QUALITY ANALYSIS AND TECHNOLOGICAL PORTFOLIO IN PRODUCTION OF THE METAL SCREWS

Stanislaw BORKOWSKI, Manuela INGALDI, Marta JAGUSIAK-KOCIK

Czestochowa University of Technology, Faculty of Management, Institute of Production Engineering, Czestochowa, Poland, EU, bork@zim.pcz.pl, manuela@gazeta.pl, jmarti@o2.pl

Abstract

The own technologies and the quality of the finished products affect the position of the company in the market and hence the existence of this company. In the paper structure of nonconformities of the metal headwood screws was presented. The corrections and preventive actions were proposed. The production process of the chosen product depicted technologically was also shown. This form of analysis with the evaluation of the technological possibilities of the production process and the screws competition, made by employees, with use of the 3x3 matrix, allows choosing the activities of the company in order to increase its market position. In the research the innovative BOST method was used.

Keywords: quality, Pareto-Lorenz diagram, FMEA, production process, 3x3 matrix

1. INTRODUCTION

The technology can be defined as the overall knowledge of the particular method of manufacture of a good or achieve a certain industrial or service effect. From this definition it can be concluded that the company, in order to produce goods of sufficient quality, which find buyers in the market, must have adequate knowledge of their production. The own technologies, and at the same time the finished products, will affect the position of the company in the market and hence the existence of this market. Therefore, to determine the appropriate technological strategy is so important for any company, including business area of metallurgy [1].

The main purpose of the research is to indicate main nonconformities of screws occurring during their production process. It let propose corrective and preventive actions. The analysis of the technological portfolio used in the production process of the screw was also conducted. The production process depicted technologically was shown. The analysis of product competition and technological possibilities of the company X according to employees opinion in the form of the 3x3 matrix was conducted. As the result main activities in order to increase the market position of the company X were chosen.

2. CHARACTERISTICS OF THE RESEARCHED COMPANY

The company X has its tradition; it has been present on the market for 75 years. First, it was a trade company (set before the II World War) than transformed also into manufactured and service. Nowadays the company produces: universal plugs, hammer drive plugs, frame plugs, plug for lavatory devices, plug for insulating materials, sleeve anchor. The company offers also: non-typical items jointly from metal (according to projects delivered by contracting parties), zinc plating and cutting of metal items, production (in own tool-room) forms to production items from plastics, blanking die and press-forming die for plate. In paper production process and quality analysis were shown on the example of the metal headwood screws (see **Fig. 1**).

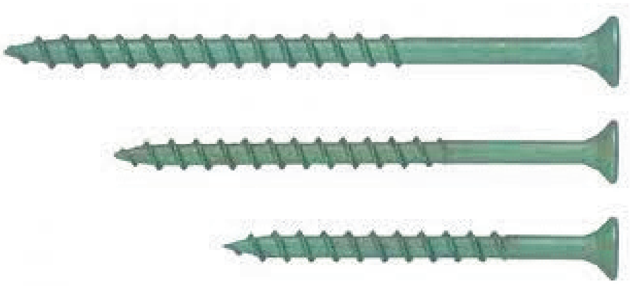

Fig. 1 Screw for wood with pozidrive recess and hexagon head [2]

3. PRODUCTION PROCESS OF THE CHOSEN PRODUCT

In **Fig. 2** production process [3] of the screw depicted technologically is presented. Before the material (wire) will be used in the production process, its diameter, species and weight corresponding to the quantity ordered screws must be checked. Then it is transported from the storage to the production hall.

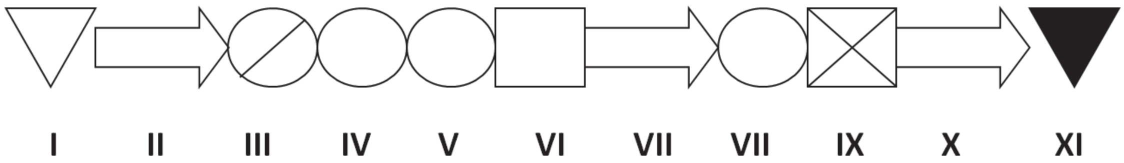

Fig. 2 Production process of the metal screws depicted technologically

Operations in the production process shown in **Fig. 2** in the researched company are:

I - Storage of the coil with low-carbon wire (grade SAE 1006).
II - Transport of the coil with the wire to production hall with forklift.
III - Straightening of the low-carbon wire with the forging machine Hilgeland CH00.
IV - Forging of the wire with the forging machine Hilgeland CH00, which means to shape the wire, consisting of the crushing of the material under the impact of the die block.
V - Cutting the wire with the forging machine Hilgeland CH00. Operation takes place on the forging machine and is performed with scissors.
VI - Inter-operation control of the dimensions of the gorged and cut parts of the screws.
VII - Transport of the material with the forklift to flat-die thread rolling machine Waterbury-Farel.
VIII - Roll threading with the flat dies.
IX - Final control of the correct screws size.
X - Transport of the finished products to the high storage with the forklift.
XI - Packaging and storage of the finished products.

4. QUALITY ANALYSIS OF THE SCREWS

The quality analysis of the screws produced in the company X was conducted. Its purpose was to indicate main causes of nonconformities which occurs during the production process of the screws.

Identification and quantitative evaluation of the causes of nonconformities were performed with use of the Pareto-Lorenz diagram [4-6]. Main 9 nonconformities were indicated, which later were ranked in terms of their frequency. The data referred to the last quarter of 2013. The summary of identified nonconformities was shown in **Table 1**, while graphical interpretation of the diagram was presented in **Fig. 3**.

Table 1 Problems of the production process

No	Cause	Percentage fraction	Cumulated percentage
N_1	Cracked screw	27.66	27.66
N_2	Crushed screw	20.21	47.87
N_3	Rusty mill shield	15.96	63.83
N_4	Deformation of the screw head	10.64	74.47
N_5	Deformation of thread	9.57	84.04
N_6	Deformation of the screw point	5.32	89.36
N_7	Wrong length of wire	5.32	94.68
N_8	Damaged mill rolling stand	3.19	97.87
N_9	Improper selection of the matrix in forging machine	2.13	100.00

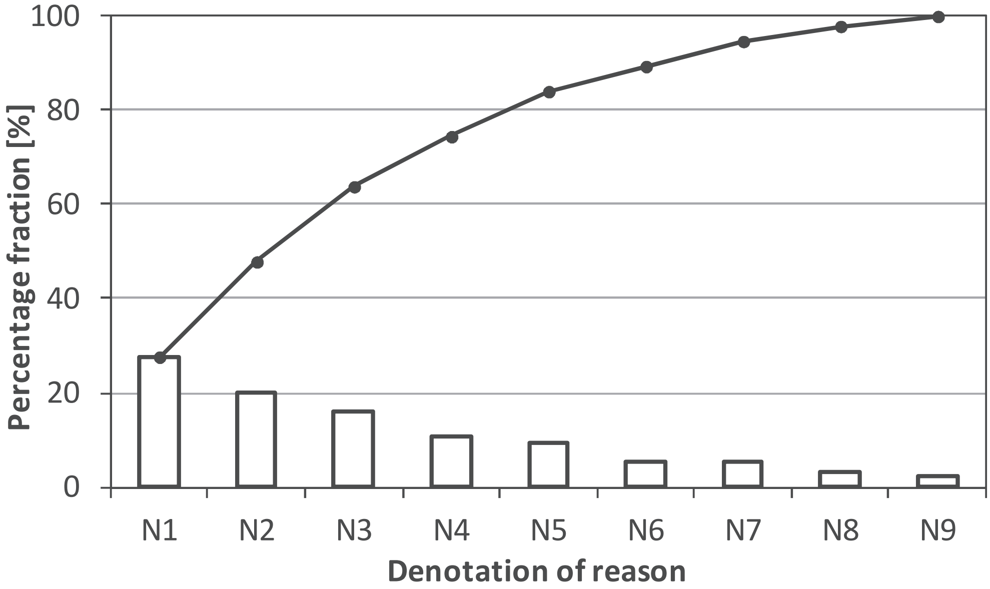

Fig. 3 Graphical presentation of the Pareto-Lorenz diagram

Analyzing **Fig. 3** it is seen that 33% of all causes are responsible for almost 64% of all nonconformities occurring during the production process of the screws. These causes are following: N_1 - cracked screw, N_2 - crushed screw, N_3 - rusty mill shield. It means that if these 3 causes are eliminated, the quantity of the nonconforming products should decrease by 64%. With this analysis it was possible to determine main causes which have an influence on the quality level.

