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EVALUATION OF THE ROLL MILL TECHNOLOGICAL POSSIBILITIES AND RIBBED WIRE COMPETITION WITH USE OF 3X3 MATRIX

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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.*

Key words: *3x3 matrix, ribbed wire, technology possibilities, product competition*

1 INTRODUCTION

In the new-built and modernized steelworks the modern technologies are introduced. They are characterized by continuity of the processes, reduced energy consumption, reduced material consumption, reduced impact on the surrounding environment, which may be used to give the required qualities of shapes, sizes, and the necessary mechanical properties to products [1].

Capabilities and parameters of the rolling mill have impact on the rolling technology of the product. Each mill has a certain peculiarity in the selection all devices. But the characteristic features of all rolling mills are their high efficiency and low cost of production. The use of flow production allows for complete mechanization and automation of the production process. This affects the high speed of rolling, and consequently, a shorter rolling pace and heat loss reduction [2-4].

All Rolling Mill in research steelworks has been on market for several years and modernized during last few years. The New Long Products Rolling Mill line was open in 2009. The Danieli Company was the supplier of equipment of this rolling mill. In the mill rods and wires and structural components are produced. The opening of the new mill allowed the steelworks to increase production capacity more than twice.

2 METHODOLOGY OF THE RESEARCH

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 [5-7]. This test method, based on the Toyota's production system can be successfully used both in production and service institutions. It was created by prof. Stanisław Borkowski. 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. The final part of the survey includes an assessment of employees, the respondent's birth certificate and determine the nature of the business. With use of the BOST method human resources company can be characterized. There are two versions of the survey questionnaire in this method.

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 research 40 production workers took part (out of 200 production workers from research rolling mill).

Why these 2 elements?

Machines and devices, regardless of human activity, use a specific technology, giving the specific characteristics to the product. These features of the products (besides money) may decide about the existence of the manufacturer on the market. So there is a defined relation between the characteristics of the products (quality) and their competition in the market. On the other hand, the existing technologies are not utilized in 100%. The gap could be named as technological capabilities that are conditioned absolutely by technology innovation, training of operators.

In the paper the 3x3 matrix, presented at first by Paul Lowe [8], with some its modifications, was used to evaluate of the relation between technological possibilities and competition of the product (ribbed wire). In the original X-axis is represented by the technological possibilities and the Y-axis by the position in the market (here changed for product competition). 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 Fig. 1. For all companies part 1 is a main goal to achieve.

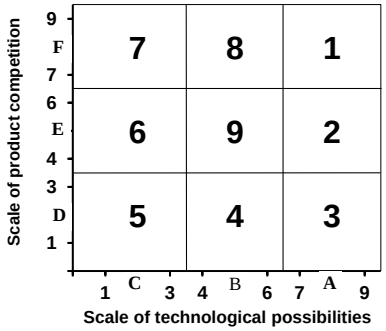


Fig. 1. *Characteristics of 3x3 matrix and denotation of its parts: 1. Focus on the revealed chance. 2. Improve the marketing. 3. Search for partners. 4. Discover the incidental market. 5. Keep in the background. 6. Keep in the background. 7. Buy the ready technology. 8. Develop your technological potential.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

3 THE RESULTS OF STATISTICAL DESCRIBTION OF RIBBED WIRE COMPETITION EVALUATION AND THE ROLLING MILL TECHNOLOGICAL POSSIBILITIES

The first stage of the BOST survey results included calculation and comparison of the basic statistics such as: average, variance, standard deviation, coefficient of variation, skewness and kurtosis for the evaluations of the factors: the ribbed wire competition (TK) and the rolling mill technological capabilities (TW). From the results (Fig. 2) it can be concluded that the average of the technological possibilities (TW) is greater than the average ribbed wire competition (TK), so the production workers evaluated the first factor higher than the second. The evaluations of the ribbed wire competition (TK) differed from the average more or less by 1.97, while in case of technological possibilities (TW) by 1.71. The variation coefficient (Fig. 2d), which determines the strength of the dispersion of the statistical test is between 28 - 35%. This means that the diversity of features (assessment) is moderate. The skewness of the assessment set (Fig 2e) is negative, what indicates that both features are characterized by a left-sided moderate asymmetry.

The kurtosis in case of both factors is negative, what means that evaluations of both factors are characterized by the distribution with the bigger flatting than normal distribution. But in case of the ribbed wire competition (TK) this flatting is very slight.

