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ANALYSIS OF REASONS FOR NON-COMPLIANCE USING THE QUALITY MANAGEMENT METHOD. CASE STUDY

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Katarzyna Midor[1] – *orcid id: 0000-0001-5680-7354*
Witold Biały[1] – *orcid id: 0000-0003-2313-0230*
Greg Galecki[2]
Wes Grebski[3]
[1] Silesian University of Technology, **Poland**
[2] Missouri University of Science and Technology, **USA**
[3] The Pennsylvania State University, **USA**

Abstract: Companies should constantly seek the causes and sources of irregularities. For this purpose, known and widely used quality management methods and tools should be used. Thanks to them, organizations will be able to identify key irregularities and then seek solutions for correction and improvement. Achieving high reliability of products, companies are able to fully meet their consumers' needs. The paper explains the basic concepts related to quality. However, the most important issue is to present an example of solution using the Poka Yoke method, for an electronics company. The company specializes in the production and development of electronic and electromechanical components, for industries of different categories: household appliances, energy, automotive. The presented solution for improvement concerns modernization of workstations**.**

Keywords: quality management methods, quality management tools, Poka Yoke

1. INTRODUCTION

Most organizations strive to achieve a significant position on the market. In order to achieve these goals, companies should provide services that fully satisfy their consumers. As far as enterprises are concerned, regardless of the type of products/services offered, the quality of products should come first. However, it often happens that customers experience dissatisfaction with the product or service they have received. In such situations, customers return the purchased goods.

Companies strive to achieve a high position on the market and are focused on the highest possible profits. For this purpose organizations should guarantee services that fully satisfy their consumers. However, there are situations when even regular buyers of a given company experience dissatisfaction with the service or product received. As a result, customers have the right to return the purchased goods. The return is understood as a quantity of the same product, returned by the customer in relation to

the complaint. In such a complaint, the customer indicates the demands with regard to handling the purchased factory.
The customer's satisfaction is defined as the perception of how much and how his expectations have been met. For each organization, regardless of the type of products/services offered, the quality of products should be given priority. The paper presents examples of non-compliance of electronic products, which may be the cause of complaints. By using quality management methods and tools, the key irregularities will be identified. It is important, above all, to find the causes of errors/defects.
The paper presents an example of solution using the Poka Yoke method, for a company in the electronics industry. The company specializes in production and development of electronic and electromechanical components for industries of different categories: household appliances, energy, automotive. Solutions for improvement will concern modernization of workstations.

2. THE CONCEPT OF QUALITY AND IMPROVEMENT

Quality is defined in several ways. The easiest way to define quality is to meet the customer's needs and expectations, providing what the customer needs for the right price (Hamrol, 2008). Products, produced by given organizations in appropriate technical conditions, are usually of good quality. Otherwise, if such conditions are not met, the product will be of poor quality (Skrzypek, 2000). Three characteristics can be distinguished, determining the product quality (Karaszewski, 2001):

1. Functionality, the components of which are e.g. standardization, technical efficiency, modernity,
2. Usability of the product, which consists of efficiency and reliability of use,
3. Social utility, where the key concepts are: operating conditions or quality uniformity.

Organizations should, above all, constantly recognize the customers' needs with regard to quality. Not every buyer of a product is guided by price, but by quality criteria. Most often customers value comfort or safety (Łunarski, 2008), (Lock, 2002), (Sujová and Čierna, 2018). In the situation when companies offer low quality products, customers resign from the offers of given organizations. The most important thing for the customer is to select the product or service in such a way that it meets their expectations (Bank, 1999).
Quality improvement can be defined as a set of measures. Activities that are interdependent and after the introduction of such activities, the product will be better. Thus, improvement is a change of state – the state in which at a given moment the object is. By introducing such a change, a given object is to achieve better or new, or initial properties (Wolniak and Skotnicka-Zasadzień, 2008), (Hamrol and Mantura, 2002) .

3. CONCEPT OF NON-COMPLIANCE

The word non-compliance is undoubtedly associated negatively. With regard to a product, a non-compliance can be defined as a failure to meet predefined requirements. The product does not fulfill the functions defined e.g. by the customer's expectations or the standard. In order to detect non-compliances, companies take action to determine the reasons for such a state. Organizations subsequently plan actions aimed at reducing or completely eliminating the resulting non-compliances. In order to determine

whether products meet the requirements, they should be subjected to quality control (Bank, 1999), (Hamrol and Mantura, 2002). Categories of non-compliance:

- systematic – defects detected in the quality management system,
- accidental – the requirement is not met, but without major consequences.

