

Human resources development as an element of sustainable HRM – with the focus on production engineers

Katarzyna Piwowar-Sulej

Wroclaw University of Economics and Business, Komandorska 118/120, 53-345, Wroclaw, Poland

ARTICLE INFO

Article history:

Received 3 June 2020

Received in revised form

26 August 2020

Accepted 29 August 2020

Available online 3 September 2020

Handling editor: Katarzyna Piwowar-Sulej

Keywords:

Sustainability

Sustainable human resources management

Sustainable HRM

Sustainable HR development

Industry 4.0

Industrial engineers

ABSTRACT

The concept of sustainability has been gaining importance and influencing the development of an approach towards employees referred to as sustainable HRM (SHRM). HR development is one of the principles of SHRM that should be implemented consistently along with other SHRM principles, which means, e.g., that the development of employees should be carried out having a long-term perspective in mind. It is crucial to acquire the so-called competencies of the future as the basis for implementing the idea of Industry 4.0.

The purpose of the article is to present the development of human potential in an organization against the background of other detailed sustainable HRM principles, to be followed by confronting the theory and the research results on the development of future competencies referring to industrial engineers in Poland as the professional group responsible for implementing the idea of cleaner production and Industry 4.0. The Author analyzed the results of three research projects based on the survey method and representative data from Eurostat and Statistics Poland.

The conducted research shows that industrial companies in Poland have more of a short-sighted perspective when it comes to developing the potential of their engineers. The HR development practices focusing only on current needs are not in line with the SHRM principles of a long-term perspective and flexibility. There is also a visible lack of employee participation in the process of making training-related decisions, which is another principle of sustainable HRM. In addition, environmental sustainability remains a neglected area of knowledge in terms of training, and the cooperation with external educational institutions is low. It results in certain implications for HR managers and educational institutions. The article also presents directions for further research.

© 2020 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Since the 1980s, a heated debate has been raging over the “proper” approach to managing people in organizations. There is much research that proves there is a strong, positive relationship between human resource management (HRM) practices and a company’s performance, including such specific areas as introducing strategy and innovation (Becker and Gerhart, 1996; Gupta, 2011; Jiang et al., 2012; Barba Aragón et al., 2014; Tian et al., 2018; Singh et al., 2019). HRM function – defined as the activities undertaken by the HR department, such as recruitment and selection, HR appraisal, HR development, and HR rewarding – has evolved from a purely administrative role to a strategic one.

In the modern world, continuous organizational changes are

becoming the norm. They consist of the reorganization of processes, the optimization of the size of an organization, decentralization, and the blurring of organizational boundaries (Piwowar-Sulej and Bąk-Grabowska, 2018). As Kaur et al. stated, “the long-term success of firms can only be ensured if they adapt their strategic and structural orientation as per the changing environmental and technological scenario” (Kaur et al., 2019, p. 44). Two emergent theoretical and practical fields related to the environment and technology are sustainability and Industry 4.0, respectively. The results of literature studies conducted by Sharma et al. (2020) indicate that the interest in matching these two above-mentioned body of knowledge has been growing.

Sustainable development is generally defined as “meeting the needs of the present generation without compromising the ability

E-mail addresses: katarzyna.piwowar-sulej@ue.wroc.pl, kapi79@o2.pl.

of future generations to meet their own needs" (WCED - World Commission on Environment and Development, 1987, p. 49). This concept is based on three pillars, called the Triple Bottom Line. The first pillar covers environmental development, the second one economic development, and the third pillar is social development (Amos and Uniamikogbo, 2016). It was established in the 1960s as a response to the rapidly growing population and related risks, such as excessive use of natural resources, environmental pollution, a high unemployment rate, malnutrition, or the destruction of the Earth's surface, especially of forests. The increased discussion on the global environmental problem was initiated by the report "The Limits to Growth" – published by the Club of Rome, founded in 1968 (Meadows et al., 1972) – which presented a pessimistic vision of the Earth's fate. Later, the need for sustainable development was highlighted in the Brundtland Commission's report in 1987 (Brundtland, 1987). Now it has been accepted that sustainable economic growth depends on an adequate degree of sustainable development in terms of social and environmental performance and also on constant learning (Wilson, 2015).

Sustainable human resource management (SHRM) refers to the concept which combines the idea of sustainability with the soft approach to human resources. This approach promotes basing an HRM strategy on fostering a culture of trust and cooperation and on developing employee involvement, one component of which is loyalty to one's employer. The soft approach to HRM aims to achieve adequate financial results, but through the policy of building a good "employer–employee relationship." A soft strategy – according to the research – is effective in retaining an employee for a longer period of time in an organization and encouraging them to share knowledge, work more productive, act with passion and commitment, generate creative ideas in order to achieve the business goals (Smaliukienė et al., 2017; Ogbeibu et al., 2018; Kim and Shin, 2019; Meier et al., 2019). Recently, significantly more interest in this concept has been observed, but the literature discussing this issue is fragmentary and highly diverse. In addition, one universally applicable, precise definition of this term has not yet been formulated, though the most frequently cited one holds that "sustainable HRM is the pattern of planned or emerging human resource strategies and practices intended to enable organizational goal achievement while simultaneously reproducing the HR base over a long-lasting calendar time and controlling for self-induced side and feedback effects of HR systems on the HR base and thus on the company itself" (Ehnert, 2009, p. 74).

It is worth mentioning that in the literature on the subject, in addition to sustainable HRM, such concepts as green HRM, socially-responsible HRM, and common good HRM are also present. Green HRM focuses on the role of HRM in attaining environmental performance (Singh et al., 2020). Socially-responsible HRM and common good HRM represent employee-oriented HRM. These concepts are reflected in decent working conditions and employee participation, for example (Dyllick and Muff, 2016; López-Fernández et al., 2018). Moreover, there are numerous studies indicating a strong, positive correlation between the relevant SHRM practices and company performance – mainly in terms of the environment (Renwick et al., 2013; Guerci et al., 2016; Haddock-Millar et al., 2016; O'Donohue and Torugsa, 2016; Dumont et al., 2017; Singh et al., 2020; Ogbeibu et al., 2020). Against this background it is worth mentioning that research conducted by Shen et al. (2018) proved that green HRM practices have a positive influence on non-green workplace outcomes such as, e.g., intention to quit.

The principles of SHRM explain how sustainable development can be used with reference to human resource management (HR function). These rules describe the type of HRM which deserves the

attribute of "sustainable." An overview of the literature on the subject leads to the conclusion that there are many approaches to the principles of sustainable HRM. Different authors pay attention to various aspects which are important to them (Zaugg et al., 2001; Cohen et al., 2010; Ehnert et al., 2016). On the basis of literature studies, these principles can be divided into general (i.e., having developed along with the concept itself) and detailed (related to specific actions towards employees).

The general principles, within the framework of the SHRM concept, include the following (Ehnert et al., 2016):

- 1) an awareness of the complex correlations between the human resource management system and the external and internal organizational environment,
- 2) actions that enable long-term reproduction of the resources, and
- 3) recognition and reconciliation of multiple – potentially contradictory – economic, ecological, and social goals.

Among the numerous detailed principles of sustainable HRM, the development of human resources is mentioned. As indicated before, HR development is simultaneously one of the basic elements of HR function. Gladwin et al. (1995) directly indicated that sustainability means the development of human potential. A far-sighted perspective requires the competencies of the future to be taken into account in the course of development processes. These competencies guarantee employment both today and in the future and are associated with the changes occurring in the modern world. This particularly refers to the development of the Fourth Industrial Revolution (including the idea of Industry 4.0), following which people and machines are mutually connected in order to simplify all processes which are being digitized. Industry 4.0 has four main characteristics: horizontal integration across countries and continents, vertical networking aiming at individualized production (Whysall et al., 2019), through-engineering, and acceleration through exponential technologies (Deloitte, 2015). As Whysall, Owtram, and Brittain state, "the speed of technological change brought about by Industry 4.0 had created a significant gap between the current capability of employees and the rapidly evolving requirements of their roles, prompting a need to consider new and more effective approaches to human resources development" (Whysall et al., 2019, p. 118).

Industrial engineers are the core group of employees in the context of these changes. They "design, develop, test, and evaluate integrated systems for managing industrial production processes, including human work factors, quality control, inventory control, logistics and material flow, cost analysis, and production coordination" (Frey and Osborne, 2020). In 1982, they were called the architects of the future (Forman, 1982). It is justified to continue referring to them in this way, since they introduce product and process innovations that are not only crucial for the survival and growth of organizations (Tohidi and Jabbari, 2012) but that also result in high-quality goods supplied to society and generate economic growth (Ahlstrom, 2010).

As far as sustainability is concerned, engineers are responsible for the implementation of innovations aiming at cleaner production, which is defined as "a preventive environmental management strategy, which promotes eliminating waste before it is created to systematically reduce overall pollution generation, and improve efficiencies of resource use" (UNEP - United Nations Environment Programme, 2014, p. 3). It is worth mentioning that the cleaner production can be one of the many effects of implementing the Industry 4.0 concept. Digitizing manufacturing means an increase

in manufacturing productivity, but this also has an impact on the economic bottom line. It may optimize the trade-off between energy consumption and machine processing cost (Rajput and Singh, 2020), influence resource efficiency through waste reduction and can minimize carbon emission (environmental bottom line) (Oláh et al., 2020). Moreover, the Internet of Things – as one of the elements of Industry 4.0 – can bring about new environmentally-friendly products (social, economic, and environmental bottom line) (Kamble et al., 2018; Braccini and Margherita, 2018; Ghobakhloo, 2020). In this way, engineers contribute to the development of a sustainable circular economy (de Oliveira Neto et al., 2020). The lack of specific knowledge on “what to do and when to do it” is one of the crucial barriers in moving manufacturing industry towards Industry 4.0 (Müller et al., 2018) and sustainability (Koho et al., 2015; Garcés-Ayerbe et al., 2019). As Chiappetta Jabbour et al. (2019) state, while the technical side of the circular economy has been broadly discussed, its “human side” requires further investigation. Sharma et al. (2020), likewise, state that “the link between the social dimension of sustainability and the use of digital technologies should be developed further”. This is an important justification for addressing the problem of developing production engineers’ competencies.

