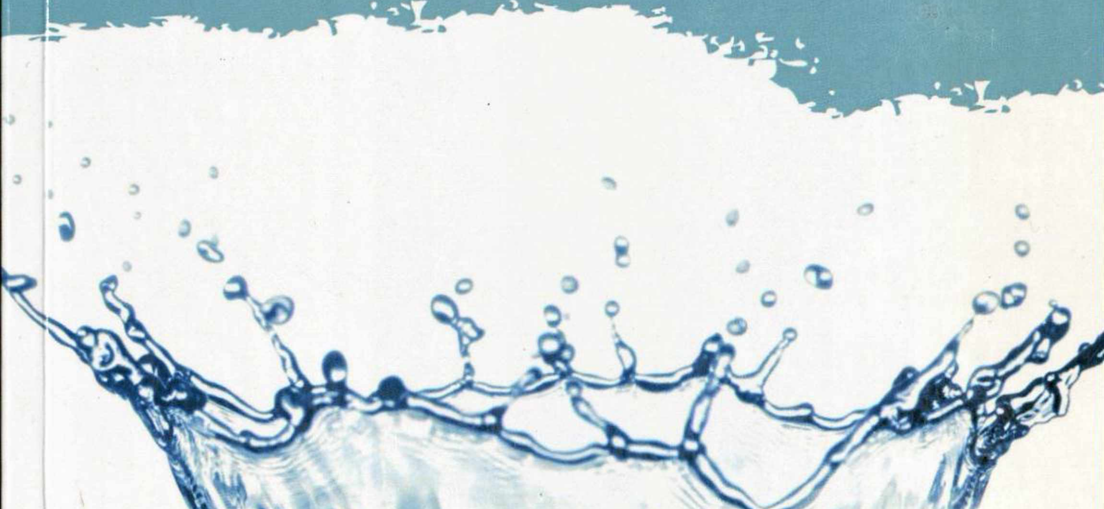
Quality Control Meaning in Products and Processes IMPROVEMENT



Stanisław Borkowski
Piotr Sygut

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Szymon Dziuba[1], Agnieszka Piekara[2], Wojciech Małas[3], Paulina Kozioł[3]

TRADITIONAL TOOLS OF QUALITY IMPROVEMENT USED TO IMPROVE FURNITURE PRODUCTION PROCESS

Abstract: At every stage of production there is a great need to observe if any deviations from the norm, which act as determinant in every process, have occurred. If the deviations have indeed occurred they should be effectively eliminated or its' effects should be decreased. That kind of action results in improving the production process to suit the end product to the consumers' needs. Furniture production is a straightforward process. Still a high precision and good quality of materials is required to produce a product that is in accordance with the standards dictated by the market. The goal of this research is to identify the nonconformities occurring in the furniture production process with the use of traditional tools of quality improvement. The reason for using the Ishikawa diagram is the fact that the above diagram allows to demonstrate the potential sources of nonconformities in a clear way. Additionally FMEA analysis was used.

Key words: Ishikawa Diagram, production process, FMEA analysis.

6.1. Introduction

The idea of quality is present in the customer's consciousness since the beginning of time. It is the customer who decides which product or service will have his appreciation. The decisive factor when choosing the product is always its' quality. Nowadays it does not matter what kind of

[1]dr inż., Wroclaw University of Economics, Poland, Faculty of Engineering and Economics, Institute of Chemistry and Food Technology, Department of Quality Analysis, email: szymon.dziuba@ue.wroc.pl

[2]mgr, Wroclaw University of Economics, Poland, Faculty of Engineering and Economics, Institute of Chemistry and Food Technology, Department of Quality Analysis, email: agnieszka.piekara@ue.wroc.pl

[3,4]student, Wroclaw University of Economics, Poland, Faculty of Engineering and Economics, Institute of Chemistry and Food Technology, email: malaswojciech@gmail.com

service or product it is but the only thing that matters is the customer's satisfaction according to the first TQM rule- focus on the customer. To fulfil the always rising expectations, companies wanting to stay on the market and more importantly reach into new markets have to constantly improve the quality of their products. To identify quality issues it is helpful to measure main parameters of the production process and isolate tendencies occurring in their development. It is also important to compare the current state with expected state and define which processes should be improved. Current practice as well as theory suggests that the quality has to be taken care of on every step of production and functioning of the product or service. One of the most effective tools of improving quality are perfecting tools. There are many to choose from and choosing one of them is based on the specification of the production or service (KONARZEWSKA – GUBALA E. 2006). To fulfil the aim of this research the cause-effect Ishikawa diagram, Pareto–Lorenz diagram as well as theFailure Mode and Effects Analysis was performed (FMEA).

