Enhancing Safety and Efficiency with Loading Room Scale Equipment

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Abstract — *This paper presents a comprehensive analysis aimed at enhancing safety and efficiency in manufacturing processes, particularly those involving hazardous materials. Using the DMAIC methodology, the study identified safety concerns and inefficiencies in the current process at a manufacturing facility. Insights from process flow diagrams, time studies and PQ analysis revealed areas for improvement in safety protocols and workflow. Implementing Loading Room Scale equipment emerged as a key solution, promising significant reductions in cycle time and labor costs. The findings underscore the importance of workplace safety policies and ongoing efforts to ensure a safe working environment. Future research should focus on exploring additional safety measures and refining equipment to further optimize manufacturing operations.*

Key Terms — *Efficiency improvement, Process optimization, Quality assurance, Safety enhancement.*

INTRODUCTION

The imperative to enhance safety protocols, primarily by minimizing exposure to hazardous materials, serves as the driving force behind the project. Simultaneously, there is a concerted effort to optimize operational efficiency. This involves refining cycle times and labor standards to mitigate potential risks associated with handling and transporting hazardous materials. Moreover, the implementation of a rigorous inspection process aims to reduce the occurrence of false notifications of escape, thus reinforcing overall safety measures within the manufacturing facility.

This paper aims to implement the Loading Room scale system thoughtfully, considering its wide-ranging implications and potential benefits. It seeks to integrate the system into the manufacturing process to enhance safety, efficiency, and the reliability of critical safety systems. Through systematic analysis and strategic implementation, the project aims to achieve tangible improvements in safety measures, operational efficiency, and overall productivity.

The process entails filling the parts and sealing them. A visual inspection is then performed to verify the accuracy of the process. Ensuring precise of the filling process is critical as any inaccuracies could compromise the functionality of the final product, underscoring the importance of meticulous procedures for both safety and operational efficiency.

Centered on the objective of enhancing safety and efficiency, the paper provides a structured overview of the project, covering its introduction, analysis approach using DMAIC methodology, presentation of results, comprehensive discussion, and conclusive remarks. Each section is designed to offer valuable insights into the project's objectives, methodologies, findings, and implications for both academic and practical applications.

LITERATURE REVIEW

Safety is crucial in manufacturing processes involving hazardous materials. Previous studies and literature, including the DOD Contractor’s Safety Manual, underscore the critical importance of limiting personnel exposure to these hazardous materials to ensure safe and efficient operations [1]. Common safety hazards in such environments include exposure risks to operators and the potential for accidents, which can significantly impact manufacturing operations. These hazards necessitate rigorous safety protocols and procedures to minimize risks and protect personnel and facilities. Implementing robust safety measures and emphasizing proper training further enhance safety protocols in such environments.

In the pursuit of manufacturing efficiency, Lean Manufacturing principles play a pivotal role, focusing on waste elimination and process optimization. A core tenet involves minimizing unnecessary transportation, as excessive movement of materials and products can introduce inefficiencies and escalate costs. This aligns with the project's goal of reducing the need for transporting parts within the facility, facilitated by Lean methodologies like single-piece flow. Originating from Toyota in the 1930s, Lean Manufacturing underscores waste reduction across supply chain processes, emphasizing precise demand forecasting to mitigate production interruptions. By prioritizing waste elimination, quality improvement, lead time reduction, and expense limitation, organizations can optimize efficiency and deliver enhanced value to customers [2].

Analysis Approach

The analysis comprehensively evaluated the safety and efficiency of the manufacturing process within the facility using DMAIC methodology. Its primary focus was to identify and address any shortcomings or areas for enhancement. This included assessing procedures, inspection methods, quality control measures, and overall workflow. Clear objectives were set, such as minimizing exposure to hazardous materials and optimizing operational efficiency, aiming to provide valuable insights for improving safety protocols and streamlining processes. Data collection methods, including process mapping and statistical analysis, were utilized to gain a thorough understanding of existing protocols and identify enhancement opportunities.

To initiate the project, the first major task involved conducting a thorough review of existing safety protocols and procedures within the manufacturing process. This comprehensive assessment aimed to identify any potential weaknesses or areas for improvement. By employing methods such as process mapping, Gemba walks, spaghetti diagram, the project team gained insights into operational practices and identified opportunities to enhance safety standards. Additionally, this task involved evaluating the utilization of resources and employees during operations to understand the current workflow and identify any inefficiencies or bottlenecks. Through the systematic application of these methods, the project laid the foundation for implementing targeted improvements that prioritized safety and efficiency in the manufacturing environment.

