POKA-YOKE – ENDER'S GAME OR MISTAKE-PROOFING TOOLBOX

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Abstract: *„Ender's Game" is a movie with good performers. However, is it a beginning of a game or that is reality? Why we are especially fashioned for „poka-yoke" (mistake-proofing toolbox). The purpose of this paper is to discuss a research on poka-yoke toolbox as part of lean management and possibility for organizations to apply this instrument. Mistake-proofing is acknowledged like an easily and with minimum time and resource waste or the concept is applicable as part of more complicated and complex standards used by the management. The conclusions drawn from the conducted research, the presented arguments, methodology, results and guidelines can be structured in the following main directions per the objective and tasks set: 1) theoretical aspects of poka-yoke and lean management are analysed; 2) how to build procedures for better industrial organization model that defects are minimized or decreased to zero level 3) guidelines based on poka-yoke for improving company attributes in business organization are suggested.*

Keywords: *Poka-yoke, Lean management.*

Introduction

Poka-yoke is a special toolbox or method through which the defects could be quickly found. The concept is including the idea for „Zero tolerance" defects and the scope is including such type of production process, though which the defects are minimized and avoided during the production stage. Poka-yoke system is a simple smart concept, where the human mistakes are decreased at the lowest possible level. The method is using inline control, where the operator could be involved in the defects detection during the time of the production or transportation of the items (Figure 1). Poka-yoke is providing two type of detection – physical control by the operator during the production cycle or machine sensor used by the equipment and calibrated accordingly with the customers' demands.

Is it easy-to-apply by any companies or the toolbox relates to the implementation of the most complicated Lean instruments? Is the methodology able to define it correctly where are critical points for the production in aspect of the defects (Repeatability of the mistakes, Quality, requirements included in the Standard Operating Procedure handbook)?

This publication is aiming to identify how could be improved the quality in industrial enterprises. It is marking the possibility to decrease the defects starting from the process of incoming materials and reaching the final production. The paper is reviewing different directions how the process could be effective and to be gained the expected by the senior management results. The management skills and techniques are part of the successful implementation and they will be not underestimated as well. This paper marks issues, which should use as guidance during the implementation of poka-yoke methodology.

Theoretical background

Poka-yoke is developed and classified the methodology by Shigeo Shingo, although he was not the first one who is invented the idea. Most of the people are connecting the toolbox and a fool-proofing, however here is using any device, because after all every one of us could make a mistake [Liker, 2004].

As mentioned by [Nedyalkov, 2012] there are with some differences between the management of the industrial organizations in aspect achieving better quality and the proper management of service production companies. There is reviewed the problem between the front-and the back office giving an examples and key points how could be overcome the quality issue topics within the service provider's companies. The decision-making process usually comes from a dialogue about standardization, which builds understanding among employees of how they should do the work.

Bulgarian books and papers dealing with related topics will be used as a fundamental reading during the process of Lean implementation including the research about risk assessment and Lean implementation toolbox as [Yorgova, 2011; Yorgova, 2015; Yorgova, 2018]. For example, on one hand, in the book of [Naydenov & Nedyalkov, 2009] gives a framework for service management and how the same could be properly maintained in the service providing companies, [Kirova, 2011] apply data analysis for the innovation process and use graphical presentation of risk assessment in management decision-making process [Kirova, 2012]. The concept for operations (including innovations) management could be found in the research of [Vitleemov, 2013] as part of the general improvement of the company processes and in the books of [Nedyalkov, 2018].

The company should be able to read and use the collected data in aspect to direct the changes, which are needed to be implemented. The data and the pictures will be useful for standardization and implementation process in the easiest and quickly adaptive for the current organization way.

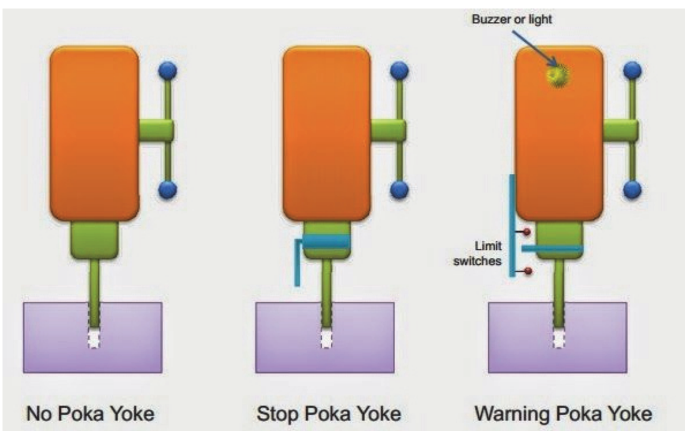

Figure 1. *Poka-yoke mistake-proofing example*

The mistake-proofing toolbox is aiming to identify and to create the path for zero-defects production models. The main concept is that within the technology of the production is created the receipt how to be avoided the mistakes during every single stage of the production cycle.

