

A STUDY ON IMPLEMENTATION OF POKA– YOKE TECHNIQUE IN IMPROVING THE OPERATIONAL PERFORMANCE BY REDUCING THE REJECTION RATE IN THE ASSEMBLY LINE

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ABSTRACT

In today's competitive world any organization has to manufacture high quality, defect free products at optimum cost. The success of any industry depends on quality of their product. During actual manufacturing of any product, different operations are carried out by operators .The whole production depends on operator mentality and their interest in work which ultimately causes silly mistake or errors by the operator. Rejection of manufactured product cannot be ignored now a days in manufacturing industry due to worldwide competition. To avoid mistakes in assembly line, poka-yoke mechanism plays an important role in manufacturing industry. In the present work, an attempt is made to identify the areas of improvement in equipment. Kaizen and poka-yoke are implemented to enhance the overall performance to increase the productivity. Why-why method of root cause analysis is used to eliminate the causes. This paper focuses on process improvement in a horn manufacturing company, using mistake proofing technique or Poka -Yoke. The study is aimed at providing process improvement ideas for existing bottleneck areas. The long term success of poka yoke gives output of saving time and can release work pressure in the minds of workers.

Key words: Poka Yoke, Process Improvement, Quality, Rejection, Productivity.

1. INTRODUCTION

Japanese management has always been a topic to be discussed and learned. All their works and innovations created large changes in the world of management. The systems were unique and useful. Though American system was developing in the 20th century, Japanese companies were booming. The Toyota Production System, which is so essential for understanding Japanese production management, can be seen as a technology-based, comprehensive production management system with the primary goals of increasing productivity and reducing costs (Monden 1983). This is achieved by reducing cycle time, increasing flexibility, reducing stock levels and shortening machine changeover times. The difference between the concepts of Lean Production and the Toyota Production System is that Lean Production (Jürgens 1994) was coined by the MIT researchers Womack, Jones and Ross and is used for any company in any branch of industry, whereas the term Toyota Production System refers to the production management system at Toyota, but includes basically the same elements.

1.1 New Forms of Work System Design

Many forms of work design were invented by Toyota management system. Most companies in the world are using them in their management systems. A term called 'Toyotism' is used in many industries. The company which is taken for the study also uses many such ideas to improve their existing system. One of the major management tools used in the manufacturing company is Poka Yoke.

1.2 Poka Yoke

Poka-yoke means "mistake-proofing". A poka-yoke is any mechanism in a lean manufacturing process that helps an equipment operator avoid (*yokeru*) mistakes (*poka*). Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur. The concept was formalised, and the term adopted, by Shigeo Shingo as part of the Toyota Production System. It was originally described as *baka-yoke*, but as this means "fool-proofing" (or "idiot-proofing") the name was changed to the milder *poka-yoke*. Each process is done on the basis of Poka Yoke to make sure that the mistake is eliminated from the starting itself. Therefore reworks can be

avoided. Poka-yoke gives a strategy and policy for preventing defects at the source. These solutions are not only cost-effective but also easy to understand and apply.

1.3 Need for Mistake Proofing

When any organization decides to implement the lean manufacturing then one of the objective is to reduce scrap because no one is interested to compensate extra inventory on account of scrap. Hence it is better to find root cause of any problem and avoid it which gives a defect free product. The main objective of this project on Poka Yoke is to study the existing issues in the company and how Poka Yoke is used to eliminate them. How Poka Yoke has become an important part in the working of a company is clearly explained here. Nowadays it is even important in day to day life to have error proof situations. In this project, recent rejection in the Barrier Audit stage is taken and Poka – Yoke is given as a solution to eradicate it. Barrier Audit is the final inspection stage before despatch. The term poka-yoke was applied by Shigeo Shingo in the 1960s to industrial processes designed to prevent human errors. Shingo redesigned a process in which factory workers, (Satish Thatavarti and K. Thammi Reddy 2017) while assembling a small switch, would often forget to insert the required spring under one of the switch buttons. In the redesigned process, the worker would perform the task in two steps, first preparing the two required springs and placing them in a placeholder, then inserting the springs from the placeholder into the switch. When a spring remained in the placeholder, the workers knew that they had forgotten to insert it and could correct the mistake effortlessly.

