QUALITY CONTROL MEANING IN PRODUCTS AND PROCESSES IMPROVEMENT

MONOGRAPHY

EDITING AND SCIENTIFIC ELABORATION

STANISŁAW BORKOWSKI

PIOTR SYGUT

Chapter 7

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POKA-YOKE METHOD USED IN TAPE QUALITY IMPROVEMENT PROCESS

Abstract: Principles of quality management are guidance in creating organization's quality policy. In the context of increasing competitiveness an essential element which must be fulfilled in the organization, which is also the 5th quality management principle, is continuous improvement. The company will not be able to reach the state of not needing an improvement of some kind. It is true that all the elements of the structure of the organization require continuous improvement. The concept was borrowed from the so-called Deming diagram (PDCA cycle: Plan - Do- Check- Act), which includes the following steps: planning, implementation, checking and correcting, which are carried out continuously, leading to the increase of effectiveness, efficiency and quality in the study area (WAWAK S.2006). A variety of tools can help to diagnose different elements of business actions. Their use is a preliminary step before taking improving and corrective actions.

Key words: poka yoke, tape, Ishikawa diagram.

7.1. Research methods

The purpose of manufacturing and service companies is to provide a product to the customer that will be in accordance with his requirements. Any situation that causes the merchandise not to meet purchaser's expectations is the reason for the manifestation of loses as

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either real or hidden costs (indirect costs) such as the loss of confidence of the customer. To prevent from such situations appropriate techniques and methods of quality management can be applied. The nature of quality tools stays in a strong correlation with the type of production and the scale of it.

Pareto-Lorenza and Ishikawa Diagram

Analysis of the situation in the company is the first action that must be taken to begin corrective action. Quality tools suitable for the preliminary examination may be for example the Pareto- Lorenz (P-L) or/and Ishikawa diagram. The P-L diagram allows gathering all of the incompatibilities in the form of readable table and a graph. In practice, the most common situation is one when only a small amount of the mistakes made generates most of the cost. In the model case illustrating the Pareto principle, 20% of the causes generate 80% of the effects. The ranking order of non-compliance indicates indirectly the corrective actions that should be undertaken. However, putting the issues in such ranking order is not the solution of the problem.

An instrument used to rank the causes of any defects which is also used to illustrate their relationships is the cause-and-effect diagram. This tool has several varieties that are adapted according to the skills and experience of the task team. Cause and effect diagram can be presented in the following ways:

- 5M (Man, Machine, Method, Material, Management),
- 5M + 1E (Man, Machine, Method, Material, Management, Environment),
- 7M (Man, Machine, Method, Material, Management, Measurement, Money, Environment),
- 5S –which is used in service industry (Surroundings, Systems, Skills, Suppliers, Safety) (PIEKARA A., DZIUBA S., KOPEĆ B. 2012, ŁUCZAK J., MATUSZAK-FLEJSZMAN A. 2007).

Poke yoke system

Japanese poke-yoke system is based on the principle of creating conditions that would allow avoiding errors. Over the years the system has been defined in many different ways (Table 7.1), but it did not substantially change the assumptions made by Shingo S. (SHINGO S. 1988). Main idea of the poke yoke method is that human errors are to be blamed for all of the occurring defects. As a result it was established that the best way to eliminate the problem would be if a mechanism could be installed that would alarm the employee of the possibility of error occurring and would, where possible, prevent or eliminate the error. Any industrial process can be facilitated by the use of the poke yoke method however it is usually used in a situation where repetitive actions are occurring that could trigger the potential man made mistake (VAN SCYOC 2008).

Table 7.1 Poka-yoke definitions

Author	Definition
Shingo S.	a mechanism for detecting errors and defects, which inspects 100% of the pieces, working independently on the operator's attention span
Grout 2007	the use of process or design features to prevent errors or the negative impact of errors
Middleton 2001	the systematic practice of eradicating errors by locating their root cause
Plonka 1997	a mechanism for detecting, eliminating, and correcting errors at their source, before they reach the customer

Source: Saurin 2012

7.2. Characteristics of the researched product

Tape is a specialized adhesive film with acrylic glue; the carrier is a silicone paper. The product is usually used in the paper and printing industry, as bonding tape (sheets of paper or paper into coils, foils, films, textiles) or an adhesive layer for attaching (foams, posters, large-format photographs, metal and plastic labels and business cards). Due to the properties of the adhesive - medium strong, with a high initial adhesion and good durability in time, the tape may have a multitude of uses (combination of metals, glass, wood, paper, painted surfaces, and many plastics), depending on customer needs.

