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Analysis of technological strategies on the example of the production of the tramway wheels

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ABSTRACT

Purpose: The main purpose of this paper is to analyse the technological strategies owned by selected metallurgical company. This will allow to evaluate the existing technology and compare it with similar technologies on the market. It will also help to make changes in these strategies because of their comparison with similar on the market.

Design/methodology/approach: Within the framework of the research different types of methods were used: STO matrix allows to compare existing technologies in the selected company with technologies in other similar companies. SWOT method and 3x3 matrix allow to determine the technological position of the test company. While with the use of the ABC technology method chosen machines used during the production process of the tramway wheels are evaluated.

Findings: As a result of carried out methods the technological position of the research company was found. The chosen machines used during production process were evaluated. The technological strategies were acquired. Presentation of the analytical methods which, according to author, can be very useful to evaluate and identify the technological strategy in the company.

Research limitations/implications: The research pursued represents part of a larger project carried out within the framework of Institute of Production Engineering, Faculty of Management, Czestochowa University of Technology.

Practical implications: It was important to show that the analytical methods used in the paper can be also used by most of the companies, as well metallurgical companies. Most of these methods are used for other purposes (SWOT or ABC method), therefore it was shown how to use them to evaluation of the technology held by the company.

Originality/value: The value of this paper is represented by an original contribution consisting of methodology ready to used by any company, and including metallurgical company. It can be very helpful in identifying by these companies of their technological strategies.

Keywords: Steel products; Technology; STO matrix; SWOT; ABC technology method; 3x3 matrix

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MATERIALS MANUFACTURING AND PROCESSING

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.

Many products require the use of certain technology or can be manufactured in different technologies, and their choice depends on many factors: technical, economic, social or cultural, such as cost, time, legislation, safety, comfort, etc. The technology and quality products, and at the same time the final result will be affected by the production equipment owned by the company.

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 [1-2].

Analysis of technological strategies on the example of a company engaged in machining and repair of technical equipment for the metallurgical sector was conducted. The manufactured parts such as rolls, wheels and axles of tramway are the product that have and had the most responsible and with the most strict quality requirements. That's why characteristics of the tramway wheels and the machines used to their production was presented.

2. Description of the research object

2.1. Characteristics of the research product

Tramway wheels type 105 N are produced with use of lot production in version: wheels G (Dutch) with dimensions: Ø 660 × 95 mm. 36 units are produced monthly. They are made from material of the forgings size with dimensions Ø 716 × 100 mm of steel grade P70 T (quenched and tempered). Required hardness of the tramway wheels is 300-365 HB according to the standard PN-K-92016:1997. The tramway wheels are elements of tram wheel sets. The tramway wheels produced in Poland are made of steel grate P70 [3]. All chemical composition is described in the standard PN-K-92016: 1997. In Figure 1 the tramway wheels TH mechanically processed is presented.

2.2. Production process depicted technologically

Production process of the research tramway wheels depicted technologically is presented in Figure 2.

The operations specified in the production process of the tramway wheels are following:

1. storage of the forgings,
2. compatibility verification of forging dimensions, grade of material to attestation,
3. transport,
4. pre-treatment,
5. compatibility verification of treated element to required dimensions from technical documentation,
6. transport,
7. proper treatment,
8. compatibility verification of treated element to required dimensions from technical documentation,
9. transport,
10. proper treatment,
11. compatibility verification of treated element to required dimensions from technical documentation,
12. transport,
13. finishing – wheels painting,
14. final control,
15. transport to a place of storing final products,
16. waiting for shipment.

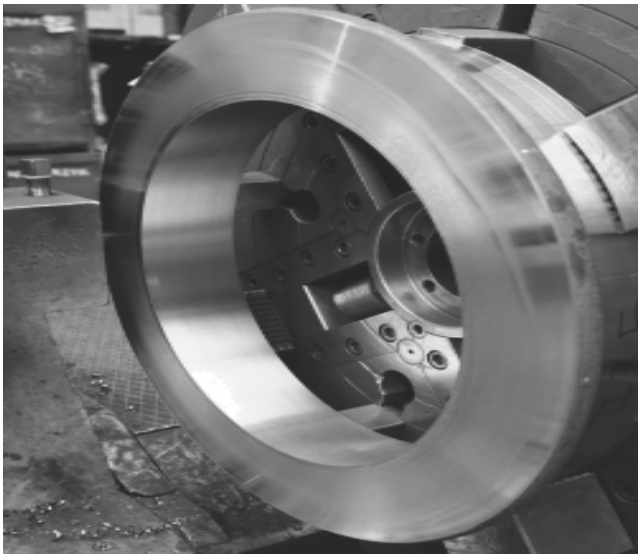

Fig. 1. Tramway wheel TH [3]

