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VALUE ENGINEERING IN THE WORKERS' COMPETENCES SHAPING

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Abstract: Modern industry confronts engineers completely new challenges. Technical skills in the light of the ongoing changes are no longer the only criterion for the effective work of engineers. On the other hand, engineers clearly show the need for development and taking new challenges. The need for a comprehensive acquisition of competences in both technical and psychosocial areas is increasingly expressed. Paper presents a model of employee competences essential for the future of enterprises operating in the Industry 4.0, which was created with using the Value Engineering methodology.

Keywords: Value Engineering, competence, Industry 4.0

1. INTRODUCTION

Dynamic changes on global and European markets have an increasing importance for local labor markets. The demand for professional competences is changing since some professions fade and others are under deep transformation. There are completely new classes requiring employees different from the previous kits of knowledge and skills. Enterprises face the question which competences that will be necessary and which will have high demand of them in the 2040 perspective.

The progressing industrial revolution changes not only production, but also the labor market. There is a need for new professions related to programming, operation and control of machines and their integration with the production system. As participants in this revolution, managers and employees must develop the capacity of continuous learning and continuous self-development.

When considering the issue of Industry 4.0, technologies and machines are the most often considered. However, the pace of Industry 4.0 development and its success largely depends on people. Therefore, a need arises to discuss what features and competences an employee 4.0 should have.

After three industrial revolutions, a fourth is coming, taking production to a higher level. Industry 4.0 is a very fast technological development. Until 20 years ago, few people could have foreseen the real scale of technology's impact on the nature of work and workplace culture. Revolution 4.0 is changing the way the people live and work.

Technological development, virtual reality or, in the long term, artificial intelligence is changing the competency model of employees. Today it is no longer possible to talk about rigid competency models assigned to specific groups of positions or specializations. One of the most important issues is developing competences outside of the own field. Many professions permeate, and the competences of one professional profile become necessary in the next. When viewed from the perspective of hard skills, technical and cyber technical competences are key.

Until recently, an engineer was then associated with technical competences, but a change was already taking place and soft skills, group work skills, knowledge of foreign languages and sales competences were also expected of him. Unfortunately, the problem arose already at the stage of educating staff at universities. At that time, there were no items that would adapt engineers to the expectations of the labor market. The need to develop a wide range of new so-called hard skills and an unprecedented number of innovations in the 4.0 manufacturing process mean that soft skills are becoming more important than ever, although of course technical and cyber technical competences come first. Equally important, however, is creativity, understood as a business competence - almost every job advertisement in the first place mentions the words "creative" and "innovative" in terms of personality requirements. Another important issue relating to soft skills is the ability to reason logically and analyze data. In the past, the latter was reserved for professions such as financial analysts. Today, in such a dynamically changing environment, data collection and analysis are essential in every professional area. This is related to another desirable feature - the ability to act quickly and make strategic decisions. Among the most important abilities is currently combining knowledge from many fields and flexibility what is expected today by both the employer and the employee. In preparation for the change, the labor market has to keep in mind that the labor market enters Millennium generation. They, in particular, expect autonomy at work, but also flexible forms of employment. Likewise, employers today expect unusual working hours and work in an international and intercultural environment. Project management competencies are also more and more important - in today's dynamic economy, efficient project implementation. Competency models of people responsible for the implementation of key projects for companies are signposts supporting the company in defining the need for specific skills and experience of project managers.

The history of Polish entrepreneurship provides information that term of the competency management is dated back to the 1990s. However, term of competency goes back to ancient times (Filipowicz, 2014). The word *competetina* meant responsibility, compliance, readiness for something. The root of this expression is the term *competere* - to be fit for something, to agree, or *competentes* - suitable, capable (Kossowska, 2002). In 1990, Gary Hamel (lecturer at London Business School) and C.K. Prahalad (from the University of Michigan), published in 1990 in the Harvard Business Review, the article *The core competence of the corporation*. In it, they described the different approaches of large American companies to management strategies and increasing market efficiency. They noticed that some organizations have a set of core competence, which makes them competitive, is their greatest strength on the market. When it was noticed that the description of such competencies of an organization helps to create a strategy of competitiveness and intensify activities to achieve the goal, this mechanism was started to be used to describe not only the organization, but also its members. This is how the competency model was created (Prahalad and Hamer, 1990).