6.2. Description of tools used in the research

FMEA – Failure Mode and Effects Analysis is an analytical tool the aim of which is to:

- check the probability of mistakes, related to production, occurring,
- find their causes and effect they have,
- classify mistakes according to their importance,
- react to the mistakes and introduce actions that can eliminate them (KONARZEWSKA – GUBAŁA E. 2006, ŁUCZAK J., MATUSZAK – FLEJSZMAN A. 2007).

Main uses of this method can be divided into three kinds of analysis:

- project FMEA analysis -that can be used mainly when introducing a new product or service. It is also of service when designing new or changed parts or parts that were applied to new uses, o process FMEA analysis, it allows to identify clutter occurring during the performed process. It can be introduced before the start of production or during the process at the moment the clutter occurs,

o service FMEA analysis, it is concerned with people, machines, materials, methods and generally understood resources. Its' aim is to maximise the satisfaction of the customer through pointing out the areas to be improved. It can be achieved for example through training (ŁUCZAK J., MATUSZAK – FLEJSZMAN A. 2007, KARASZEWSKI R. 2006).Necessary condition in the cause-effect analysis of mistakes is to construct the RPN (risk priority number) index, which is counted out through the product of the probability of mistake occurring (P), meaning of the mistake to the client (Z) and detectability of the mistake (W). Causes and effects of every mistake are classified on a scale from 1 to 10, and grading of particular mistake is made according to the indicator of the risk's value (Tab.6.1) (KONARZEWSKA – GUBAŁA E. 2006).

Table 6.1 Point estimation of the risk of exposed mistakes

Probability of mistake occuring (P)	**I.**	**Meaning of the mistake to the customer (Z)**	**I.**	**Degree of mistake recognition (W)**	**I.**
Slight chance of occurring	1	Imperceptible	1	Very significant	1
Very unprobable	2-3	Slight	2-3	Big	2-5
Unlikely	4-6	Moderate	4-6	Recognisable	6-8
Slightly probable	7-8	Big	7-8	Very hard to recognise	9
Very probable	9-10	Very big	9-10	Unrecognisable	10

I.- Importance

Source: KONARZEWSKA – GUBAŁA E. 2006

Analysis and grading in this methodis done by a team created for that reason. The team should comprise of people competent in their field as their opinions are not objective and that is why their experience and knowledge are so important. The results of the team's work have to be compiled in a form that has to be created separately for every company and type of industry (ŁUCZAK J., MATUSZAK – FLEJSZMAN A. 2007, KARASZEWSKI R. 2006).

Ishikawa's diagram also called 'fishbone diagram' is a graphic tool enabling to line up the reasons of occurring mistakes and relationships between them that result in negative effects seen by the company. This diagram is created by drawing a fish 'skeleton'. En effect is positioned at the end of the main fishbone. Possible causes are placed on the other parts of the fishbone (KONARZEWSKA – GUBAŁA E. 2006, ŁUCZAK J., MATUSZAK – FLEJSZMAN A. 2007)

Causes are isolated during brainstorming and then they are divided into subject groups. Most used rule which, during the production process, divides causes to fit into one of the five factors, this rule is called the 5M rule and the 5 factors are as follows:

1. Manpower-that is the people, work-force and their knowledge and skills.
2. Method-methods, procedures, instructions and specifications.
3. Machine-that is machines, Machine Park, their condition,how technologically advanced they are, efficiency and precision.
4. Material-that is resources, elements, parts and semi-finished products.
5. Management-management and generally understood organisational structure, conditions of work (KONARZEWSKA – GUBAŁA E. 2006, ŁUCZAK J., MATUSZAK – FLEJSZMAN A. 2007).

