technical transactions

No. 2022/015

mechanics

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Managing the process of adjusting the competences of employees aged forty or over to the requirements of industry 4.0

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Received: December 4, 2022
Accepted: December 20, 2022

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing interests: The authors have declared that no competing interests exist.

Citation: Zembski, S., Ulewicz, R. (2022). Managing the process of adjusting the competences of employees aged forty or over to the requirements of industry 4.0. *Technical Transactions, e2022015*. https://doi.org/10.37705/TechTrans/e2022015

Abstract

The article presents the preliminary results of research in the field of preparing employees aged forty or over to the challenges of industry 4.0. Based on literature research and the results of own research, an assessment of the current human resources in the automotive industry was presented, with a particular emphasis on the age structure and digital competences. The main barriers in the process of preparing forty-plus employees to the requirements of the work environment 4.0 were identified. Existing training methods were assessed. It was indicated that PBL in the field of acquiring digital competences in the group of forty-plus employees has great potential to achieve the success rate of bridging the digital competency gap.

Keywords: Industry 4.0, digital competences and skills, employee 4.0, employee 40+, training program, barriers, PBL

1. Introduction

One of the biggest challenges faced by today's organisations is finding and employing a qualified employee who will find himself in the dynamically developing industry 4.0 environment, which is saturated with digital transformation. Industry 4.0, launched years ago in Germany, has now become a panacea for the diseases of the current world, which is driven by pandemics unprecedented in modern times and a progressive shortage of qualified employees whose average working age is significantly increasing year by year. This results in greater problems with adapting to new digital workplaces, increased resistance to change and less flexibility of work. An important assumption of industry 4.0 is reliance on the concept of the dynamic implementation and transformation of the current work environment, which is largely based on machines and their operators in places where intelligent machines cooperate on each other and communicate the activities performed to the operators (Zhong, 2017; Deja et al. 2021).

The first dynamic changes in Industria 4.0 were in the automotive industry, which was encouraged by the possibility of increasing work flexibility, and improving the flow and interconnection of the supply chain in production (Castelo-Branco, 2019). The new concept of work has enabled companies to increase efficiency and deal with the challenge of producing individualised products in a short period of time, while ensuring maximum quality requirements (Wittenberg, 2016; Zhong, 2017).

The potential of Industry 4.0 also lies in the greater flexibility and scalability of production systems thanks to information technology and industrial automation (Brettel, 2014; Dassisti, 2019). It should also be mentioned that industrial production plays a significant role in the EU economy and industry is the main engine of research, innovation, job creation and exports. The manufacturing industry is responsible for 80% of the innovative production of the European Union and 75% of its exports, while its role in the economy of Central and Eastern Europe is much higher than the European Union average (Nagy, 2020).

Industrial revolution 4.0 plays, and will certainly continue to play, a significant role in the development of the manufacturing industry of Eastern Europe, which is significantly late to join its Western European neighbours in implementing new digital technologies and developing a training system for employees of various age groups. This article will answer the following areas:

1. The development of a management method for the process of adjusting digital competences of forty-plus employees
2. The identification of key digital competences of forty-plus employees
3. The identification of barriers to equipping forty-plus employees with the required digital competences
4. The development of an effective, practice-based training program for the acquisition of digital competences

2. Human resources in the era of transformation 4.0

In 1763, a Scottish engineer and inventor took up the challenge of improving the atmospheric engine invented by Thomas Newcomen. This invention started a new world in which change became the main driving force for increasing productivity along with reducing costs was the overriding goal. The first three industrial revolutions saw significant productivity gains, driven by rapidly evolving general-purpose technologies: mechanisation, electricity and IT solutions (Kagermann, 2013; Veza, 2015).

