THE USE OF 3X3 MATRIX TO EVALUATE A MANUFACTURING TECHNOLOGY OF CHOSEN METAL COMPANY

Stanisław BORKOWSKI, Manuela INGALDI, Marta JAGUSIAK-KOCIK
Czestochowa University of Technology

Abstract:
Manufacturing technology of steel products, including ribbed wire, is a very important factor influencing the final result of production and hence the cost of production. The product competition decides about the existence of the manufacturer on the market. Therefore, it was decided to use the 3x3 matrix to evaluation manufacturing technology of ribbed wire. This matrix can be easily used to evaluate the technology of all steel products. In the paper the 3x3 matrix was used to in the Polish steelworks.

Key words: technology, competition, 3x3 matrix, ribbed bars

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, 3, 4].

The aim of this paper is to evaluate the position of the company on the basis of two factors: the product competition (TK) and the technological possibilities of the manufacturing process (TW). This evaluation allows to indicate directions for further activities of the company and can be used as an element indicating the company's strategy in term of technology.

RESEARCH METHOD

The research, which is presented in the article, is a part of the researches connected with BOST method conducted at Institute of Engineering Production, Faculty of Management, Czestochowa University of Technology [5, 6, 7, 8]. This test method, based on the Toyota's production system can be successfully used both in production and service institutions. It is a survey method which describes material and non-material resources such as: the most important areas of improvement, visual control of factors, elements of the manufacturing process, competitive products and manufacturing processes.

In the article one of the questions from the questionnaire was presented. 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 of their company (TW) (1 - low, 9 – high evaluation).

In the paper the 3x3 matrix, presented at first by Paul Lowe [9], with some its modifications of authors presented already in papers [5, 6, 7, 8], was used to evaluate both factors. In the original version 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. It was necessary to change locations of the borderlines to avoid problem with interpretation. Now they are placed between the possible answer. On the axes the letter symbols were introduced. Characteristics of the 3x3 matrix with the description of its parts is presented in Figure 1. For all companies part 1 is a main goal to achieve.

The survey was conducted among the employees of one of the Polish rolling mills. The research included 30 production workers of that rolling mill.

CHARACTERISTIC OF THE RESEARCH COMPANY

The research steelwork is a modern company with a stable production process, organizational system, friendly for the surrounding environment. The mission of the company is to strengthen the company's position in Poland and

122   Management Systems in Production Engineering 3(15)/2014

S. BORKOWSKI, M. INGALDI, M. JAGUSIAK-KOCIK - The use of 3x3 matrix to evaluate a manufacturing technology of chosen metal …

abroad as the most efficient producer of long steel products with high quality.

The rolling mill of the research company is a continuous average type of rolling mill. It was launched in 1999. At the beginning its assortment included rounds flat steel bars, round steel bars and reinforced bars.

The research rolling mill is equipped with a devices from the company Danieli Morgardshammar. It is one of the most modern rolling mills in Europe, and the most modern in Central and Eastern Europe. In this rolling mill it is possible to implement the stringent requirements of designers connected with engineers or technical parameters and quality of ribbed bars, for both domestic and foreign market. This rolling mill is still modernized in order to meet the requirements of the customers [10].
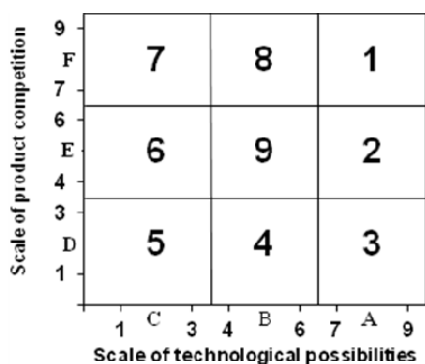

Fig. 1 Characteristics of 3x3 matrix and denotation of its parts.
1. Focus on the revealed chance.
2. Improve the marketing.
3. Search for partners.
4. Discover the incidental market.
5. Keep in the background.
6. Keep in the background.
7. Buy the ready technology.
8. Develop your technological potential.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

CHARACTERISTIC OF RESPONDENTS

The survey was conducted among 30 production workers of the rolling mill in one of the Polish steelworks. In Table 1 it is shown the general characteristics of the respondents (demographics of the survey). However, in Table 2 the characteristics of surveyed employees were presented. The research characteristics of the respondents are following:
− gender (MK),
− education (WE),
− age (WI),
− job seniority (SC) – that is experience,
− mobility (MR) – that is which place of work,
− mode of the employment (TR).