Pareto-Lorenz Chart is a universal tool that allows classifying, using given statistic factors influencing the researched occurrence. This diagram presents data graphically in decreasing order using histograms. Additional element of this chart is a linear chart of cumulated values that can be applied on a bar graph (KONARZEWSKA – GUBAŁA E. 2006,

ŁUCZAK J., MATUSZAK – FLEJSZMAN A. 2007). In accordance with a set empirical 80/20 rule that clearly states that 20% of causes leads to 80% of effects it was determined that applying less expenditure as well as effort can lead to achieving better results. This statement which makes sense in relation to reality of market economy resulted in corrective actions focusing on 20% of the most important reasons for non-conformities.

Use of the above diagram can result in the following:

- getting rid of the phenomena occurring most often,
- elimination of the causes for the biggest loses,
- deeper research and analysis of the importance and frequency of the problems occurring (KONARZEWSKA – GUBAŁA E. 2006, ŁUCZAK J., MATUSZAK – FLEJSZMAN A. 2007).

6.3. General characteristics of the researched product

The subject of the research is the analysis of the arisen quality defects during 3-door wardrobe production process. It is a free standing furniture item with closing doors that can be used to store everyday use items such as clothes, books or dinning ware. The most usual accessories are shelves, parallel rod for cloth hangers, drawers, mirror as well a hanger for ties or belts etc.

The wardrobe consists of elements packed in two boxes. Detailed contents of the boxes are presented in Table 6.2.

Table 6.2.Elements divided into boxes

Box 1	Box 2
1. Door (2 pieces size A and 1 piece size B)	1. Left side
2. Socle (glued over 1 piece, raw1szt.) + horizontal bar	2. Fiber board
3. Assembly accessories + hinges + grips	3. Partition
4. Shelf (4 pieces size C and 1 piece size D)	4. Top rim
	5.Bottom rim
	6. Right side

Source: Materials provided by the production company during the research

During production process additional requirements are presented, they are as follows:

- permanent symbol identifying particular batch of the product, those symbols should be visible on the front panel, in the lower left corner,
- every bulk container also has to carry a symbol, each palette contains boxes with wardrobe parts to be put together by the customer, and the symbol is a label that contains a bar code, serial number, date, weight and the number of elements in each box,
- not more than ten boxes can be placed on the palette- that is five complete wardrobes.

6.4. The technological process of three door wardrobe production

Description of the operations and processes:

1. Cutting the chip board

Aim: to cut the chip board in half, creating of the so called strips.

Cutting operation of 40 boards lasts circa 15 minutes. The waste of this process is the chip dust which, using special de-dusting system moves into special silo.

2. Enamelling the boards.

Aim: to cover the strips of chip board with foil using glue.

The process of covering a strip of raw board lasts about 10 to 12 seconds. For the process to be effective specific conditions (temperature, humidity or pressure) have to be fulfilled.

3. Formatting

Aim: cutting forms, of suitable measurements, out of the enamelled board strips (gross).

The process of formatting of 50 board strips lasts from 4 to 20 minutes.

4. Enamelling the edges.

Aim: taking careful measurements of the forms (net), and putting finishing touches on the forms' edges using the ABS scale-board.

The process of scale-boarding one form lasts around 40 seconds.

5. Drilling holes

Aim: To create montage holes in the components of the wardrobe components.

It is the shortest but very important stage since without holes the customer could not assemble the wardrobe at home. Drilling the holes in one form lasts about 2 seconds. This process accumulates a considerable amount of the chip dust

6. Packing

Aim: to pack the components into boxes.

To box the elements quickly and efficiently constant work of 15 workers is necessary. The time needed to pack one full box is seven minutes. The employees involved in packing are required to visually asses the quality of the product. The elements that do not fulfil the required norms are sent back to the repair warehouse and the ones that cannot be repaired are treated as a waste.

6.5. Identifying the occurring quality defects

During the research that lasted for twenty one days it was established that during the production process some non-conformities have occurred. Table 6.3. containing most important non-conformitiesas well as their percentage share in production of a three door wardrobe was created.

On the basis of the data compiled in Table 6.3 the Pareto-Lorenz diagram was created which presents the scale of the issues in a clear way (Fig.6.1).