The first industrial revolution at the end of the eighteenth century was to replace the muscles of humans and animals with a steam engine [Berg, Hudson, 1992]. This was followed by the second revolution at the turn of the end of the nineteenth and the beginning of the twentieth century in which electricity illuminated the homes of every average person, allowing them to extend and

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change the way of life. This opened up new prospects for the popularisation of mass production, which was closely associated with Henry Ford, the father of large-scale serial production (Mokyr, 1998). The third revolution took place in the second half of the twentieth century; as a result of the development of electronics and IT solutions, the large-scale automation of production began (Greenwood, 1999; Ghobakhloo, 2018; Kagermann, 2013).

Today, the fourth industrial revolution can be considered to be a new digital revolution that is fundamentally changing the industry and business, as well as the economy and civil society (Demeter, 2019). Industry 4.0 differs from previous revolutions in that it applies to all areas of life (Ślusarczyk, 2018; Ingaldi and Ulewicz 2022). It is characterised by the progressive digitisation and automation of production, as well as the creation of digital value chains to enable communication between the machine – human and the surrounding cyberspace (Lasi, 2014). Figure 1 below shows the successive stages of the industrial revolution.

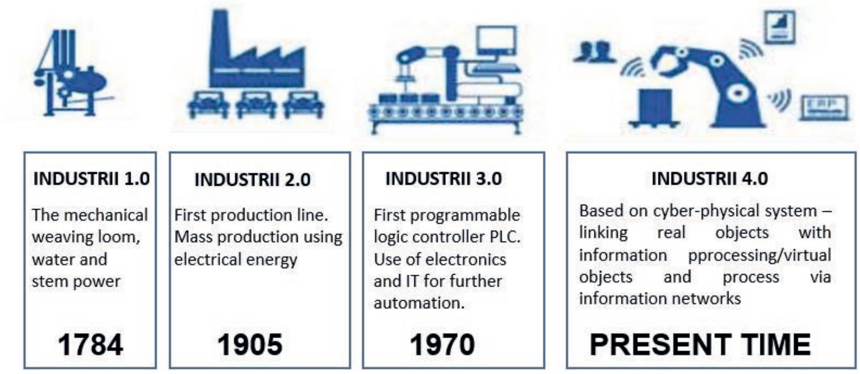

Fig. 1. The development of industrial revolutions over the last 100 years (own study)

Industry 4.0 is also a progressive digitisation of the entire supply chain, which makes it possible to connect objects and systems based on real-time data exchange (Dorst, 2015). This allows processes, machines and the supply chain to adapt to a dynamically changing environment (Hecklau, 2016; Magistretti, 2019). Figure 2 shows the dependencies and connections of industry 4.0 with the surrounding cyberspace.

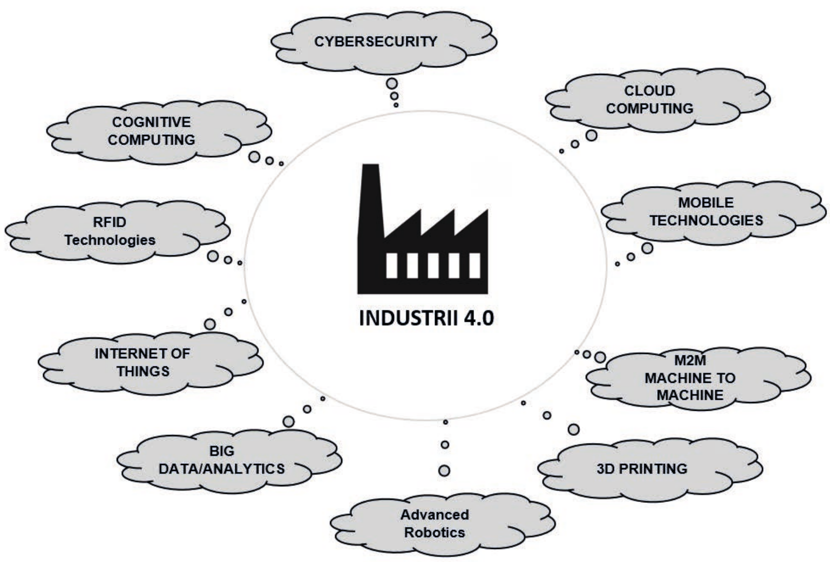

Fig. 2. Industry 4.0 in the age of digitalisation (own study)

