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ASSESSMENT OF COMPETENCY PROFILES IN THE EMPLOYEE SELECTION PROCESS USING THE THURSTON AND TOPSIS METHODS. A CASE STUDY

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Purpose: The article presents a case study of the assessment of competency profiles in the process of employee selection using the Thurston method and using the TOPSIS analysis. The author presents the results of his own research carried out in plants producing wood-based panels, for the position of visual quality control employee.
Design/methodology/approach: The presented method is based on an expert survey, an employee survey, and analysis of the collected data using the Thurston method and TOPSIS analysis. Finally, it again uses surveys of subjective employee assessments by the supervisor.
Findings: The application of TOPSIS analysis to the assessment of visual quality control employees presented in the article was successfully implemented in one of the plants producing wood-based panels that participated in the research.
Research limitations/implications: The method described applies to selected job positions in a specific industry. Therefore, research should be undertaken to validate the method in other settings. The weakest link in the presented method is the subjective assessment of employees performed by their manager. An unbiased, subjective assessment can be distorted by interpersonal relationships between the manager and the employee. Objectifying this stage will certainly improve the results obtained using the presented method.
Originality/value: The presented content is based on research conducted by the author as part of his doctoral dissertation and has not been previously published. The author's approach to assessing competency profiles is an innovative approach, demonstrating a systematic approach to organizing and selecting employees across the spectrum of problems related to exemplary quality control in the wood-based products industry.
Keywords: competency profiles, Thurston, TOPSIS, employee selection.
Category of the paper: Case study.

1. Introduction

In today's economy, amidst global competition and the global crisis, the importance of product quality is growing. Globalization and intense competition are trends observed worldwide. Unpredictability and turbulence have become inherent features of the environment,

from which opportunities and risks emerge (Włodarkiewicz-Klimek, 2018). Advancing technological advancement helps achieve the best process results. This is largely related to process automation (Gollinger-Tarajko, 2017), enterprise management systems, and general technological advancement. However, as many authors note, despite the growing importance of Industry 4.0 initiatives (Bendkowski, 2017; Basl, 2017; Yazdi et al., 2020), and thus largely the automation of production processes (Stojanovic et al., 2001; Giesko, Mazurkiewicz, Abrowski, Czajka, 2011; Sgarbossa, Grosse, Neumann, Battini, Glock, 2020), people still play a significant role in manufacturing processes. Processes involving human involvement require appropriate competencies, experience, and skills. Therefore, it is necessary to select appropriate employees for processes, operations, and tasks. This allows for optimal utilization of employee potential while ensuring appropriate process security. The question arises: what characteristics should the ideal employee possess for a given process? How can we assess the competency profiles of process employees so that they can be delegated to the appropriate processes?

This article is based on the author's doctoral dissertation. It discusses the competency profile assessment method, defined as a method for assessing "the fundamental characteristics of individuals that determine effective task performance and performance" (Klemp, 1980), in the employee selection process using the Thurston method and TOPSIS analysis. The presented example is based on visual quality control workers in the wood-based panel industry.

2. Visual quality control. Employee characteristics

The importance of visual quality control is widely described in the literature – Hamrol, Kowalik, 2006; Kujawińska, Vogt, 2015; Bożek, Kujawińska, Hamrol, Diering, Rogalewicz, 2017; Gruszka, Tytyk, 2018; Bae, Han, 2021. Visual quality control processes in organizations vary, including in terms of the difficulty of their implementation and their importance to the organization. Therefore, it is important to select the right employees – in this case, controllers – for specific quality control processes. This will allow for optimal utilization of employee potential and appropriate process security.

The literature on the subject lists a wide range of desirable characteristics that a quality controller should possess. These include, among others: mindfulness, objectivity, detail-oriented (Tomic, 2016), but also perceptiveness, experience, temperament or creativity (Vogt, Kujawińska, 2013). Other authors point to knowledge, abilities, skills, health, attitudes and values or motivation (Szymankowska, 2009). According to the National Standard of Professional Competences, quality controllers of mechanical products (2013) should be characterized by good eyesight, accuracy, the ability to distinguish colors, the ability to maintain concentration, resistance to stress, the ability to work under time pressure, technical

and organizational skills, but also communication skills, self-control, innovation and openness. How to assess which of the indicated features are the most important and which of them and to what extent are possessed by employees of a given, specific organization?