The purpose of the article – its theoretical section – is to present how the development of human potential in an organization should be organized against the background of other detailed principles of SHRM. In other words, the paper answers the basic academic questions of “what and how to do” (Whetten, 1989) in order to perform the element of HR function (HR development) in a sustainable way. The article utilizes a number of relevant research findings published mostly in journals indexed in the Scopus database. The empirical section presents research addressing the sustainable HR development in relation to production engineers in Poland, conducted within three research projects. The first research project – “The Development of Engineers’ Competencies” – was carried out in 2016 on a sample population of 114 engineers from manufacturing companies. The second research project – “Smart Industry Poland 2019” – was implemented for the Ministry of Entrepreneurship and Technology in cooperation with Siemens and analyzed a sample of 200 engineers. The third research project is of a preliminary nature, covering 50 engineers working in industrial companies. The survey method was used in each of these research projects. For the purpose of this study, the author utilized representative data presented by Eurostat and Statistics Poland as well.

The paper is organized as follows. The second section of the article – presenting the theoretical background – discusses the problem of employee development in the context of other detailed sustainable HRM principles. The typology of SHRM principles presented by Stankevičiūtė and Savanevičienė (2019) was used. This section also characterizes the competencies considered to be the competencies of the future. The third section – the empirical part of the article – addresses the sources of data regarding the situation in Poland, the research results, and discussion. The last section of the article provides conclusions. It also presents the respective implications for practitioners and researchers.

The article contributes to theory development in a few ways. Firstly, the author provides a description of one of the principles of SHRM (and one of the elements of HR function, namely, HR development) including a set of relationships between this principle and other HRM principles. Secondly, the idea of sustainable HRM – with a focus on HR development – is combined with the concept of Industry 4.0. The developed theory offers “a statement of relations between concepts within a set of boundary assumptions and constraints” (Bacharach, 1989, p. 496). Thirdly, the link

between the above-mentioned conceptual framework and the empirical research is presented. Finally, the author formulates directions for further research with the focus on sustainability.

2. Literature background

2.1. Guidelines for the development of human potential including other detailed principles of sustainable HRM

Human resources development – as an element of HR function – in the general literature on HRM is defined as the “integrated use of training and development, career paths, and organizational development to improve individual and organizational effectiveness” (McLagan and Suhadolnik, 1989, p. 1). Sims (2006) links the development of personnel to such concepts as learning, performance, and changes. The main instrument of human resources development is appropriate training. Training means a “systematic development of the knowledge, skills, and expertise required by a person to effectively perform a given task or job” (Schmidt, 2007, p. 483). The basic assumption in general HRM is that employers should focus on the competencies required to achieve their business objectives and should remain competitive and agile, which requires them to ensure their employees receive the necessary training to fill these competency gaps. Employees need to acquire competencies “on demand” in order to adapt to their changing roles and responsibilities (Hinton, 2018).

Some authors discussing the issue of sustainable HRM focus on HR function (called also HR bundles) and include HR training within this function (Jackson et al., 2011; Jackson and Seo, 2010; Guerci et al., 2016; Ogbeibu et al., 2020). Others discuss the “dimensions” of SHRM which go beyond HR function and include, e.g., teamwork, organizational culture, or top management support (Jabbour and Santos, 2008; Zibarras and Coan, 2015; Dumont et al., 2017; Piwowar-Sulej, 2020a; Muduli et al., 2020). Still others address the conditions connected with HRM, which must be fulfilled in order to build a sustainability-driven organization. They include organizational justice, psychological empowerment, green balance between professional and private life, organizational citizenship behavior, and job satisfaction (Muster and Schrader, 2011; Singh and Singh, 2019). Finally, Zoogah (2011) proposes a meta-theory and presents green HRM as a function of a cognitive/social HR information processing system.

For the purpose of this article, the conceptual framework presented by Stankevičiūtė and Savanevičienė (2018) was used. Based on literature studies, these authors have prepared – in addition to human resource development – the following list of detailed principles of SHRM: 1) a long-term perspective, 2) flexibility, 3) employee participation or empowerment (involving employees in many decision-making processes beyond those for which their participation is a legal requirement), 4) fair and equal opportunities, 5) the protection of human resources (care of employees), 6) cooperation between employees, 7) the protection of the environment, 8) external partnership, and 9) profitability.

The development of human resources is discussed below in relation to the remaining principles of SHRM. The effective implementation of this concept requires all of the rules to be applied simultaneously and the correlations between them to be determined.

As highlighted in the Introduction, the development of human resources, taking into account the long-term perspective (Principle 1), means that developing the competencies which employees need “here and now” is insufficient. It is important to define and develop such employee skills which can prove useful for them and

the organization in the future. Contemporary organizations must remain flexible.

Flexibility (Principle 2) can apply to the entire organization, but also to its individual components, e.g., people. The scientific literature mentions a subjective (referred to as the actor's) approach to flexibility, which states that the flexibility of an organization is determined by the individual flexibility of its participants (Volberda, 1998). Within the framework of personal flexibility, the following can be listed (Piwowar-Sulej, 2016):

- task flexibility, meaning substantive preparation and readiness to undertake tasks specific to other than one's own position
- psychological/mental flexibility, helping the employee to stay immune to the effects of stress caused by change

The following types of flexibility are distinguished in the general literature addressing HRM (Buhler, 2002; Beardwell and Holden, 1997):

- a) quantitative flexibility – adapting the number of employees to the changing needs of an organization
- b) functional flexibility – the ability of employees to perform various tasks. This type of flexibility is related to individual task flexibility.
- c) working time flexibility – using various forms of working time. Introducing flexible working time also involves allowing team members to create their own work schedules.
- d) wage flexibility – allowing multiple types of remuneration (including the option for employees to choose the most appropriate type for themselves).

From the perspective of SHRM, flexibility is not identified with staff quantitative flexibility. It is not about making ad hoc decisions that involve hiring or dismissing employees. Flexible SHRM is reflected in the ways of organizing work. It covers, e.g., employee rotation and replacement, the possibility of working from home, and a flexible work schedule, which allows it to be tailored to the interests of both the employer and the employee.

Referring the indicated attributes of flexible HRM to the problem of human resources development, it should be stated that the first two actions mentioned above (job rotation and substitutions) are considered the training methods (Rekalde et al., 2017). At this point, it is worth mentioning that it was proven in the 19th century that 90% of the knowledge acquired in a classroom is forgotten after 30 days and 60% after just 1 h. Although we live in the 21st century, the research since that time shows that only 10%–20% of the skills learned during training courses are transferred to the workplace (Holton et al., 2000; Parsloe and Wray, 2008). The forms of training and methods of work with the training participants are, beyond any doubt, manifested in more extensive specific knowledge, skills, or attitudes. They should be selected according to the purpose and subject of the training and should also respond to the expectations of employees. Listening to employees' suggestions, and taking them into account in the employer's decisions, is part of the process of employee participation (Principle 3). The highest form of employee participation is employee empowerment (Cierniak-Emerych and Piwowar-Sulej, 2017). A flexible training process allows employees to acquire knowledge and skills even from home at a convenient time. This can be achieved by introducing e-learning, which is a subject of the digital development within Industry 4.0. Thus, the training process is carried out with the employees' work–life balance in mind (Stankevičiute and Savanevičiene, 2018).

Treating an employee as the most crucial resource in an

organization constitutes the basis for developing a good employee–employer relationship. This means recognizing investment in an employee as the best of all possible options (Becker, 2011). Furthermore, employees should have fair and equal access (Principle 4) to the training initiatives offered by their employer. It has been proven that organizational justice in fact has a strong impact on job satisfaction, and that a satisfied employee is a predictor of success in the implementation of different organizational activities, including sustainable development (Singh and Singh, 2019). The issue of employees' equality is broadly discussed in the literature on socially-responsible HRM (Shen and Zhu, 2011; Newman et al., 2016).

Care for an employee (protection of employees, or Principle 5) means employee retention and regeneration, among other things (Ehnert, 2009). As a result of training, employees can acquire various professional (technical) and interpersonal skills. Training can also teach one how to take care of oneself, how to combat stress, and how to develop proper eating or exercise habits in order to regenerate after work.

Learning new skills and improving existing competencies brings benefits not only to an employer, but also to the employees themselves. A competent and healthy employee becomes a key employee in an enterprise and has a chance for long-term employment in their current workplace. The effects of an employee's work are reflected in the company's performance – accomplished in various fields (including sustainable development). Training supports the development of a culture of cooperation (Principle 6), as well (McEwan et al., 2017; Hebles et al., 2019).

Highly developed competencies are gaining importance in times of change, including economic crises. Even if an employee is made redundant, owing to his/her skills, he/she will easily find another job. The development of human resources is closely related to an increase in employability (Blanco, 2014). Therefore, an employer who is unable to guarantee long-term employment performs a social mission by facilitating employees in making their way on a competitive job market.

At this point, it is worth mentioning that some managers voice concerns that employees trained at the expense of their employer will leave for the competition. This is one of the myths about training courses (McGrath, 2015). Independent research shows that training is an important factor in employee retention (Khan, 2018; Beynon et al., 2015). Thus, the competencies of the future should be developed in the form of employee training, all the more so because – due to the current demographic changes – employees are remaining on the job market despite reaching the age of retirement (Fox and O'Connor, 2015).