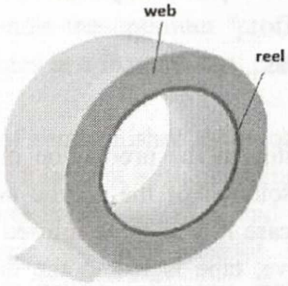

Fig. 7.1. Tape.

Source: producer materials

The product intended for sale must have a certain width and length of the roll of ribbon. According to the manufacturer's specifications:

- dirt and debris are not permitted on the roll as well as damage, cuts, scratches, indentations on the edge of the roll,
- the presence of small scraps of material on the cutting edge,
- unevenly wound tape layer with a constant deviation in one direction,
- gaps between the layers of tape wound,
- curved outer edges resulting from too much tension in winding,
- coil may extend beyond the wound band of ± 1 mm.

Table 7.2 . List of raw materials

Basic materials	Additional Materials	
-Silicone infused paper with defined weight and thickness -The acrylic adhesive base as defined in the specification of viscosity and solids content of 18 - 23%.	-Foil sleeve of established measurements -Paper coil of established measurements -Paper interleaf of established measurements	collectivebox Label

Source: Personal research based on provided information

7.3. Production process

Coating is the first step in the production of adhesive film. It is the process during which a solution of the acrylic adhesive is applied to the adhesive carrier - in this case it is silicone infused paper. Immediately after application of the adhesive, tape is led to the drier, in which, under the influence of temperature, evaporation of the solvent contained in the solution takes place. Solid substances remain on paper. The products of this process are the roles of tape, with applied adhesive. Roles are taken down using hydraulic jacks and stored in suitable metal stands, and then transported for further processing.

Acrylic base adhesive is provided by an external supplier, it arrives in the barrels. It is a solution of the substance constituting in its' core of solid product in an organic solvent. In order to liquidize the adhesive prior to administration, it is brought to the pallet station. An adhesive coating is applied to head by a system of membrane hoses and pumps. Silicone infused paper is supplied by the manufacturer on pallets in the form of rolls assuming that the machine is using hydraulic jacks.

Coating is performed using the coater consisting of 4 basic parts listed in points 1-4.

1 Unwinding - a place of loading the input material (paper), adjustable parameters in the process at this point: strings unravel - a web of paper must be sufficiently tight so that the paper is not wrinkled, does not get torn apart and so that the glue does not run down.

2. Coating head - a place of applying glue on paper; adjustable parameters in the process at this point: the thickness of the adhesive layer - too thick or too thin adhesive coating has a negative effect on altering the material in the next step of production.

3. Dryer – the step of evaporation of solvent from adhesive; adjustable parameters in the process at this point are: temperature, usually dryers are divided into identical sections, each of them has a separate temperature control in order to determine the optimum "profile" of the temperature at which the solvent evaporates in a manner that produces optimal product for further processing.

4 Winder - a place of semi-finished downloading machine, adjustable parameter in the process at this point is: the winding strings.

The values of parameters are specified and regulated by the internal manufacturing instructions.

At this stage of production following quality defects may occur: inadequate thickness of the applied adhesive resulting at a later stage of processing in the adhesive adhering to the cutting blades (too much adhesive), or formation of the places where the evaporation of the solvent there remains a layer of adhesive film called "no glue areas "(too little glue) and contaminants that can hit the tape from the air or the environment (such as dust, pollen, insects, small pebbles).

After eliminating the defects or determination of their deficiencies the intermediate is converting. Tape from the coating machine goes to the cutting machine (called slitter), which cut large rolls into less of the desired width and length, this step takes place as the final test, the quality of the product and its packaging in wrapping. Input material spreader rolls are delivered to the site by using handling equipment (forklift trucks). Additional

raw materials and supporting materials can be found on the shelves at the positions of cutting machines and are taken directly by the operators.