Competences are defined in general and detailed terms (Armstrong, 2005). General competencies are required of all those who practice the profession or all those working in similar positions:

1. Competence is the ability of the employee to act to achieve the intended goal in the given conditions by specific means; it is also the whole of the employee's knowledge, skills, attitudes, experience and readiness to act in specific conditions, including the ability to adapt to change these conditions (Thierry, et al., 1994).
2. Competencies are a set of behaviors that certain people master better than others, which makes them work more effectively and efficiently in a given situation (Levy-Leboyer, 1997).
3. Competences represent the potential contributing to the achievement of specific, measurable results (Armstrong, 2000).
4. Competences include all relatively permanent human properties that create a cause-and-effect relationship with the high or above-average work results achieved by him, which have a universal dimension (Pocztowski, 2003).

In detail, competences mean:

1. Knowledge, skills, abilities or personality traits that directly affect the results of a person's job (Becker and Huselid, 2002).
2. All the features that employees have, i.e. knowledge, skills, experience, abilities, ambitions, values, styles of action, the possession, development and use of which by employees enable the implementation of the company's strategy in which they are employed (Rostowski, 2004).
3. A set of characteristics of a person, which consists of elements characteristic for this person, such as motivation, personality traits, skills, self-esteem related to functioning in a group, and the knowledge that the person has acquired and uses (Whiddett and Hollyforde, 2003).

Lucia and Lepsinger provide definition of a competency known as a cluster of related knowledge, skills, and attitudes that affects a major part of one’s job (a role or responsibility), that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved via training and development. So a competency is bigger than a skill, includes knowledge, connects to performance, and can be improved. That’s one competency when treated in isolation. We get even more power from a competency model: the integrated set of competencies required for excellent performance (Lucia and Lepsinger, 1999).

Given the turbulent practice environment, and the magnitude and pace of the growth of competency modeling, it is not surprising that practitioners and Consumers of human resource services alike are looking for some meaningful reference points to guide their work. To aid in this effort, the Society for Industrial and Organizational Psychology (SIOP) commissioned a task force in September 1997 to investigate and review the practice of competency modeling (Shippmann, 2006).

The use of competency methods as the basis for human resource management has become widespread in the United States and is gaining a foothold in international HR practice (Athey and Orth, 1999). Competencies have attracted much attention in large US corporations, and there is growing interest in competencies in medium-sized and smaller organizations. Interest in using competencies as a foundation for human resource management programmes stems from continued downsizing in organizations, declining profit margins, increasing market volatility in many industries, and growing

acceptance of behaviorally-based research. Training and development professionals use competency models to identify organization-specific competencies with a view in mind of improving human performance (Rothwell and Lindholm, 1999).
One of the elements of the competency management system is the competency model developed in the company. Such a model, including competency profiles, is a tool used in the human resource management process, both in planning employment in its strategic dimension, as well as in recruitment and selection. It enables an objective and standardized assessment of personnel competencies as well as the creation and implementation of systems for increasing the level of employee competencies. The condition for success, i.e. effective implementation of the model in the organization, is its consistency with the strategy and culture of the organization, and the implemented competency model ensures an appropriate level of human resources competences and achieving a high level of work efficiency, and enables employees to be prepared for possible future changes in the organization (Malinowska and Wekselberg, 2014; Wojtas-Klima, 2014). A company that has implemented competency-based systems can transparently determine the future needs of the size of employment, as well as the competences of future employees (Juchowicz and Sienkiewicz, 2006).
Paper presents example of the model of employee competences essential for the future of enterprises operating in the Industry 4.0. The model was created with using the Value Engineering methodology. Analysis presented in the paper shows research results of Polish enterprises implementing competences models as the reply to challenges of Industry 4.0.