Sustainable HR development should also increase employees' environmental awareness (Principle 7) taking into account recent developments in rapidly growing body of environmental knowledge (Yang et al., 2021). In the literature on the subject, HR development in the form of training is considered the basis for building a pro-environmental attitude and a green organizational culture (Susan E. Jackson and Seo, 2010). As the research conducted by Zibarras and Coan (2015) has shown, HR training is in the first place on the list of practices considered to be the most effective in shaping employees' pro-environmental behavior. As Cabral and Lochan Dhar (2019) confirmed in their study, green training has a positive impact on enhancing green knowledge and skills. HR training has a positive influence not only on individual performance, but also on employees' collective organizational citizenship behavior towards the environment (Pinzone et al., 2016) and team creativity (Ogbeibu et al., 2020). Training can be used as a way of responding to barriers to the adoption of environmental practices

(Lopes de Sousa Jabbour et al., 2020). At this place it is worth mentioning that constant changes in technology (called technological turbulence) don't strengthen the positive relationship between green training and team creativity related to solving environmental problems (Ogbeibu et al., 2020).

External partnership (Principle 8) in the context of HR development means cooperating with the educational system. An example of such practices is the organization of training courses (in cooperation with training companies) or postgraduate studies (in cooperation with universities). The inter-organizational transfer of experience may not be enough, especially in the context of developing future competencies. That is why companies must not only analyze the training which is available on the market, but also communicate their needs. In this way the industrial companies can contribute to positive changes in the educational system and society, going beyond only their own benefits. HR development also takes place in the form of creating new innovative knowledge. Industrial companies can participate in the creation of research and development centers at universities, contributing to the technological development of the industry and resulting in the development of science.

Taking into account profitability (Principle 9), it should be stated that this principle of SHRM – like the others – is in line with the concept of the Triple Bottom Line. It reflects the economic bottom line. Financial outcomes are no longer the only criteria to measure a company's success, but this area still is important. Profitability in the context of HR development means that competent and motivated employees will contribute to company development and introduce innovations, thus bringing profits to the organization. As indicated above, sustainable HRM practices – including HR development – has a positive influence on a company's performance, including financial indicators (Renwick et al., 2013; O'Donohue and Torugsa, 2016). In the decision-making process related to training (its forms, the employment of trainers, or the use of modern e-learning technologies), one should take into account the costs as well as the long-term profits. However, it is necessary to consider training first of all as an investment, not an expense. Finally, companies can take advantage of public funds, e.g. from the European Union, devoted to the support of HR development and green-related issues (Guerci and Carollo, 2016).

2.2. Competencies of the future

According to Deloitte's Industry 4.0 research, enterprises are already subject to digital transformation because of the most frequently mentioned benefits: increased productivity, reduced operational risk, and meeting customer demands to a greater extent (Hanley et al., 2018).

As was pointed out in the Introduction, the Fourth Industrial Revolution combines people and technology. Three alternative scenarios of the technological impact on the future workforce are being discussed (McGowan, 2018). According to the first of them, work would be optimized through automation. A company would use the available opportunities to expand, as the workforce would be supported by robots and artificial intelligence, thus optimizing future work. In the second scenario, automation would be replaced by cooperation, being the priority for Industry 4.0. In addition, this scenario would provide the workforce with a voice, making it more involved rather than alienated. Its aim would be to take advantage of the best practices from technology companies, eliminating the tools that disrupt the workforce and joining labor organizations and governments in the development of new workforce strategies. The third and final scenario would bring about a digital transformation that would result in a workforce transformation. The level of expertise in automation would

frequently exceed human ability, which should nonetheless not be underestimated in terms of the potential ingrained in specifically human skills, making them even more important in Industry 4.0. In Trompisch's (2017) point of view, the progressing application of Industry 4.0 technologies will not result in total automation causing a competitive conflict between humans and machines, but efforts will be made to achieve the best possible collaboration between humans and machines.

Moreover, in the future, the division of labor should be based on a three-dimensional typology (Farkas and Török, 2011):

- 1) Value creation dimension, i.e. the tasks completed as part of IT processes and the actors responsible for them (executive managers, R&D experts, engineers, integrators, operators, and supervised personnel)
- 2) Relationship dimension, i.e. the types of needs and skills connected with constructing relationships for professional purposes, including such actors as network developers, network-linked, and non-linked employees
- 3) Decision-making dimension, i.e. the position held by an individual in the decision-making process and their capacity for being involved in the decisions made when acting as a decision-maker, contributor, or executor.

In the opinion presented by the German Institute for Labor Market Research, the demand for highly skilled employees will grow as a result of the aforementioned transformations, and there will be less demand for workers presenting less advanced qualifications (Spermann, 2016; Weber, 2016). Thus, it is of the utmost importance to make efforts to prepare employees for the new challenges imposed by technological changes (Piwowar-Sulej, 2018; Whysall et al., 2019). That is why it seems justified to describe which employee competencies will be crucial in the future.

The report "Employers' Perception of Graduate Employability," prepared by the Gallup Organization in 2010, presents research conducted in the form of interviews with recruiters from 7036 businesses located in 27 European Union countries and 4 from outside the EU (The Gallup Organization, 2010). The competencies indicated as being very important for university graduates – in descending order of importance are as follows:

- 1) teamwork skills,
- 2) technical skills,
- 3) interpersonal communication skills,
- 4) computer literacy, and
- 5) the ability to adapt and act in new situations and the ability to read and write well.

The rep published in 2011, presents the list of competencies required in the future: new media literacy, multidisciplinary, sense-making, social intelligence, cognitive load management, cross-cultural skill, design mindset, novel and adaptive thinking, computational thinking, and virtual collaboration (Davies et al., 2011).

Hecklau et al. (2017) conducted a meta-study analysis of future competencies in Industry 4.0. They distinguished the following four groups of competencies which were mentioned in at least three studies:

- a) social competencies (communication and cooperation)
- b) methodological competencies (analytical competence, complex problem-solving, and decision-making),
- c) personal competencies (willingness to learn), and

- d) domain competencies (digital networks, digital security, coding competence, process understanding, and interdisciplinary competence).

The lists of competencies expected from industrial engineers are also presented in the subject literature (Santandreu-Mascarell et al., 2011; Najwa Azmi et al., 2018; Pais-Montes et al., 2019). It is believed that the Industry 3.0 engineer is a logical, analytical, and systematic person who follows the appropriate procedures and has an innate need to perform tasks properly and to focus on issues rather than people. He/she can work with people, but in a familiar team; he/she does not like changes or new situations; he/she works in a calm and thoughtful manner from start to finish and has the ability to get things done; he/she is a very attentive, polite, well-organized, predictable, and methodical person. In contrast, the Industry 4.0 engineer is an open, active person who likes diversity, both in terms of contact with people and the tasks performed; he/she can communicate highly technical, detailed information to others with enthusiasm and optimism, evoking positive feelings about the shared ideas; he/she attaches great importance to detail and strives for perfection, ensuring a high quality of work and compliance with standards by following the rules and procedures (Gracel and Stoch, 2019).

The Engineering Competency Model (ECM) for engineers, developed in 2017 by the Employment and Training Administration (ETA) and the American Association of Engineering Societies (AAES) is the best-known one. Fig. 1 shows this comprehensive competency model covering the groups of competencies required from engineers. Each group presents a list of specific competencies. For example, interpersonal skills include such competencies as demonstrating sensitivity/empathy, demonstrating insight into

behavior, maintaining open relationships, and showing cultural awareness.

In the context of engineers' professional competencies, there is a need for interdisciplinary skills. An engineer should have the technical competencies that allow them to function efficiently in several areas by combining IT knowledge in programming or cybersecurity with an understanding of production processes, automation, robotics, etc. In addition to expanding the scope of professional competencies in various fields, employers expect an engineer to present the respective competencies to production, project, and team management.

It is worth pointing out here that the competencies referred to as soft skills constitute the foundation of the above-presented model and cover communication skills with the other employees on one's team as well as the representatives of other departments, flexibility, and the ability to adapt to changing conditions, and thus to initiating and introducing changes in an organization.

Moreover, in this model, the problem of sustainability was also addressed. Although the literature studies conducted by Beier et al. (2020) show that there are only a few articles that establish the relationships between Industry 4.0 and sustainability, and Industry 4.0 is often considered to be a disruption in industrial production, "Sustainability and Societal and Environmental Impact" were included among the industry-wide technical competencies.

It is worth mentioning here that there has been no common approach in defining the competencies needed for sustainable development (Eizaguirre et al., 2019). Some authors associate them with the general competencies required in the future (Lambrechts et al., 2013; Lozano et al., 2017), while others try to build a list of specific features, such as "1) an appreciation of the importance of environmental, social, political, and economic contexts for each

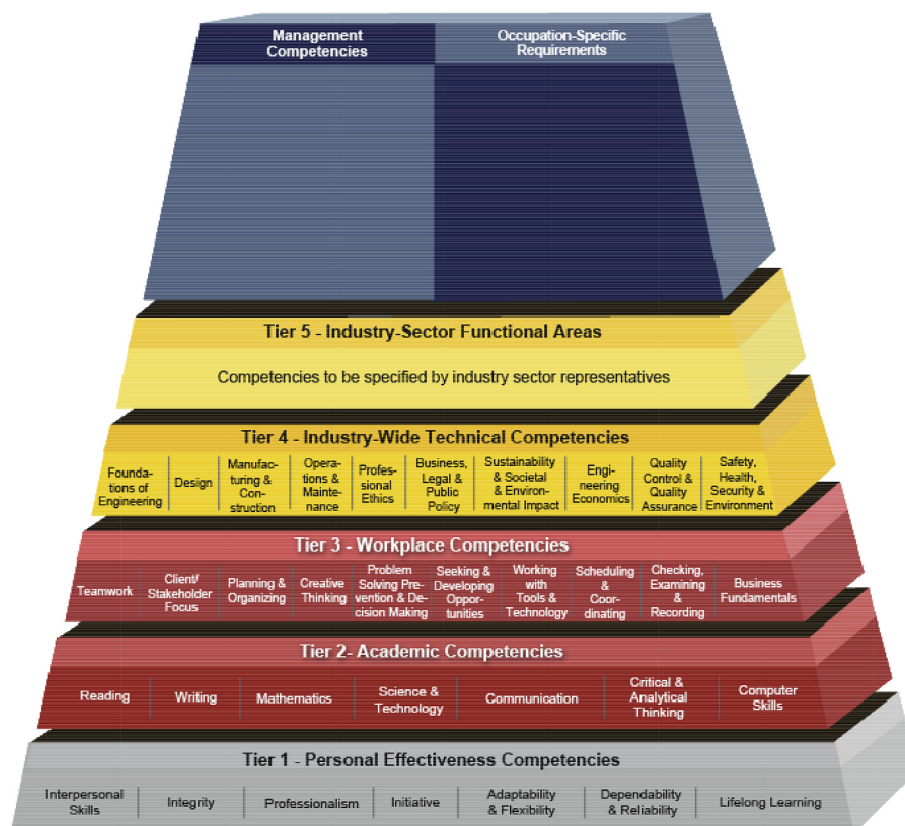


Fig. 1. Engineering competency model (ECM) (CareerOneStop, 2020).