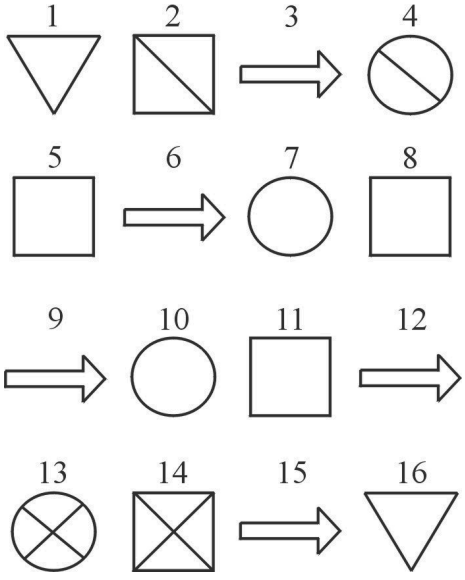

Fig. 2. Production process of the tramway wheel depicted technologically

2.3. Characteristics of chosen machines

During mechanical treatment of the tramway wheels there are used numerically controlled lathes: vertical 157 and chucking 198. The production process starts at the CNC machine 157, the pre-treatment takes place. In the next stage of mechanical treatment CNC machine 198, at which ready element is turned, is used. In Tables 1 and 2 there are basic characteristics of both lathes presented.

Table 1.
Characteristics of the numerically controlled lathe 157

Type of the machine:	vertical KCH-100 NM numerically controlled
maximum diameter of the workpiece:	1000 mm
maximum height of the workpiece:	700 mm
maximum diameter of turning with	1500 mm
power of the main engine:	45 kW
maximum weight of the workpiece:	1800 kg
quantity of the tool seats:	12
year of production:	1986

Table 2.
Characteristics of the numerically controlled lathe 198

Type of the machine:	chucking TZN 80C
maximum diameter of the passage above the cradle shields:	880 mm
maximum diameter of the chuck turning:	800 mm
maximum length of the rolling:	A2 - 11
steering:	SINUMERIK 810 D
drive:	SIMODRIVE 611 D
dimensions of the machine:	3500 × 1895 × 2050 mm
mass of the machine:	6000 kg
year of production:	1991

3. Chosen analysis of technological strategy

3.1. The use of the STO matrix

Strategic area of technology is defined as a set of skills used in the manufacture of a particular product or service, that is equivalent to specific customer requirements. Strategic area of technology, that is technical area, is defined by the STO matrix [4]. The essence of this method consists of evaluating the technological level in four scales:
0 – not used technology,
1 – delayed technology,
2 – average technology,
3 – leading technology.

Matrix of the strategic areas of technology is represented as a matrix array, where each strategic technology areas are placed in the individual line, and the products manufactured by each company in the column matrix. The production capacity of the research company in different areas is compared with a production capacity of the competitors.

In Table 3 technological areas according to production process presented in Figure 2 in the research company were evaluated comparing to similar in the market.

Table 3.
Evaluation of strategic areas of technology used during production of the tramway wheels

Technology area	Evaluation
Storage of the forgings	1
Compatibility verification of forging dimensions, grade of material to attestation	2
Pre-treatment	2
Compatibility verification of treated element to required dimensions from technical documentation	2
Proper treatment	3
Compatibility verification of treated element to required dimensions from technical documentation	2
Proper treatment	3
Compatibility verification of treated element to required dimensions from technical documentation	2
Finishing - wheels painting	2
Final control	2

Analysing Table 3 it can be concluded that the company compared to other does not care too much about storage of production materials - forgings (Evaluation 1). Quality control was assessed at 2, which results from fact that the company does not use any special methods of controlling with the use of modern measuring devices, although compatibility verification occurs after each stage of treatment and at the end of the process. Pre-treatment (turning) and finishing (wheels painting) were evaluated on the average.

The strategic area of the wheels machining technology turns out to be the right treatment, performed on a precision numerically controlled machine, with the use of the special machining program.

