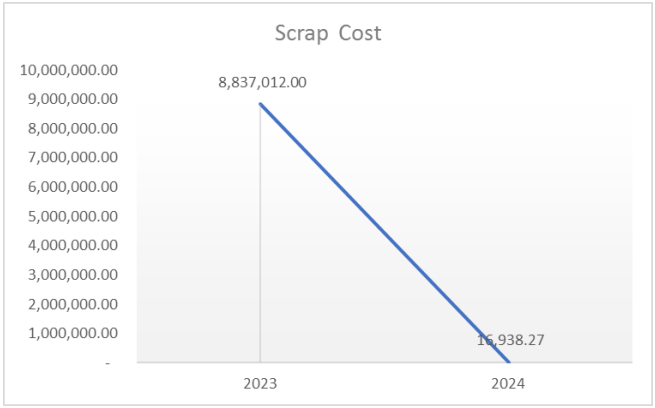
4.0 RESULTS AND DISCUSSION

During the implementation of the Elite Inline Repair System, comprehensive data was collected to evaluate its effectiveness and gauge its influence on the production area. The team compiled data on the scrap rate, its associated costs, and the improvements in production yield. Additionally, data on the reduction in repair cycle time was collected. Ultimately, the total cost savings, presented in an annualized format, were also determined. The data and graphs provided below demonstrate the improvements realized after the system's implementation.

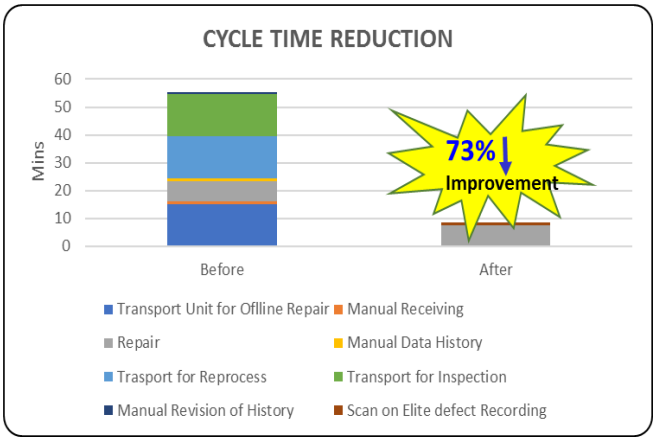
4.1 Data Collection Process and Analysis – Result



Reduction of Scrap Units After Implementation



Reduction of Scrappage Cost After Implementation



Improvement of Reduced Repair Cycle Time After Implementation

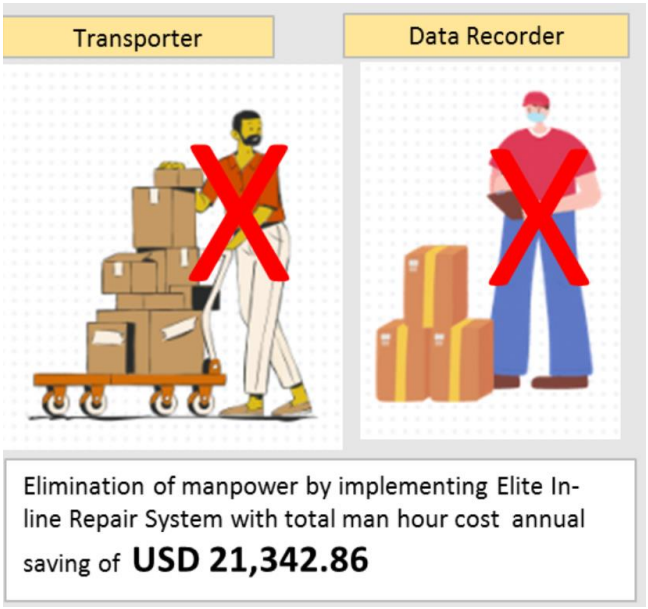


Table 11. Projected annual savings upon Elite Inline Repair implementation

Reviewing the data and graphs provided, it is evident that there has been a significant improvement in the process, reduction in scrap rate, and increase in annual savings.

5.0 CONCLUSION

In conclusion, the implementation of the ELITE Inline Repair System represents a significant advancement in streamlining the repair process for NG (defective) units. By integrating repairs directly into the production line, the system eliminates the need for unit separation, thereby reducing wait times, transport risks, and the likelihood of additional defects. This innovative approach not only enhances operational efficiency but also ensures that units maintain continuity with their original lots, contributing to a more cohesive and reliable manufacturing process. The Inline Repair System too was shared to our customers.

6.0 RECOMMENDATIONS

Based on the positive outcomes and customer endorsement, it is advisable to expand the ELITE Inline Repair System across additional Surface Mount Technology (SMT) and Backend lines. Implementing this system is anticipated to reduce the buildup of batch lot units significantly, thereby streamlining the manufacturing process and enhancing overall efficiency. This strategic deployment can lead to consistent improvements in production quality and a reduction in repair-related delays
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7.0 ACKNOWLEDGMENT

The successful deployment of the Inline Repair through ELITE System is a great example of what can be achieved through teamwork and dedication. We owe a debt of gratitude to our team of engineers and software developers whose expertise and commitment have been instrumental in developing a system that simplifies production processes and eliminates the batch lot process within our company.

Our hard work and innovative problem-solving have ensured that our system not only meets but exceeds the standards of quality and efficiency expected in our industry. Our contributions as engineers have been invaluable, and it is through our efforts that we have been able to achieve such significant improvements in our production workflows. This project could not have been successful without the collective efforts of each team member involved.

We are grateful for our dedication, and we look forward to continuing improvements and collaboration in the future.

8.0 REFERENCES

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9.0 ABOUT THE AUTHORS

Irah Faith Lorico is an accomplished Process Engineer, boasting two years of expertise at EMS and a four-year tenure at Tsukiden Electronics. She earned her Bachelor of Science in Electronics Engineering from Laguna State Polytechnic University, equipping her with a solid foundation of theoretical and practical skills essential for her profession. Driven by a passion for refining manufacturing processes, Irah is steadfast in her pursuit of perpetual enhancement. She adeptly employs engineering principles to real-world challenges, prioritizing efficiency and quality in her endeavors. Her unwavering dedication to excellence and innovation elevates the standards of her contributions at EMS.

Rachel Labis is a skilled Senior Process Engineer with extensive experience in the electronics manufacturing industry. She has spent almost 6 years honing her expertise at Tsukiden Electronics, followed by an additional year at Gruppo EMS. Rachel holds a Bachelor of Science degree in Electronics Engineering from AMA Computer University. Throughout her career, Rachel has demonstrated exceptional proficiency in data analysis, process optimization, and continuous improvement. Her analytical skills and innovative approach have consistently contributed to enhancing operational efficiency and driving significant improvements within her teams. Rachel's commitment to excellence and her ability to implement effective solutions make her a valuable asset in the field of electronics engineering and process management.

Adonis De Vera is a software developer who is dedicated to innovating and making processes more efficient. He has over two years of experience in system support for ELITE System Develop at GRUPPO EMS's Information Management Department (IM). expert in developing customized programs for manufacturing companies. His commitment to creating solutions that make processes more streamlined and cost-effective has contributed to the success of his projects. He enjoys taking on challenges and is motivated to continuously improve systems to improve productivity and effectiveness within the company