discipline; 2) a broad and balanced foundation knowledge of sustainable development, its key principles, and the main debate within them, including its contested and expanding boundaries; 3) problem-solving skills in a non-reductionist manner for highly complex real-life problems; 4) the ability to think creatively and holistically and to make critical judgements; 5) the ability to develop a high level of self-reflection (both personal and professional); 6) the ability to identify, understand, evaluate, and adopt values conducive to sustainability; 7) the ability to bridge the gap between theory and practice; 8) the ability to practice creatively in interdisciplinary teams; and 9) the ability to initiate and manage change” (Kagawa, 2007, pp. 318–319). It is noticeable that most of these competencies are soft skills, interpersonal in nature.

As indicated in the Introduction, engineers are responsible for introducing product and process innovations such as, e.g., sustainable lean production (Tiwari et al., 2020). In this way, they not only help to achieve company goals, but they also contribute to the development of a circular economy. A modern engineer is able to operate with a Triple Bottom Line, incorporating financial profitability, environmental integrity (“a complex set of concepts that describe a healthy natural system” (Payne, 2017, p. 40)), and corporate social responsibility. They know how to analyze the impacts of a project component on diverse stakeholders. Finally, they can integrate engineering and the arts and humanities.

Based on the different lists of competencies presented above, one can conclude that a process of constant learning is needed. Many entities are involved in ensuring the skills desired by employers are available to them. As indicated earlier, employers are responsible for the sustainable development of their employees. The educational system is also of great importance in shaping the competencies of the future. It should create a society of educated and entrepreneurial people.

At this point, it is worth noting that a survey conducted in 2015, covering the production industry in Poland, found that in 16% of companies data are still collected manually on paper. In most cases (59% of companies), data are manually entered into a computer system. The Third Industrial Revolution is still a challenge for Polish production plants, let alone Industry 4.0 (76% of companies are only partly automated) (Iwański and Gracel, 2016). There are many reasons for Poland’s technological delay in comparison with the most industrialized countries: late access to Western technologies (not before 1989, i.e., following the communist system’s collapse), low labor costs, or inadequate access to capital.

In 2018, the group of professionals known as “scientists and engineers” accounted for 7.3% of the active population, whereas in Germany the figure was 7.6%, in the UK it was 10.7%, and in Sweden 11.2% (Eurostat, 2020a). In addition, labor market analysts have already identified a gap between employee skills and employer requirements. The problem may result from an absence of developmental thinking among Poles and being locked within the limits of one’s learned profession (Zych, 2017). In the times of digitization, an attractive position on the labor market depends on well-developed digital competencies. In this regard, Poles still lag behind other Europeans. One in five Poles has never used the Internet and only 39% use a computer at work, while in the European Union the respective average percentage amounts to 50%. Only 13% of Poles broaden their knowledge in the field of new technologies (Zych, 2017). A recently conducted study by the Association of Internet Industry Employers shows that Poland lacks a unified and internally cohesive educational model. Polish universities are not equipped to address the constant changes in communication methods in relation to new media development and the digital world (Kolenda, 2017). In this context, it is interesting to answer the research question, “do industrial companies practice sustainable HR development towards engineers?”

3. Material and methods

As indicated in the Introduction to this study, the results of three research projects were used to achieve the purpose of the article. The first of them, entitled “The Development of Engineers’ Competencies,” was implemented in 2016 by ASTOR Academy (ASTOR, 2017). The respondents were 114 engineers from manufacturing companies.

The second project – “Smart Industry Poland 2019” – was carried out in the second quarter of 2018 and covered a nationwide sample of 100 small and 100 medium-sized industrial businesses performing production activities in Poland (Ministry of Entrepreneurship and Technology/Siemens, 2019). The engineers employed in these companies took part in the survey. The study was conducted by Kantar Polska S.A. using the CATI method, i.e. computer-assisted telephone interviews during which an interviewer interacts with a respondent using a computer equipped with specialized software. Over half of the respondents (57.5%) worked in heavy industry and the rest represented light industry. Thus, it can be adopted that the research reflects – relatively evenly – the two basic branches of industry. In addition, the sample population covered engineers with highly diverse work experience – from individuals just starting out in their careers (24.5%) to those capable of boasting over 20 years of work experience (15%). Women constituted 13% of the respondents. This allowed the researcher to treat the sample as representative, which provides for more reliable inferences based on the results.

The analysis also used data from Eurostat and Statistics Poland regarding the practice of employee training in companies.

In addition to desk research, the article also presents the preliminary results of research on developing pro-environmental attitudes in the workplace. This research project started in March 2020; however, due to the COVID-19 pandemic, it was only possible to collect (electronically) 50 correctly completed surveys in March and April of 2020. The engineers – Master’s degree students studying at Wrocław University of Economics and working in industrial companies – participated in the survey. The article presents only the results that address the problem of employee development in the training process.

4. Results and discussion

The survey on the needs of industrial engineers carried out by ASTOR in 2016 found that the main motivators for engineers in their everyday work are as follows: a desire for continuous development and experience, ambitious challenges, various projects, professional passion, and self-fulfillment. At the same time, 68% of the respondents admitted that their company does not offer any development programs for employees; 55% claim that their company does not actively search for employee training. If, however, training courses are organized, the company finances 85% of the cost. The department manager, the company president, or the owner decide when to send employees for training. In only 8% of cases these decisions are made by an employee individually or after consulting the manager. Therefore, the surveyed companies do not meet the principle of SHRM in the form of employee participation.

The research carried out as part of the Smart Industry Poland 2019 project showed an awareness among the majority of respondents that the profession of engineer is evolving towards the role of a change leader in an organization, who comes up with new and creative solutions to support the company in various areas, including sustainable development. A readiness for change and flexibility is a defining feature of the job of an engineer; thus, it is not surprising that even among older professionals many are open to a new formula, aiming at taking the role of a change leader.

Table 1

Assessment of the significance of competencies in the context of future industry development scenarios – Smart Industry Poland 2019 survey.

Competence groups	Percentage of respondents considering competencies important (N=200)
Technical competencies	93%
Personal competencies	89%
Social and managerial competencies	81%
Analytical and IT competencies	66%

Among the youngest respondents, the percentage of those who expect changes in the engineering profession was as high as 84%, which shows that the individuals choosing this particular profession expect to experience such a process in the course of their own career.

At the same time, the respondents indicated that technical skills are of key importance in the context of implementing the idea of Industry 4.0 (Table 1). Technical competencies included hard workplace and academic competencies from the ECM as presented above. Personal competencies covered analytical thinking, problem-solving, a creative approach, an openness towards innovation, responsibility, effective handling of the decision-making process, proper time management, a readiness for constant learning, and knowledge transfer. These competencies correspond to levels 1, 2, and 3 in the ECM. Social competencies were associated with soft workplace competencies from the ECM, such as teamwork; interpersonal competencies were connected with personal effectiveness in the ECM; and managerial competencies and communication were included in the academic competencies of the ECM. Analytical and IT competencies were a part of the academic competencies presented in the ECM.

According to Polish engineers, the foundation of their professional authority is, above all, their technical knowledge. On the one hand, this is understandable, as technical competencies constitute the profession of an engineer. On the other hand, however, fetishizing these competencies and presenting logical and analytical thinking alone can constitute a barrier to industry innovation (Piwowar-Sulej, 2020b), including product and process innovation that allows the transition from a linear to a circular economy. Cheah and Ng (2012) reached such conclusions, extensively considering the technical optics of engineers as a barrier for implementing the design thinking concept in chemical product development. In this context, it is worth noting that a high level of personal competencies, e.g., a creative approach (89% responses) or social competencies (81% responses), is perceived as positive.

As indicated earlier, digital competencies occupy an important place among future competencies (The Gallup Organization, 2010; Davies et al., 2011; Hecklau et al., 2017). New areas of competence, such as integrating control systems, programming industrial robot teams, integrating analytical systems in data clouds with local systems, ensuring cybersecurity, or applying artificial intelligence algorithms in automation systems will gain importance. The Internet of Things is now at the heart of companies' digital investment; however, within the next three years the focus will be on a more extensive application of artificial intelligence (Deloitte, 2020). However, analytical and IT-related competencies were

identified by the respondents as being the least important. Slightly more than half of the engineers declared that employers do not expect employees to expand their knowledge on digital technologies, and 12.6% indicated that there is definitely no such expectation. This attitude is reflected in Eurostat statistics. Poland ranks below the EU average in the indicator "Percentage of individuals who have basic or above basic overall digital skills" (Table 2).

The lack of digital competencies is not only a barrier for creating a reputation of being a modern company, but also for the transition from a linear to a circular economy. Although it has been mentioned repeatedly above, it is worth noting again that the digitization of the manufacturing sector will enable the development of environmentally-friendly practices and this can lead to socioeconomic sustainability (Kamble et al., 2018).