3.2. The use of the technology SWOT analysis

The SWOT method described in paper [5], is a tool used to internal analysis and its business environment in order to optimisation of management strategy of the company or creation of the new strategic plan. An organization, project or investment as well as any event in the field of business can be analysed. The main goal of the SWOT analysis is to determine the current position of the research object and its prospects, and with the best strategy for working.

The SWOT analysis can be conducted also for only one area of business activity of the company, such as a technology, to identify only the technological strategy.

In the paper the SWOT analysis was conducted only in terms of the technology. The results of this analysis are shown in Table 4.

Table 4.
SWOT analysis of technology

Strengths:	Weaknesses:
• high quality of the products, • qualified workforce, • good organization of production, • own machinery, • obtained certificates enabling performance of welded structures in class I and II, • possession of he overhead crane to move the large-size parts (up to 40,0 tons), • willingness to invest in new technologies and products, • modernization of machinery and equipment for machining and welding, • long-time tradition.	• energy-consuming machines and devices, • not enough people of personnel in relation to owned machinery, • unused full possible capacity of the owned machinery, • poor aesthetics of the machinery in the production hall, • advanced state of wear of the owned machinery.
Opportunities:	**Threats:**
• developing tramway market, • resignation of the main recipient of self-regeneration of the tramway parts and pieces, • short distance from the feedstock supplier.	• economic crisis, • decrease of exchange rate of Polish zloty, • high interest rate of credits, • interest in the tramway market by tramway competitors.

3.3. The use of the 3x3 matrix

To determine the relationship between the company's position in the market and technological possibilities, 3x3 matrix was created, as it is described in paper [4], in which each of nine fields specifies a different position in the company.
The scale of evaluations was following:

- W – weak 1-3,
- A – average 4-6,
- S – strong 7-9.

30 employees of the evaluated company were asked for help. On the basis of their experience both elements were evaluated with the use of nine-point scale. After calculating the average values indicated by employees it was possible to determine the position of the company in the 3x3 matrix. In Figure 3 the results of these studies are presented.

In Figure 3 the connection between the company's position in the market and technological possibilities is presented. The company is located in the field "Discover the incidental market", due to this fact the company's position in the market is relatively mild.

On the other hand, the main recipients of the tramway parts, who so far have been regenerated the products in their own maintenance workshops, and now due to advanced state of wear of machinery, are forced to ask for help of the research company. Finding a new market (new product) the company would make maximum use of existing technologies as well as attract new customers.

POSITION IN THE MARKET				
	S	Buy the ready technology	Develop your technological potential	Focus on the revealed chance
	A	Keep in the background	Search for occasions	Improve the marketing
	W	Keep in the background	Discover the incidental market	Search for partners
		W	**A**	**S**
		TECHNOLOGICAL POSSIBILITIES		

Fig. 3. The 3x3 matrix including links between the position in the market and technological possibilities

3.4. The use of the ABC technology method

To evaluated up-to-dateness of machine and devices ABC technology method, described in paper [6-9], can be used. 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. Evaluations are made on the basis of Parker's five-point scale

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.

In Table 5 evaluation of the technological up-to-dateness of the numerically controlled lathe 157, which is used during the pre-treatment of the tramway wheels, is made. While in Figure 4 its graphical interpretation is presented.

Table 5.
Evaluation of the up-to-dateness level of the parts of the numerically controlled lathe 157

No	Parts of main subassembly A	Evaluation
A1	Control system	3
A2	Control desk	5
A3	Program	4
A4	Tool - knife CRLNN 2525P20	3
	Parts of supportive subassembly B	
B1	Power transmission system	3
B2	Hydraulic system	3
B3	Manipulator	3
B4	Slide	2
	Parts of collateral subassembly C	
C1	Construction of the machine	2
C2	Foundation	2
C3	Cooling system	3
C4	Lubrication system	3
C5	Transport of chips	2

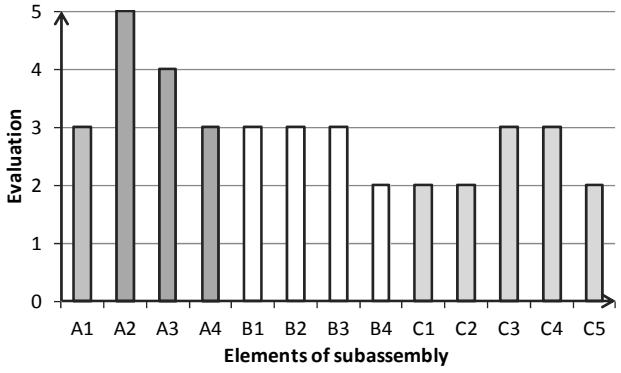

Fig. 4. Graphical interpretation of the ABC technology method of the numerically controlled lathe 157