1.4 Methodology of Poka Yoke

Identify Problem
Observation at workstation
Brainstorming for idea
Select best idea
Implementation Plan
Implement
Monitor and sign off

Mainly there are 2 types of poka yoke:

1.5 Prevention-Based Poka-Yokes

Prevention-based mechanisms sense an abnormality that is about to happen, and then signal the occurrence or halt processing, depending on the severity, frequency or downstream consequences. There are two approaches for prevention-based poka-yokes:

- **Control Method:** This method senses a problem and stops a line or process, so that corrective action can take place immediately, thus avoiding serial defect generation.
- **Warning Method:** This method signals the occurrence of a deviation or trend of deviations through an escalating series of buzzers, lights or other warning devices to detect and solve defects

1.6 Detection-Based Poka-Yokes

In many situations, it is not possible or economically feasible to prevent defects, particularly where the capital cost of the poka-yoke mechanism, far exceeds the cost of prevention. The three categories of detection-based poka-yokes are as follows:

- **Contact Method:** This method detects any deviation in shape, dimensional characteristics or other specific defects, through mechanisms that are kept in direct contact with the part.
- **Fixed Value Method:** This method is used in operations, in which a set of steps is sequentially performed. The fixed value method employs automatic counters or optical devices and controls the number of moves, rate and length of movement as well as other critical operating parameters.
- **Motion Step Method:** This method ensures that a process or operator does not by mistake perform a step that is not part of the normal process. An example of this is colour coding of electronic components on drawings and totes to prevent using mixed or incorrect parts.

2. Objectives of the Study

- To study the impact of poka yoke implementation in improving the operational performance in assembly line
- To study the impact of poka yoke implementation in reducing the rejection rate
- To study the improvement in productivity while practicing the poka yoke system

- To analyze and suggest the scope of implementation of poka yoke system in various process

2.1 Research Design

- The research design used was descriptive in nature

2.2 Data Collection

- Primary Data: Interviews from employees
- Secondary Data: Rejection rate details from NC(Non - Conformities) department and Barrier Audit report

3. ANALYSIS AND INTERPRETATION

3.1 CASE 1: Family: FC4

Stage Name: Terminal connector bending and Mounting Bracket Assembly and Tightening

Existing Process: Mounting bracket assembly and tightening process is carried out after the horn is placed in the fixture and the terminal connector bending is done.

Existing Problem: Terminal Connector final bending operation is missing. Here the operator will carry out the mounting bracket assembly and process it to the next stage by performing the bending operation.

Solution Found:

Poka Yoke implementation:

A sensor was included in the fixture to ensure the housing in the fixture. Only if the housing was placed in the fixture air supply will be provided to the pneumatic gun for mounting bracket assembly. So here the operator is stopped from doing the mistake before it happens.

Type of Poka Yoke implemented:

Preventive type- This type of Poka Yoke will prevent the manual error. Preventive Poka Yokes are used to stop a line or process, so that corrective action can take place immediately, thus avoiding serial defect generation. So here without Terminal Connector Bending, mounting bracket assembly cannot be done.

Implementation month: January 2017

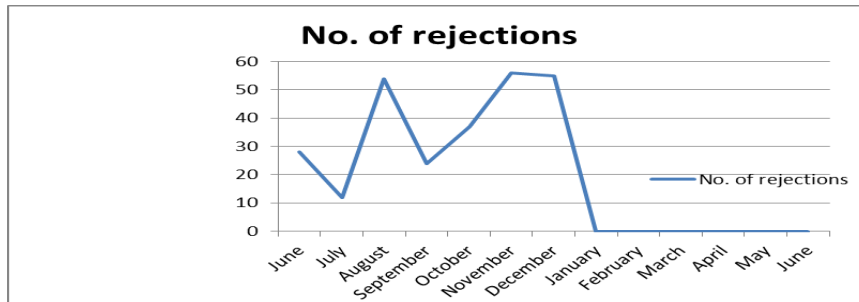
Table 1: Rejection rate before and after implementation of Poka Yoke

Rejection Rate			
Before implementation of poka yoke		After implementation of poka yoke	
Month&Year	No. of rejections	Month&Year	No. of rejections
June 2016	28	Jan 2017	0
July 2016	12	Feb 2017	0
Aug 2016	54	Mar 2017	0
Sept 2016	24	Apr 2017	0
Oct 2016	37	May 2017	0
Nov 2016	56	June 2017	0
Dec 2016	55		

Table 2: 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 2016	41054	January 2017	46504
July 2016	45894	February 2017	48757
August 2016	41879	March 2017	49422
September 2016	45980	April 2017	54935
October 2016	32345	May 2017	37745
November 2016	44908	June 2017	56789
December 2016	50367		

Chart1:Rejection rate before and after implementation of Poka Yoke



Interpretation:

From table1, it can be clearly seen that before implementing poka yoke the rejection rate was very high each month. 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 poka yoke can be proved.

