



Achieving Zero Defects in The Production Line Through the Use of Poka-Yoke Techniques

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Abstract

In an increasingly competitive industrial environment, organizations must consistently deliver defect-free products while maintaining cost efficiency. The evolution of Total Quality Management (TQM) and Total Productive Maintenance (TPM) across manufacturing and service sectors has introduced structured methodologies aimed at continuous quality enhancement. Techniques such as Kaizen, Six Sigma, Just-in-Time (JIT), Poka-Yoke, and Flexible Manufacturing Systems (FMS) contribute significantly to establishing a sustainable quality-oriented culture. Manufacturing processes frequently involve repetitive and routine tasks that may lead to operator fatigue and reduced concentration, thereby increasing the probability of human error. Given the inherent limitations of human performance, preventive quality control mechanisms become essential. The Poka-Yoke approach, based on mistake-proofing principles, offers practical and cost-effective solutions to eliminate inadvertent errors at their source. Its systematic implementation not only reduces defects and rework but also alleviates cognitive burden on workers. Consequently, employees are able to redirect their skills and creativity toward more value-adding and innovative activities, enhancing overall organizational performance and long-term operational efficiency.

Keywords: Operational Efficiency, Human Error Reduction, Six Sigma, Lean Manufacturing and Quality Culture.

1. Introduction

Nowadays, each and every company wants profit, high productivity, value in market. There are slogans in most factories stating defect reduction targets, but the ultimate aim should always be zero defects. "POKA-YOKE" is a vital factor in eliminating defects. Poka-yoke is a concept in total quality management which is related to restricting errors at source itself. It deals with "fool-proofing" or "mistake-proofing". A poka-yoke is any idea generation or mechanism development in a total productive management process that helps operator to avoid (yoke) mistakes (Poka). Main aim of Poka Yoke concept is to make whole system error proof that means no one can make mistake although some one wants to make mistake sin attentionally. It eliminates the defects or faults. This term was coined

by Shigeo Shingo in 1960s for the part of Toyota Production System. The aim of Poka-yoke is to design the process so that mistakes can be detected and corrected immediately, eliminating defects at the source. A methodical approach to build up Poka-Yoke countermeasures which consists in a three-step analysis of the risks to be managed gap, promoting inclusivity and understanding. This document outlines the design, implementation, and testing of the Digital Vocalizer system, detailing the hardware and software components involved. Our goal is to contribute to the development of assistive technologies that empower differently-abled individuals and foster a more inclusive society [1].

1.1 Methods of Poka Yoke Techniques

- **Contact Method:** The contact method

works by detecting errors through physical contact or shape. It ensures that parts are correctly positioned or inserted before the process can continue. For example, a machine may refuse to operate unless a component is correctly aligned plug only fits in one orientation Shown in Table 1.

- **Fixed-Value Method:** The fixed-value method ensures that a process happens a specific number of times. It is commonly used to prevent missing or extra steps. For instance, counting screws during assembly ensures exactly four screws are used [2].
- **Motion-Step or Sequence Method:** This method prevents errors related to missing steps or incorrect sequence. A process may include sensors or checklists that verify each step before allowing the next one. For example, an assembly line may prevent a worker from moving forward until the previous operation is completed correctly.
- **Control Method:** The control method prevents errors by stopping the process entirely if a mistake occurs. It enforces correct operation rather than just alerting the operator. For example, ATM cards cannot be inserted backward, and machines may shut down if a part is improperly installed.
- **Information Method:** The information method helps prevent mistakes by providing clear guidance or instructions. This includes visual cues such as colours coding, labels, diagrams, or written instructions to ensure correct operation. For example, color-coded wires in electronics assembly reduce the risk of wrong connections.

The Methods sections components to allow only correct assembly Use color coding to distinguish parts and stages. Implement warning signals and indicator lights. Apply sensors to verify positioning and presence. Introduce interlock mechanisms for machine safety. Use checklists to standardize work steps add visual guides to prevent operator confusion [3].

1.1.1 Tables

After implementation of Poka Yoke in January

2017, it can be seen that the rejection rate has become nil from table2, it can be clearly seen that production has increased each month. Since indirect losses have been decreased, total time has been saved. Thus, the effectiveness of poke yoke can be proved.