The cutting machine is made of slitter, rewind and unwind. Unwind - a place where inputs are loaded (intermediate from the coater), adjustable parameters at this point are the strings unwinding. Slitter (cut length) - the place where the web (web) width of the input material is cut with adjustable blades into strips of desired width, adjustable parameters in the process at this point is: pitch blades. Rewinding machine - the place where the cut strips are wound onto the target coil, and at a given length of cut and packaged, the adjustable parameters in this process include winding strings, the length of the wound roll. The values of parameters are regulated by the internal manufacturing instructions. At this stage following quality defects are possible to occur: dirt and debris on the reel, damage, cuts, scratches, recesses on the edge of the roll, presence of small scraps of material after cutting the edges, unevenly wound tape layer with a constant deviation in one direction, the gaps between the layers of the wound tape, curved outer edges under the influence of too much tension applied at the reel.

After removing the above defects or declaring that no defects have occurred, product is boxed and prepared for shipment. This is the last step in the manufacturing process, finished rolls are downloaded from the machine and are subject to quality assessment (measurement and visual evaluation) and then packed in small packs according to the packing standards. Each of the rollers are separated from the other using paper inserts to prevent them from sticking together, the entire batch is secured by plastic sleeve to protect the product against the potential negative impact of exposure to atmospheric conditions. Label is placed on the wrapper providing identification and traceability. Packed product is stacked on euro pallets. Rolls, after the amounts corresponding to the client's order have been accumulated are placed on the palette and wrapped with stretch film to secure cargo in transit. Transport documents are filled in (product, quantity of items, customer number, order number and destination) and passed to forwarding.

At this final stage of production, quality defects likely include improper labeling (the product in a wrapper with an identifying label being inadequate) or incomplete number of rolls inside the wrapper.

7.4. Analysis of defects

Assessment of the finished product, which is performed by the staff, allows detecting non-conformities of the final product which generate quality costs. Possible errors are presented in Fig. 7.3. The Ishikawa method was applied to present possible reasons of non-conformities (Fig. 7.3, Fig. 7.4)

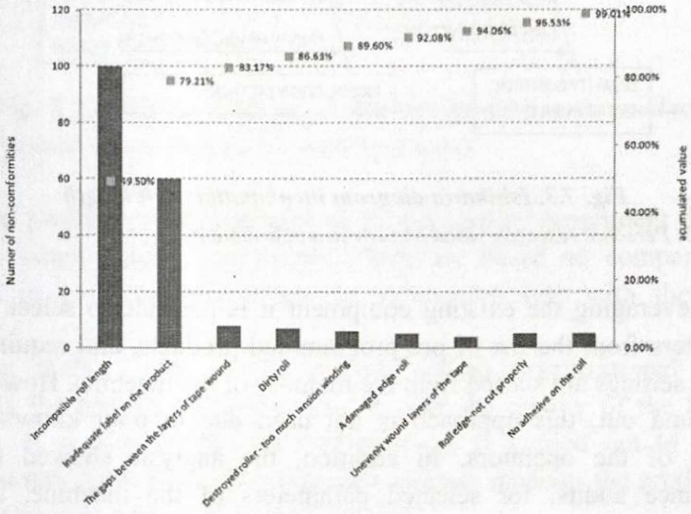

Fig. 7.3. Pareto-Lorenz chart

Source: Personal research based on provided information

Nominal length of the roll of tape is entered manually by an employee operating the machine. The employee also has other duties which may cause errors and unnecessary process variability. The machine

that is used to perform this operation offers the functionality of the programming of various parameters such as length for different products.