3. Methodology

Due to the characteristics of the chosen industry, the author selected a targeted sample – production plants of the largest corporations producing wood-based panels. In the initial phase, 10 production plants in Europe were invited to participate in the study. Ultimately, four plants participated. The research was conducted between March and August 2021. The material was developed as part of the author's doctoral dissertation.

An expert survey was used in the study. Quality assurance department managers (from the four selected plants) with at least two years of professional experience were considered experts. As a result of this stage, the nine most relevant traits desired in visual quality control employees, in the opinion of the expert group, were selected.

In the initial stage of the Thurston analysis, a matrix was developed presenting the weighting assigned by the controllers to the individual criteria selected by the experts (Table 1).

Table 1.
Criteria weightings by controllers

	CRITERIA								
CONTROLLER	**Cr1**	**Cr2**	**Cr3**	**Cr4**	**Cr5**	**Cr6**	**Cr7**	**Cr8**	**Cr9**
C1	2	9	3	5	7	6	1	8	4
C2	3	8	9	7	6	1	5	2	4
C3	1	5	4	3	8	7	2	9	6
C4	3	2	4	7	5	8	1	9	6
C5	6	9	4	8	5	7	1	3	2
C…	6	4	7	2	3	5	9	1	8
C86	4	5	3	8	7	6	1	9	2

Source: own study.

The next step in Thurston's method was to develop a table of proportions. For this purpose, the evaluated criteria were listed in rows and columns. At the diagonal, at the intersection of the same criteria, a proportion value of "0" was entered, as a proportion between the same parameters is impossible. For the remaining intersections of rows and columns, a resulting value was entered, indicating the dominance of one criterion over another - a column over a row (Table 2). These values result from determining the number of times a given criterion was rated as more important than the opposite one. This value is divided by the number of possible cases, i.e., 86 controllers. For example, the dominance value of Criterion 2 over Criterion 1 is 0.71.

Of the 86 respondents, 61 considered Criterion 2 more important than Criterion 1. Therefore, dividing 61 by 86 yields a value of 0.71.

Table 2.
Proportion – Dominance according to Thurston

Criterion	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8	Cr9
Cr1	0,00	0,29	0,60	0,45	0,29	0,36	0,62	0,24	0,48
Cr2	0,71	0,00	0,69	0,58	0,42	0,50	0,67	0,28	0,56
Cr3	0,40	0,31	0,00	0,40	0,20	0,22	0,47	0,15	0,33
Cr4	0,55	0,42	0,60	0,00	0,35	0,42	0,63	0,30	0,53
Cr5	0,71	0,58	0,80	0,65	0,00	0,56	0,69	0,38	0,66
Cr6	0,64	0,50	0,78	0,58	0,44	0,00	0,69	0,34	0,63
Cr7	0,38	0,33	0,53	0,37	0,31	0,31	0,00	0,28	0,38
Cr8	0,76	0,72	0,85	0,70	0,62	0,66	0,72	0,00	0,70
Cr9	0,52	0,44	0,67	0,47	0,34	0,37	0,62	0,30	0,00

Source: own study.

Next, according to Thurston's method, the standard normal distribution function was used to obtain standardized values used to determine the importance of individual criteria. These values were taken from mathematical tables of distributions. The standardized data used in the study, presented in Table 3, come from the Statsoft website (November 21, 2021) (Table 3).

Table 3.
Standard normal distribution function

	0	**0,01**	**0,02**	**0,03**	**0,04**	**0,05**	**0,06**	**0,07**	**0,08**	**0,09**
0	0,0000	0,0040	0,0080	0,0120	0,0160	0,0199	0,0239	0,0279	0,0319	0,0359
0,1	0,0398	0,0438	0,0478	0,0517	0,0557	0,0596	0,0636	0,0675	0,0714	0,0753
0,2	0,0793	0,0832	0,0871	0,0910	0,0948	0,0987	0,1026	0,1064	0,1103	0,1141
0,3	0,1179	0,1217	0,1255	0,1293	0,1331	0,1368	0,1406	0,1443	0,1480	0,1517
0,4	0,1554	0,1591	0,1628	0,1664	0,1700	0,1736	0,1772	0,1808	0,1844	0,1879
0,5	0,1915	0,1950	0,1985	0,2019	0,2054	0,2088	0,2123	0,2157	0,2190	0,2224
0,6	0,2257	0,2291	0,2324	0,2357	0,2389	0,2422	0,2454	0,2486	0,2517	0,2549
0,7	0,2580	0,2611	0,2642	0,2673	0,2704	0,2734	0,2764	0,2794	0,2823	0,2852
0,8	0,2881	0,2910	0,2939	0,2967	0,2995	0,3023	0,3051	0,3078	0,3106	0,3133
0,9	0,3159	0,3186	0,3212	0,3238	0,3264	0,3289	0,3315	0,3340	0,3365	0,3389
1	0,3413	0,3438	0,3461	0,3485	0,3508	0,3531	0,3554	0,3577	0,3599	0,3621