Qualification of non-compliance:

- minor non-compliance – an isolated, proven case of non-compliance,
- large (critical) non-compliance – a defect of the whole system, systematic non-compliance, possibly a significant number of non-compliances with the quality management system requirements.

Documentation of non-compliance requires:

- indication of the requirement which has not been fulfilled,
- determination of what the non-compliance is,
- indication of evidence.

Reference to the requirement should be precise. The wording of non-compliance should be obvious, unambiguous, concise. In turn, the evidence must be documented and sufficiently detailed. If a non-compliance is found, corrective action (e.g. removal of non-compliance) and preventive action (elimination of the cause of non-compliance) shall be taken. Once the actions have been taken, their effectiveness must be verified. There should be objective evidence of full implementation of the corrective action and its effectiveness (Jagusiak-Kocik, 2016), (Juszczak, 2012), (Kowalczyk, 2010), (Dudek-Burlikowska and Szewieczek, 2009).

4. POKA YOKE

A number of methods and tools are used in quality management. They are used to solve quality problems to assess product, its parameters, its quality, its production process, which appear in industrial enterprises. The methods and tools should be used not only to seek non-compliance but above all for improvement.

One of the methods that can be used for improvement is Poka Yoke. This method is aimed at reducing human error. Using Poka Yoke makes it possible to prevent causes that can lead to errors. Human errors are not only the result of low competence, but often also of thoughtlessness or lack of concentration on the part of employees. There are also situations where the lack of procedures, e.g. at a given workplace, contributes to this. Using the Poka Yoke method, the number of errors and effects decreases, and thus the costs of repair or disposal of defective products decrease. Moreover, it also contributes to the increase in the quality of products manufactured by enterprises (Łuczak and Matuszczak-Flejszman, 2007), (Grudzewski and Hajduk, 2004), (Skarga and Kądzielawa, 2017). Four principles can be distinguished within the Poka Yoke method (Łuczak and Matuszczak-Flejszman, 2007), (Hetmańczyk and Michalski, 2014):

1. Control at source, i.e. paying attention to the capabilities, skills of employees, materials used, documents and deliveries.
2. Use of 100% control, i.e. visual control or using simple devices.
3. Implementation of control into the process and its recognition as part of the process.

4. Awareness that people make mistakes and the use of adequate Poka Yoke protections.

In terms of application and function, the following methods can be distinguished, which will prevent errors:

1. Setting function (Łuczak and Matuszczak-Flejszman, 2007):
   - Contact method – devices detect product non-compliance by contact or lack of contact between product and device sensor.
   - Constant value method – non-compliances are detected by verifying the number of movements or elements, in operations that require a fixed number of repetitions or the use of a specific number of elements.
   - Step motion method – non-compliances are identified when a specific motion will be performed at a specific time or in a specific order.

2. Regulatory function (Łuczak and Matuszczak-Flejszman, 2007):
   - Control method – in this method it is important to stop the machine when a defect occurs. The subsequent defective component should be corrected or eliminated before the machine restarts.
   - Warning method – this method uses an audible alarm or light signal. The purpose of this is to inform operators about the defect.

5. PRACTICAL APPLICATION OF POKA YOKE

The company of electronic industry with its seat in Silesia is a part of an international corporation of 13 plants located around the world. The organization specializes in the production and development of electronic and electromechanical components for industries of different categories: household appliances, power industry, automotive industry. The company's customers are the most recognizable producers on the market in such industries as:

- Household appliances include such brands as LG, Indesit, Electrolux, Samsung or Whirlpool,
- Automobile industry include e.g.: Fiat, Citroen, Valeo, Denso, Bentley, BMW, Ford, Volkswagen or Ferrari.

Groups of customers from other sectors:

- motorcycles and scooters department: Harley Davidson, BMW, Yamaha, Ducati, KTM,
- HVAC department (ventilation, air-conditioning, heating) is e.g.: Bosch, Fugas, Ariston, Vaillant,
- energy department: Enel.

The paper presents an analysis of selected components from the field of household appliances. One of the electronic components produced in the company in question are PCBs, used in everyday equipment. On their example, a non-compliance analysis was conducted. An example of one of non-compliance is presented in Figure 1.

