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MODERNITY EVALUATION OF THE MACHINES USED DURING PRODUCTION PROCESS OF METAL PRODUCTS

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Abstract

Most manufacturing companies realize its technologies, implemented through concrete machinery parts. They differ in terms of importance, the relevance of their selection and the level of their modernity. Modernity and efficiency of the machine are also very important during production process of the metal products. They have an influence on the quality of these products. The purpose of this article is to analyse the chosen production machine (CNC machine AFE-3D8-T) used during production process of metal products in terms of its modernity. The ABC technology method was chosen to do this research. Individual parts of this machine were divided into 3 subassemblies (parts of main subassembly A, parts of supportive subassembly B, parts of collateral subassembly C) and then each part was evaluated on the basis of Parkers' five-point scale.

Keywords: ABC technology method, machines, modernity, technology, metal product

1. INTRODUCTION

Production technology and the state machinery park affect the company's competitiveness in the market, which is why company executives should take into account these elements when taking any decisions concerning the production process. The state of the machinery park, according to various sources [1-2], can be evaluated for various aspects: effectiveness, productivity, energy consumption, material consumption, the use of human labour, but also modernity. Most of the features of the machine depend on its modernity. Therefore, any analysis of the state of the machine park, according to the author, should start exactly from the analysis of its modernity.

Most manufacturing companies realizes their technologies, implemented through concrete machinery parts. They differ in terms of importance, the relevance of their selection and the level of their modernity.

Modernity of machines and devices can be classified, with use of the ABC technology method. The competitive advantage, expressed for example as the richness of the product assortment, can be used as a criterion for evaluation. This can be achieved thanks to the flexibility of devices that allow for variation in the type and quality of the product.

The purpose of this article is to analyse the chosen production machine used during production process of metal products in terms of its modernity. In this case ABC technology method was used. Different graphical form were used to show more detailed information about obtained results.

2. METHODOLOGY

To evaluated modernity of machine and devices, the ABC technology method, described in following papers [3], was used. This method, called also Pareto-Lorenz method or the 80-20 rule, belongs to the techniques

determining the actions aiming at improvement of the processes levels and quality characteristics of material goods and services. This analysis is based on the principle according to which, in each group several segments can be divided into marked with the letter A, which largely determine the results. Parts of main subassembly A appear at the beginning of system, at the end of the system parts of collateral subassembly C appear. In the middle of the system there are parts of supportive subassembly B.

Technologies of level A, also known as main technologies, are basic technologies, fundamental for business. They help to give special attributes to produced products.

Technologies of level B are the enabling technologies of a general nature, available to all companies in a given industry. The company does not show interest in development, but benefits from such progress during the purchase of the machine.

Technologies of level C are supporting technology which are usually part of the overall business. These technologies are associated with its own machinery or equipment and are not subject to the innovative activity of the entity using it. User first of all cares for their proper maintenance, aiming to shorten their downtime and to eliminate their premature withdraw from use [4-5].

The evaluations of individual parts of the machine can be made on the basis of the Parker's five-point scale [5]:

- Level 1 concerns of easy the machine parts manufactured with use of craft technologies.
- Level 2 concerns of the machine parts manufactured with unchanging technologies used for years.
- Level 3 concerns of the machine parts manufactured with more complex technologies, requiring technical skills and knowledge.
- Level 4 concerns of the machine parts manufactured with modern technologies.
- Level 5 concerns of the machine parts manufactured with the most modern, unique technologies, not known by other producers.

Parts of subassemblies of the machinery park and technology used by the company are extremely important for the quality of products. Machinery and devices equipped with modern parts, components not only work more efficiently, but also produce products with much higher quality [6-7].

The ABC technology method was used in the article to evaluate modernity of the CNC machine cutting the wire with a symbol AFE-3D8-T. All parts of this machine were divided, in accordance with described method, into three groups: parts of main subassembly A, parts of supportive subassembly B, parts of collateral subassembly C. Then each of these parts was evaluated in the previously described scale. The results were shown in tabular manner.