Figure1: Sensor connected to fixture



As shown in the picture above, a sensor is connected to the fixture for implementing Poka-Yoke

3.2 CASE 2:Family: Windtone75

Stage Name:Air gap Measuring and Adjusting

Existing Process:Horn is placed in the fixture and air gap is tested. If not correct, adjustment is made by using adjusting screws, and passed to next stage.

Existing problem:Improper air gap - so the horn after testing is sent back for rework to adjust the air gap.

Poka Yoke Implementation:Shutter is provided in the conveyor system and inter-looped with ‘OK’/’NOT OK’ result. Shutter opens only when the air gap is ‘OK’ and closes when air gap is ‘NOT OK’.

Type of Poka yoke:Preventive –Onlyif there is correct air gap, it will go to next stage. Here the Poka Yoke is preventing the mistake to happen.

Implementation month:January 2017

Table 3: Rejection rate before and after implementation of Poka Yoke

Rejection Rate					
Before implementation of Poka Yoke			After implementation of Poka Yoke		
Month	No. of reworks	Delay in assy/day	Month	No. of Reworks	Delay in assy/day
Sept 2016	1009	30 min	Jan 2017	0	0
Oct 2016	600	16 min	Feb 2017	0	0
Nov 2016	1122	43 min	Mar 2017	0	0
Dec 2016	978	35 min	Apr 2017	0	0

Table 4: 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 2016	44400	January 2017	59034

July 2016	48932	February 2017	59823
August 2016	42098	March 2017	59030
September 2016	48903	April 2017	53902
October 2016	45093	May 2017	50020
November 2016	45083	June 2017	49030
December 2016	42042		

Interpretation:

From the table it can be inferred that before implementation of Poka Yoke number of reworks were very high. So it was taken as a major problem and Poka Yoke was implemented. The delay due to reworks in lines per day varied from 16 to 43 min. After the implementation both the reworks and time delay were reduced. The production rate is also increased. Each month there is a drastic increase in production, before and after implementation of Poka Yoke.

Major types of Poka Yoke used in each stage

Poka-yoke mechanisms stops / reduces mistakes from happening, thereby reducing the cost of scrap, rework and warranty claims. What's more, they let workers survey the whole assembly process and come up with ways to improve it. And most poka-yoke devices are simple and affordable. They include electronic devices that do not activate the assembly process until the right part has been installed in the right position as well as precautions such as changing the shape of the part or the fixture so that things could only fit together in the correct position.

1. Load cell provided with OK and not OK condition is an indicative type Poka Yoke. In this type, conditions are checked mostly using sensors.
2. Another mainly used Poka Yoke in each stage is coil continuity checking process. In this the coil is checked and only then it can be assembled on the housing. An Interlocking mechanism means that coil checking fixture is interlocked with the fixture of housing.
3. Pressure transducers check that the correct pressure is applied. These transducers check the pressure and shows a NOT OK or OK condition for the correct limited pressure.

4. To ensure that Teflon is present, Poka Yoke is used. Otherwise the operators will miss the rivets with Teflon and without Teflon.
5. Another important Poka Yoke technique is the SNAP gauge which will ensure that only one shim is used. The operator will pass the shim through the SNAP. In the SNAP also a sensor is provided which will ensure that this checking is done.
6. A gripper mechanism is used to control the contact point alignment.

Name of the line: F1

Products of F1 line:

ElectrominiN1, ElectrominiSM, ElectrominiN3, Vibromini(When production is high)

Problem found out in:

Barrier Audit Stage, where final checking is done before despatch. In this stage sampling is used for checking.

BARRIER AUDIT

This is the stage where final inspection is done before despatch. Quality checking is done by sampling. From every lot of 1000 numbers, 5 numbers are taken as sample. Here different instruments are used to check their physical properties and appearance. In this stage the final checking for continuity, current and voltage is also done. All results are marked in the Barrier Audit Sheet and the final option of 'Accepted' or 'Rejected' is marked in the end. Even if one observation is 'Not Ok', it is marked rejected. If one piece is rejected then the whole lot is rejected and is sent back for 100% inspection. Each horn is checked and rework is done. Again the lot is given to Barrier Audit. For Re-inspection barrier audit sample size will be 10 numbers for a lot with 1000 horns. Again if any 1 horn is rejected then the same procedure is repeated with doubling the sample size each time. In this audit, the problem of short circuit was identified.