The hypothesis can be put forward that having members of Generation C, people born after 1990, enter the job market brings some hope for companies. In the name of this generation, also referred to as "always-on," the letter "C" comes from the English word "connected". This term reflects the role played by the Internet in the life of Generation C. The other words this name may refer to are communicating, content-centric, computerized, community-oriented, always clicking, or change. The research indicates that people from Generation C are not only familiar with technology, but also concerned about environmental problems (Kusá and Piatrov, 2020). Therefore, they should have and should be willing to develop digital competencies; they should also force employers to comply with the idea of environmental sustainability.

The barrier to implementing an Industry 4.0 strategy that was most often indicated in the Smart Industry Poland 2019 survey was the need to employ new, adequately qualified specialists (53%). The strategies which businesses adopt to retain relevant knowledge are mainly based on training new employees (83%). Most often, however, training takes the form of informal guidance received from more experienced employees (61%).

Against this background, the continuing vocational training (CVT) survey conducted by Eurostat shows that as many as 55.5% of industrial companies did not provide CVT in 2015. Generally, from the reasons for businesses not to provide training, 85.2% of all respondents indicated that the existing qualifications, skills, and competencies correspond to the current needs of a company (Appendix 1). Such an attitude stands in conflict with a basic general principle of sustainability and one of the detailed principles of sustainable HRM, i.e., maintaining a long-term perspective. The principle of HR flexibility is not followed here either.

The studies carried out by Statistics Poland (Central Statistical Office in Poland) every 5 years show that, in 2015, among all companies located in Poland the highest percentage of companies which do not offer training was observed among industrial companies (73.3%) dealing in the production of textiles, clothing, and leather products. No correlation between company size and the practice of staff training was recorded in this case (Statistics Poland, 2017).

The extent of the training courses conducted can also be assessed by analyzing the availability rate of courses, calculated as

Table 2

Percentage of individuals who have basic or above basic overall digital skills (Eurostat, 2020b).

Year	2015	2016	2017	2019
EU-28 (2013–2020)	55	56	57	58
Poland	40	44	46	44

the ratio of the number of course participants to the number of employees. According to [Statistics Poland \(2017\)](#), the lowest value of the availability rate of courses (0.316) was recorded in industrial companies (production of textile goods; production of clothing; production of leather and leather products). The fewest training hours per year per employee were recorded in the entities operating in such industry sectors as the production of wood, cork, straw, and wicker products, furniture production, and other production of goods (10.7 h). Among the skills acquired by the employees participating in courses, the skills most often indicated by companies were technical, practical, or professional competencies recorded in 49.6% of the businesses providing courses. In terms of the business type, these skills were indicated by the largest number of companies in such industry sectors as the production of motor vehicles, trailers, and semi-trailers and the production of other transport equipment – 76.7% of the total number of companies. The same group of industrial companies was also characterized by the prevalence of internal courses (79.5% of the total number of entities included in this group), which corresponds to the results of the Smart Industry Poland 2019 survey ([Ministry of Entrepreneurship and Technology/Siemens, 2019](#)). The majority of companies under study do not follow the principle of external participation with educational institutes.

As presented in Section 2.1, the sustainable development of employees aimed at human protection means investing in training which covers such topics as coping with stress, proper nutrition, and regenerating and relaxing exercises after work. They should also increase employees' environmental awareness because environmental sustainability is a core concept of sustainability. Research on non-mandatory activities focused on personnel health in companies employing over 50 workers was also carried out in Poland in 2015. They show that 3.7% of 1000 participating research organizations conducted stress-coping training, whereas health education unrelated to health and safety regulations (concerning, e.g., chronic diseases or lifestyle) was provided in only 1.3% of organizations ([Puchalski and Korzeniowska, 2016](#)). Unfortunately, these studies do not take into account the division into industrial and other companies.

The research initiated in March 2020 has been focused on the problem of developing pro-environmental attitudes. In order to create sustainable value for an organization, it is necessary to develop the sustainable competencies of the future ([Hart and Milstein, 2003](#)). The respondents (50 industrial engineers) were asked about the practices followed in the industrial companies they are employed in. As part of these practices, the training courses on pro-environmental issues were specified. [Table 3](#) presents the percentage of responses according to types of companies as well as to groups of respondents. The companies were divided by size and the origin of their capital, while the respondents were grouped

according to the position held.

As confirmed in many studies ([Jackson and Seo, 2010](#), [Zibarras and Coan, 2015](#), [Pinzone et al., 2016](#), [Cabral and Lochan Dhar, 2019](#), [Lopes de Sousa Jabbour et al., 2020](#)), green training has a positive impact on enhancing green awareness and pro-environmental behavior. As [Table 3](#) shows, training on environmental issues is most often provided in very large companies. This is probably associated with ISO 14001 certification. According to the ISO Survey 2018, Poland ranks 146th out of 181 countries in the number of sites per country which have implemented ISO 14001:2015 ([Open Text, 2020](#)). At this point it is worth mentioning that small and medium-sized enterprises (SMEs) constitute a strategic sector of the Polish economy, not only due to their positive impact on regional development, but also because of their share in the growth of gross domestic product (GDP) and the reduction of the unemployment rate ([OECD, 2019](#)). The analysis covering Europe highlights the fact that SMEs are responsible for about 64% of industrial pollution, which is in line with their contribution to general production ([Constantinos et al., 2010](#)). Therefore, it is crucial to develop environmental awareness and knowledge in modern technologies in order to enable sustainable development among employees of SMEs.

In addition to company size, the origin of capital also matters. There is a clear gap between Polish companies and those with foreign capital. The awareness of training importance in developing pro-environmental behavior is higher among people in managerial positions. It is difficult to fill in the competence gap in the area of sustainability without providing proper training. Competence in this respect is important because it is the companies that take responsibility for sustainable development worldwide.

5. Conclusions

The transformations occurring in the contemporary economic reality relating to both the developing idea of sustainability and to the Fourth Industrial Revolution are identified with incredible technological progress. As part of sustainable human resource management, attention is drawn to the need for employee development, which is treated as both an element of HR function and as one of the detailed principles of SHRM.

This study addresses emerging topics such as sustainability, Industry 4.0, and sustainable HRM. It extends the current state of knowledge on the theme of sustainable HR development. The article answers the question of how such development should be implemented, considering other principles typical of sustainable HRM. It was emphasized that long-term orientation and ensuring flexibility means developing “the competencies of the future.” These competencies were presented, focusing on engineers as the professional group responsible for implementing the idea of

Table 3
Research results on training courses including environmental issues.

Characteristics of companies in the sample	Frequency of responses in a given group of company			
	never/rarely	sometimes	always/often	Total
Polish (n=10)	60%	40.00%	0%	100%
Foreign (n=40)	35%	45.00%	20%	100%
Very large (over 5,000 employees) (n=10)	20%	20.00%	60%	100%
Large (251–5,000 employees) (n=28)	28.57%	64.29%	7%	100%
Small (up to 50 employees) (n=4)	100%	0.00%	0%	100%
Medium-sized (51–249 employees) (n=8)	75%	25%	0%	100%
How significant is the absence of such training courses as a barrier in developing appropriate attitudes?	insignificant/hardly significant	moderately significant	highly significant	Total
Job level: non-supervisory (n=34)	11.76%	58.82%	29.41%	100%
Job level: managerial/supervisory (n=16)	0%	62.5%	37.50%	100%

cleaner production and Industry 4.0. Moreover, it was stated that sustainable HR development should remain in line with other detailed principles of sustainable HRM, such as employees' cooperation and participation, equality, and human and environmental protection.

The analysis of the results of three research projects and the data presented by Eurostat and Statistics Poland shows that industrial companies in Poland have more of a short-sighted perspective when it comes to developing the potential of their engineers. The HR development practices focusing only on current needs are not in line with the sustainable HRM principles of a long-term perspective and flexibility. There is also a visible lack of employee participation in the process of making training-related decisions, which is another principle of SHRM. In addition, environmental sustainability remains a neglected area of knowledge in terms of training, and the cooperation with external educational institutions is low.

5.1. Implications for practitioners

The first implication for practice concerns the central role of industrial engineers within the processes of innovation and sustainability. Their potential must be developed so that they can work effectively today and in the future and contribute to the company's sustainable development.

In 2035, the demand for emerging technologies alone could even be double that of primary production in 2013 for specific raw materials (Marscheider-Weidemann et al., 2016). It will be necessary to find substitutes or use resources more efficiently in production and consumption (e.g., proper recycling and purification). This, in turn, requires technological innovation (Bonilla et al., 2018), and thus, the involvement of industrial engineers.

According to a report by Deloitte, 3.5 million jobs will be available in the manufacturing sector, but it is estimated that the existing qualified staff can fill less than half of them. This report reveals that the skills gap could result in as many as 2.4 million vacancies in the period 2018–2028 (Pajula et al., 2018). These numbers point to the growing gap between available jobs that have to be filled and appropriately qualified personnel to perform these jobs. The report also indicates that in the coming years it will be three times more difficult to recruit employees with digital competences and qualified staff to work in manufacturing processes. These predictions provide substantial grounds for undertaking appropriate development activities in industrial companies.

The research covering Poland shows that the focus of both engineers and their employers is primarily on technical competencies. Digital skills represent a neglected area that is currently in high demand and gaining importance in the context of future challenges. Another area of competences requiring training is also the one directly related to the idea of sustainability. Competencies are predominantly developed in the form of internal training courses. Meanwhile, continuing vocational training should be based on employees' access to specialized, professional training courses offered by external institutions. The companies delivering professional training services should focus on the competencies required in the future.

The results identify practical implications not only for training providers and industrial companies, whose HR managers should implement sustainable human resource development. The employees themselves – as the employee 4.0 profile shows – should care about developing their own competences. According to the results, they do not care for the development of their digital competencies.