More detailed analysis of nonconformities identified with the use of the Pareto-Lorenz diagram was conducted with the use of the FMEA method [4-6]. Denotations of individual causes of nonconformities are the same as in the Pareto-Lorenz diagram. This time analyses included effect and reasons of all production problems. Additionally, individual causes of nonconformities were examined for the associated risk. Then corrective and preventive actions were proposed. The results were presented in **Table 2**.

Analyzing results of the FMEA method shown in **Table 2** it should be observed that the highest risk priority number was noted in case of the cause N_2 - crushed screw. This problem was caused by too strong power of the beater in the the forging machine. Speed improvement of the forging machine as a corrective action was proposed. In addition to prevent the occurrence of the problem in the future, it was proposed to carry out more frequent technical surveys and controls of the machine.

Also the cause N_1 - cracked screw was characterized by high risk priority number. This problem was caused by wrong type of wire. The wire should be replaced and in the future employees should have additional training of better material selection.

Table 2 FMEA analysis for the production process of the screws

No	Effect	Reason	D	P	S	RPN	Correction actions	Preventive action
N_1	Damaged screw	Wrong type of wire	6	4	7	168	Replacement of the wire	Employees trainings
N_2		Too strong power of the beater in the the forging machine	6	5	7	210	Speed improvement of the forging machine	More frequent technical surveys and controls
N_3	Leak of the rolling machine	Oil leak from the oiler in the rolling machine	3	4	8	96	Improvement of machine leaktightness	
N_4	Damaged screw	Wrong type of the die block in the the forging machine	2	3	7	42	Replacement of the die block	Employees trainings
N_5		Bad rolling of the thread in the rolling mill	3	5	6	90	The correct setting in the rolling mill rolls	
N_6		Jamming rolling stand	2	4	6	48	Replacement of the bearings	More frequent technical surveys and controls
N_7	Wrong length of the screw	Inaccurate cutting process	3	4	6	72	Replacement of the scissors	
N_8	Inadequate work of the machine	Overheated electric engine of the rolling machine	4	7	4	112	Repair of the electric engine	
N_9		Deformated wire	5	4	5	120	Displaying instructions in a visible place	Construction analysis/ Employees trainings

5. EVALUATION OF SCREWS MANUFACTURING TECHNOLOGY

It can be noticed that most indicated problems were connect with condition of the equipment owned by the company X, that is, in consequence, also the level of the technological portfolio held by the company. Therefore, subsequently the analysis of technological possibilities and product competition with the use of the 3x3 matrix was conducted.

The research, which is presented in the article, is a part of the researches connected with BOST method conducted at the Institute of Engineering Production, Faculty of Management, Czestochowa University of Technology [7]. In the article, it is presented one of the questions of the questionnaire. Respondents were asked for the assessment on a scale from 1 to 9 of the product competition (TK) and the technological possibilities of the manufacturing process (TW) (1 - low, 9 - high evaluation).

In the paper the 3x3 matrix, presented at first by Paul Lowe [8], with some its modifications of author presented already in papers [9-11], was used to evaluate both factors. In the original X-axis is represented by the technological possibilities and the Y-axis by the position in the market (changed for product competition by authors). The matrix shows that the adopted scale of assessment must be divided by 3. Characteristics of the 3x3 matrix with the description of its parts are presented in **Fig. 4**. For all companies part 1 is a main goal to achieve.

The level of screws competition and the technological possibilities of the research company according to opinion of the production employees was analysed and the results of this analysis were presented in the form of the described 3x3 matrix. In the research 32 production employees from the company X, who participate in the production process of screws, took part. According to the authors, they know a lot about production process because they are part of it. The results are presented in **Fig. 5**.

