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A REVIEW OF POKA -YOKE: A STEP TOWARDS EFFICIENT QUALITY MANAGEMENT

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Abstract
This paper focuses on reviewing on process improvement in manufacturing industries to reduce bottlenecks and alleviate workers' work-related stress. It aims to introduce the Poka-Yoke technique to prevent errors on the assembly line, along with Kaizen, to boost productivity and improve overall performance. Poka-Yoke is a technique used to prevent rejection of made parts and increase productivity in liner manufacturing companies. It is applied to a cutting handling tool of a liner cutting machine to prevent liner mouth misalignment. Poka-Yoke is a tool for reducing human error in management and manufacturing processes, enabling producers to achieve their objectives by eliminating rejected products.
Keywords: Poka-Yoke, mistake-proofing, prevention, error detection, error prediction, planning, quality control, productivity engineering (IIIE).

I. Introduction

Poka-Yoke (PY) is a novel technique that was developed to improve quality and reduce the cost of mistakes. It has been studied in academic research, but there is still no formal definition. The authors of this paper are working on many projects to use LEAN principles and technologies in an effort to find a solution for mistake removal. Authors found that reviewing PY-related publications and books was really helpful in solving issues. Errors must be reduced to an absolute minimum and quality must be raised to a competitive level.

The designer's goal, practical knowledge, and the idea of PY as a LEAN tool were the main design elements that were applied to provide solutions for the problems that were seen. It was decided that PY research would be the best source to find the usual cross-section of sentiments in this area. The review's objective is to draw attention to those rational, widely accepted attitudes and actions that could be utilised to characterise PY. Furthermore, some of the paper's findings ought to be helpful in creating a PY design model, facilitating the development of solutions for diverse work processes more quickly. It is commonly known that sufficient equipment needs to be installed in order to recognise this.Any thought or system development in a general process of gainful administration that prompts the administrator to avoid mistakes (*yokeru*) is known as a Poka-Yoke. The fundamental idea of Poka-Yoke is to include error checking throughout the system, which implies that there is no room for mistakes. It eliminates flaws or defects at every step of the process.

Shigeo Shingo created this phrase in the 1960s to describe a component of the Toyota Production System. Poka-Yoke is intended to arrange the process such that errors may be quickly detected and corrected, eliminating abnormalities at their source.

The Poka-Yoke is a method for preventing workplace mistakes caused by people. There are two possible states in which a flaw or imperfection exists: either it has already happened, in which case defect detection is necessary, or it is about to happen, in which case defect prediction is necessary. The process is first examined for potential issues, pieces are identified based on their dimension, shape, and weight, and process departure from the nominal procedural norms is detected.

2.1 Methodology

There are three varieties of Poka-Yoke based on the fundamental functionality; these are explained in more detail below. [1]:

2.1.1 Shutdown Poka-Yoke
2.1.2 Control Poka-Yoke
2.1.1Warning Poka-Yoke

2.1.1 **Shutdown (Prevention)**

One kind of preventive technique is the shutdown method. Poka-Yoke gadgets monitor critical process variables and stop the process when a situation out off tolerance zone. This shows that errored product has either been produced or is about to be producing . It is commonly known that treatment is never preferable to prevention. [2]. We can guarantee that our products will be 100% defect-free by using the shutdown approach [1]. It has 0% likelihood of producing a defective product, thus we can rely on it. An example can be as the use of a fuse in an electrical circuit. Fuse operation stops the flow of electricity when there is a short circuit, preventing any additional accidents [2].

2.1.2 Control method

In the Control technique, Poka-Yoke gadgets, which are mounted on process equipment and/or work pieces and prevent the production of flaws and/ are regulatory in nature. Similar to the Shutdown method, quality control methods provide 100% defect-free goods [2]. The control ensures that, in the unlikely event of a problem, it does not leave the manufacturing line and does not reach the client [1].

2.1.3 Warning method (Alert)

With this technique, the operator is made aware that something is amiss. A worker can be informed that a problem has been made using Poka-Yoke devices, thanks to a simple mechanism or design. Operators are required to intervene in processes right away to fix the process(es) that are to blame for the issue when they receive such a notice. Despite receiving a warning notice, if an operator behaves irresponsibly, the next batch of products will still have the same flaw and produce non-conforming goods. In a nutshell, this strategy is dependent on the character and actions of people[2]. The alert approach provides 30% of the guarantee of high-quality items, as determined. In actuality, this approach indicates the presence of defects but does not guarantee and is not always of high quality. Common warning techniques include the use of blinking lights and blaring alarms[1]. For instance, the ATM machine may beep or flash when the user takes out his ATM card to let him know he is secure and to make sure the card is not still within the machine.

2.2 Implementation

A systematic approach to dealing with Poka-Yoke countermeasures includes a six stage analysis of the threats to be monitored [1]:

2.2.1 Problem identification

This phase involves gathering customer complaints from both internal and external sources. The number of customer complaints, the number of defects found by quality control, and the materiality of the defects are some of the criteria used to determine the standard. Following this, the data is broadly segregated. Based on the results of the data analysis, the company intends to create a Poka-Yoke system for the chosen issue. In this manner, the problem is implemented in the first stage.