When you look at the fourth revolution, you can see its impact on the business world in three main areas (Punjabi, 2018):

1. Digitisation and integration of vertical and horizontal value chains, which means cloud computing, mobile devices and Internet-of-Things (IoT) platforms
2. Digitisation of products and services that allow for the creation of augmented reality, multi-level interaction with customers and the profiling of services for them
3. Data analytics through the use of intelligent algorithms, digital business models and advanced interactive human-machine-human interfaces

The digital transformation is associated with challenges that seem different from previous technological changes. Many organisations are in a critical situation caused by the variety of traditional solutions used in companies on a daily basis; the solutions used so far in the process of improvement and the development of the company are becoming insufficient – they do not keep up with the current business models and do not create sufficient added value (D'Ippolito, 2019; Ulewicz et all. 2022). The adaptation of enterprises and their employees to digital technologies becomes necessary to achieve digital transformation ensuring for some time meeting the expectations of the market shaped by the customer, whose expectations also change very dynamically but are based on three fixed values: price, quality, timeliness (Ardito, 2019).

Manufacturing has evolved from manual processes to high-tech fully automated processes that enable maximum efficiency, while requiring well-defined professional competencies that exclude workers with low professional and digital qualifications. New Industry 4.0 technologies will improve the autonomy of the workforce, but the demand for highly skilled workers with advanced digital competences is increasing as the new approach requires collaboration between people and machines (Tabarés , 2018).

Industry 4.0 requires the following professional competences from employees:

1. Technical skills requiring knowledge and understanding of the production process, including the ability to operate and configure production control systems and the ability to intervene in the event of a failure.
2. Personal skills based on analytical thinking, problem solving, creativity, openness to innovation, responsibility, coping with decisions, good time management, willingness to constantly learn and transfer knowledge.
3. Social skills related to communication and cooperation with other people (also representatives of other cultures), understanding needs, leadership and establishing and maintaining business contacts.
4. Data management skills, knowledge in the field of collecting, storing, protecting, analysing data, the ability to make decisions based on data and the skills of programming, building algorithms, using digital tools.

New Industry 4.0 technologies improve the autonomy of the workforce, but the demand for highly skilled workers with advanced digital competences is increasing as the new approach requires cooperation between people and machines at a higher level than before (Tabarés, 2018). This is a great challenge for European industry. The employment structure in industry has changed very dynamically over the last five years, the percentage of people aged over forty employed in industry has increased, which has a significant impact on digital skills of employees. Figure 3 shows the dynamics of changes in the average age of people employed in industry.

In 2019, the percentage of people who had at least basic digital skills reached 58%; however, a large proportion of the EU population still lack basic digital skills, even though most jobs require it (Skroban, 2015). Industry 4.0 is at a stage where people are sceptical of new technologies. Employees, mainly physical workers, are afraid that digital solutions will take away their jobs (Kinzel, 2017).

According to many studies, one of the biggest challenges in implementing Industry 4.0 technologies lies in the fact that do not have qualified personnel