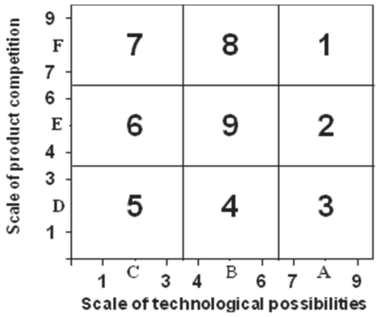

Fig. 4 Characteristics of 3x3 matrix and denotation of its parts:
1. Focus on the revealed chance. 2. Improve the marketing.
3. Search for partners. 4. Discover the incidental market.
5. Keep in the background. 6. Keep in the background.
7. Buy the ready technology. 8. Develop your technological potential.
9. Search for occasions [8-11]

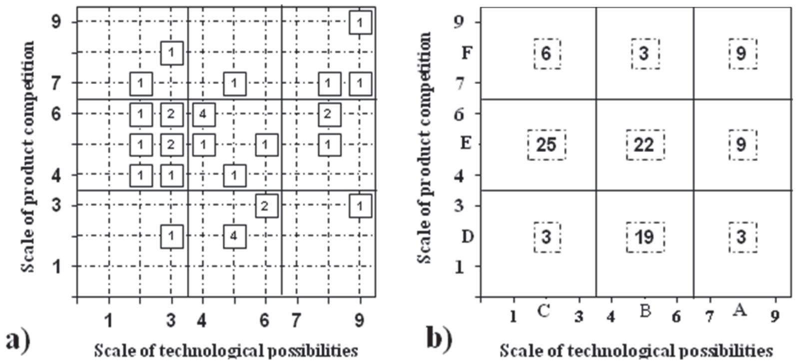

Fig. 5 Presentation of research results in the form of: a) map of evaluations b) map of sum of evaluations number for each area of 3x3 matrix

To point out the results peculiarities, the authors used a graphical interpretation of the results. **Fig. 5**a shows the map of the evaluations number on the 3x3 matrix background. With this map, it is easy to see the distribution of the evaluations. For better understanding of obtained results, as proposed by the various graphic forms of presentation were used, as expressed in **Fig. 5b**. In individual parts of the 3x3 matrix, the number of evaluation was summed, then percentages were calculated and put in the figure.

From **Fig. 5** it results that the employees did not indicate clearly any part of the matrix. In this case the employees gave weak and average or average evaluations at the same time to screws competition and the technological possibilities of the research company. Most evaluations were recorded successively in the case of parts 6, 9 and 4 of the matrix. It can be also seen that many evaluations were places on the border of the parts 6 and 9, therefore it can be concluded that this is the technological position of the research company. It is worth mentioning also the fact that none of the employees gave evaluation 1 to both elements.

It can be concluded that according to the production employees the research company should „Keep in the background" (part 6). But at the same time the company should „Search for occasions" (part 9). So the practical recommendation is that the research company should think about intensification in order to make greater use from technological possibilities. To increase technical possibilities, the research company should think about new investments in production equipment. This will help to improve the quality of the research products, which will allow increasing partly also screws competition. At the beginning it is enough if these are small investments due to the part 6 of the matrix. It is enough that they will affect the improvement of the state of the production equipment of the research company.

CONCLUSION

A quality item (an item that has quality) has the ability to perform satisfactorily of the customers and is suitable for its intended purpose. The quality of the finished product depends on many factors [12-15]. The technology, as it was shown in the article, was the one of those factors.

In the paper the analysis of the structure of nonconformities of the metal headwood screws was conducted. This analysis was done with the use of 2 important instruments: the Pareto-Lorenz diagram and the FMEA method. According to results there are 2 important causes of nonconforming product: N_1 - cracked screw and N_2 - crushed screw. It turned out that most indicated problems were connect with condition of the equipment owned by the company X, in consequence, also the level of the technological portfolio held by the company.

The 3x3 matrix was used to study the technological portfolio of the research company. This matrix allowed identifying technological position of the company according the opinion of the staff of the research company. According to the production employees the research company should „Keep in the background" (part 6). But at the same time the company should „Search for occasions" (part 9). In the opinion of the employees both the technological possibilities of the research company and the product competition are on a low or medium level. Therefore, the research company should first think about the investments in technological possibilities, which will also improve the product competition due to a better quality of manufactured screws.

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