However, the division machinery on parts and their evaluation is not enough. The results are more visible and better understanding in the graphical form, which is why in the article these forms were used. This allows for easier interpretation of the results. With use of the histogram a graphical interpretation of the results, which shows the differences in the allocated evaluations, was presented. With use of the pie charts graphical summary of the percentage shares of individual levels for each part in every assembly was demonstrated. Final results of the ABC technology method for the entire research machine was shown in the traditional way: percentage shares of each level in the form of bars, and accumulated shares in the form of a linear function.

3. CHARACTERISTICS OF THE RESEARCH OBJECT

The research company was founded in 1975 as a production-service company. It started from performing minor services, mainly related to turning, metalwork and varnishing. At the beginning in the offer of the company a customer could find decorative metal-plastic products, often copper plated, including decorative plates on the walls, city coat of arms, consumer products, for example tea sets, coasters, napkin holders,

racks for glasses, ashtrays with different themes, plant stands. They were formed mainly of steel sheet, copper plated steel sheet or regular steel sheet. Later the assortment was expanded to hangers for skirts or shirts, pasta cutters and many other household equipment, articles for shop fitting, which are produced until now. Nowadays, the products are sold in Poland and abroad, mainly in the European Union.

During production process of metal product, the company uses many different machines and devices. The basic and at the same time the first machine used in this production process is CNC machine cutting the wire with a symbol AFE-3D8-T. Its basic parameters are presented in Table 1.

Table 1. Parameters of the CNC machine AFE-3D8-T [8]

Machine model	**AFE-3D8-T**
Wire diameter range [mm]	2-8
Max wire tensile at max wire diameter [N/mm^2]	550
Performance specifications	
Feeder axis	
Wire feed resolution [mm]	+/- 0,006
Max wire feed speed [m/min]	100
Bender axis	
Bender resolution [˚]	0,0005
Max bender speed [˚/sec]	1000
Max bender angle [˚]	Unlimited
Turret axis	
Turret axis tool change time [mSec]	400
Set-up time	
Same wire diameter [min]	1
Change feeder rollers and bending tools [min]	15
Power consumption, electrical and air requirements	
Average power consumption [kWh]	2.0
Electrical requirements	50/60 Hz, 400 or 460 V, 3 phases
Installed power	45 KVA
Air requirements	100 PSI @ 2 SCFM
Dimensions and weight	
Width, depth and height [m]	2,59x2,08x2,13
Gross weight [kg]	4220

4. RESULTS

The modernity research was conducted for the CNC machine AFE-3D8-T. The most difficult stage of the study was to specify the different parts of the machine and their division into individual subassemblies. Evaluation of modernity level of individual parts of the research machine is presented in Table 2.

Table 2. Evaluation of the modernity of the parts of the CNC machine AFE-3D8-T

No	**Parts of main subassembly A**	**Evaluation**	**Average**
A1	Control system	4	3.2
A2	Control panel	4	
A3	Programming system	4	
A4	Controllers feeders	3	
A5	Safety device modules	3	
A6	Cutting system	3	
A7	Wire rollers	3	
A8	Wire delivery system	3	
A9	Wire bending system	3	
A10	Stationary breaking cap	2	
	Parts of supportive subassembly B		
B1	Integrated power units	3	2.8
B2	Height adjustment mechanism	3	

B3	Fan	3	
B4	Utilities connection system	3	
B5	Wire length measure system	3	
B6	Main power transmission system	3	
B7	Feeders	3	
B8	Start-up system	3	
B9	Rollers spacing change system	2	
B10	Bearings	2	
	Parts of collateral subassembly C		
C1	Stainless steel machine construction	3	
C2	Shields	3	
C3	Four leg frame	3	
C4	Sensors	2	
C5	Wires	2	2.3
C6	Switch key	2	
C7	Control buttons	2	
C8	Screws	2	
C9	Screw caps	2	
C10	Rubber pads	2	

In Figure 1 graphical interpretation of modernity level of research machine was presented. In Figure 2 the structure of modernity level of the research machine taking individual subassembly into consideration was presented. In Figure 3 the final result of the ABC analysis is presented.