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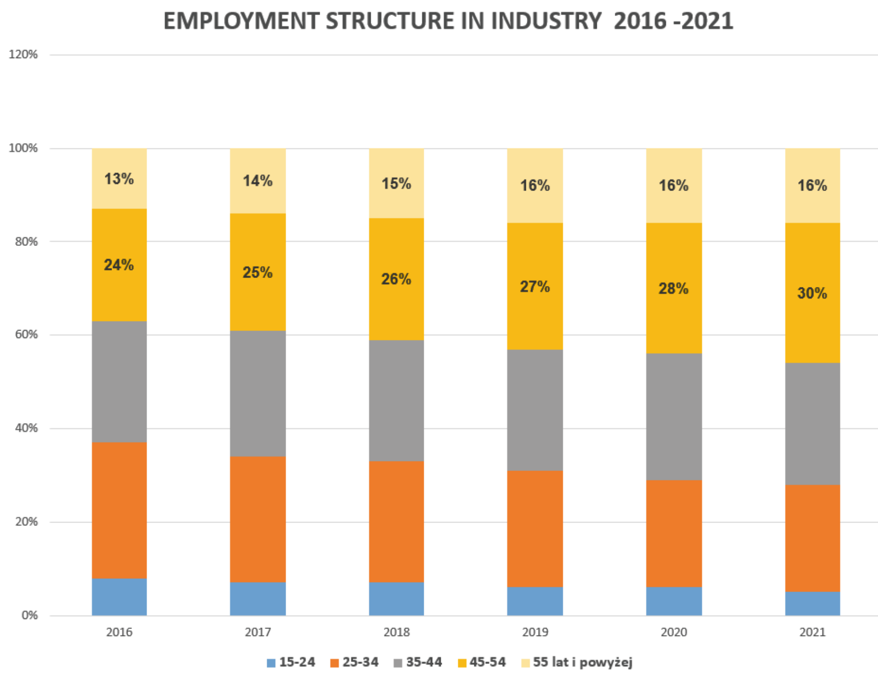

Fig. 3. Employment structure in industry in 2016–2021 (own study based on GUS research, 2021)

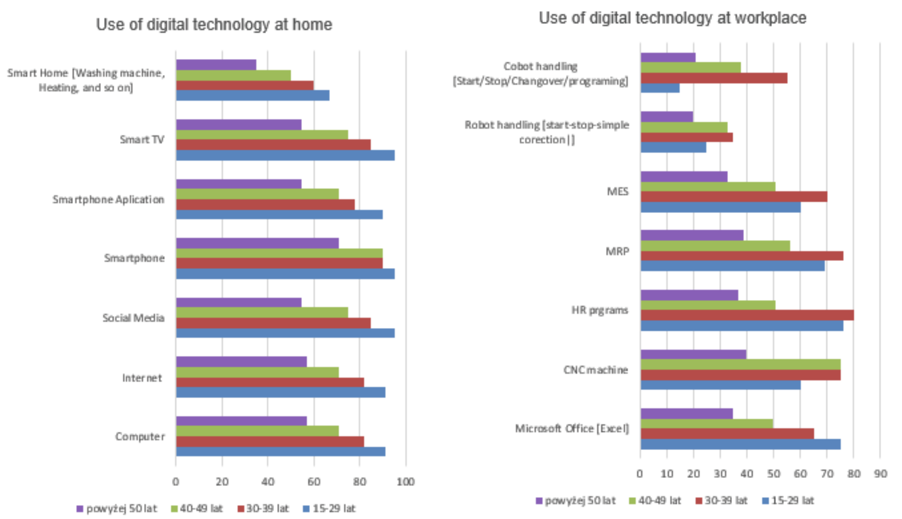

Fig. 4. Comparison of digital skills of people aged 15-65 based on the use of household appliances and the workplace (own study)

or the process of transforming the existing ons ineffective and very complicated and fails to keep up with the dynamically changing work environment focused on digital technologies (Shami, 2016; Müller, 2018; Kiel, 2017). As a result, employees do not want to indulge in change. Complicated training and adaptation processes deter them and discourage them from expanding their knowledge and improving their skills (Nelles, 2016; Wang, 2016). Moreover, the lack of understanding of the new technology and fear of the unknown is evident (Horvath, Szab, 2019). A survey conducted by the Massachusetts Institute of Technology has found that teams of humans and robots are more effective than the independent work of a human or a team of robots. Robots and machines should be viewed not as a threat to employees, but rather as their colleagues or teammates who share a working space and complement each other (Kolewa, 2019). An automated system can support employees and provide active physical assistance, which compensates, for example, the decline in human capacity with age (Saggiomo, 2016; Wang, 2016; Götz, 2017)

