POSSIBILITIES TO WEIGHTING THE GLOBAL INDICATORS OF QUALITY DETERMINED WITH THE QUALITY ASSURANCE MATRIX

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Abstract. *The paper presents the possibilities that offers the use of Matrix of Quality Assurance to provide largest protection against nonconformities in the manufacturing process. Are presented the two indicators that highlight the level of protection provided: the overall quality of workplace (preventing the passage of nonconforming product downstream) and the overall quality of the factory (preventing irregular delivery of final products outside plant). So, the matrix allows assessing the level of protection (against non-quality) of a internal customer and external customer. But it highlights a shortcoming in the calculation of the two global indicators: no differentiation is made between failures according to their gravity. To take this into account and in this way to have a more realistic appreciation of the protection of the customer, it is proposed to weighting these indicators: new relationships take into account the gravity weight faults.*

Keywords: *Matrix of Quality Assurance , protection level of customer, weighting of global indicators.*

1. INTRODUCTION

To reveal the degree of protection against occurrence of nonconformities in manufacturing processes can be used two factors the overall quality of workplace (far as it prevents the passage of non-compliant products in downstream) and the overall quality of plant (insofar as it prevents delivery of non-compliant products outside of plant). These indicators allow the level of protection (against non-quality) of internal customer and external customer [1].

Thus Matrix of Quality Assurance (MQA) is a quality tool that is based on the principle that any failure (non-compliance) to a manufacturing process that affects a customer (who may be the next process or final customer) must imperatively be eradicated.

MQA permit a periodic quantification of the level of production processes quality, verifying the reliability (in the sense of trust or even effectiveness) of means of control existing in the production process, the necessity and the possibility of implementation of anti-error systems (Poka-yoke) or other nonconformities protection systems [5].

This method allows sensitive prevention and reduction of defects in more or less extensive areas, ranging from internal Customers (processing lines, assembly or final assembly of the product) to the external client (network sales).

The method ranks, for potential and existing defects, the reliability limits of the control systems in the manufacturing process, thus allowing the implementation a necessary corrective measures and achieving in this way a quality objectives [2].

Thus, acting on the causes of quality problems materializes in terms of the quality basic principle: not to pass and not to be accepted any defect.

2. STRUCTURE OF MATRIX OF QUALITY ASSURANCE

MQA is built on the PDCA cycle structure (table 1): Plan - Establish quality goals and defining the technological process; Do - Making analysis; Check – Verifying the reliability of control set; Act - Application of remedies for jobs that do not provide the level of quality set [4].

Table 1. The structure of Matrix of Quality Assurance

Post number	Name of the process	Failure mode	Influential parameter	Importance	Antecedent	Risk	Process of control						Amount of guarantee of quality			Defects recorded			Level of guarantee of quality			Comments
							Workshop			Outside workshop												
							...	Post no. ...	...	...	Post no. ...	....	Workshop	Outside workshop	Plant	Workshop	Outside workshop	Customer	Workstation	Workshop	Plant	
PLAN							DO						CHECK									ACT

In the first zone of matrix MQA (PLAN) are noted, for each workstation, the defects and their severity. But a brief analysis is needed on the concept of defect:

• failure: it is found at the product by the client;

• noncompliance: it is found at the product by the surveillance plan;

• influential parameter: it is found at the process by the surveillance plan.

Thus, in manufacturing is talk of conformity and of influential parameters (causes of damage), items that will be highlighted in the MQA still under the generic name of faults.

Defects are differentiated according to their severity using a severity index, often as stated below – table 2:

Table 2. The differentiation of defects

Impact	*Criteria for assessment*	*Quotation*
Grave	Failure preventing use your product or creates a strong dissatisfaction, with repair request	5
Very embarrassing	Fault for the customer expresses dissatisfaction in a survey	3
Embarrassing	Discovered fault of the customer, but tolerated	1

Failures are highlighted in different columns depending on their type:
• real faults: that occurred at least once and are therefore proven as real.
• potential faults: that do not manifested themselves yet, but have been identified through risk analysis (FMEA).

However, they will be treated with the same attention in the MQA, which is an instrument for guaranteeing the quality of the client - internal or external.

In the next area (DO) is analyzed the process of control (within the process of production and its downstream).

Thus, is highlighted the quality guarantee at the workstations and at control stations (in the manufacturing process or after), using different quotations depending on the efficacy or safety control carried out (table 3).

Table 3. Quatations of different levels for quality guarantee

Quality Guarantee	*Quotation*
100% automatic control Mounting impossibility or need further machining Poka-yoke of prohibition / control	5
Poka-yoke alert Statistical Control 100% human control with milestones	3
100% human control without milestones (based on senses) Periodically audit	1

In the third area it is assessed the degree of the quality assurance on the production process analyzed. The amount of guarantee of quality is determined for each failure mode identified (real or potential) in three columns:
1. Workshop (sum quotations guarantee of quality in the workshop);
2. Outside the workshop (sum quotations guarantee of quality downstream);
3. At the factory (by adding the first two values).

It highlights, in another set of columns, the number of defects registered (in the workshop, in the factory or at the client) - obviously not the potential defects, only the true defects. Is determined level of quality assurance for each fault by comparing the importance of the fault (set in the first zone) with guarantee values from:

- workstation;
- workshop;
- plant.

The level of quality assurance is achieved (at the workstation, in the workshop or at the level of factory) if the amount of the guarantee is at least equal importance fault, in which case the sign is marked OK (otherwise it will mark KO).

If the level of guarantee is not met (KO), then are studying and the influential parameters. It is considered as influential parameter is of equal importance with the failure mode it generates. To observe this principle, influential parameter will not be mentioned on the same line failure mode that causes him, but on an additional line.