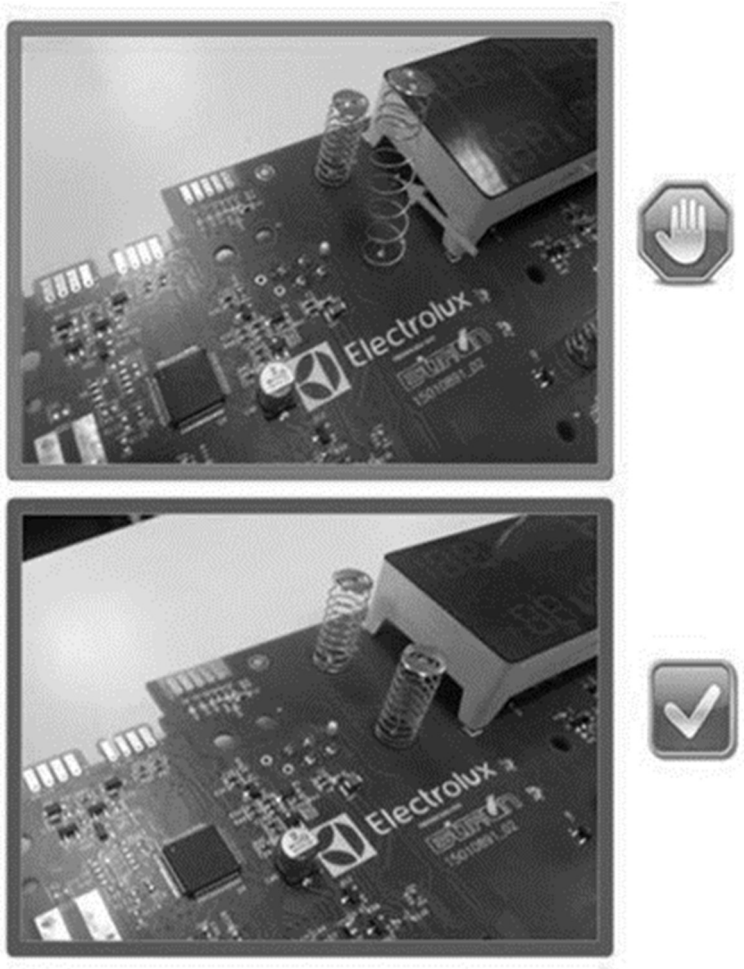

Fig. 1. Example of non-compliance – stretched button spring
Source: (Company materials, unpublished)

However, examples of the most common irregularities in PCBs are presented in Table 1.

Table 1
Examples of irregularities in PCBs

Lp.	Irregularities
1	Incomplete assembly – missing component
2	Component elsewhere
3	Inadequate component height after assembly
4	Tin spillage on the PCB
5	Assembly of a component of another type or value
6	Holes in solder
7	No solder
8	No overflow
9	Tin residues under the PCB
10	Wrong component polarity
11	Labels adhered in the wrong place or curved
12	Incorrect identification labels
13	Label inverted 180 degrees
14	Factory damaged plastic component
15	Damage to the label during adhesion
16	Incorrectly composed plastic parts, version confusion
17	Mechanical damage to plastic parts

18	Damage to the PCB during assembly, screwing
19	Label adhered in the wrong place
20	Incomplete screwing of the device

For the company in question, within the Poka Yoke method, solutions have been developed which, once implemented, can make it much easier for employees to carry out their tasks and, above all, will prevent irregularities in the produced details. In the company, errors created during the production of electronic products are the result of human error. However, it is not always caused by inattention or oversight. This is most often due to bad organization of the workplace. Therefore, five Poka Yoke solutions concern modernization of workstations in order to increase effectiveness of performed activities.

The first solution concerns proper preparation of a workstation for the operator. Currently, it is very often the case that containers with parts are not set up sequentially, where the consequence is mistakes in the selection of parts. Therefore, the order in which containers are placed is important, which will suggest the order of assembly of given parts. This is a simple yet inexpensive change that should certainly have the desired effect. This type of solution will allow for quick and efficient assembly of parts. In addition, it will eliminate the inconsistencies associated with poor assembly. The proposal of this solution is presented in Figure 2.