From Table 5 and Figure 4 it results, that parts of main subassembly: A2 – Control desk and A3 – Program got the highest evaluation, reaching 5 and 4. While part of supportive subassembly: B4 – Side and parts of collateral subassembly: C1 – Construction of the machine, C2 – Foundation and C5 – Transport of chips were evaluated only at 2.

It means that the newest parts of the numerically controlled lathe 157 are parts of the main subassembly A: Control desk and Program. These 2 parts were produced with very modern technologies and they are very important from the point of view of the operator. While parts, which were produced with use of technologies known and used from many years, are mainly parts of the collateral subassembly C.

Parts of main subassembly A were the most often evaluated at 3 (more than 50%). In this case they are Control system and tool (knife). This subassembly received also evaluation 4 and 5 (each 25%).

The parts of supportive subassembly B are dived by Parker's five-point scale into 2 levels. Level 3 with the percentage of 75% contains: Power transmission system, Hydraulic system and Manipulator. Level 2, which concerns machine parts manufactured with unchanging technologies used for years, includes Slide with 25%.

Percentage fraction of the parts of collateral subassembly C are more even and are: level 3 – 40% (Cooling system and Lubrication system) while level 2 – 60% (Construction of the machine, Foundation, Transport of chips).

Generally, the entire machine can be evaluated at level 3, which means that some parts of subassemblies were produced with more complex technologies, requiring technical skills and knowledge. But the research machine (the numerically controlled lathe 157) is not modern.

In Table 6 evaluation of the technological up-to-dateness of the numerically controlled lathe 198, which is used during the pre-treatment of the tramway wheels, is made. While in Figure 5 its graphical interpretation is presented.

From Table 6 and Figure 5 it results, that the part of main subassembly: A2 – Control desk – touch screen got the highest evaluation, reaching 5. While part of supportive subassembly: B4 – Side and parts of collateral subassembly: C2 – Foundation and C5 – Transport of chips were evaluated only at 2.

Table 6.
Evaluation of the up-to-dateness level of the parts the numerically controlled lathe 198

No	Parts of main subassembly A	Evaluation
A1	Control system	4
A2	Control desk – touch screen	5
A3	Program	4
A4	Tool - knife PTDPN 2525M22	3
	Parts of supportive subassembly B	
B1	Power transmission system	3
B2	Hydraulic system	3
B3	Manipulator	3
B4	Slide	2
	Parts of collateral subassembly C	
C1	Construction of the machine	3
C2	Foundation	2
C3	Cooling system	3
C4	Lubrication system	3
C5	Transport of chips	2

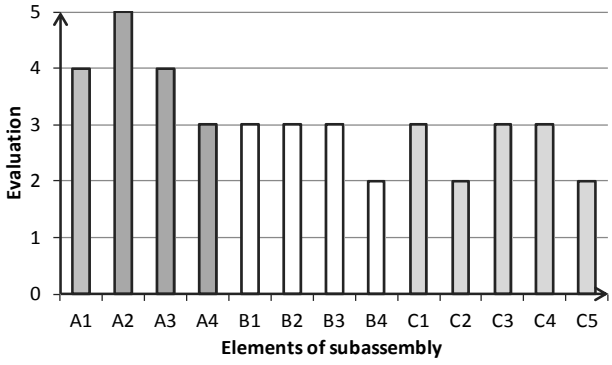

Fig. 5. Graphical interpretation of the ABC technology method of the numerically controlled lathe 198

In the numerically controlled lathe 198 the most modern part is Control desk – touch screen – the part which is responsible for quality of the product. While parts, which were produced with use of technologies known and used from many years, are Foundation, Transport of chips and Slide.

Parts of main subassembly A were the most often evaluated at 4 (more than 50%). In this case they are Control system and Program. This subassembly received also evaluation 3 and 5 (each 25%).