Table 1
Features of respondents. Characteristic

Sym bol	Features' marking and their characteristic					
	MK	WE	WI	SC	MR	TR
1	Men	High school	< 30	< 5	1	Regular
2	Women	Professional	31 - 40	6 do 10	2	Transfer
3		Secondary	41 - 50	11 do 15	3	Finance
4		Higher	51 - 55	15 do 20	4	
5			56 - 60	21 do 25	5	
6			61 - 65	26 do 30	6	
7			> 66	31 do 35		
8				> 36		

Table 2
Features of respondents. Percentage characteristic

Sym bol	Features' marking and their rate characteristic					
	MK	WE	WI	SC	MR	TR
1	90	7	17	23	43	63
2	10	17	23	10	33	20
3		47	33	20	0	17
4		30	10	23	10	
5			10	7	7	
6			7	7	7	
7			0	10		
8				0		

Like in every company, also in the research rolling mill it was noted high diversity of the surveyed employees. Among the surveyed production employees 90% are men. It is important to remember that the rolling mill, where the working conditions are very difficult, is the research company. Almost 50% of employees have secondary education, 30% higher education. Over 30% are people who are 41-40, with 11-15 or 15-20 job seniority (experience). In the company over 66 year-old people do not work (pension age). For most of the employees the research rolling mill is 1st or 2nd place of work, what means that the managers of the rolling mill steelwork think about experienced staff, and they know how much the employees training costs the company. Over 60% of people got their work in the research rolling mill in regular mode of the employment.

RESULTS OF THE RESEARCH

The production workers of the research company were asked to evaluate product competition (TK) and technological possibilities (TW) of the company where they work on the scale from 1 to 9, where 1 – low, 9 – high evaluation. The results of the researches were presented in different forms (Fig. 2). The map of evaluations is a first form. Thanks to it, it is possible to find out exactly what evaluation pairs have been granted by the interviewed workers. Visually, we can notice if the evaluations distribution is even. With the use of the map of sum of evaluations number it is possible to specify exactly which field of the 3x3 matrix dominates in the research company (its position) in the matrix. From the substantive point of view, a radar chart is appropriate to perform a graphical presentation of results, relatively simple, without annoying description of the axis.

From the map of evaluations (Fig. 2a) it results that there is no dominant evaluations pairs given by the employees. In four cases two employees gave the same pair of evaluations. Noteworthy is the fact that the assessment 1, coupled with any other assessment, was not given to any of the two factors. The technological possibilities (TW) received evaluation 9 only from one employees who in the same time gave 8 to the product competition (TK). However, the product competition (TK) received 9 twice, while the second factor was evaluated very low (once evaluation 2 and second time 3).

Analysing the map of sum of evaluations number (Fig. 2b) and radar graph (Fig. 2c) it can be noticed that none of the fields of the 3x3 matrix dominates, that is, there is no clear indication of the company's position.