Table 1 Production Rate Before and After Implementation of Poka Yoke

Production Rate			
Before Implementation of Poka Yoke		After Implementation of Poka Yoke	
Month & Year	Production	Month & Year	Production
June 2024	41054	January 2025	46504
July 2024	45894	February 2025	48757
August 2024	41879	March 2025	49422
September 2024	45980	April 2025	54935
October 2024	32345	May 2025	37745
November 2024	44908	June 2025	56789
December 2024	50367	-	-

1.1. Figures

Figures should be provided separately from the main text. The graph illustrates the impact of implementing poka-yoke techniques on error rates over six measurement points. The blue line labeled "Before" shows the error levels prior to using poka-yoke, with fluctuations ranging from a high of 2 at the first point, dropping to zero at the third point, then sharply rising to a peak of 4 by the fifth point, before slightly declining to 3. This variability indicates inconsistency and frequent mistakes in the

process. In contrast, the purple line labeled "After" remains consistently at zero across all points, indicating that the poka-yoke system effectively eliminated errors entirely [4 - 8].

1.2. Figures

Figures should be provided separately from the main text. The graph illustrates the impact of implementing poka-yoke techniques on error rates over six measurement points. The blue line labeled "Before" shows the error levels prior to using poka-yoke, with fluctuations ranging from a high of 2 at the first point, dropping to zero at the third point, then sharply rising to a peak of 4 by the fifth point, before slightly declining to 3. This variability indicates inconsistency and frequent mistakes in the process. In contrast, the purple line labeled "After" remains consistently at zero across all points, indicating that the poka-yoke system effectively eliminated errors entirely Shown in Figure 1.

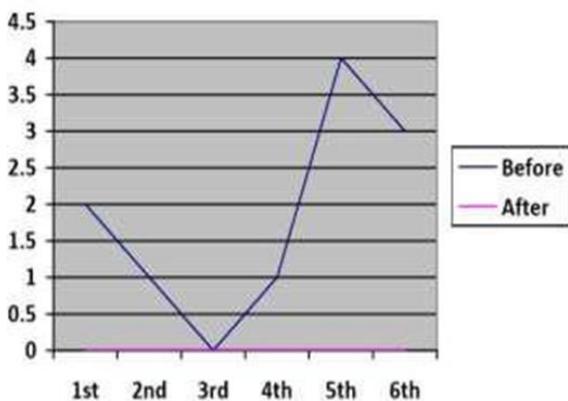


Figure 1 Result Before and After

Results and Discussion

Results

The implementation of Poka-Yoke techniques in the production line resulted in a noticeable reduction in operational errors and product defects. By introducing simple mistake-proofing mechanisms inspired by the quality philosophy developed by Shigeo Shingo, repetitive tasks became more reliable and consistent. Operators were able to detect incorrect actions immediately, preventing defective components from progressing through the system. This led to improved production efficiency, reduced rework and inspection time, and better

utilization of resources. Overall, the production workflow became smoother, with enhanced quality control and higher confidence among workers, demonstrating that practical error-prevention systems significantly contribute to near zero-defect manufacturing.

Discussion

The discussion of Poka-Yoke focuses on how mistake-proofing improves manufacturing reliability by preventing human errors before they become defects. The concept, introduced by Shigeo Shingo, emphasizes that errors are natural in repetitive industrial work, but defects are preventable when processes are intelligently designed. By embedding simple safeguards into tools, fixtures, or workflows, operators receive immediate feedback whenever an incorrect action occurs. The results highlight that mistake-proofing is more effective when embedded directly into routine operations rather than relying solely on post-production inspection Shown in Figure 2.

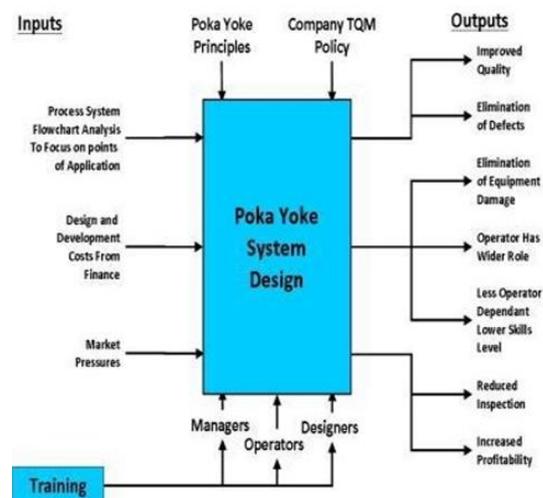


Figure 2 Poka-Yoke System Design

Conclusion

Poka yoke is one of the most important tool in TQM (Total Quality Management). Successful poka yoke results in increased productivity with minimum waste (waste due to rework, scrap) because we are sure about the quality of product, as mistakes are blocked at source itself. There may be some practical limitations in poka yoke but we have to overcome all that for achieving the aim of "Zero Defects, Zero



Waste and Zero Delays”. In one sentence poka yoke is launching preventive actions for systematic movement on the success ladder of QMS (Quality Management System) with higher level of performance and productivity of system with high quality products at minimum cost.

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