Table 6.3.Non-conformities during the production of 3-door wardrobe

	Description of the deffect	Number of deffects	Relative share [%]	Acumulated number of defects	Cumulative share [%]
1	Ungluing foil	378	54,94	378	54,94
2	Badly drilled holes	162	23,55	540	78,49
3	Ungluing edge	51	7,41	591	85,90
4	Wrinkled foil	42	6,10	633	92,01
5	Visible glue remains	23	3,34	656	95,35
6	Wrong measurements of the cut board	16	2,33	672	97,67
7	Damage during transport	10	1,45	682	99,13
8	Damage during the inside transport	4	0,58	686	99,71
9	Wrong measurement of the formatted of the elements	2	0,29	688	100,00
	Total	688	100		

Source: Materials provided by the production company during the research

Analysis of the causes of quality defects

Through the use of the Pareto-Lorenz diagram it was possible to isolate two effects that directly influence the quality and functionality of the final product. Those effects generate 78.49% of non-conformities. To eliminate the reasons for most often occurring nonconformities traditional quality management tools were applied. They are as follows:

- Ishikawa Diagram for the problem concerning the foil coming unglue,
- review of FMEA process particularly for the incorrectly drilled holes.

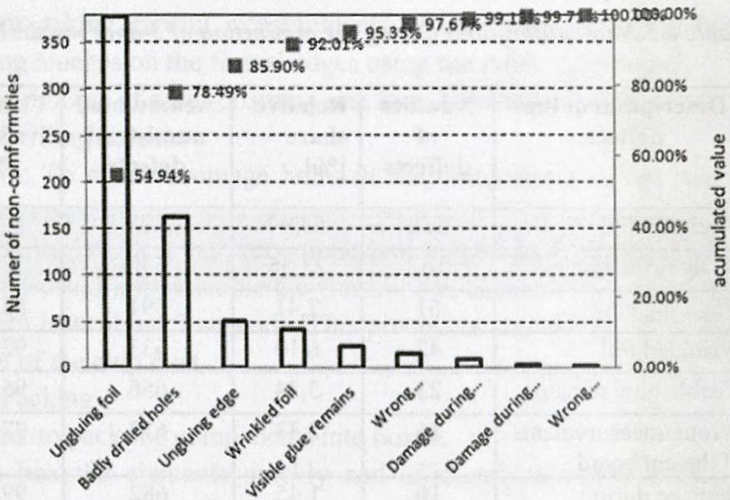

Fig 6.1. The Pareto-Lorenz diagram.

Source: Materials provided by the production company during the research

From Fig.6.2 it can be deducted that the materials delivered to the factory have a big influence on the foil coming unglue effect. Lack of control, as the parts come 'through the door', and lack of audits at the suppliers' companies increases the non-conformities.Another aspect is the out of date and old fashioned machine park. Machines are often repaired by one of the employees without qualifications, tools or spare parts to do it. Operators of the machines work without motivation or dedication and do not show any creativity. Production plans are changed very often since failures and standstills force that to happen.

AnotherFMEA method was reviewed to prevent the issue of incorrectly drilled holes. FMEA form with the analysis of the above issue is presented in Table 6.4.

From Table number 6.4, which contains the part of FMEA analysis it can beinferred that there are four main reasons for the incorrect holes drilling cause. The most important are:

- o incorrect parameters of the machine set by the operator,
- o failure of the machine or drill,

- machine regulated incorrectly,
- dirty roller conveyor.

6.6. Conclusions

Based on the research the following solutions that could help to eliminate the occurring quality issues:

- introduction of the Control Card (SPC) to collect one element every hour and careful measuring of its' parameters, hourly scores should be noted down in the SPC product card and after that it should be handed in to the control unit after the finished shift. The control unit can then react immediately if any nonconformities in parameters have occurred,
- training for operators on operating machines and their maintenance,
- detailed instructions on the use of drill at the drill station and check-up, done by the manager of the shift, if the employee follows the instructions carefully,
- putting pressure on controlling the quality of incoming chip boards,
- testing the foil and glue from various suppliers in variety of conditions and then choosing two or three suppliers to work closely with,
- introduction of the 5S at the work stations,
- introduction of the periodical machine replacement and keeping up a calendar of machine parts replacements,
- producing a test batch before every change of glue, foil or change of the produced element,
- keeping a close contact between the operators and the maintenance as well as technology units.

Introducing those solutions in stages should decrease the number of claims for refund done by the customer. This way will also be helpful when establishing which of the solutions will be most beneficial for the company.