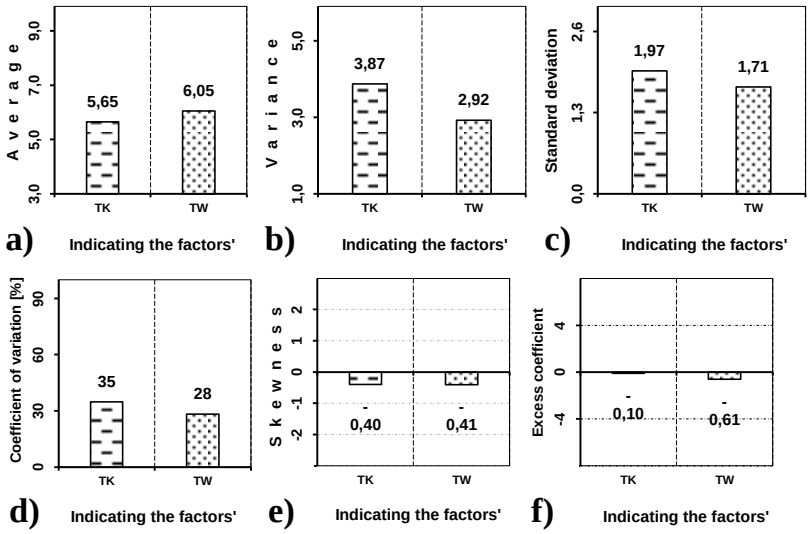


Fig. 2. *Comparison: a) average, b) standard deviation, c) variance, d) coefficient of variation,*
e) skewness, f) kurtosis for factors of matrix 3×3
Source: own study

4 ANALYSIS OF THE RESEARCH RESULTS

4.1 Presentation of the research results

Typically, results are presented in the form of tables. In this case, a tabular variant would take too much space and, certainly, do not point out the results peculiarities. Therefore, using the observations the authors used a graphical interpretation of the results, from the most difficult to easiest way.. Figure 3a shows the map of the assessments number on the 3x3 matrix background. Visually, we could notice that the assessments distribution is not even. The evaluations couples (the technological possibilities (TW) and the ribbed wire competition (TK)) are concentrated in the central part of the matrix, whereas in the early part of the system there were no results.

For better understanding of obtained results, as proposed by the various graphic forms of presentation were used, as expressed in Figure 3b. In individual parts of the 3x3 matrix, the number of evaluation were summed. It is easy to find out that in the existing conditions, 13 pairs of assessments (the technological possibilities (TW) and the ribbed wire competition (TK)) are in the BE part (Part 9). This shows that the rolling mill should search for occasions, which leads to "better the attractiveness" of the wire (e.g. reduction in the wire price). Secondly, the technological possibilities (TW) and the ribbed wire competition (TK) have been evaluated with highest note by 9 out of 40 employees (part 1 – focus on the revealed chance). But it is important to underline that not all workers gave so high evaluations especially that one rolling line was modernized and second opened 2 years before the research. Finally, the analysis of figure shows that 32 out of 40 respondents evaluated both factors with high vote (4 and more).

To use the easiest way of results graphical presentation, the radar graph was used (Fig. 3c). It does not include annoying description of the axis. The analysis of the Fig. 3c easily indicate the earlier statements: area 5 contains no assessments couples, while the area 9 include 13 couples.

An interesting form of results presentation is 3D graph (Fig. 4) which for some readers is certainly more understandable than the previous forms of graphics, especially for these who do not feel the differences of numbers. For better interpretation the height of individual bars (in this case cones) was used. This kind of the results graphic form we could read and confirm earlier dependences.