The methodology employed a range of techniques to enhance process efficiency. Detailed time studies gauged task durations, pinpointing areas with potential for improvement. PQ Analysis identified parts frequently inspected, allowing focused examination of inspection times. Then, labor standards were established by cross-referencing findings with hours logged by the team members. This systematic approach facilitated a thorough grasp of the process, guiding informed adjustments for smoother operations.

Results

The process flow analysis revealed significant inefficiencies in the current process, aligning with Lean Manufacturing principles. Key findings indicate unnecessary transportation of hazardous materials to and from the inspection area, leading to wasted time and resources. Moreover, prolonged waiting times for processing in the work-in-progress queue were identified, highlighting additional inefficiencies. These findings underscore the urgent need for process optimization to eliminate waste and enhance overall efficiency. Further analysis identified various types of waste, including transportation waste, waiting waste, defects waste, and talent waste. Addressing these forms of waste is essential for streamlining the current process, improving productivity, and maximizing resource utilization.

Additionally, the current and future state process flow diagrams (Figures 1 and 2) illustrate the critical to quality (CQT) operations, providing visual representations of the proposed improvements. Similarly, the department process flow diagrams (Figures 3 and 4) depict the flow of activities within the facility, highlighting areas for enhancement. Furthermore, the spaghetti diagrams (Figures 5 and 6) visually demonstrate the movement of materials and personnel within the workspace, facilitating the identification of inefficiencies and optimization opportunities.

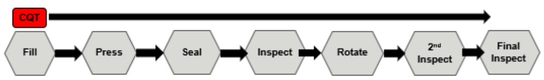

Figure 1
Current State Process Flow Diagram CQT (Critical to Quality)

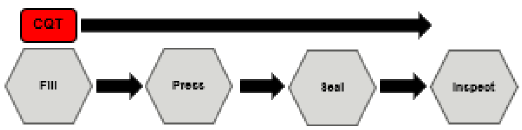

Figure 2
Future State Process Flow Diagram CQT (Critical to Quality)

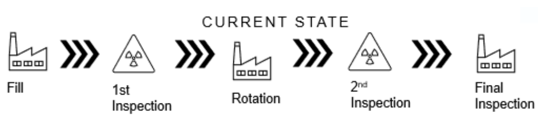

Figure 3
Current State Department Process Flow Diagram

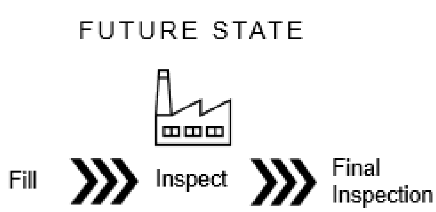

Figure 4
Future State Department Process Flow Diagram

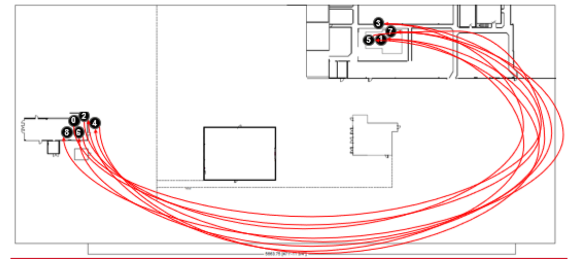

Figure 5
Current State Spaghetti Diagram

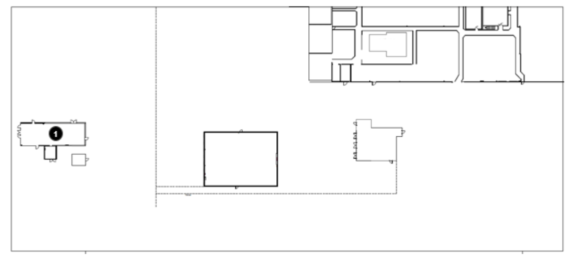

Figure 6
Future State Spaghetti Diagram

The analysis of collected data provided valuable insights into the efficiency of the manufacturing process. Utilizing PQ Analysis (Figure 7), the team identified the top six-part numbers that accounted for 58% of the demand, enabling a focused approach to resource allocation. In conjunction with the PQ Analysis, efforts were directed towards validating the labor hours charged by inspectors, providing crucial insights into labor cost reduction opportunities.