3. Forty-plus employees – gaps in digital competences

Digital civilisation, cyberculture, is already an everyday reality from which there is no turning back, and technological development has resulted in the transfer of many forms of social life into the digital space (Stawicka, 2015). They occur in various spheres of life, such as medicine, banking, commerce, military, science, office, etc. New applications and digital opportunities appear increasingly often in our lives. Their role is to facilitate our lives and professional opportunities. United Nations (UN) forecasts predict that by 2030, the percentage of Europe's population over 65 will be 23.8%. It should be added that this is twice as many as was the case in 1990 (Stawicka, 2015). According to the estimates of the Central Statistical Office of Poland, in 2030, 40% of the non-working age population will account for approximately 60% of the working age population, of which the post-working age population will constitute 26.9% of the total E-exclusion, i.e. digital exclusion is social exclusion in the information society and is understood as the lack of access to specific goods necessary for normal functioning in society (Stawicka, 2015). According to CBOS, the most important factor, which is also a barrier, is age. The percentage of people aged 45–54 who use the internet is 60% for those aged 55–64, the figure is 39%, and for those aged 65 and over, it is 15%. Equipment, digital applications and the Internet network should be adapted to each social group, especially the elderly and people with disabilities (Stawicka, 2015).

Information technology is a very broad concept. It is often equated with information and communication technology (ICT) encompassing many domains that are related to the extraction, processing, modification and distribution of information. Information technology is one of the many approaches employed for the processing of information. It creates a combination of hardware and programming solutions as well as methods for designing and implementing software. At the same time, ICT technologies are characteristic of the so-called the fourth industrial revolution. Industry 4.0 refers to the collaboration of intelligent machines (artificial intelligence) and systems in production processes. This integration is aimed at introducing changes in production processes leading to increased production efficiency and introducing flexible changes to the product range.

The wording of Industry 4.0 is related not only to technology, but also to new ways of working in industry as well as to the new role of the employee. The definition of the fourth revolution therefore means the integration of the real world of production machines with the virtual world of the Internet and information technology. The resources that are used in the process, such as people, machines and IT systems, automatically exchange information during production. This information can be exchanged within a single enterprise and within various IT systems operating within it. It is a solution that allows us to access any useful information, at any time, from anywhere. This enables the economical production of individualised products and short series, the so-called Mass Customisation (e-exclusion).

However, before the fourth revolution permanently appears in our plants, barriers to the introduction of a production worker to industry 4.0 must be fully removed, which include:

1. Place of residence – many studies clearly indicate that the larger the city, the greater the awareness and technological commitment of a given community, focused on new technological trends.
2. Education – with the development of man, his skills and the development of consciousness, the need to deepen it and use new sources of knowledge, including information technologies, increases. Thus, along with the next steps on the path of education, people are more involved in new technologies.
3. Social and professional status require from a person continuous self-improvement, self-development, education and the deepening of their knowledge; therefore, they must use the sources of knowledge that

surround them, which to a large extent are already in the data cloud of the surrounding Internet of Things.

4. Age is a key factor that has a significant impact on the speed of assimilation and the adaptation of new data.
5. Motivation influences the behaviour of an individual on the way to achieving a given goal, exploring and using the knowledge that surrounds us to achieve our goals, which also depend on the place of birth, education and upbringing, and the environment in which we live.
6. Training methods – properly selected training methods allow an individual to smoothly adapt to the changing environment and the process of digitisation of their life and work environment. They indicate the advantages of using new technologies and the ease of using them while maintaining a low contribution of own involvement and work.

More and more jobs are being performed with the use of new information technologies. It is said that in less than three years, as many as nine out of ten types of professions will require digital skills. ICT has become an everyday and permanent part of our lives. However, it should be borne in mind that for some, it is a great help, and for others, it is a cause of additional social exclusion.