Short Circuit Problem

- The vehicle's fuse will be blown and vehicle will stop if short circuit is found
- It affects the customers most
- Still problem exists and customers complain about the problem even after checking process is carried out.

Root Cause for the problem

- LCF(Leakage Current Flow) Meter is outside the tone testing chamber

- Short Circuit being checked in the final inspection stage
- Lack of Operator awareness

Existing system:

The horn is placed in the fixture and whenever the pedal is pressed, the horn can be removed from the fixture. After testing the tone at different voltages current is checked, pedal is pressed and horn is removed from the fixture and passed for final inspection. Here, the current is checked and along with that short circuit is checked using LCF meter.

Major Findings from the case:

Case 1:

From the above case 1, it can be clearly seen that before implementing Poka Yoke many direct and indirect losses were present. The operator just passed the horn without bracket assembly. This will result in the rejection of the horn in the final testing stage. Then it will be sent back for rework.

Indirect losses may be

- Extra Manpower – Workers have to carry the rejections to NC department. Extra manpower needed in the NC department to do the rework.
- Delay in delivery - This is because if rejections are there,despatches will be stopped till correct number of accepted products are available.
- Risk of not identifying the error and sending it to the customer.
- Time loss due to more reworks.

After implementing Poka yoke, the number of rejections has gradually reduced to zero.

Drawbacks of the system

Since it is just a sensor, even if the operators are showing their hand it works and passes to next stage.

Case 2:

From the 2nd case we can see that, the use of shutter will ensure proper adjustment of air gap. Earlier even if it is not having correct adjustment it was sent to the next stage. This will cause major problems later. Indirect losses may be:

- Extra man power- That is extra manpower needed to do the reworks.
- Waste of time – as to adjust the air gap the product has to be dismantled.
- Rework will cause the current line to be stopped for reworking
- If horn is passed by mistake, without the correct air gap the horn will have a defective sound.

Thus after implementing Poka Yoke the shutter will only open if the air gap is correct as recommended. This will result in avoiding the mistake even before it happens.

Drawbacks of the System

The shutter will be open always in some cases by switching off the power supply to the system. Thus the use of shutter will become useless.

Findings from the Problem

It was found that no Poka Yoke is used in the stage no.70, Horn tuning and testing. Therefore the short circuit checking is missed in this stage. The horn is passed to next stage without testing.

The horn can be removed whenever the pedal is pressed. This will cause the horn to be passed to next stage, In the next stage the horn is again tested for short circuit outside the testing chamber. Here there is a use of an extra manpower. The operator here also may pass it to Barrier Audit without LCF checking. This will cause serious problems. Since the problem was found out in barrier audit stage, the rework and rechecking has to be done for the entire lot. Since short circuit is the major problem it will be the best to be taken for the study.

Suggestions for case study findings:

Case 1 & 2:

The effectiveness of the implementation of Poka Yoke was 100%. There were no reworks or rejections after Poka yoke implementation. If both the applications are utilized better, then many other rejections can also be eliminated effectively. There is a possibility that the operators use methods to avoid the poka yoke application and hence steps should be taken to ensure that they use it strictly.

For the problems:

Inter-looping system with pedal

A Poka Yoke can be used by inter-looping the pedal and fixture arrangement with the LCF checking. The mistake proofing can be implemented before and after testing.

Before Testing-

After the horn is placed in the fixture only if LCF checking is pressed the horn can be released from the fixture.

After testing-

If the LCF meter shows NOT OK then if the horn is transferred to NC bin, next horn can be placed in the fixture. This will ensure checking of LCF always and avoid the extra worker needed for this purpose. Thus a major problem of Short Circuit can be avoided permanently using Poka Yoke or Mistake Proofing.

4. CONCLUSION

Management processes, their evaluation, monitoring and improving are most assisted by the eight fundamental principles of quality management and quality: methods, tools and techniques. The aim of Poka-Yoke is to eliminate or minimize human errors in manufacturing processes and management as a result of mental and physical human imperfections. For the main part, it is to eliminate errors independently. The main idea of this method is preventing causes, which may result in errors and use relatively cheap control systems for determining compliance of the product with the model. By this project, the impact of Poka Yoke in the company's quality maintenance was clearly understood. The horns in the company which are using Poka Yoke in their manufacturing have 100% effectiveness in reducing the rejection rates. The study of Poka Yoke has helped in understanding the ways of eliminating mistakes from the root itself and before it happens.

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