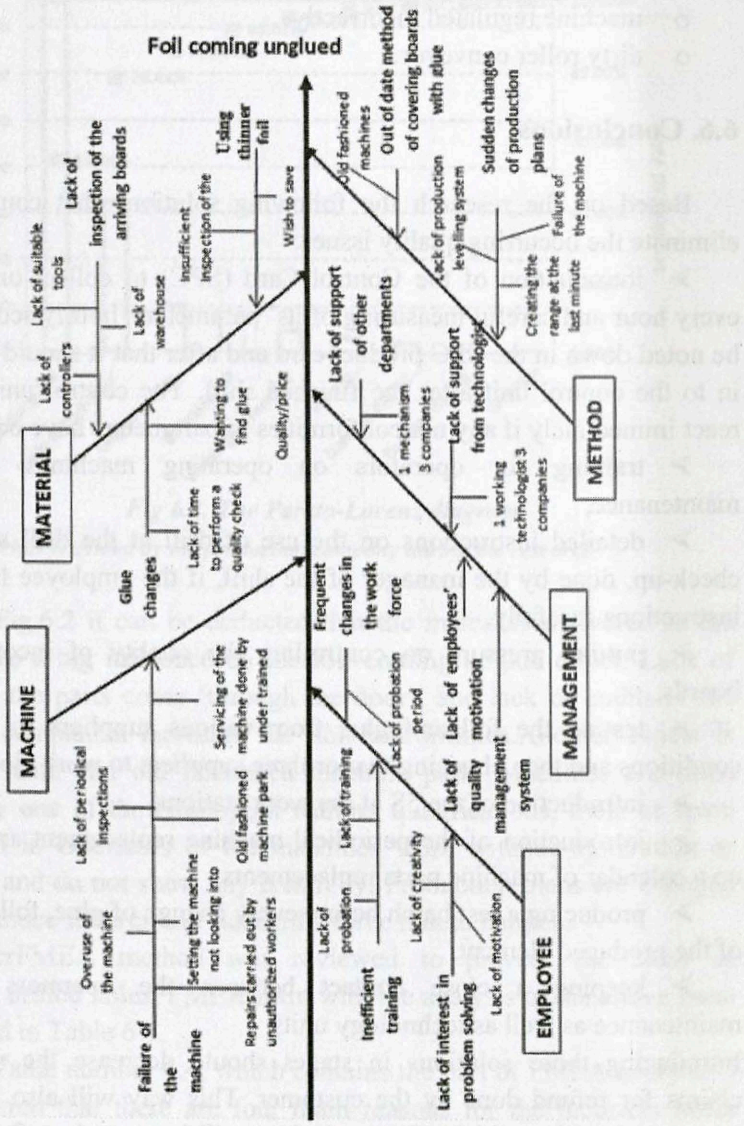

Fig. 6.2. Cause – Effect Ishikawa Diagram for the problem of the foil coming unglued.

Table 6.4.A part of FMEA analysis

Operation	Potential deffects	Potential effects	W	Potential causes	Z	P	Suggested actions	Action taken	RPN
Drilling holes	Badly drilled holes	The customer is not capable of hanging the wardrobe; not possible to assemble the elements and fit them to the hinges	8	Machine out of order; drill out of order	6	5	Introduction of the periodical machine inspection, inspection of the drill before starting every batch, inspection of the first product	Visual inspection of drill before starting work; inspection of the first product	240
				Spontaneous change of machine's settings	3	6	Inspection of the first product +SPC during the process	Inspection of the first product	144

				Wrong parameters of the machine set by the operator	8	5	Inspection of the first product+ SPC during the process; training employees on the machine; longer training period for new workers clear instructions and process cards placed next to the work stations	Inspection of the first product	**320**
				Dirty roller turner	4	1	Periodical inspection of the roller turner, 5S in the poke-yoke work space	Introduction of the sensor detecting residue on rollers that causes the machine to stop automatically(poke-yoke)	32

Source: personal study based on the above research

More over to improve the process of managing refunds the introduction of the refund card was suggested. The general layout of the card can be found in table 6.5.

Table 6.5. Example of card of complaints

CARD OF COMPLAINTS		Number of compliant
Company	Problem description (characteristics, photos, drawings.....)	
Contact person		
Date of order		
Number of order		
Inspection date	Responsible department:	
Inspection result	Proposed action	

Source: own study

Card entails customers' information and information on the person responsible for managing this particular refund. To quickly and easily identify the series the refund is concerned with the date and number of refund has to be placed by the contractor. It is also suggested that the customer should entail photography of the defect.

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