4. Using problem-based learning as a technique of preparing forty-plus employees to the challenges of industry 4.0

Training is a planned and systematic process of changes in the behaviour of an employee, enabling the acquisition of the knowledge, skills and competences necessary for the proper implementation of tasks and meeting the personal needs of an organisation (Armstrong, 2003; Abdullah, 2014; Oczkowska, 2016). Training can also be defined as an investment aimed at increasing the quality and standards of work performed by employees of a given enterprise (Bramley, 2001). On the other hand, the main goal of the training is to improve the results achieved by the unit and to maximise the use of the employee's potential. Before we start the training process, we should define the expectations posed by the company entrusting us with its employees in order to improve their knowledge and professional competences. The effectiveness of the training consists of three levels; therefore, before we start the training process, we should classify the expectations of the entrepreneur and the employee's competences, this will allow us to properly select the transferred knowledge and achieve the intended goal. According to Rae L, we have three levels (Rae, 2015):

I. Implementation level – the aim is to improve the standard of work performed, equating to the best. The need to conduct training is determined by identifying a skill gap or checking the level of knowledge of employees in relation to the standards created.

II. Level of improvement, which refers to the degree of improvement in the implementation of tasks. We deal with it when the purpose of training is to streamline processes and increase work efficiency. Participants should feel energised to engage in teamwork and motivated to learn from each other.

III. The level of innovation, i.e. for the extent to which new methods of operation are sought out. Training at this level initiates changes in the organisation and prepares employees to implement innovations. It is worth emphasising stimulating cooperation, exchanging experiences, combining skills to achieve a common goal, inspiring good practices and awakening a sense of responsibility for implementing innovations.

The figure below shows the three levels of training for a production worker.

Each of the above levels should be used in modern companies based on the concept of industry 4.0 because they enable better and faster implementation. However, many enterprises are still not aware of the need to improve and implement innovations, while the "equation to standards", i.e. the first level, often replaced by job training or a basic training package, will not allow

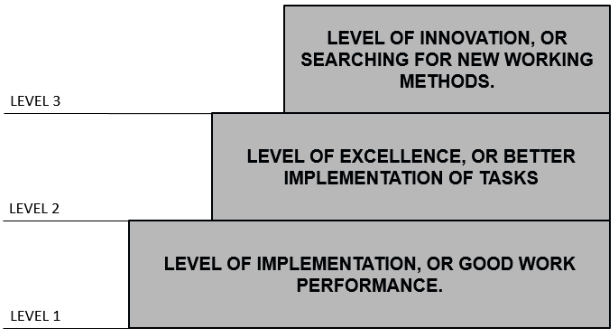

Fig. 5. Employee training levels (own elaboration based on Kossakowska, 2011)

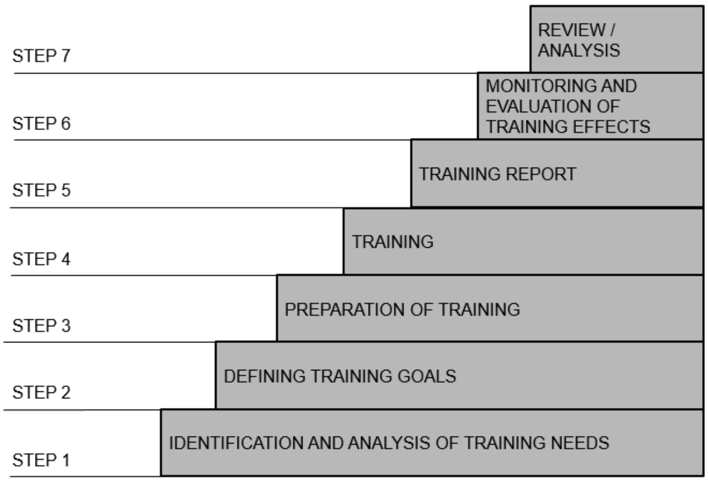

Fig. 6. Stages of employee training (own study based on Kossakowska, 2011)

employees to adapt to the dynamically changing work environment, and will not allow them to use their potential. After specifying the level, the training is divided into smaller steps – stages that will allow minimising the time necessary to train the employee and maximise the effectiveness of the training. Kossakowska M. divided the training into the steps shown in Figure 3 (Kossakowska, 2011).