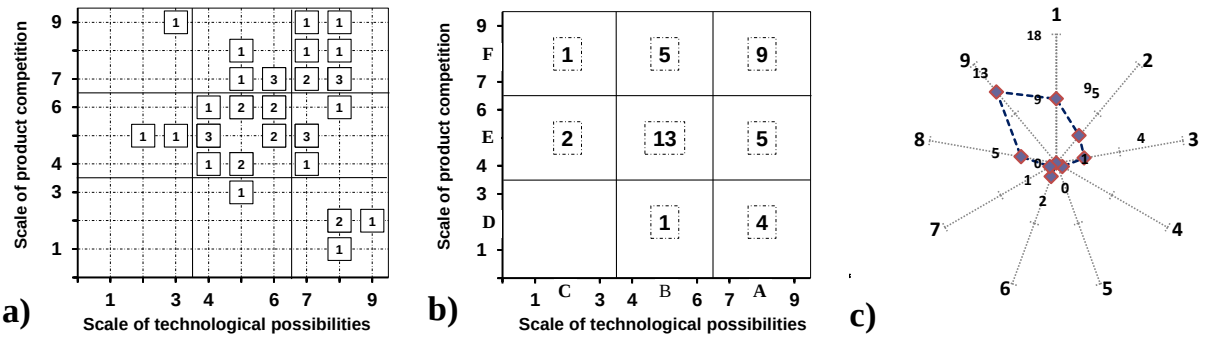


Fig. 3. *Presentation of research results in the form of: a) map of evaluations b) map of sum of evaluations number for each area of 3x3 matrix, c) radar graph*
Source: own study

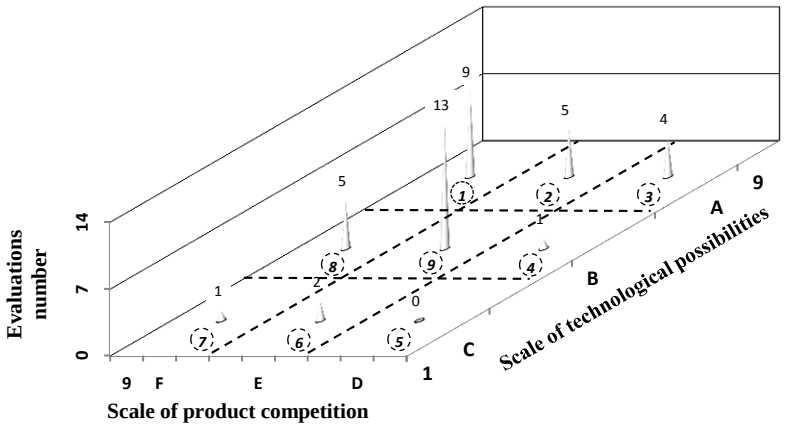
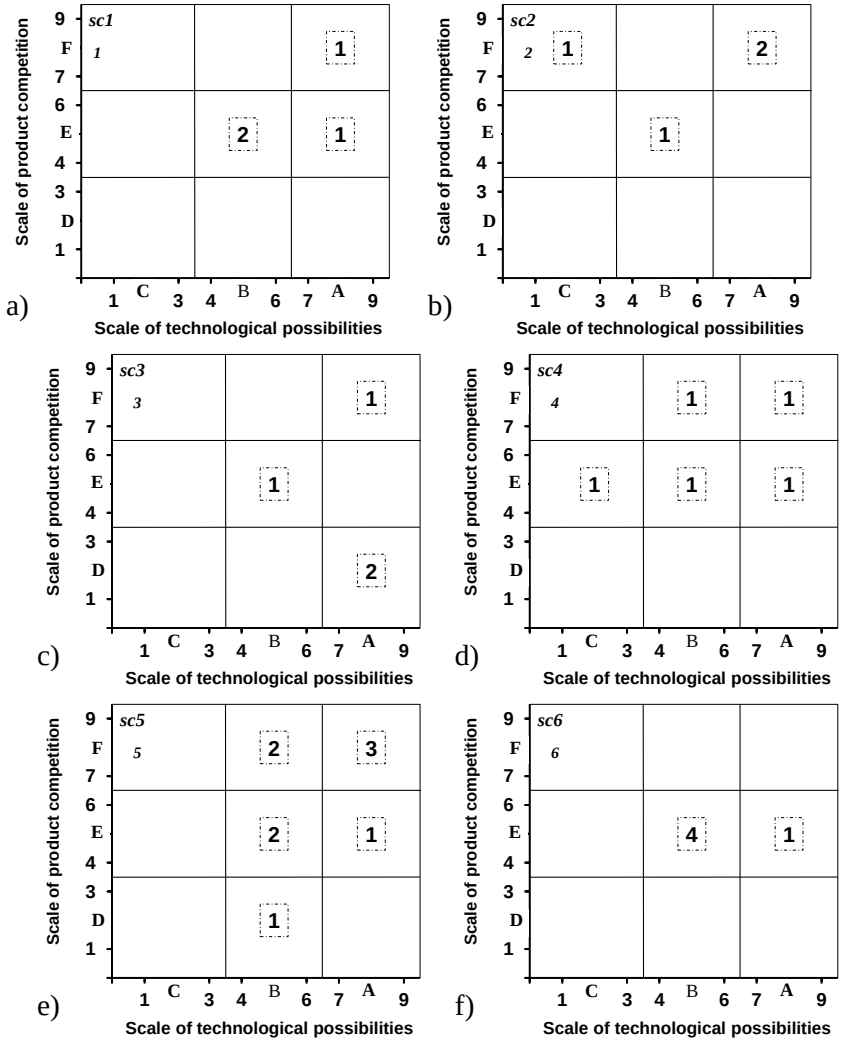