Finally, public schools are responsible for public education. In terms of engineers, this refers to academic teaching, which should

prepare engineers for work. The researchers point out that in order to improve management quality in this area, it is also imperative to incorporate into the university curriculum not only the general idea of sustainability, but also the problem of SHRM. Knowledge of modern management methods, including sustainable HR development, will contribute to a greater awareness of future managers and, at the same time, will positively affect the quality of leadership (Opatha, 2019). Sustainable leadership should accompany sustainable HR practices undertaken by an HR department (McCann and Holt, 2010). In addition, universities should offer post-graduate studies that keep up with changes and focus on the development of future competencies.

5.2. Implications for researchers

As indicated above, the paper answers the basic academic questions of “what to do and how” in order to develop human potential in a sustainable way, i.e., taking into account other detailed principles of sustainable HRM. The problem of sustainable HRM, and thus of sustainable HR development is a relatively new issue. The concept of sustainable HRM continues to evolve.

There are some limitations of this study which can nonetheless act as a basis for further research. Firstly, the article is based on the typology of SHRM principles published by Stankevičiūtė and Savanevičienė (2019). The further conceptualization of sustainable HR development can include different perspectives of analysis, including the dimensions of SHRM presented in Section 2.1 (i.e., organizational culture or top management support) or the issue of job satisfaction.

Secondly, this article provides information originating from different research projects. Due to the unavailability of data, it was not possible to assess whether industrial companies – while developing HR – meet all of the other detailed principles of SHRM. It was found that the surveyed companies do not have a long-term perspective, are not focused on flexibility, do not promote employee participation in training decisions, and do not cooperate with educational institutions. SMEs, in particular, do not provide employee training that covers environmental issues. Although technical optics prevails in the analyzed organizations, it cannot be unequivocally concluded that the training offered to employees do not contribute towards developing a culture of cooperation. It is also unknown whether the employees have equal access to training. When it comes to training on wellbeing, the conclusions are based on non-sector-specific research. Also, the profitability of HR development was not a topic of research. There is a need to conduct complex research on sustainable HR development that includes all the other detailed principles of SHRM.

Thirdly, this paper focuses on engineers working in Poland. Further research may compare the situation between different countries, for example. The results of such research could provide information that is useful in the decision-making process for investment location and engineers' professional career development. Industrial trainers are also representatives of the professional groups recognized as knowledge workers. Determining how sustainable HR development is implemented in relation to these professional groups could be an interesting research challenge.

Finally, a more concerned society and different organizations (public sector, non-government institutions) demand that the industrial companies produce in a Triple Bottom Line manner (Sarkis and Zhu, 2018). However, as indicated in this study, there is a problem with defining sustainable competencies. The challenge for academics is to operationalize the concept of sustainable competencies and design the appropriate measures. Further research should investigate how and under which conditions the particular sustainable competencies contribute to sustainable development.

An interesting research area is to identify which teaching methods used at universities and training methods used by professional training providers are the most effective in developing sustainable competencies.

Appendix A

Companies providing CVT and reasons for not providing CVT – based on (Eurostat, 2015).

Country	Companies providing CVT (% of total companies)	The proportion of companies not providing CVT that cited selected reasons for not providing CVT								
		High costs of CVT courses	Focus on IVT rather than on CVT	Major CVT efforts made in recent years	Existing qualifications, skills and competences correspond to the current needs of the company	Lack of suitable CVT courses on the market	People with the skills needed are recruited	Difficult to assess the company's training needs	High workload and limited/no time available for staff to participate in CVT	Other reasons
EU-28	70.6	28.2	24.6	13	81.8	13.4	54.9	16.2	32	16.6
Belgium	88.1	10.7	3.2	2	75.5	6.4	28.3	2.5	19	
Bulgaria	41.8	42.7	21.7	9.5	81.2	21.5	82.8	15	39.5	6.7
Czechia	92.1	5.6	1	1.4	69.1	2.3	4.3		5.6	23.3
Denmark	82.6	22	44	4.5	73.9	19.5	65.3	38.1	41.9	16.4
Germany	79.9	23.3	47.1	13.9	87.7	12.2	53.2	23.3	32.4	21.8
Estonia	82.6	8.8	1		43.9	2.3	15.8		10.7	36.7
Ireland	75.9	14.8	7	3.5	78.6	9.3	51.3	10.3	27.3	15.1
Greece	23.5	28.8	16.4	2.7	65.7	13.8	55.5	9.2	42.2	12.6
Spain	87.2	38.3	4.2	22	84.4	31.2	61.4	20.3	47.7	33.4
France	81.5	48.3	58.3	33.5	88.5	21	63.4	36.8	72.6	19
Croatia	53.8	14.1	4.2	2.2	79.2	7	34.5	6.2	12.1	11.6
Italy	61.4	13.3	8.5	12.1	74.3	6	15.4	4.9	14.5	17.1
Cyprus	70.9	19.8	7.4	8.7	78.2	13.8	59.7	3.8	34.2	3.3
Latvia	99.9									100
Lithuania	60.4	63.7	15.8	12.2	87.4	26.1	85.2	45.5	40.3	6.6
Luxembourg	80.3	6	4.2		70.1	3.5	22.3		16.1	15.3
Hungary	47.1	30.6	14.2	5	85.2	13.4	63.5	10.5	22.7	16.9
Malta	55.7	20.7	6.9	3.8	79.9	8.2	60.9	11.5	39.6	15
Netherlands	85	14.1	5.9	2.2	73.1	4.4	53.5	3.1	9.5	33.3
Austria	88.6	32	12.2	1.6	88.2	10.8	50	10.9	44	19.2
Poland	45.5	33.7	38.3	16.1	85.2	11.4	70.4	12.1	24.9	17.7
Portugal	71	46.3	22.3	7.9	76.5	30.3	64.4	30.6	40.5	40.4
Romania	27.3	34	5.4	5.6	83.5	8	78.3	6.7	26.1	1.5
Slovenia	84.8	31.3	11.9	30	92	10.1	64.1	5.5	20.8	13
Slovakia	71.6	30.6	22.9	15	74.2	8.9	48.1	7.9	30.2	12.2
Finland	81.6	39.9	36.1	5.1	89.3	14.4	66.2	17.5	48.7	16.4
Sweden	91.9									
UK	82.2	19.1	23.3	13.6	88.7	19.4	73.2	30.8	35.7	10.8

The problem of sustainable HRM has not been thoroughly covered as yet due to its complexity and relevance not only for current employers and employees but also for future generations who will be living in the world designed by people working today.

CRedit authorship contribution statement

Katarzyna Piwowski-Sulej: Conceptualization, Methodology, Investigation, Resources, Formal analysis, Writing - original draft, Writing - review & editing, Visualization.

Declaration of competing interest

The authors declare the following financial interests relationships which may be considered as potential competing interests:

Katarzyna Piwowski-Sulej, 2020.

Acknowledgements

I would like to thank the three anonymous reviewers who have provided constructive as well as challenging feedback on previous versions of this paper.

The project is financed by the Ministry of Science and Higher Education in Poland under the program "Regional Initiative of Excellence" 2019–2022 project number 015/RID/2018/19 total funding amount 10 721 040,00 PLN.

References

- Ahlstrom, D., 2010. Innovation and growth: how business contributes to society. *Acad. Manag. Perspect.* 24, 11–24. <https://doi.org/10.5465/amp.24.3.11>.
- Amos, O.A., Uniamikogbo, E., 2016. Sustainability and triple bottom line: an overview of two interrelated concepts. *Igbinedion Univ. J. Account.* 2, 88–126.
- ASTOR, 2017. *Inżynierowie Przemysłu 4.0 (Nie)gotowi Do Zmian? [Engineers of Industry 4.0 (Cracow) (Not)Prepared for changes?]*.
- Bacharach, S.B., 1989. Organizational theories: some criteria for evaluation. *Acad. Manag. Rev.* 14, 496. <https://doi.org/10.2307/258555>.
- Barba Aragón, M.I., Jiménez Jiménez, D., Sanz Valle, R., 2014. Training and performance: the mediating role of organizational learning. *BRQ Bus. Res. Q.* 17, 161–173. <https://doi.org/10.1016/j.cede.2013.05.003>.
- Beardwell, I., Holden, L., 1997. *Human Resources Management. A Contemporary Perspective.* Pitman Publishing, UK.
- Becker, W., 2011. Are you leading a socially responsible and sustainable human resource function? *People Strateg.* 34, 18–23.
- Becker, B., Gerhart, B., 1996. The impact OF human resource management ON organizational performance: progress and prospects. *Acad. Manag. J.* 39, 779–801. <https://doi.org/10.2307/256712>.
- Beier, G., Ullrich, A., Niehoff, S., Reißig, M., Habich, M., 2020. Industry 4.0: how it is defined from a sociotechnical perspective and how much sustainability it includes – a literature review. *J. Clean. Prod.* 259, 120856. <https://doi.org/10.1016/j.jclepro.2020.120856>.
- Beynon, M.J., Jones, P., Pickernell, D., Packham, G., 2015. Investigating the impact of training influence on employee retention in small and medium enterprises: a regression-type classification and ranking believe simplex analysis on sparse data. *Expert Syst.* 32, 141–154.
- Blanco, T.M., 2014. The meaning of employability in the new labour relationships between company-employee: a model of training in companies. *Procedia - Soc. Behav. Sci.* 139, 448–455. <https://doi.org/10.1016/j.sbspro.2014.08.039>.
- Bonilla, S., Silva, H., Terra da Silva, M., Franco Gonçalves, R., Sacomano, J., 2018. Industry 4.0 and sustainability implications: a scenario-based analysis of the impacts and challenges. *Sustainability* 10, 3740. <https://doi.org/10.3390/s10103740>.