Necessary for the proper implementation of the training is the appropriate selection of training techniques, which can be divided into individual and group techniques as well as techniques applied directly at the workplace ('on the job') or conducted outside the workplace ('off the job'). The individual training techniques conducted at the workplace include (Abdullah, 2014; Oczkowska, Bukowsk, 2014):

- training of orientation and adaptation of new employees;
- training without distraction from work;
- vocational training;
- consultations with the supervisor;
- mentoring called education at work;
- coaching;
- job rotation;
- specialized instruction;
- replacement at the workplace.

Currently, one of the most commonly used training techniques outside the workplace, 'off the job', is Problem Based Learning, which is a mixture of a simulation method and a role game based on the gradual acquisition of knowledge through problem solving. The pioneers of the implementation of Problem Based Learning were Barrows and Tamblyn (Barrows, 2001), who used this teaching method in the early 1960s at McMaster University in Hamilton. The program they created was designed to stimulate young medical students who spent their first three years absorbing a huge amount of material, unable to apply it in any way. The aim of the program was to stimulate students to use their acquired knowledge to fulfil future roles. The program also made it possible to analyse problems that are real challenges facing future young doctors. Great interest among medical students resulted in the dynamic development of CLL in other fields of study, such as law, education, economics, and engineer.

Problem-based learning has been defined as a teaching philosophy that describes a set of principles and standards necessary in the process of effective teaching (Graff, Kolmos, 2008). These rules can be modelled in any way depending on the needs and goals to be achieved (Kolmos, Graff, 2008). It should also be mentioned that the problem-based teaching process was also heavily analysed in Polish education. There have been many studies on problem-based education. The precursors of problem-based teaching in Polish education were Wincenty Okoń and his student, the promoter and author of the first study on the subject of the effectiveness of problem-based learning, Czesław Kupisiewicz (Kupisiewicz, 1962).

Problem-based learning is a concentrated method of learning through experience, i.e. solving an open problem imposed by a teacher or trainer. The main feature of this method is not focusing on a specific method of solving the problem. The goal itself is to develop the skills and qualities of the trainee in line with the expectations of the teacher and trainer. This method includes acquiring knowledge through action, teamwork and communication (Kolmos, Graff, 2008; Dolmans, Grave, 2014). This process allows students to develop skills that will be used in their future practice. It strengthens critical evaluation, and encourages continuous learning in a team environment (Okoń, 1964). The problem learning method is based on working in small groups, in which their members assume specific more or less formal roles. These roles are often changed and adapted to the real conditions in which they have to solve a problem and take up the challenge of performing a given task. The Problem Based Learning method is based on the following five steps (Dahms, 2016):

- Step 1 – feeling difficult;
- Step 2 – problem formulation;
- Step 3 – searching for solutions, creating hypotheses of potential solutions;
- Step 4 – logical and if possible empirical verification of hypotheses;
- Step 5 – observation of the introduced solutions, accepting or rejecting the solution, which in turn leads to a return to the third or even the second step.

Problem-based learning is a model example of seeking education, perfectly fitting into the natural phases of human development, regardless of age, education or social role. Classes conducted with this method constitute a natural sequence of successive activities, known to us from everyday life, that lead to the solution of a specific problem. W. Okoń emphasised that the end of well conducted training is the student’s ability to apply knowledge in everyday life (Okoń, 1964). The basic condition for the effective teaching and training of independent thinking of production employees in the implementation process is the recognition of problematic material, enabling employees to formulate, solve and check specific issues in the course of their own cognitive activities based on mental and practical activities. The basis of practical thinking is action, i.e. all intentional internal and external activities constituting the main way of checking conclusions, guesses and ideas regarding the solution of a given problem. An active attitude to the world and the ability to cope with new, difficult, as yet unknown situations can be greatly strengthened by introducing employees to solving specific tasks resulting from specific problem scenario.