2. METHODOLOGY OF RESEARCH

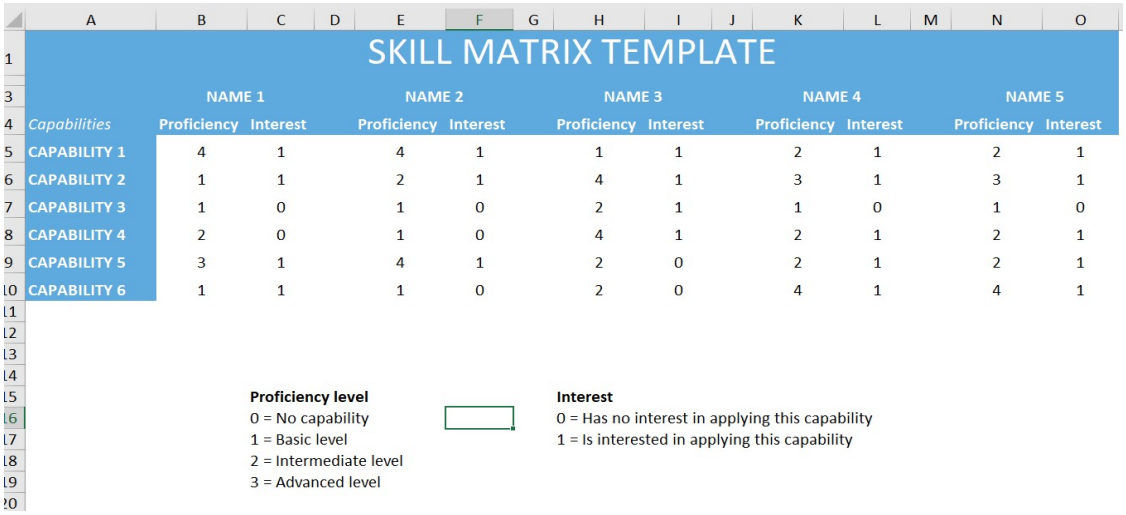
For the study, it was assumed that the competence model in an organization is a set of features that are the most important for the efficient functioning and development of an enterprise. Competences are grouped and matched to individual positions.
Competence is understood as a set of features and behaviors that are important in the functioning of a specific organization. Employees' competences include: knowledge, skills, talents, styles of action, personality, principles, interests. These competences should be determined taking into account the impact on the effectiveness of activities in a given position. When creating competency models, it is worth grouping them into several categories.
There are two competency models:

- quantitative competency model - it consists in categorizing individual competences in terms of the number of required behaviors. It is about assigning an employee's level of competencies to the following levels: low, medium, high, etc. - the more skills they have, the higher the level in the model;
- qualitative competency model - in this case, the levels of behavior differ in terms of behavior. It consists in delimiting the extent to which a given competence is used by an employee.

Building a competency model can be simplified in a few steps. First, the most important competences are selected from the perspective of the entire organization and individual positions. Next, behaviors are described (behavioral description) that exemplify the use of a given skill and adjusted to a quantitative or qualitative model (setting levels or quality of competences). At a later stage, the required level of competence for individual positions is established. Finally, the model is validated and incorporated into a human resource management strategy. The competency model was prepared on the basis of:

• the specificity and strategic plans of the organization,
• best practices in management by competences,
• legal provisions and regulations;
• consultations with representatives of the organization.

Competence model applied in the research analysis was presented in figure 1. Capability is related to: nature, character, personality, quality, features, skill (social and technical). Capabilities are evaluated with using scale 0÷3. Employees and employers evaluate own interest in the evaluated capability from the point of own view. Employer evaluate the importance of capability (interest) in the context of the enterprise's core, strategy and clients requirements.



SKILL MATRIX TEMPLATE

Capabilities	NAME 1		NAME 2		NAME 3		NAME 4		NAME 5	
	Proficiency	Interest	Proficiency	Interest	Proficiency	Interest	Proficiency	Interest	Proficiency	Interest
CAPABILITY 1	4	1	4	1	1	1	2	1	2	1
CAPABILITY 2	1	1	2	1	4	1	3	1	3	1
CAPABILITY 3	1	0	1	0	2	1	1	0	1	0
CAPABILITY 4	2	0	1	0	4	1	2	1	2	1
CAPABILITY 5	3	1	4	1	2	0	2	1	2	1
CAPABILITY 6	1	1	1	0	2	0	4	1	4	1

Proficiency level
0 = No capability
1 = Basic level
2 = Intermediate level
3 = Advanced level

Interest
0 = Has no interest in applying this capability
1 = Is interested in applying this capability

Fig. 1. Skill Matrix Template
Source: based on Skill-Matrix-Template

Competence model was supported by idea of Value Engineering stages presented in the figure 2.