Most evaluations pairs were placed in 2nd field of the 3x3 matrix, i.e. „Improve the marketing" (6 evaluations pair), and also in the 1st field, i.e. „Focus on the revealed
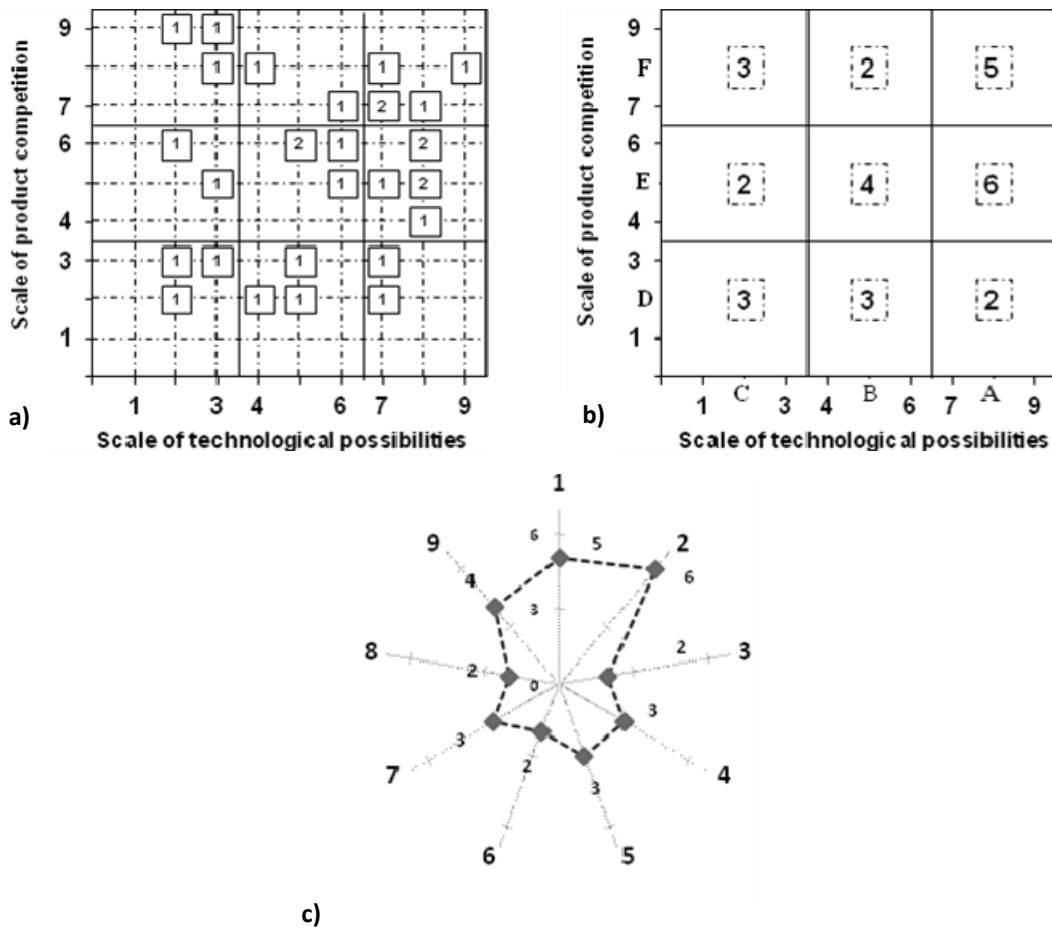
Fig. 2 Presentation of research results in the form of:
a) map of evaluations, b) map of sum of evaluations number for each area of 3x3 matrix, c) radar graph
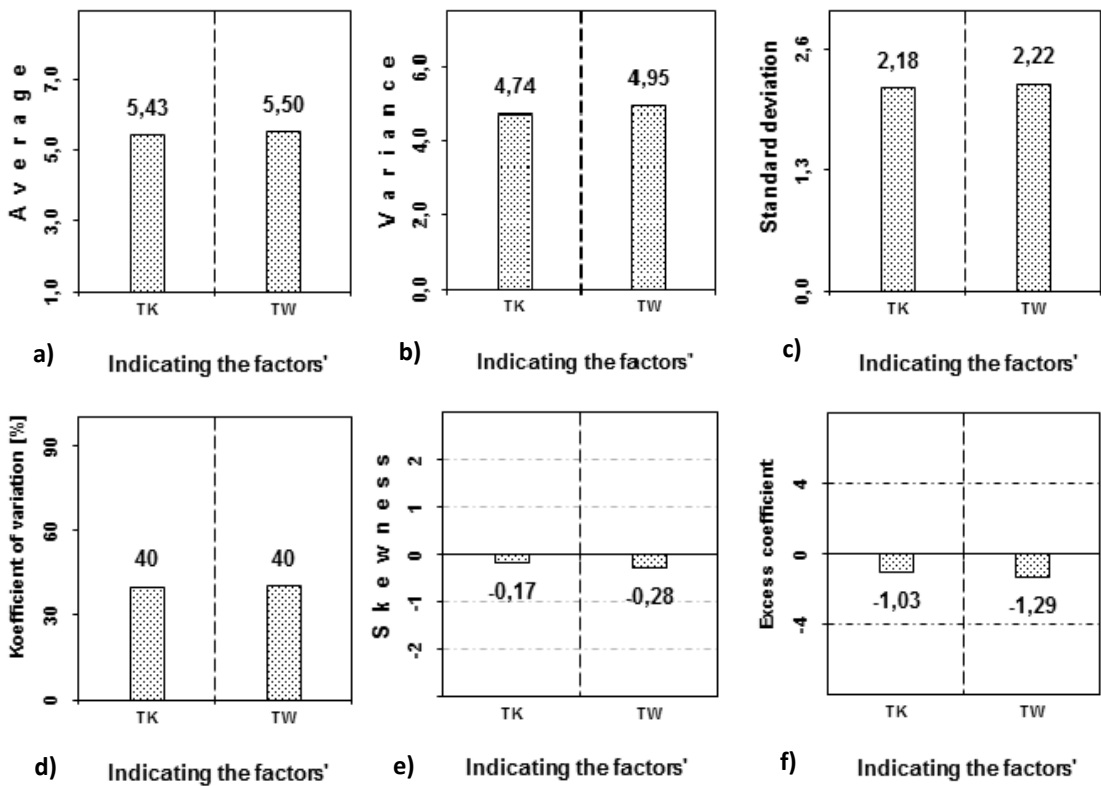