The parts of supportive subassembly B are dived by Parker's five-point scale into 2 levels. Level 3 with the percentage of 75% contains: Power transmission system, Hydraulic system and Manipulator. Level 2, which concerns machine parts manufactured with unchanging technologies used for years, includes Slide with 25%. So supportive subassembly of the both machines were evaluated in the same way.

Percentage fraction of the parts of collateral subassembly C are more even and are: level 3 – 60% (Cooling system and Construction of the machine, Lubrication system) while level 2 – 40% (Foundation, Transport of chips).

Generally all research machine was evaluated at 3, what means that, like in case of the numerically controlled lathe 157, many parts of the numerically controlled lathe 198 were produced with more complex technologies, requiring technical skills and knowledge. But this machine is not modern.

After the evaluation of technological up-to-dateness of the subassemblies of both numerically controlled lathes used during production process of the tramway wheels it is possible to conclude that the company should pay more attention to parts of supportive and collateral subassemblies B and C representing 50% of all evaluated part and evaluated at 2 and 3.

The technical survey, possible replacement or repair of individual parts significantly raise the level of modernity. Special attention should be pay to part of the main subassembly A, which were evaluated at 3. Selection of appropriate tools will allow for faster and more precise product machining.

4. Conclusions

The main goal of the article was is to analyse the technological strategies owned by selected metallurgical company. This company is mainly involved in machining and repairing of equipment. The tramway wheels are produced for special orders of one of the main recipient. Before the analysis it was necessary to present the production process of the research product. The process consists of 16 different operations.

With the use of STO matrix it was possible to evaluated existing technology in comparison with other technologies existing in the market. Individual technological areas received an average of 2, what means that the technology in the research company used to production of tramway wheels is ordinary.

The SWOT analysis, used only in case of technology, showed the main strengths, weaknesses, opportunities and threats connected with this area.

With use of 3x3 matrix it was determined connection between the position in the market and technological possibilities according to the answers of workers. It turned out that the research company has very weak position in the market and its technological possibilities are average. It means that the company is in the part of the 3x3 matrix called “Discover the incidental market”. It means that there is a need of new, small customers of the products.

After the evaluation of the technological up-to-dateness of the subassemblies of both the numerically controlled lathe used during production process of the tramway wheels, with use of ABC Technology method, it is concluded that the research company should pay more attention to parts of subassemblies B and C, which were evaluated only at 2 and 3. So the company should repair or replaces individual parts of machines.

All the carried out analysis let concluded that the technology existing in the research company is not modern. It means that the company is not competitive in the market. In the future it can results to its failure if the corrective actions are not introduces.

References

[1] R. Prusak, E. Kardas, Z. Skuza, Strategy analysis in the company positioning company. production and management in the metallurgy, R. Budzik (Ed.), Publisher of WIPMiFS, Politechniki Częstochowskiej, Series: Metalurgia 54 (2010) 135-138 (in Polish).

[2] J. Rosak-Szyrocka, M. Konstanciak, K. Knop, Chapter 5, Meaning of technological up-to-dateness and efficiency of machines used in HACPP system, Operating efficiency and machines modernity, Ed. and Scientific Elaboration S. Borkowski, J. Selejdak, Publisher Endi Miletić, Sisak, 2010, 57-70.

[3] Materials from the research company.

[4] P. Lowe, The management of technology. perception and opportunities. Publishing House Śląsk, Katowice, 1999 (in Polish).

[5] J. Rosak, The use of SWOT analysis in the activities of medical units, The economy in the face of euro transition, J. Stankiewicz (Ed.), Publishing House of University of Zielona Góra, Zielona Góra 2004, 153-158 (in Polish).

[6] S. Borkowski, J. Selejdak, S. Salamon, The effectiveness of the operation of machinery and equipment. Pub. of Faculty of Management, Czestochowa University of Technology, Czestochowa, 2006 (in Polish).

[7] R. Ulewicz, S. Borkowski, Production management, Production systems, Publishing House Humanitas, 2008 (in Polish).

[8] E. Kardas, The use of ABC method to analyze the materials in blast furnace process, Logistics 4 (2010) 64-68 (in Polish).

[9] J. Selejdak, M. Konstanciak, K. Mielczarek, Chapter 3, Evaluation of technological efficiency and up-to-dateness of machines used in building industry, Operating efficiency and machines modernity, Ed. and Scientific Elaboration S. Borkowski, J. Selejdak, Publisher Endi Miletić, Sisak 2010, 33-46.