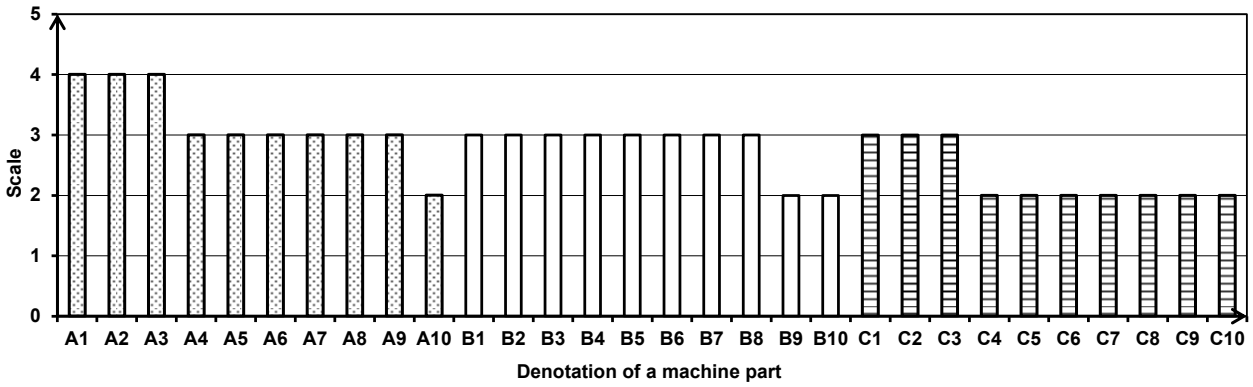

Figure 1. Modernity level of parts of the CNC machine AFE-3D8-T

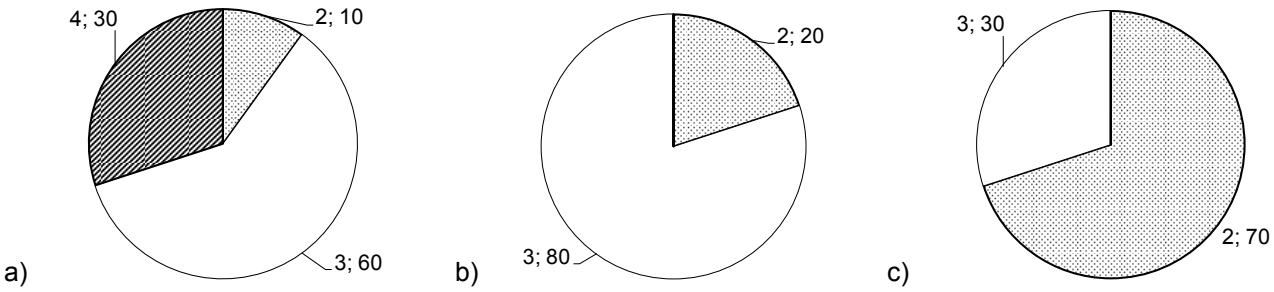

Figure 2. The modernity structure of subassemblies of the CNC machine AFE-3D8-T in: a) main subassembly, b) supportive subassembly, c) collateral subassembly

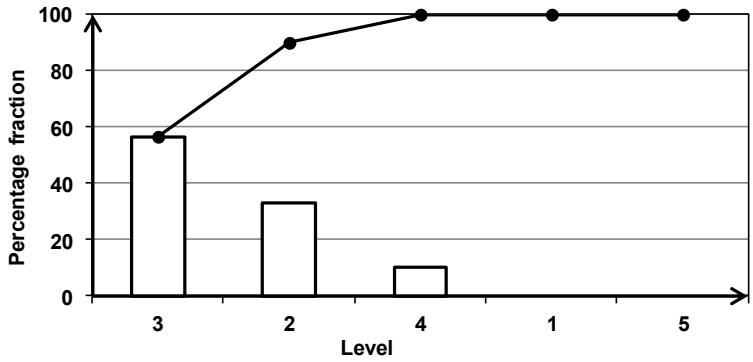

Figure 3. ABC analysis of the modernity level of the CNC machine AFE-3D8-T

Individual parts of the CNC machine AFE-3D8-T, according to Table 2, Figure 1 and Figure 2, were classified in following way:

- Parts of main subassembly A: in 60% are on level 3, in 30% on level 4 and in 10% on level 2. So 3 was the most often given evaluation (6 times). The highest evaluated parts (level 4) were: control system, control panel and programming system. These are parts which to a large extent determine if the machine is easy to use. Stationary breaking cap was the lowest evaluated (2) part of the of main subassembly A. No part of this subassembly received evaluation 1 or 5. It should also be noted that the evaluations of parts of this subassembly were the most diverse. This group had the highest average evaluation (3.2). This means that the average part of the subassembly was manufactured with more complex technologies, requiring technical skills and knowledge.
- Parts of supportive subassembly B: in over 80% are on level 3 and in over 20% are on level 2. So 3 was the most often given evaluation (8 times). Rollers spacing change system and bearings are two part with the lowest evaluation (evaluation 2). None of the parts received evaluation 1, 4 and 5, which means small diversity in evaluations. In case of subassembly B, the individual parts were evaluated only at 2-3, the average evaluation was 2.8, which means that parts of this subassembly were manufactured with more complex technologies, requiring technical skills and knowledge or with unchanging technologies used for years.
- Parts of collateral subassembly C: in over 70% are on level 2 and in 30% are on level 3. None of the parts received evaluation 1, 4 and 5, which means small diversity in evaluations and also lack of modernity. Stainless steel machine construction, shields and four leg frame are parts with the highest evaluations in this subassembly. Average evaluation of all subassembly was 2.3, which means that on average parts of this subassembly were manufactured with unchanging technologies used for years.

Average evaluation of the entire machine was 2.8, which means that, as in the case of the subassembly B, most of the parts were manufactured with more complex technologies, requiring technical skills and knowledge or with unchanging technologies used for years. It should be emphasized that the average evaluation of parts of subassembly A was higher than the average for the entire machine.

Analysing Figure 3 it can be concluded that evaluation 3 was the most often given evaluation to individual parts of the research machine (almost 60%). Evaluation 2 was next in the order (over 35%). Evaluations 4 had little impact on the overall evaluation of modernity of the research machine.

It means that the research machine is not modern. Perhaps company managers should think about changing this machine for newer one. This is the first condition, which tends to take such decision. This would allow for improvement of the technical parameters of the products, increase in production efficiency and reduction of the amount of nonconforming products. Therefore, it can be concluded that a properly selected and correctly

applied parts of the subassemblies contribute to the improvement in quality of products and the efficiency of the machine.

5. CONCLUSION

Modern and efficient production machinery park own by the company determines the course of the production process and the level of quality of products. Modernity of the machines can be evaluated with use of ABC technology method, which can indicate, which technologies were used during production process of the individual parts of the machine. This analysis is also a part of the evaluation of the technological strategic position of the company [9-12].

In the article the results of the research conducted in company producing metal product was presented. The analyses was supposed to show if the production machinery park used during production process is modern. The CNC machine cutting the wire with a symbol AFE-3D8-T was analysed. From the conducted analysis of the research machine it results that most of the parts were manufactured with more complex technologies, requiring technical skills and knowledge or with unchanging technologies used for years.

The research machine is not modern, so managers should consider its change. It should be remembered that the more modern machine is and the same time the more modern its part are, the higher efficiency and productivity of its work are. Modernity also usually entails higher quality of products. Therefore, further research of the machine in terms of its efficiency and productivity of its work are planned.

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