Problem Based Learning should be seen as an activity project in which the subject intends to discover a path that is not necessarily consistent with his or her previous knowledge and experiences. Classes using the problem-based teaching method are usually based on small groups of employees with a maximum of eight to ten people. The advantage of a small group, apart from the ease of transferring knowledge and controlling it, is also less destabilisation of the work of the plant in which a given problem is being solved – e.g. employees may be from several separate production shifts. The beginning of the meeting is devoted to discussing the challenges that the "sponsor" will put before the employees (colloquially referred to as the Plant's Director, President). The word problem is omitted on purpose, because in Polish conditions the word "problem" is understood negatively and from the very beginning it causes the release of negative emotions that disrupt the positive work atmosphere that should be present during effective training.

Most of the time is taken by formulating the challenge because the success of the entire training depends on this part. The challenge is formulated by the group working together, thanks to which each of the training members is involved so that they have knowledge about the essence of the problem. It usually happens that some members of the group have rudimentary knowledge that may help define or partially solve the problem. After defining the problem, the group is divided into two independent subgroups, which divide the tasks between their members in their area. During problem solving, the groups process the presented information in such a way as to be able to present it to other group members and present hypothetical solutions to a given challenge or, if necessary, redefine the challenge in the process of discussion with the leader. After completing the thought process, the group meets again to draw final conclusions. Presentation of conclusions takes place in the forum in front of the teacher and other training participants. During the presentation, there is usually a lively discussion and debate concerning the adopted potential hypotheses for solving a given challenge. During the training, other meetings may be held to clarify the challenge posed by employees. There may also be a situation in which the reasoning is interrupted due to the lack of information necessary to correctly define and create potential hypotheses necessary for logical and empirical verification. Consequently, if employees do not even achieve the intended goal, they will come to partial solutions that will enrich their knowledge and competences, allowing them to take further steps closer to the goal.

Problem-based learning includes the principles of good learning, which is why it is so willingly and effectively used, because in addition to good results regarding the rapid implementation of employees into the production process, it also encourages self-sufficiency – it promotes active and deep exploration of knowledge through problem solving and the implementation of challenges. Another important feature of PBL is peer learning. The teacher is part of the group, actively encourages students to analyse the information and plays a large part in creating hypotheses and choosing paths to achieve the challenge set for the group. There are many signposts on the path of PBL, creating clues that lead to a solution to a problem or opening the way to further hypotheses and assumptions. The goal of problem training itself is not an unequivocal answer to the questions asked or solving a problem but to teach employees the process of continuous improvement, reaching knowledge by constantly searching for and trying new improved solutions, so that the word excellence is associated with the constant search for better new solutions.

5. Conclusion

Organisations today are under intense competitive pressure to improve performance and meet the ever-increasing demand of customers who have highly personalised expectations for innovative products at competitive prices. This requires the organisation to reduce costs and improve efficiency by increasing the level of integration, communication and cooperation between business processes, which in turn is associated with the implementation of innovative solutions.

The emergence of Industry 4.0 is a response to the expectations of a market rich in the complexity of new concepts. However, Industry 4.0 itself is a revolution that requires companies to take a new approach in the implementation process, unlike previous revolutions that took place at the level of technological changes regarding new machines and the driving force. The current revolution is the changes taking place in cyberspace, a part of which is a human operator.

The average age of employees in the automotive industry is growing. Existing machine operators must undergo retraining and become part of a digital environment in which they are forced to manage, process and analyse data in a digital world in which a co-worker is a robot or other for of artificial intelligence. The problem-based learning method is the answer to the process of rapid changes and transformations that forty-plus employees must undergo in order to fit into the current technological trends saturated with the digitisation process. This problem-based method significantly accelerates the learning process, supports the key skills of forty-plus employees to ensure the optimal use of their skills in the new cyber world. It develops the skills of critical thinking, reasoning, and cooperation in an interactive group located on the digital cloak. Problem-based teaching is also problem-solving, building professional knowledge, self-education and motivation to learn. PBL has shown positive learning outcomes in many countries around the world, which shows that this teaching method can be used in a variety of settings if, of course, it is well planned and implemented. The publication also showed that it can become a leading technique, a method of educating forty-plus employees in the process of the adaptation to Industry 4.0.

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