Fig. 3 Comparison: a) average, b) standard deviation, c) variance, d) coefficient of variation, e) skewness,
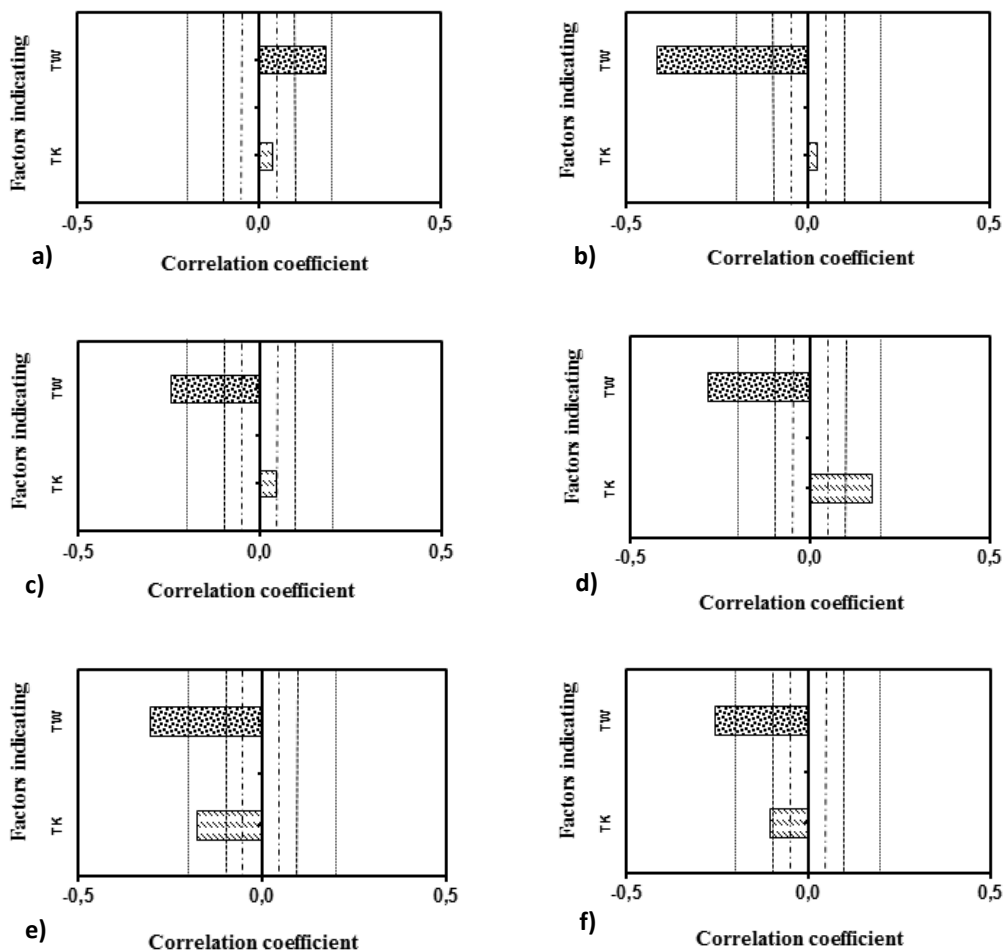f) kurtosis for factors of matrix 3*3. It concerns production company

124   Management Systems in Production Engineering 3(15)/2014

S. BORKOWSKI, M. INGALDI, M. JAGUSIAK-KOCIK - The use of 3x3 matrix to evaluate a manufacturing technology of chosen metal ...

Fig. 4 Correlation graphs of evaluations for matrix 3*3 factors depending on the respondents feature:
a) gender, b) education, c) age, d) job seniority, e) mobility, f) mode of the employment.
α = 0.2 (internal lines), α = 0.1 (central lines), α = 0.05 (external lines).
It concerns production company

chance" (5 evaluations pair). Many evaluations pairs were placed close to the borders between these fields of the 3x3 matrix.

It can be concluded that the employees evaluated both factors as good or very good, with small domination of the technological possibilities (TW). In its strategy, the company should therefore recognize the element associated with the improvement of marketing, which will help to improve the product competition (TK) in order to be in 1st field of the 3x3 matrix, i.e. „Focus on the revealed chance".

The basis statistics for both factors were also calculated, The results of this part of the research were presented in Figure 3.

From Figure 3a it results that on average factor the technological possibilities of the research company (TW) was evaluated slightly higher than its product competition (TK). However, diversity of evaluations in case of both factors was same (Fig. 3d).

The relation between respondents features and given evaluations was also checked. The results of this analysis was presented in the form of correlation graphs (Fig. 4). The research was conducted at the following significance levels: α=0.2; α=0.1 and α=0.05. These levels were marked in Figure 4 by 3 types of dashed lines.