Evaluation of influential parameters guarantee is made in the same way as failure modes, but influential parameter analysis is performed only at the level of workstation, because even when controlling from the outside, they are only at workstations respectively. As a result, the quality guarantee for the influential parameters is analyzed (and labeled) only at the workstation.

The exception is if the defects were found, a situation when the attribute is automatically assigned KO (it appears that protection exists theoretically, but defects occur downstream).

This gives a complete picture of the entire production process: for each fault is marked existence or absence of quality assurance at the workstation, workshop or plant.

In the last zone (ACT), where due to failure is not assured quality (at workstations, in the workshop or factory) will be included proposals to eradicate of defects, following one of the ways:
• improvement of existing controls (such the quotation control increase and it can become effective);
• introduction of additional controls in some positions;
• a combination of the first two ways.

It is desirable to provide improved existing controls before they introduce additional controls positions.

3. EVALUATION THE OVERALL LEVEL OF THE QUALITY ASSURANCE

As shown above, guarantee the quality for each fault identified is valued attributive in binary: quality is ensured (OK) or quality is not assured (KO).

However, the overall level of assurance (or quality guarantee) at the workshop or factory level can be quantified numerically, which provides a more sensitive appreciation of the level of internal customer protection, external respectively, against failure.

Thus, using the level of quality guarantee determined for each fault registered in the workshop or plant, can be determined next two indicators of global guarantee of quality:

• the overall level of quality guarantee at the production workshop, AQ_{at}:

$$AQ_{at} = \frac{n_{OK,at}}{n_{OK,at} + n_{KO,at}} \qquad (1)$$

• the overall level of quality guarantee at the plant, AQ_{uz}:

$$AQ_{uz} = \frac{n_{OK,uz}}{n_{OK,uz} + n_{KO,uz}} \qquad (2)$$

Since the calculation of the two indicators (quality assurance at the plant include, alongside measures to the workshop and its downstream measures), it is obvious that there is constant relationship:

$$AQ_{uz} \geq AQ_{at} \qquad (3)$$

An example of data processing by using the matrix of quality assurance is represented in the figure 1 [3].

Failure mode / Influential parameter	Importance	Antecedent	Risk	Process of control							Amount of guarantee of quality			Defects recorded			Level of guarantee of quality			Comments
				Workshop				Outside workshop												
				Post no. 1	Post no. 2	Post no. 3	Post no. 4	Post no. 1	Post no. 2	Post no. 3	Workshop	Outside workshop	Plant	Workshop	Outside workshop	Customer	Workstation	Workshop	Plant	
Fail1	1	•		3							3	0	3	0	0	0	OK	OK	OK	
Fail 2	3			3						1	3	1	4	0	0	0	OK	OK	OK	
Fail 3	5			1				5	1		1	6	7	0	1	0	KO	KO	OK	
Fail 4	5		•		1	1			1		2	1	3	0	0	0	KO	KO	KO	
Fail 5	5		•		1						1	0	1	0	0	0	KO	KO	KO	
Fail 6	2				1						1	0	1	0	0	0	KO	KO	KO	
Par.1	5						1	1			1	1	2				KO	X	X	

Figure 1. Example of data processing using MQA

It is noted that at three fault the level of quality warranty defect is not properly in workshop: even if it has a higher value that the importance of the defect, a fault occurred outside the workshop.

Analyzing the quality guarantee on the last column is observed that it is ensured at all stages for the first two failure modes and it is secured just outside of the plant for the third failure mode.

Instead, failure modes no. 4, 5 and 6 there is no guarantee of quality for any of the stages - workstation, workshop or factory. Similarly, in terms influential parameter, there is no protection to the workstation (for workshop and factory not calculated).

As a result, concerns necessary to ensure the level of quality for failure modes 3, 4 and 5 and influential parameter, in specified stages.

The values for the two levels of global guarantee of quality are:

- in the workshop, $AQ_{at} = 33\%$;
- in the plant, $AQ_{uz} = 50\%$., $AQ_{uz} = 50\%$.

It appears that, although the overall level of plant quality guarantee is higher than the level of the production workshop, both values are not satisfactory, thus improving client protection efforts must be made to ensure quality at all stages.

4. CONCLUSIONS AND PROPOSALS

The working instrument is used with sucess by manufacturers, because it provides an actually image on the quality assurance for the production process and allows the quantification of the improvements of quality.

There is however a weakness in the calculation of the two global indicators: no differentiation is made between failures according to their gravity.

To take this into account and in this way to have a more realistic appreciation of the level of protection of customer can be use the following weighted relations (to consider the weight of gravity faults):

• the overall level weighted quality guarantee at production workshop, $AQ_{at,p}$:

$$AQ_{at,p} = \frac{\sum_{at,i} n_{OK,i} \cdot p_i}{\sum_{at,i} n_{OK,i} \cdot p_i + \sum_{at,i} n_{KO,i} \cdot p_i} \qquad (4)$$

• the overall level weighted quality guarantee at production plant, $AQ_{uz,p}$:

$$AQ_{uz,p} = \frac{\sum_{uz,i} n_{OK,i} \cdot p_i}{\sum_{uy,i} n_{OK,i} \cdot p_i + \sum_{uz,i} n_{KO,i} \cdot p_i} \qquad (5)$$

In addition, it can improve the sensitivity of the two global indicators through the use of other scale, more sensitive, to the seriousness of failures, namely the level of quality guarantee: for example, instead of scale 5/3/1 to be used the scale 5/4/3/2/1.

Apart from the need for continuous updating MQA - to perpetuate the application of PDCA cycle in order to continuously improve quality – also it is important to follow the dynamics of these two global indicators of quality, which must confirm the continuous growth of customer protection against damage.

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