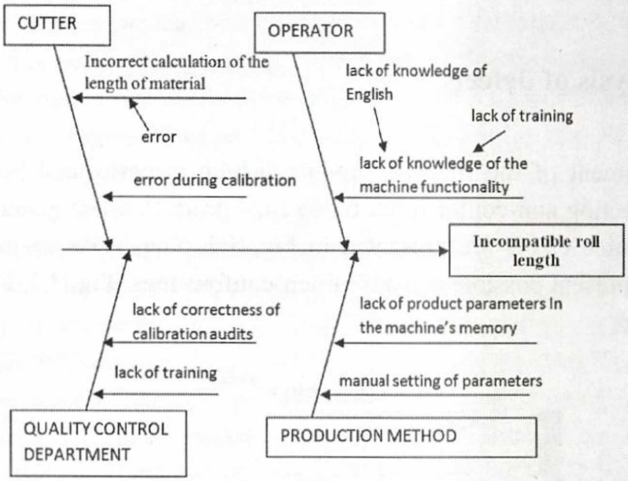

Fig. 7.3. Ishikawa diagram incompatible roll length

Source: Personal research based on provided information

When leveraging the existing equipment it is possible to select desired parameters from the list of pre-programmed products, and required pre-defined settings are started from the memory of the machine. However, as was found out, this approach is not used due to poor knowledge of English of the operators. In addition, the analysis showed that no compliance audits, for selected parameters of the machine, actually occurring and the lack of systematic training concerning machine operating. Failures occur mainly due to errors on the employee's part such as sticking with the finished product packaging labels. Labels and boxes for all types of tapes produced are the same size and have a similar layout. A person can therefore pack the product into the wrong box. In addition, there are no photos of packed products that facilitate and accelerate the inspection of the product after completion process.

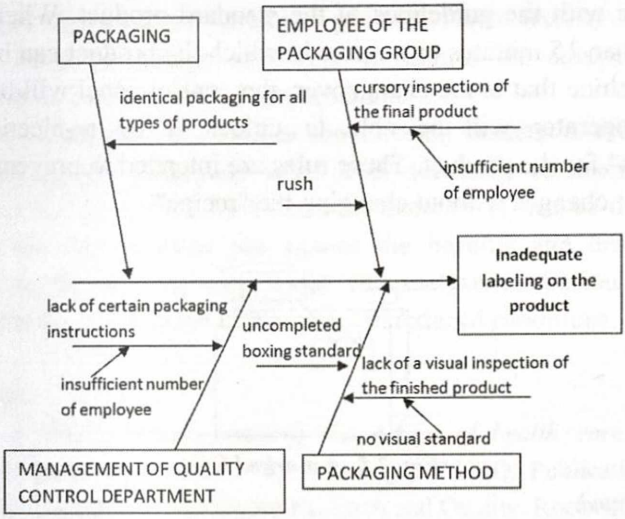

Fig. 7. 4. Ishikawa diagram- inadequate labeling on the product

Source: Personal research based on provided information

Standard packing process developed by the quality department does not provide visual quality inspections which are based on comparing the product to be discharged from the production line with the model product.

The analysis also showed a very serious organizational breach, which is the lack of sufficient control over the quality of the finished product. Inspection of the finished products is carried out to quickly which in turn leads to the fact that the customer receives the product that does not comply with what he had ordered.

7.5. Conclusions

As a result of studies using poka-yoke method the following solutions for defects were suggested:

1. Entering to the machine software "final parameters" for each product, which will be automatically, inflicted cutting parameters in

accordance with the guidelines of the standard product. When stopping for more than 15 minutes or no time in which the product can be changed on the machine that is the changeover, the control panel will be blocked, and the operator will be able to unlock it by re-election, "final parameters" for the product. These rules are intended to prevent a fault of the product changes without changing the "recipe".

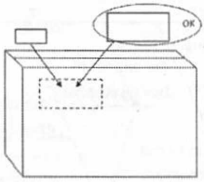

Fig. 7.5. A marked box.

Source: own study

2. The introduction of a variety of label sizes for each product, and dedicated them the place marked boxes of label (according to the size of the label), will prevent erroneous selection of the carton and label (Fig 7.5). In addition, all products will have a visual inspection on the basis of standard reference images located on the operator's workstation. Such action should reduce the number of errors generated by human error.

Efforts have also been made on the organizational level. Improvement of work at the organizational level should help to reduce the amount of non-conforming products. The first proposed measure is the introduction of scheduled audits of machine calibration. The Ishikawa diagram (Fig. 7.3, 7.4) indicated that the problem is the lack of knowledge of the options available using the machine and the machine's parameters so the proposed action is to conduct induction training and reminder training concerned with operating of the machine. To prove the extra training each employee must have a certificate issued by the instructor.

Until the full implementation of the new solutions and the apparent reduction in the number an additional person was assigned to the final

inspection of the finished packaged product. Such activity will be an additional financial charge, however it should be compensated by a smaller number of non-compliant products.

The use of the proposed actions should bring benefits to the company. After deploying the poka-yoke tools it is necessary to determine their effectiveness and to analyze their financial benefits. IT can be of particular interest to see the expenses put against the benefits and limited losses (resulting from the introduced methods). This analysis can be conducted only when the process is stabilized in the newly introduced conditions.

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