- su10103740.
- Braccini, A., Margherita, E., 2018. Exploring organizational sustainability of industry 4.0 under the triple bottom line: the case of a manufacturing company. *Sustainability* 11, 36. <https://doi.org/10.3390/su11010036>.
- Brundtland, G.H. (Ed.), 1987. *Report of the World Commission on Environment and Development: Our Common Future*. Oxford University Press, Oxford.
- Buhler, P., 2002. *Management*. Helion (Gliwice).
- Cabral, C., Lochan Dhar, R., 2019. Green competencies: construct development and measurement validation. *J. Clean. Prod.* 235, 887–900. <https://doi.org/10.1016/j.jclepro.2019.07.014>.
- CareerOneStop, 2020. Engineering competency model - download model [WWW Document]. URL <https://www.careeronestop.org/CompetencyModel/competency-models/pyramid-download.aspx?industry=engineering>.
- Cheah, S.-M., Ng, C.H.T., 2012. Integrating design thinking into chemical product design – an initial experience. Proceedings of the 14th Asia Pacific Confederation of Chemical Engineering Congress. Research Publishing Services, Singapore, p. 707. https://doi.org/10.3850/978-981-07-1445-1_664.
- Chiappetta Jabbour, C.J., Sarkis, J., Lopes de Sousa Jabbour, A.B., Scott Renwick, D.W., Singh, S.K., Grebnevych, O., Piwowar-Sulej, K., Filho, M.G., 2019. Who is in charge? A review and a research agenda on the 'human side' of the circular economy. *J. Clean. Prod.* 222, 793–801. <https://doi.org/10.1016/j.jclepro.2019.03.038>.
- Cierniak-Emerych, A., Piwowar-Sulej, K., 2017. Employee empowerment – terminological and practical perspective in Poland. *Oeconomia Copernicana* 8, 301. <https://doi.org/10.24136/oc.v8i2.19>.
- Cohen, E., Taylor, S., Muller-Carmen, M., 2010. HRM's Role in Corporate Social and Environmental Sustainability. SHRM Foundation's Effective Practice Guidelines Series, Alexandria.
- Constantinos, C., Sørensen, S.Y., Larsen, P.B., Alexopoulou, S., 2010. SMEs and the Environment in the European Union No Title (Taastrup).
- Davies, A., Fidler, D., Gorbis, M., 2011. *Future Work Skills 2020*. University of Phoenix Research Institute, Phoenix.
- de Oliveira Neto, G.C., Santana, J.C.C., Godinho Filho, M., Chiappetta Jabbour, C.J., 2020. Assessment of the environmental impact and economic benefits of the adoption of cleaner production in a Brazilian metal finishing industry. *Environ. Technol.* 41, 1814–1828. <https://doi.org/10.1080/09593330.2018.1551426>.
- Deloitte, 2015. Industry 4.0. Challenges and Solutions for the Digital Transformation and Use of Exponential Technologies [WWW Document]. URL <https://www2.deloitte.com/content/dam/Deloitte/ch/Documents/manufacturing/ch-en-manufacturing-industry-4-0-24102014.pdf>.
- Deloitte, 2020. Tech Trends 2020 [WWW Document]. URL <https://www2.deloitte.com/content/dam/Deloitte/pt/Documents/tech-trends/TechTrends2020.pdf>.
- Dumont, J., Shen, J., Deng, X., 2017. Effects of green HRM practices on employee workplace green behavior: the role of psychological green climate and employee green values. *Hum. Resour. Manag.* 56, 613–627. <https://doi.org/10.1002/hrm.21792>.
- Dyllick, T., Muff, K., 2016. Clarifying the meaning of sustainable business. *Organ. Environ.* 29, 156–174. <https://doi.org/10.1177/1086026615575176>.
- Ehnert, I., 2009. *Sustainable Human Resources Management: A Conceptual and Exploratory Analysis from a Paradox*. Physica-Verlag HD, Heidelberg.
- Ehnert, I., Parsa, S., Roper, I., Wagner, M., Muller-Camen, M., 2016. Reporting on sustainability and HRM: a comparative study of sustainability reporting practices by the world's largest companies. *Int. J. Hum. Resour. Manag.* 27, 88–108. <https://doi.org/10.1080/09585192.2015.1024157>.
- Eizaguirre, A., García-Feijoo, M., Laka, J.P., 2019. Defining sustainability core competencies in business and management studies based on multinational stakeholders' perceptions. *Sustainability* 11, 2303. <https://doi.org/10.3390/su11082303>.
- Eurostat, 2015. *Education and Training in the EU – Facts and Figures*.
- Eurostat, 2020a. *Scientists and Engineers as % of Active Population - RIO_SCIENG_OF_ACT*.
- Eurostat, 2020b. *Individuals Who Have Basic or above Basic Overall Digital Skills - TEPSR_SP410*.
- Farkas, M.F., Török, L.G., 2011. Knowledge workers, competencies, virtuality and management. *Polish J. Manag. Stud.* 4, 67–77.
- Forman, T.H., 1982. The production engineer, architect of the future. *Eng. Costs Prod. Econ.* 6, 77–80. [https://doi.org/10.1016/0167-188X\(82\)90040-4](https://doi.org/10.1016/0167-188X(82)90040-4).
- Fox, K., O'Connor, J., 2015. *Five Ways Work Will Change in the Future*. Guard.
- Frey, C.B., Osborne, M.A., 2020. Will robots take my job? [WWW Document]. URL <https://willrobotstakemyjob.com/17-2112-industrial-engineers>.
- Garcés-Ayerbe, C., Rivera-Torres, P., Suárez-Perales, I., Leyva-de la Hiz, D., 2019. Is it possible to change from a linear to a circular economy? An overview of opportunities and barriers for European small and medium-sized enterprise companies. *Int. J. Environ. Res. Publ. Health* 16, 851. <https://doi.org/10.3390/ijerph16050851>.
- Ghobakhloo, M., 2020. Industry 4.0, digitization, and opportunities for sustainability. *J. Clean. Prod.* 252, 119869. <https://doi.org/10.1016/j.jclepro.2019.119869>.
- Gladwin, T.N., Kennelly, J.J., Krause, T.-S., 1995. Shifting paradigms for sustainable development: implications for management theory and research. *Acad. Manag. Rev.* 20, 874. <https://doi.org/10.2307/258959>.
- Gracel, J., Stoch, M., 2019. *Inżynierowie przemysłu 4.0: jak ich rozwijać?* Harvard Bus. Rev. Pol.
- Guerci, M., Carollo, L., 2016. A paradox view on green human resource management: insights from the Italian context. *Int. J. Hum. Resour. Manag.* 27, 212–238. <https://doi.org/10.1080/09585192.2015.1033641>.
- Guerci, M., Longoni, A., Luzzini, D., 2016. Translating stakeholder pressures into environmental performance – the mediating role of green HRM practices. *Int. J. Hum. Resour. Manag.* 27, 262–289. <https://doi.org/10.1080/09585192.2015.1065431>.
- Gupta, B., 2011. A comparative study of organizational strategy and culture across industry. *Benchmark Int. J.* 18, 510–528. <https://doi.org/10.1108/14635771111147614>.
- Haddock-Millar, J., Sanyal, C., Müller-Camen, M., 2016. Green human resource management: a comparative qualitative case study of a United States multinational corporation. *Int. J. Hum. Resour. Manag.* 27, 192–211. <https://doi.org/10.1080/09585192.2015.1052087>.
- Hanley, T., Andy, D., Cotteleer, M., Sniderman, B., 2018. *The Industry 4.0 paradox*. Executive Summary. Deloitte Rev.
- Hart, S.L., Milstein, M.B., 2003. Creating sustainable value. *Acad. Manag. Perspect.* 17, 56–67. <https://doi.org/10.5465/ame.2003.10025194>.
- Hebles, M., Yaniz-Álvarez-de-Eulate, C., Jara, M., 2019. Impact of cooperative learning on teamwork competence. *Academia. Rev. Latinoam. Adm.* 32, 93–106. <https://doi.org/10.1108/ARLA-10-2018-0217>.
- Hecklau, F., Orth, R., Kidschun, F., Kohl, H., 2017. *Human resources management: meta-study - analysis of future competences in industry 4.0*. Proceedings 13th European Conference on Management Leadership and Governance (ECMLG). ACPI, London, pp. 163–174.
- Hinton, S., 2018. *How the Fourth Industrial Revolution Is Impacting the Future of Work*. Forbes.
- Holton III, E.F., Bates, R.A., Ruona, W.E.A., 2000. Development of a generalized learning transfer system inventory. *Hum. Resour. Dev. Q.* 11, 333–360. <https://doi.org/10.1002/1532-1096>.
- Iwański, T., Gracel, J., 2016. *Industry 4.0*. Cracow.
- Jabbour, C.J.C., Santos, F.C.A., 2008. Relationships between human resource dimensions and environmental management in companies: proposal of a model. *J. Clean. Prod.* 16, 51–58. <https://doi.org/10.1016/j.jclepro.2006.07.025>.
- Jackson, Susan E., Seo, J., 2010. The greening of strategic HRM scholarship. *Organ. Manag. J.* 7, 278–290. <https://doi.org/10.1057/omj.2010.37>.
- Jackson, S.E., Renwick, D.W.S., Jabbour, C.J.C., Muller-Camen, M., 2011. State-of-the-Art and Future Directions for Green Human Resource Management: Introduction to the special issue | Forschungsstand und entwicklungs-möglichkeiten für umweltorientiertes personalmanagement: einführung in das schwerpunktheft. *Zeitschrift für Pers* 25, 99–116. https://doi.org/10.1688/1862-0000_ZfP_2011_02_Jackson.
- Kagawa, F., 2007. Dissonance in students' perceptions of sustainable development and sustainability. *Int. J. Sustain. High Educ.* 8, 317–338. <https://doi.org/10.1108/14676370710817174>.
- Kamble, S.S., Gunasekaran, A., Gawankar, S.A., 2018. Sustainable Industry 4.0 framework: a systematic literature review identifying the current trends and future perspectives. *Process Saf. Environ. Protect.* 117, 408–425. <https://doi.org/10.1016/j.psep.2018.05.009>.
- Kaur, S., Gupta, S., Singh, S.K., Perano, M., 2019. Organizational ambidexterity through global strategic partnerships: a cognitive computing perspective. *Technol. Forecast. Soc. Change* 145, 43–54. <https://doi.org/10.1016/j.techfore.2019.04.027>.
- Khan, N., 2018. Does training and employee commitment predict employee retention? *AIMS Int. J. Manag.* 12, 153–160.
- Kim, K.S., Shin, T.H., 2019. Additive effects of performance- and commitment-oriented human resource management systems on organizational outcomes. *Sustain. Times* 11. <https://doi.org/10.3390/su11061679>.
- Koho, M., Tapaninaho, M., Heilala, J., Torvinen, S., 2015. Towards a concept for realizing sustainability in the manufacturing industry. *J. Ind. Prod. Eng.* 32, 12–22. <https://doi.org/10.1080/21681015.2014.1000402>.
- Kolenda, P., 2017. *ICAN Institute, Warsaw. Internet 2016/2017*.
- Kusá, A., Piatrov, I., 2020. Perception of global environmental problems by Generation C and its marketing communication preferences. *SHS Web Conf* 74, 01021. <https://doi.org/10.1051/shsconf/20207401021>.
- Lambrechts, W., Mulà, I., Ceulemans, K., Molderez, I., Gaeremynck, V., 2013. The integration of competences for sustainable development in higher education: an analysis of bachelor programs in management. *J. Clean. Prod.* 48, 65–73. <https://doi.org/10.1016/j.jclepro.2011.12.034>.
- Lopes de Sousa Jabbour, A.B., Vazquez-Brust, D., Chiappetta Jabbour, C.J., Andriani Ribeiro, D., 2020. The interplay between stakeholders, resources and capabilities in climate change strategy: converting barriers into cooperation. *Bus. Strat. Environ.* 29, 1362–1386. <https://doi.org/10.1002/bse.2438>.
- López-Fernández, M., Romero-Fernández, P.M., Aust, I., 2018. Socially responsible human resource management and employee perception: the influence of manager and line managers. *Sustain. Times* 10. <https://doi.org/10.3390/su10124614>.
- Lozano, R., Merrill, M., Sammalisto, K., Ceulemans, K., Lozano, F., 2017. Connecting competences and pedagogical approaches for sustainable development in higher education: a literature review and framework proposal. *Sustainability* 9, 1889. <https://doi.org/10.3390/su9101889>.
- Marscheider-Weidemann, F., Langkau, S., Hummen, T., Erdmann, L., Espinoza, L.T., 2016. *Raw Materials for Emerging Technologies 2016 (Berlin)*.
- McCann, J.T., Holt, R.A., 2010. Defining sustainable leadership. *Int. J. Sustain. Strat. Manag.* 2, 204. <https://doi.org/10.1504/IJSSM.2010.032561>.
- McEwan, D., Ruissen, G.R., Eys, M.A., Zumbo, B.D., Beauchamp, M.R., 2017. The effectiveness of teamwork training on teamwork behaviors and team performance: a systematic review and meta-analysis of controlled interventions. *PloS One* 12, e0169604. <https://doi.org/10.1371/journal.pone.0169604>.