Fig. 4. *Research results' combination in 3D system with marking elements of matrix 3×3.*
Source: own study

4.2 Influence of the respondents' characteristics on the assessment of the technological possibilities and the competition of ribbed wire

In the research 40 production workers took part. But it is important that usually members of the staff are different from each other. To see the variability of these workers their following characteristics were used: gender, education, age, job seniority, mobility, mode of employment. In Fig. 5 the effect of respondents job seniority on the evaluation of both factors is presented. The job seniority was chosen as an example because of its answers diversity.

As it is seen in Fig. 5, in groups of workers: below 5, 6 to 15, 16 to 20, 21 to 25, 31 to 35, 36 to 40, above 41 years of job seniority are more or less the same (4-5 workers in each group). It means that in the research company there are people with small and big job experience. It means that youngers can learn from olders experience. Group 26-30 years of job seniority is the most numerous. In this group people the most often gave evaluated both factors in part 1 (Focus on the revealed chance). In case of group31-35 there was strong domination of answers from the part 9 (Search for occasions). In the other cases the was no domination of answers.



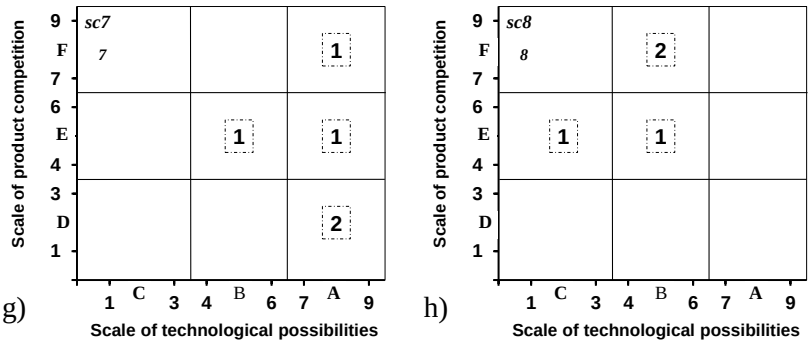


Fig. 5. *Sum of evaluations in individual elements of matrix 3*3 depending on respondents' job seniority.*
a) < 5, b) 6 to 15, c) 16 to 20, d) 21 to 25, e) 26 to 30, f) 31 to 35, g) 36 to 40, h) > 41 years
Source: own study

4.3 Summary influence of the respondents' characteristics on the results of the assessment of 3x3 matrix factors

Fig. 6 shows the correlation coefficients between the characteristics of respondents and evaluations assigned by them, concerning on rolling mill technological possibilities (TW) and ribbed wire competition (TK). The correlation coefficients in the form of histograms were presented.

On the X-axis value of 0 was applied (in the middle), to the left and right side of this distinction there are three characteristic lines present. The lined marked on the graphs representing the statistical significance leveled α = 0.05, 0.10, 0.20 (external, central and internal lines). It is maximum possible level of mistake.

It is possible to see that the correlation is significant in 3 cases: First one, there was correlation between technological possibilities (TW) and gender (for α = 0,02 and 0,01). It means that women evaluated better this factor, Second, there was correlation between ribbed wire competition (TK) and age (for α = 0,02). The older workers gave worse evaluations to this factor. Last one, there was correlation between technological possibilities (TW) and mode of employment (for α = 0.02). People who change their work because of financial conditions evaluated this factor TW better.

In other cases the correlation is not significant. Lack of correlation can be explained by enterprises culture, which according to Toyota's philosophy is defined and specific for each company.

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