2.2.2 Observation at work stations

The actual on-site investigation of the issue is done in this step. Using a fishbone diagram, which is a cause-and-effect diagram created by Japan's management guru Ishikawa, the causes of the issue are identified. The causes could have to do with a person, a machine, a material, or a technique; in such case, a thorough sorting is done.

2.2.3 Brainstorming for the idea

It is a technique to capture the creativity and skills of employees. The problem to be investigated in brainstorming is brought before the committee. All members then study the problem and propose

different solutions to avoid failure. Since each person has their own unique approach, this step ends up with multiple alternative solutions to the same problem.

2.2.4 Select the best ideas from the various alternative solutions

It's time to choose the best answer from all of the ones that were gathered. Selection criteria could include things like cost, time needed, modifications to the current system, chance to create new solutions, ease of use, etc. The committee arrives at one or more of the best solutions by referring all of the selection criteria.

2.2.5 Implementation plan

This step deals with planning for implementation. It addresses the need for materials, how those materials are processed, and how the manufactured mechanism is finally put into use at the actual working location.

2.2.6 Monitoring and sign-off

By inspecting the resultant goods under investigation for flaws and keeping an eye on the Poka-Yoke system's functionality, the project comes to an end.

Author	Area of implementation Automobile Industry
Connolly[7]	The car flash system, which has two robots on either side of the vehicle, enhances hand-held devices used during the car paint inspection procedure. Sensor detectors, smart cameras linked to a PC network for component tracing, and multi-angle spectrophotometers for colour examination enhance optical inspection robots. 100% of the inspection was completed.
Rajendra et al[8]	It was found that there was a problem with the way the retainer and stop ring were made between starter motors. To make sure that the right assembly procedures were followed, the team used sensors between the retainer and stop ring and fittings to replace the missing final pressing step. Laser sensors were used to detect the pieces' presence and the pressing head's movement. The outcomes showed that PY is capable of resolving problems caused by human error at every stage of assembly.
Yi and Yusof [9]	A broken plastic part that was fastened to an automobile's sun visor was one of the main problems that arose during the assembly process. Colour coding and the design of distinct parts and dimensions have improved workers' ability to self-inspect and find and eliminate additional assembly flaws.
Dano et al. [10]Deshmukh and Mandale [11]	In this case study, PY works for an automotive manufacturer of car seat skeletons in Poland and is responsible for installing a rubber seal on a mechanism that regulates the movement of the seat [69]. Double buttons for safety and warning signs were utilised for visual identification of the completed product, while PY was utilised as a laser and pressure sensor for part and position detection, slots, pneumatic actuators, and intelligent printers for printing barcodes. PY reduced expenses, time, and quality. Deshmukh and Mandale [44] provide another example of a car seat assembly problem that was resolved by a fencing device placed atop a conveyor to halt subpar parts that weren't up to par.

Author	Area of implementation Manufacturing
Saurin et al. [12]	By defining PY's attributes, the authors introduced a framework for evaluating the safety and quality of PY devices. Four case studies were used to test the framework. High-quality PY were used on the car axle polishing machine, which has a clamp with a hole-detection sensor and an end yoke component. When a worker places their hand or any other part of their body in the press area, a press machine's sensor is used to shut down the press. Additionally, the press machine's red and green lights indicated safety PY. Before packaging, a second quality PY checks the dimensions and placement of the brake pads. In this instance, PY is composed of three components: belt to transport the components
Tak and Wagh [13]	A straightforward and profitable PY device solved the punching machine's missing metal clip issue. The PY system used sensors, solenoid valves, and an electronic control panel to stop the compressor's air flow.
Kumar et al. [14]	Two case study events involving the Lean Kaizen concept's application in Indian SMEs are presented in this paper. To control the variation of slide cylinder grinding PY, a digital device was used to measure the distance between the wheel and the face. A dial indicator was used to show the position of the wheel slide. The outcomes showed improvements in product quality.

2.3 Example

The first automobile company to employ the Poka-Yoke approach is the Japanese car manufacturing giant – Toyota. Gearbox manufacturing and assembly as well as engine production for factories in its own group are the organization's two primary production sectors. The production of these high-quality components that adhere to quality standards and follow the principles of continuous improvement (Kaizen) is the primary goal. Use of Poka-Yoke tactics is one approach to implement a better strategy. They are especially helpful in businesses that are involved in the assembly of components and the production of parts, as an engine must have between 310 and 350 pieces.

2.4 Summary

Although it has been researched in academic circles, a formal definition is still lacking. By deploying LEAN techniques and principles on several projects, the authors of the current work intend to find a solution for mistake detection & removal. The designer's goal, practical knowledge, and the idea of PY as a LEAN tool were the three main design elements utilized to produce solutions for difficulties. The review aims to highlight those rational, widely held ideas and actions that might be used to characterize PY.Poka-Yoke's basic principle is to incorporate error checking across the entire system, which indicates that nobody can make a mistake.

II. Conclusion

The investigation's main goals were to provide a thorough analysis of the accomplishments in the PY field, as well as to explore novel theoretical perspectives on PY and the fight against errors in the workplace. The Poka-Yoke method seeks to reduce or eliminate human error caused by mental and physical flaws in management and manufacturing processes. Error independent elimination is the primary goal. This method's primary goal is to prevent errors by using a relatively inexpensive control system to measure how closely the product complies with the model.

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