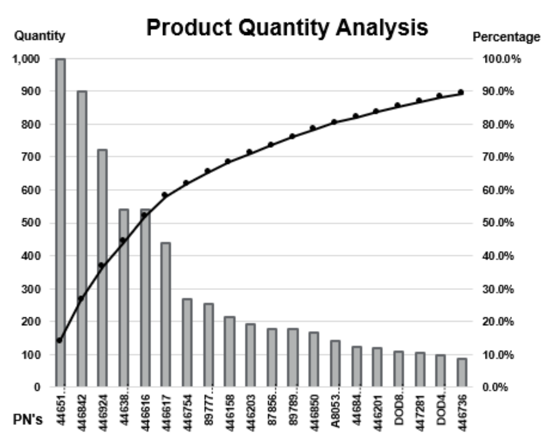

Figure 7
PQ Analysis Graph

Concurrently, time studies revealed inefficiencies in the process, with personnel spending significant time on parts transportation. Additionally, examination of inspection data highlighted the substantial labor required for each order (Table 1 and 2). These findings underscored the imperative for process optimization. The implementation of proposed equipment is anticipated to yield significant improvements in efficiency and labor cost reduction.

Table 1
Inspector Hours Labor Charged

Inspectors Labor charge (Aug 23' - April 24')			
Orders	Total hrs	Avg hrs	Avg min
104	138	1.33	80

Table 2
Inspection Process

Inspection Process				
Operations	Personell	Minutes	Total Min	Total Hrs
Delivery	2	15	30	0.5
First Inspection	1	80	80	1.3
Pickup	2	15	30	0.5
Rotation	1	30	30	0.5
Delivery	2	15	30	0.5
Second Inspection	1	80	80	1.3
Pickup	2	15	30	0.5
Final Inspection	1	30	30	0.5
Total			340	5.66

To understand the potential impact of the new Loading Room scale equipment, an analysis of the current labor hours worked was conducted. The following calculations illustrate the expected improvements in efficiency and reduction in cycle time with the new equipment. Previously, each order required 5.66 labor hours at a cost of $850, totaling $25,500 monthly for 30 orders. The new process reduced labor to 0.5 hours per order at $150 per hour, resulting in $75 per order and $2,250 monthly. This change achieved approximately 90% labor cost reduction, from $25,500 to $2,250 per month.

After careful calculations, it is evident that the anticipated time for completing one order using the new Loading Room scale equipment is approximately 0.5 hours. In contrast, the current process, necessitates approximately 5.66 hours, as depicted in Table 2. This substantial reduction in cycle time signifies a noteworthy enhancement in efficiency, estimated at around 91%.

Conclusion

In conclusion, the project has made substantial strides towards enhancing safety and efficiency through the integration of Loading Room Scale equipment. The endeavor has been underscored by a commitment to saving lives through safety risk reduction, aligning with minimizing exposure to hazardous materials and reducing cycle time by over 90%. By minimizing transportation exposure and enhancing inspection steps, particularly in mitigating risks associated with notification of escape (NOE), the project has prioritized safeguarding lives. Moreover, the emphasis on critical to quality (CQT) operations, notably in the process, demonstrates a dedication to ensuring product integrity and mitigating operational risks.

The project's outcomes have been meticulously examined, revealing critical insights into the current manufacturing process. Identification of various forms of waste, including unnecessary transportation and idle waiting times, has highlighted the urgent need for process optimization. Leveraging Lean Manufacturing principles, such as single-piece flow and waste elimination, has emerged as a pivotal strategy to address these inefficiencies and enhance operational efficiency. Time studies and PQ analysis have provided quantitative evidence of these inefficiencies, laying the groundwork for targeted interventions.

Moving forward, the project's findings extend beyond immediate implications, emphasizing the importance of organizational protocols to further optimize safety and efficiency. Future work will focus on exploring additional safety measures and continuing research efforts to enhance the effectiveness of Loading Room Scale equipment, ensuring sustained evolution and improvement in the manufacturing landscape. Through systematic analysis and strategic implementation, the project has laid a solid foundation for ongoing improvement initiatives, reinforcing the commitment to safety, efficiency, and sustainability in manufacturing operations.

References

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