The purpose of poka-yoke toolbox is a) not to allow the defects to reach the next stage of the production; b) to be minimized and where possible not to be created defects; c) not to be accepted defects during the production stage.

The classification made by the founder of the concept Shigeo Shingo was that the control could be made through warnings (sound or lights, which are indicating the mistakes) and through control (which are physical check to prevent the defects).

Poka-yoke identify and clarify the difference between “mistake” and “defect”. The mistake, which is not repaired on time and reached the client is becoming a defect product, which is one of the main prevention targets of the toolbox. In some publications, the poka-yoke is classified mainly as quality toolbox as it was reviewed in the research of [Shingo, 1986].

The everyday examples of poka-yoke principles are everywhere starting with washing machines that won’t work with the door open, which prevents a laundry tsunami in your house. Child resistant caps for medicine bottles and chemicals are created to keep curious children from consuming the contents. Sinks in the bathroom and kitchen have overflow outlets to keep your house from becoming a swimming pool if the drain becomes blocked. Elevator doors have a sensor that causes them to open if there is obstruction. This prevents the squishing of objects, pets or people.

Poka-yoke principles could be quickly applied in the production process through installing additional lighting signals, sound alarms or through additional control done by inspectors. The main complex of the toolbox is to limit the mistake up to the level of foundation.

The concept is very universal and could be adapted very easily for different areas of the business without any additional cost except the relevant for the quality process. The project management nowadays is created very dynamically and the organization should be using all sides of the advantages which the Lean system is providing to them.

In this paper, selected quality problems connected with quality engineering, quality monitoring and quality process improving are selected and reviewed and are given suitable examples of different companies for usage of poka-yoke principles (Figure 2).

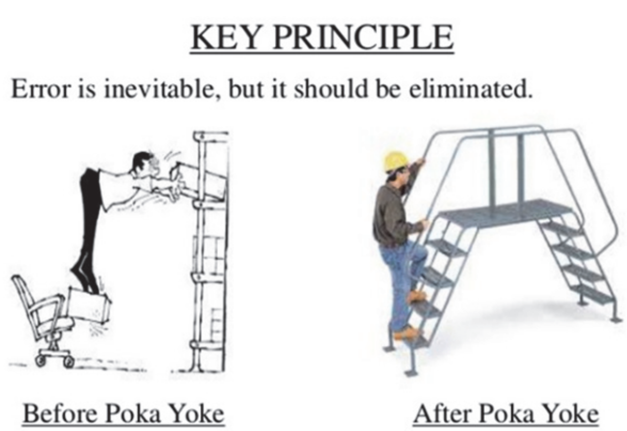

Figure 2. *Key principles of poka-yoke*

Practical application

Poke-yoke mistake proofing most commonly is performed by sensors with physical contact (Figure 3) or without physical contact. The advantage of the non-contact sensors is that they are photoelectric or inductive most frequently. The physical contact sensors were selected based on the areas of application, costs or the individual functionality of the work place.

Poka-yoke could be compared with quality controls, but the main differences between the both of them are within the level of effectiveness, as it was researched by the Nikkan Kogyo Shimbun & Factory Magazine, 1989):

- During the inspection – the inspector inspects (AQL principles, etc.)
- Informative inspection – use a system to monitor the process within the production
- Poka-yoke – inspection is done before the fact of the creation of the defects as a final goods.

Figure 3. *Poka-yoke sensor with physical contact*

The Quality control workers and the physical inspection could be not underestimated, they have their value and results but if one operator is checking 1000pcs, it is expected 100 of them to be missed. If the second operator is inspecting 100 pcs, he will miss only 10 of them. If we have third operator and he inspect the rest of 10 pcs, the result will be that it is expected to have only 1pcs, which is passed though the control with any kind of mistake. The result of 90% is still not the best one and not the most reliable.

Poka-yoke principles are functioning in three levels of control and detection of the production mistakes:

- Level 3– the production could be not done. This level is the highest possible in aspect to be avoid defective production during the operation process. Noncomplying parts could be not produced at this stage of poka-yoke. Good example for 3rd level of poka-yoke are the children puzzles – there is only one way two parts to be assembled. Is it real poka-yoke a child game which the most of the companies are underestimating or there is something much more complex? Most of the USB slots and other assembling devices operating on this level could be not mentioned if the both parts are not completely matching each other.