Source: own study.

Having a table of the standard normal distribution function for values between "0" and the value of the "Z" variable, we move on to determining the standardized values (Table 4). This is done by assigning to each value from the proportion table the appropriate value from the standard normal distribution function table.

Table 4.
Standardized values

	Criterion								
	Cr1	**Cr2**	**Cr3**	**Cr4**	**Cr5**	**Cr6**	**Cr7**	**Cr8**	**Cr9**
Cr1		0,1141	0,2257	0,1736	0,1141	0,1406	0,2324	0,0948	0,1844
Cr2	0,2611		0,2549	0,2190	0,1628	0,1915	0,2486	0,1103	0,2123
Cr3	0,1554	0,1217		0,1554	0,0793	0,0871	0,1808	0,0596	0,1293
Cr4	0,2088	0,1628	0,2257		0,1368	0,1628	0,2357	0,1179	0,2019
Cr5	0,2611	0,2190	0,2881	0,2422		0,2123	0,2549	0,1480	0,2454
Cr6	0,2389	0,1915	0,2823	0,2190	0,1700		0,2549	0,1331	0,2357
Cr7	0,1480	0,1293	0,2019	0,1443	0,1217	0,1217		0,1103	0,1480
Cr8	0,2764	0,2642	0,3023	0,2580	0,2324	0,2454	0,2642		0,2580
Cr9	0,1985	0,1700	0,2486	0,1808	0,1331	0,1443	0,2324	0,1179	
Zn	0,2185	0,1716	0,2537	0,1990	0,1438	0,1632	0,2380	0,1115	0,2019
W*n*	0,7527	0,4226	1,0000	0,6157	0,2271	0,3637	0,8896	0,0000	0,6356

Source: own study.

$$\mathrm{Wn} = \frac{\mathrm{Zn} - \mathrm{Zmin}}{\mathrm{Zmax} - \mathrm{Zmin}} + 1$$

where:
The Zn value represents the arithmetic mean for the nth column.
The Wn value represents the importance of the nth criterion, expressed by the formula:
Zmin is the minimum value of the arithmetic mean of the Zn means from the table.
Zmax is the maximum value of the arithmetic means of the Zn means.

The validity criterion Wn was rescaled due to the fact that normalization in the 0-1 range implies that the lowest-ranking criterion will receive a value of "0," which may be problematic in further arithmetic transformations and interpretation of results. In the analysis result considered in this paper, such a situation occurs for criterion 8. After rescaled to the range (0.1-1.0), we obtain the following results (Table 5).

Table 5.
Rescaled validity criterion

criteria (j)	**Cr1**	**Cr2**	**Cr3**	**Cr4**	**Cr5**	**Cr6**	**Cr7**	**Cr8**	**Cr9**
Wn	0,7775	0,4803	1,0000	0,6541	0,3044	0,4274	0,9006	0,1000	0,6721

Source: own study.

This resulted in a ranking of the importance of the features (Table 6) desired in an ideal employee performing visual quality control of products.

Table 6.
Ranking of the importance of the features of an ideal WKJ controller

Criterion (j)	**Results (Wn)**
Experience	1,000
Observation	0,9006
Decisiveness	0,7775
Training	0,6721
Intelligence	0,6541

Cont. table 6.

Determination	0,4803
Motivation	0,4274
Health	0,3044
Temperament	0,1000

Source: own study.

This stage aimed to answer the question of which of the identified characteristics of visual quality control employees were most important.

The next stage of the study involved a subjective assessment of the quality control employees from a given organization by their supervisor – the head of the quality assurance department. The evaluation focused on the characteristics desired in an ideal quality controller in the indicated industry, identified in the first stage of the study. The survey form developed by the authors used a five-point Likert scale.