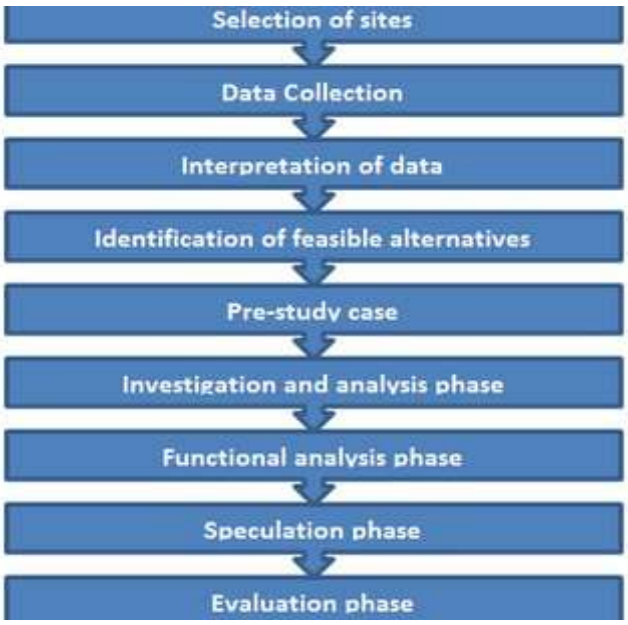


Fig. 2. Value Engineering stages
Source: Chakravarthy, 2018.

VE is an organized/systematic approach directed at analyzing the function of systems, equipment, facilities, services, and supplies for the purpose of achieving their essential functions at the lowest life-cycle cost consistent with required performance, reliability, quality, and safety (Office of Management and Budget, 1993).
In fundamental terms, VE is an organized way of thinking or looking at an item or a process through a functional approach. It involves an objective appraisal of functions performed by parts, components, products, equipment, procedures, services, and so on— anything that costs money. VE is performed to eliminate or modify any element that significantly contributes to the overall cost without adding commensurate value to the overall function (Mandelbaum and Reed, 2006).
Digital transformation is a process to which most manufacturing plants are intentionally open. In terms of the analyzed enterprises, only 5% of the respondents stated that their companies did not plan to change the use of data and processes, communication methods, etc., so as to make full use of the opportunities offered by digital technologies. Currently, engineers do not see radical changes in digital transformation at the level of individual requirements or challenges that they will have to meet. Engineers do not feel that the changes aimed at implementing the transformation significantly affect the expectations that the employer has for employees regarding, for example, digital competences. On the one hand, it may mean belief in the currently possessed competences or the belief in the ability to easily and quickly acquire new ones, on the other hand, it cannot be ruled out that some engineers are not fully aware of what kind of new qualifications will be necessary in a full digital transformation. Among the various competences of an engineer, the employees considered technical skills as the most important, requiring knowledge and understanding of the production process (93%). Personal skills (89%), which include: analytical thinking, problem solving, as well as personal qualities, such as readiness for continuous learning, ranked slightly lower. Over 80% of respondents considered social skills related to communication and cooperation with other people, understanding their needs, leadership as well as establishing and maintaining business contacts as definitely important or rather important. The prospect of transforming the engineering profession and taking over the role of a change leader is more obvious to representatives of this profession with a shorter employment history. Among the youngest respondents, the percentage expecting the evolution of the engineering profession was as high as 84%. However, also for engineers with longer experience, a change in competences connected with the profession of an engineer seems inevitable (65%).
Employee representatives and unions sometimes assume that there is no difference between ‘good’ and ‘bad’, higher-value and lower-value work. On this view ‘work is work’, so there has to be equal pay for equal work. Therefore, employee representatives are generally against variable remuneration and flexible working hours.

3. INDUSTRY 4.0 AND COMPETENCES

Industry 4.0 (German: *Industrie 4.0*) is a general term used to describe technical innovations and concepts of value chain organisation that change industrial production in a revolutionary way.
Industry 4.0 is an area in which the Internet of Things plays a big role, thanks to intelligent machines that work together and communicate with users. Industry 4.0 is based on connected systems that seamlessly support activities along the entire value