- Level 2 – there could be not possible to be assembled. This is warning level due to the fact that the production operator is informed for the non-compliance between the product and the technical data sheet. The announcement is made through lighting or sound signal, which is alarming the employee that there is mistake or defect in the product unit. The relevant side of the product depending of the level of the acceptance is turning on or turning off the lighting process within the production line (Figure 4).
- Level 1 – the unit should be not accepted or passed. The product is not allowed to continue forward in the operational process line.

Most of our everyday devices are equipped with error proofing system. Most of the cars have sound signal if the safety belt is not used. In another case, there is a lighting indicator on the car screen that we have open door during the driving process. All this poka-yoke toolbox is intended to prevent any defects/ incidents or injury during the usage of the equipment.

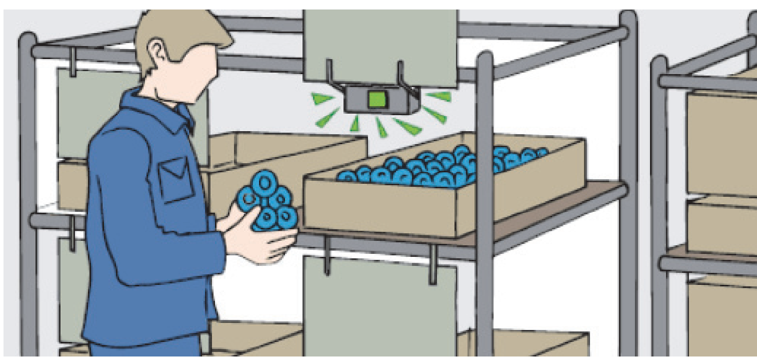

Figure 4. *Alarming poka-yoke device*

Benefits of poka-yoke application

The toolbox is mostly functioning to prevent the human mistake or to alarm for detection of any abnormal production units. Most of the mistakes, which are occurring in the production are result of human behaviors such as: misunderstanding; wrong identification; forget fullness; lack of experience; lack of standardization; unexpected errors; intentional errors, etc.

As a result of the implementation the technology not only the human mistakes are expected to be controlled and decreased but as well there is expected the training time for the employees to be decreased in a less time consuming frames. Rejection time of units should be decreased and quality is expected to be quickly improved.

The fundamental idea of the poka-yoke toolbox is that the work should be done by the first time, which means that all operations should be performed with zero tolerance defects in their operational cycle. If the company is planning correctly its production and the process is carefully monitored during all steps of the operations, poka-yoke (and lean concept in general) could bring a lot for their management teams.

Conclusions

In the paper is observed is it quick implementation process for the companies to start their collaboration of the lean principles and especially with poka-yoke mistake proofing. Could be managed the mistake proofing process and what type of benefits it is given after the implementation process. Some theoretical aspects are reviewed on the literature references, where the quality and lean methodology theory are analyzed. Benefits from the application of the toolbox are analyzed and the key points important during the implementation process.

Based on the presented literature analyses, theoretical and practical examples it is found that the company quality presentation could be improved through the poka-yoke in every small and medium-sized organization and it is expected to give a real result in a short-term period. The toolbox is transforming the situation in competitive advantage showing to the customers and the stakeholders' good business behavior, good manufacturing practices, lower level of accidents, better Health & Safety culture and minimum time waste. The poka-yoke set is giving to the companies a better morale and reputation within the customers. For more of them the quality is an essential point from the business collaboration and that is why it is crucial to be developed a partnership based on loyalty and good production practices.

If it could be marked another advantage of poka-yoke, it is decreasing the hidden costs created during the production cycle. One of the most underestimated of them is eliminating the cost for re-work of the wrong parts, waiting for eliminating the mistakes in wrong assembling or packing etc. Sometimes the same operation could be rework twice due to missing information before the starting process in the very beginning. Eliminating the errors or the potentially risky situation in the workflow is generating great extent and better management control of the wastes.

Some of the companies marked as a big issue and disadvantage of the concept that zero-defects is practically not easy possible to be achieved. That is because it is impossible to eliminate completely the human errors in all stages from the beginning till the end of the production workflow. Some of the factories claimed that it is more abstract and hard to be applied completely.

Based on the experience it is established that not all defects and mistakes are equal as consequences. The goal of the poka-yoke principles is at least to minimize the level of this defects, which will be critical for the company reputation, image, quality costs or team environment.

It is established that to invest in poka-yoke mistake proofing toolbox as part of the Lean management program is a step in the direction to be more competitive and business pro-active. Every company could be a leader only when the same knows how to maintain effectively the costs, the defects and the level of the innovation within the technological operations.

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