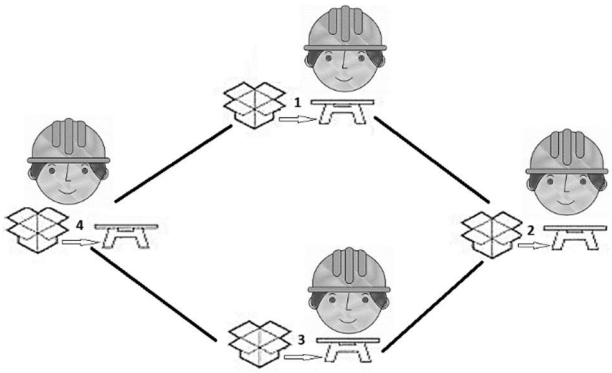

Fig. 2. Poka Yoke – the right operator position

The next proposal within Poka Yoke also concerns manual assembly and container placement. The order is crucial. As before, a small modification is able to make the work easier for operators and reduce the occurrence of defects in the details. Containers with components should be placed in front of the operator from left to right. This will allow the operator to reach for the components in the right order. The modification proposal is shown in Figure 3.

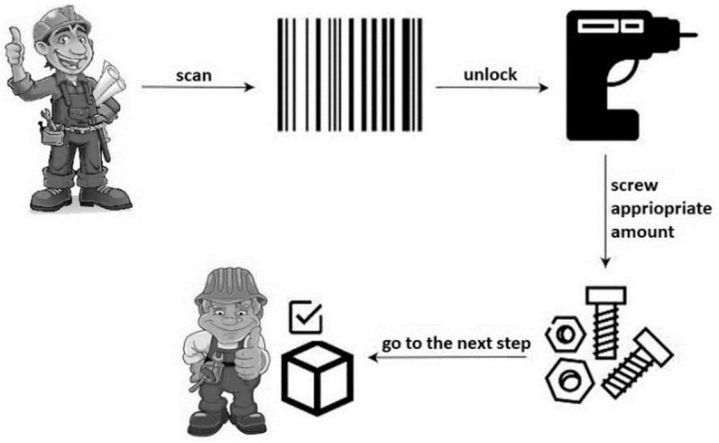

Fig. 3. Poka Yoke – containers position

Another possibility for improvement is to specify the number of movements to be made by the operators. The process should be set in such a way that if, for example, the operator does not scan the label first, the screwdriver will not be unlocked. It is often the case that operators screw too few screws into the workpiece. This process should definitely be improved. If the operator only screws three screws instead of four, he will not be able to proceed to the next step at the workstation, e.g. to print a label on a cardboard box. The operation described is shown in Figure 4.

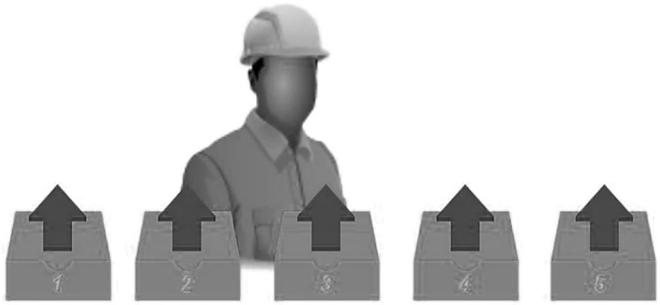

Fig. 4. Poka Yoke – indication of the number of movements

The next solution, using the Poka Yoke method, is to prevent any mistake earlier. In a company, one of the departments often makes mistakes – errors due to incorrect arrangement of details in the press. Avoidance of such errors is possible by proper selection of the mould. The press for crimping, welding of given parts should be constructed in such a way that the operator cannot insert the parts in another way. The importance of eliminating such mistakes is precisely the properly prepared mould. Only one setting is correct. Otherwise the press will not clamp. The solution is shown in Figure 5.