chain and create a fully digital landscape. This means lowering costs, improving the efficiency, speed and scale of production, as well as better products and services.
Automation is not a new phenomenon; industrial robots have been a fixture on factory floors for several decades and software algorithms help logistics companies optimize the route planning of deliveries in a faster and more efficient manner than human route planners could. McKinsey Global Institute stated in the report, that about 50% of the time spent on work activities in the global economy could theoretically be automated by adapting currently demonstrated technologies. As research reports confirm, automation could replace 9% to 26% of the work hours in six countries by 2030. Taking into account the technical, economic and social factors affecting the pace and extent of automation, described above, the proportion of work actually displaced by 2030 will likely be lower. It is estimated that up to 30% of current work activities could be displaced by 2030, with a midpoint of 15%, or the hours of about 400 million full-time equivalents (McKinsey Global Institute, 2017). Nissan, for example, has halved the time it takes to move from final product design to production thanks to an automated system, while BMW has reduced machine downtime by 30 to 40 percent—effectively generating fresh economies of scale with minimal investment—through AI-enabled condition-based maintenance (Chui, 2017). It is estimated that 60 million to 375 million individuals around the world may need to transition to new occupational categories by 2030 , in the event of midpoint or early automation adoption (although that number would be negligible in 2030 in our edge case slow automation adoption scenario). Nearly all jobs will involve a shifting mix of tasks and activities. Within occupations, the mix of activities and the capabilities required will skew toward more personal interactions and more advanced levels of cognitive capabilities. Educational requirements will also change: net of automation, a greater share of jobs in the future will likely require higher levels of educational attainment (McKinsey Global Institute, 2017).
From the employer's point of view, it is very important to verify what competences they have and what they will have to acquire from the market. Often the biggest challenge is to change the mindset and approach to work in order to put machines into production plants at all. According to the McKinsey 2016 report, so far the level of digitization of the Polish economy is 34%. lower than that of Western Europe, which in turn lags behind the United States. However, when the transformation in our country is already at an advanced level, the way of performing work and its place will have to change, which in turn will force changes in the method of management. In addition, many laws and regulations will have to be adapted to broadly understood digitization. The pace of these changes must be very fast, and the transforming business models will immediately translate into acquired competences. All this shows how important the ability of government, society, corporations and employees to proactively adapt to the situation will play. The digitization of the economy will create a completely new, flexible work environment. Education systems, vocational education and training related to work activities will have to adapt to the changing requirements of the labor market.
The need for workers in production and assembly, as well as performing routine mental tasks such as production planning, may decrease. On the other hand, the demand for employees with technical competences in the IT area will increase significantly, e.g. dealing with programming, data analysis, designing IT solutions and interfaces for machine users, as well as for employees from research and development areas.
The dynamics of the changes taking place mainly results from the emergence of completely new technological areas, which force the development of new competences.

Industry 4.0 creates new interactions between humans and robots. These interactions significantly affect the way work is performed and organizational structures in the enterprise. New specializations will appear mainly in the field of engineering. Engineers must develop in the coordination of robots, as simulation experts or, for example, service engineers using digital technologies in place of a service technician. In turn, the development of R&D departments requires that companies acquire R&D, IT and digital support systems competences.
Currently, higher education offers specialized, albeit narrow specializations. Industry 4.0 expects knowledge from many fields to be combined. A huge challenge for technical universities is the implementation of soft skills science, and for humanities universities - enabling the use of technological tools. Postgraduate courses in Industry 4.0 and taking into account subjects in specific fields are already beginning to appear, so it is visible that the study programs are adapted to the market expectations. Although universities have been cooperating with industry for years with varying degrees of success, today there is no modern competence center in this process, adapted to the expectations of the fourth industrial revolution. The answer to this is the idea of establishing at the Silesian University of Technology - in cooperation with the Katowice Special Economic Zone and with the possible support of the Ministry of Development - the so-called factories 4.0. Unfortunately, this cooperation is still not the same as, for example, in the USA, where universities actually cooperate with business and adjust their education programs to the needs of the economy. They also cooperate with companies in Poland, supporting their development.

4. CONCLUSION

The competency system allows you to plan activities such as:

- Recruitment and selection - competence descriptions allow you to create a detailed profile of the candidate and select recruitment and selection tools. Knowing the required competences makes it easier to find the right employee.
- Adaptation of new employees - the competency model is an excellent source of information for a new employee about the company's expectations and criteria for assessing behavior, attitudes and work results.
- Employee assessment - the competency model facilitates the implementation of audit projects (AC / DC) and employee assessment systems (180 ° and 360 ° assessments), during which employees' competencies must be determined anyway.
- Career paths - the competency model is also useful when planning promotions - knowing the required competences in a higher position, everyone knows what needs to be achieved to climb up.
- Training - in the competency model, competency gaps are defined.

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