The final data analysis, which compared the importance of characteristics and the controllers' ratings, was conducted using TOPSIS analysis. The analysis was used to develop an aggregated index of controller excellence. This analysis allowed for the ranking of specific employees based on their possession of the identified key characteristics of an ideal controller. As a result, the TOPSIS analysis allowed for the aggregation of both the importance of characteristics of an ideal controller and the employee ratings conducted by managers of the studied organizations into a single index. The TOPSIS analysis has been used in various analyses and described in numerous publications, i.e. Chu and Lin (2003), Rahim and Supiyandi et al. (2019), and Widianta, Rizaldi et al. (2018). The TOPSIS algorithm consists of six steps, presented in Table 7.

Table 7.
TOPSIS analysis algorithm

1. Creating a normalized attribute matrix	2. Creating a normalized weight matrix	3. Determining the weighted decision matrix
4. Establishing ideal and anti-ideal reference values	5. Calculating the Euclidean distance from reference objects	6. Determining the ordering measure, creating a ranking of decision variants

Source: own study based on Kacprzak, 2018

In the first step, the author created a normalized attribute matrix, which involved normalizing the attribute values for each variant of a given decision matrix according to the following formula:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

where the number of decision objects/variants i = 1, 2... m; and the number of decision criteria j = 1, 2,… m.

In the second step, a normalized matrix for the decision criteria was determined. The described TOPSIS method does not impose any methods for determining the weights of the decision criteria.

In the next, third step, a weighted, normalized decision matrix was developed using calculations according to the formula:

$$v_{ij} = w_j * z_{ij}$$

Step four involved determining the ideal and anti-ideal values.

$$\text{Ideal value: } a^+ = \begin{cases} \max v_{ij} \text{ for stimulant} \\ \min v_{ij} \text{ for destimulant} \end{cases}$$

$$\text{Anti-ideal values: } a^- = \begin{cases} \min v_{ij} \text{ for stimulant} \\ \max v_{ij} \text{ for destimulant} \end{cases}$$

In step five, all Euclidean distances separating the values of the tested variants for each criterion from the ideal and anti-ideal solutions were calculated.

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - a_j^+)^2} \text{ for } i = 1,2,\dots,m \text{ and } j = 1,2,\dots,n$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - a_j^-)^2} \text{ for } i = 1,2,\dots,m \text{ and } j = 1,2,\dots,n$$

The last, sixth step consisted in determining the ordering measure and creating a ranking of decision variants.

$$R_i = \frac{d_i^-}{d_i^+ + d_i^-}$$

$$i = 1,2,\dots,m \text{ , and } 0 \le R_i \le 1$$

Ri is a number between zero and one, where one represents the relatively best and zero represents the relatively worst.

The used analysis allowed to rank employees based on their distance from the ideal and anti-ideal, using an aggregated controller goodness-of-fit index based on the importance of the ideal controller's characteristics and the controllers' assessment of those characteristics.

4. Summary

The application of TOPSIS analysis to the assessment of visual quality control employees presented in this article was successfully implemented in one of the wood-based panel production plants that participated in the study.

The presented model can also be used by organizations in other industries with different specificities, or to conduct employee assessment processes in various departments. The key is to correctly identify the characteristics that a theoretically ideal employee should possess. A reliable assessment of the importance of these characteristics is also crucial – this is where the Thurston method comes in.

The weakest link in the presented method is the subjective assessment of employees made by the supervisor – in this example, the department manager. This subjective assessment can be distorted by interpersonal relationships between the supervisor and the employee. Therefore, it is advisable to use objective methods for this stage, which will certainly contribute to improving the results.

In the next phase, using the TOPSIS method, an aggregated indicator of employee excellence should be obtained. By considering the importance and assessment of a given characteristic of an ideal employee, we obtain a ranking of the best and least predisposed employees to perform visual quality control tasks.

The data obtained through the use of the presented method can be used for appropriate personnel management – delegating employees closest to the ideal to the most important and challenging tasks. They can also be used to develop individual training plans, strengthening employees' weakest traits.

Further research directions include developing objective methods for assessing quality control employees by their supervisors, for example, using personality tests to avoid subjectivity. Consideration should also be given to designing integrated solutions utilizing IT tools for calculations and data analysis, which will significantly facilitate and accelerate the practical application of the method, particularly in facilities classified as large enterprises due to their employment size.

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