It can be noticed that evaluations given to factor the technological possibilities (TW) depend on all respondents features. In case of gender, positive correlation at α=0.1 was noticed. It means that statistically women evaluated

higher this factor. In case of other features the correlation with the technological possibilities (TW) was significant at all levels and it was negative relation.

There was different situation in case of the product competition (TK). There was no relation with the gender, education and age of respondents. In case of the job seniority, mobility and mode of the employment the correlation was significant at α=0.1. It was positive relation with the job seniority what means the people working longer in the research company evaluated product competition (TK) higher. While in case of other features it was negative relation.

SUMMARY

The aim of this paper was to evaluate the position of the company on the basis of two factors: the product competition (TK) and the technological possibilities of the manufacturing process (TW). The survey was conducted among the employees of one of the Polish rolling mills. 30 production workers of that rolling mill were asked to evaluate both factors on a scale from 1 to 9.

From the relation between technological possibilities and position of the company in the market it results that the company is located in the 2 or 1 field of the 3x3 matrix, which means respectively Improve the marketing" and „Focus on the revealed chance".

3x3 matrix is a very useful tool in defining the technology strategy for the company on the basis of its position in

the market and its technological possibilities. According to the authors the change of the position in the market into product competition should facilitate the evaluation with use of this matrix. Also the change of the values on both axes proposed by the authors should help in reading the final technological strategy. So it was shown that the research methods existing in literature can easily be modified to the needs of the investigator. In practice, this means that with a single research tool it can be carried out research into various areas of a business or subjecting the various elements of the study. This method can be used in various manufacturing and service companies, because, according to the authors, the competitiveness of our services can be also be used.

REFERENCES

[1] M. Konstanciak. "Analysis of technological strategies on the example of the production of the tramway wheels". *Archives of Materials Science and Engineering*, vol.57, iss. 2, 2012.

[2] R. Ulewicz. "Quality Control System in Production of the Castings from Spheroid Cast Iron". *Metalurgija*, vol. 42, no 1, 2003.

[3] J. Selejdak. "Analysis of Factors Influencing Seamed Tubes Quality". *Metalurgija,* vol. 41, no 3, 2002.

[4] A. Grunwald, G. Kappler, L. Leible. "Technology assessment in engineering practice. The case of Bioliq® - fuel production from biomass". *Management Systems in Production Engineering*, no 2(10), pp. 12-18, 2013.

[5] S. Borkowski, R. Ulewicz, J. Selejdak, M. Konstanciak, D. Klimecka-Tatar. "The Use of 3x3 Matrix to Evaluation of Ribbed Wire Manufacturing Technology" in *Proc. 21st International Conference on Metallurgy and Materials METAL 2012,* 2012.

[6] S. Borkowski. M. Konstanciak. "Evaluation of the roll mill technological possibilities and ribbed wire competition with use of 3x3 matrix". *International Journal Transport & Logistics*, vol. 12, iss. 22, 2012.

[7] S. Borkowski, M. Ingaldi. "Workers Evaluations of Ribbed Wire Competition and Rolling Mill Technological Possibilities" in *Proc. 22nd International Conference on Metallurgy and Materials METAL 2013,* 2013.

[8] M. Ingadi, S. Borkowski. "Upravlenie tehniceskimi vozmoznostami i konkurencia tovarov na rynke v opredelennoj kompanii" in Proc. VI Mezdunarodnoj naucno-prakticeskoj konferencii, posvascennoj 40-letiu Samarskogo gosudarstvennogo universiteta putej soobscenia, 2013, pp. 104-107.

[9] P. Lowe. *Zarządzanie technologią. Możliwości poznawcze i szanse.* Katowice: Śląsk, 1999.

[10] H. Dyja, S. Mróz, P. Sygut, M. Sygut. *Technologia i modelowanie procesu walcowania prętów okrągłych o zawężonej tolerancji wymiarowej*. Częstochowa: Wydawnictwo Wydziału Inżynierii Procesowej, Materiałowej i Fizyki Stosowanej Politechniki Częstochowskiej, 2012.

prof. n tech. i n. ekon. dr hab. inż. Stanisław Borkowski,
dr inż. Manuela Ingaldi, mgr inż. Marta Jagusiak-Kocik
Czestochowa University of Technology, Faculty of Management
Institute of Production Engineering
Armii Krajowej 19B Street, 42-200 Czestochowa, POLAND
tel. +4834 3250 399
e-mail: bork@zim.pcz.pl
          manuela@gazeta.pl
          jmarti@go2.pl