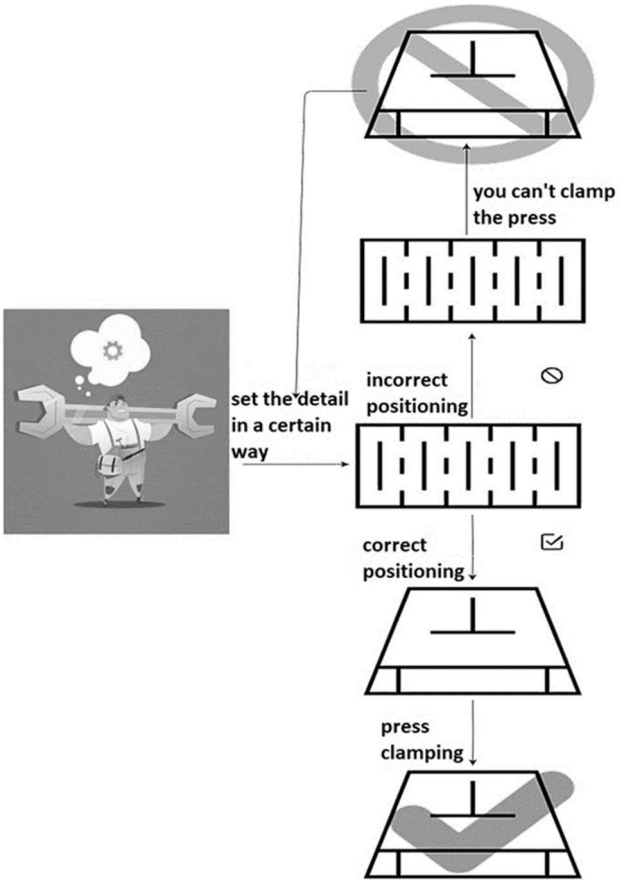

Fig. 5. Poka Yoke – preventing confusion

The last stage in the control of an item correctness is the proposal presented in Figure 6. The idea of this solution is as follows. On the line, after the components have been assembled, when a complete board passes through the stove, an audible alarm is activated when an error is detected. In addition to the audible alarm, a visual alarm can also be triggered, e.g. by lighting the lamp in orange.
At the visual inspection station, the elements that would not pass the test would be considered defective. This type of operation, in contrast to the previously proposed ones, would take place without the operator's involvement.

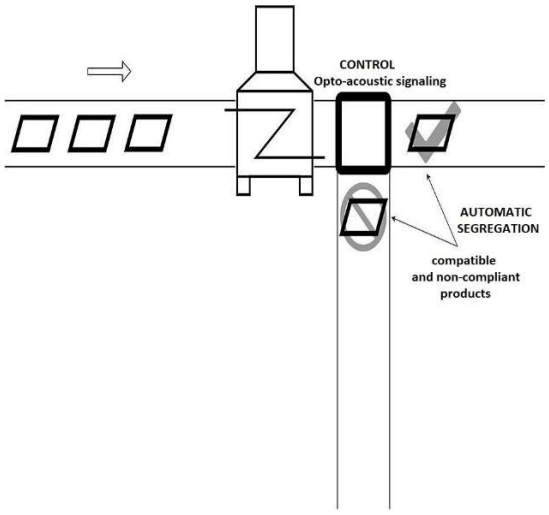

Fig. 6. Poka Yoke – automatic segregation

With the Poka Yoke method, it is possible to improve the process or workstation. In the selected company, irregularities that are caused by operators' errors prevail. Seeking opportunities to avoid such irregularities, it is not necessary to incur high costs. The presented solutions are characterized by simplicity and concern mainly good organization of the workplace. It should be noted that all types of possibilities for correction, prevention or improvement should primarily be presented by operators. It is the operators who spend most of their time on workstations. Operators are able to indicate what is the cause of defects in products. The company should implement the suggested solutions in order to reduce the occurrence of defects.
The presented solutions do not require high costs, while of course, there are also more expensive improvement opportunities that can be used.

5. CONCLUSION

A company that produces electronic products constantly strives to improve the efficiency of its services/products. The analysis was based on non-compliance of products, which were the most frequent reasons for complaints. Through the search for causes of defects and then introducing corrective actions, the organization is able to reduce the number of received returns. It is most often the case that the causes of defects in electronic components are caused by human error. However, this is not always due to inattention or oversight. Organizations, in order to maintain their customers and acquire new ones, should constantly monitor the production process to search for the cause of errors. After identification of such causes, measures should be taken to eliminate them and improvement actions should be implemented.
An important role in the improvement of an organization producing electronic products could be played by the proposed solution using the Poka Yoke method. Therefore, a proposal has been presented that does not require any costs to be incurred and can be implemented immediately. It is enough to properly organize workstations in order to avoid mistakes in the selection of parts when completing products. This will not only eliminate the resulting non-compliances, but above all will make the operator's work easier and more efficient.
The implementation of proposed solutions may undoubtedly contribute to the increase of efficiency and company development.
Another solution may be automatic segregation of products. Although it is a very expensive solution, it will certainly simplify product inspection. A large part of the irregularities that have arisen are due to human error. In such a situation, the automation proposal would eliminate the operator's participation in this activity. However, not every organization is able to invest in this type of solution.

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