- McGowan, R., 2018. Here Are 3 Alternative Visions for the Future of Work [WWW Document]. World Econ. Forum Annu. Meet. URL: <https://www.weforum.org/agenda/2018/12/alternative-future-work-opportunity-fear-industry/>.
- McGrath, M., 2015. 5 Myths about Employee Learning [WWW Document]. HR Mag. URL: <https://www.shrm.org/hr-today/news/hr-magazine/pages/0515-employee-learning.aspx>.
- McLagan, P., Suhadolnik, D., 1989. Models for HRD Practice: the Research Report. ASTD Press, Alexandria.
- Meadows, D.H., Meadows, D.L., Randers, J., Berens III, W.W., 1972. The Limits to Growth, first ed. Potomac Associates, US.
- Meier, S., Stephenson, M., Perkowski, P., 2019. Culture of trust and division of labor in nonhierarchical teams. *Strateg. Manag. J. smj*. 3024 <https://doi.org/10.1002/smj.3024>.
- Ministry of Entrepreneurship and Technology/Siemens, 2019. Report Smart Industry Poland 2019. Inżynierowie w dobie czwartej rewolucji przemysłowej, Warsaw.
- Muduli, K.K., Luthra, S., Kumar Mangla, S., Jabbar, C.J.C., Aich, S., Guimarães, J.C.F., 2020. Environmental management and the “soft side” of organisations: discovering the most relevant behavioural factors in green supply chains. *Bus. Strat. Environ.* 29, 1647–1665. <https://doi.org/10.1002/bse.2459>.
- Müller, J.M., Kiel, D., Voigt, K.-I., 2018. What drives the implementation of industry 4.0? The role of opportunities and challenges in the context of sustainability. *Sustainability* 10, 247. <https://doi.org/10.3390/su10010247>.
- Muster, V., Schrader, U., 2011. Green work-life balance: a new perspective for green HRM | Green work-life-balance: eine neue perspektive für umweltorientiertes personal management. *Zeitschrift für Pers* 25, 140–156. https://doi.org/10.1688/1862-0000_ZfP_2011_02_Muster.
- Najwa Azmi, A., Kamin, Y., Khair Noordin, M., 2018. Competencies of engineering graduates: what are the employer's expectations? *Int. J. Eng. Technol.* 7, 519. <https://doi.org/10.14419/ijet.v7i2.29.13811>.
- Newman, A., Miao, Q., Hofman, P.S., Zhu, C.J., 2016. The impact of socially responsible human resource management on employees' organizational citizenship behaviour: the mediating role of organizational identification. *Int. J. Hum. Resour. Manag.* 27, 440–455. <https://doi.org/10.1080/09585192.2015.1042895>.
- OECD, 2019. OECD SME and Entrepreneurship Outlook 2019. OECD, Paris. <https://doi.org/10.1787/34907e9c-en>.
- Ogbeibu, S., Senadjki, A., Luen Peng, T., 2018. An organisational culture and trust-worthiness multidimensional model to engender employee creativity. *Am. J. Bus.* 33, 179–202. <https://doi.org/10.1108/AJB-12-2017-0043>.
- Ogbeibu, S., Emelifeonwu, J., Senadjki, A., Gaskin, J., Kaivo-oja, J., 2020. Technological turbulence and greening of team creativity, product innovation, and human resource management: implications for sustainability. *J. Clean. Prod.* 244, 118703. <https://doi.org/10.1016/j.jclepro.2019.118703>.
- Oláh, J., Aburumman, N., Popp, J., Khan, M.A., Haddad, H., Kitukutha, N., 2020. Impact of industry 4.0 on environmental sustainability. *Sustainability* 12, 4674. <https://doi.org/10.3390/su12114674>.
- Opatha, H.H.D.N.P., 2019. A study of bachelor's degrees in human resource management in three Sri Lankan leading state universities. *Univers. J. Educ. Res.* 7, 2361–2371. <https://doi.org/10.13189/ujer.2019.071114>.
- Open Text, 2020. ISO Survey of Certifications to Management System Standards.
- O'Donohue, W., Torugsa, N.A., 2016. The moderating effect of 'Green' HRM on the association between proactive environmental management and financial performance in small firms. *Int. J. Hum. Resour. Manag.* 27, 239–261. <https://doi.org/10.1080/09585192.2015.1063078>.
- Pais-Montes, C., Freire-Seoane, M.J., López-Bermúdez, B., 2019. Employability traits for engineers: a competencies-based approach. *Ind. High. Educ.* 33, 308–326. <https://doi.org/10.1177/0950422219854616>.
- Pajula, S., Wellener, P., Dollar, B., 2018. 2018 Skills Gap in Manufacturing Study.
- Parsloe, E., Wray, M., 2008. *Trener i Mentor*, second ed. ABC Wolters Kluwer, Warsaw.
- Payne, C.R., 2017. Defining the 'environment' and the principle of environmental integrity. In: Stahn, C., Iverson, J., Easterday, J.S. (Eds.), *Environmental Protection and Transitions from Conflict to Peace: Clarifying Norms, Principles and Practices*. Oxford University Press, Oxford, pp. 40–68.
- Pinzzone, M., Guerci, M., Lettieri, E., Redman, T., 2016. Progressing in the change journey towards sustainability in healthcare: the role of 'Green' HRM. *J. Clean. Prod.* 122, 201–211. <https://doi.org/10.1016/j.jclepro.2016.02.031>.
- Piwońar-Sulej, K., 2016. Flexibility in the context of project team's human potential. *Przełąd Organ.* 6, 48–54.
- Piwońar-Sulej, K., 2018. Employee 4.0 from the competitive perspective. *Stud. i Pr. WNEiE* 52, 121–129. <https://doi.org/10.18276/sip.2018.52/3-12>.
- Piwońar-Sulej, K., 2020a. Pro-environmental organizational culture: its essence and a concept for its operationalization. *Sustainability* 12, 4197. <https://doi.org/10.3390/su12104197>.
- Piwońar-Sulej, K., 2020b. Design thinking. Istota koncepcji oraz możliwości jej zastosowania w przemyśle chemicznym. *Przem. Chem.* 1, 124–127. <https://doi.org/10.15199/62.2020.3.16>.
- Piwońar-Sulej, K., Bąk-Grabowska, D., 2018. Enterprise boundaries in the area of human resources. *Argumenta Oeconomica* 41. <https://doi.org/10.15611/aoe.2018.2.16>.
- Puchalski, K., Korzeniowska, E., 2016. Workplace health promotion in Poland in 2015 – diagnosis based on a representative survey of companies employing more than 50 employees. *Med. Pr.* <https://doi.org/10.13075/mp.5893.00532>.
- Rajput, S., Singh, S.P., 2020. Industry 4.0 model for circular economy and cleaner production. *J. Clean. Prod.* 123853 <https://doi.org/10.1016/j.jclepro.2020.123853>.
- Rekalde, I., Landeta, J., Albizu, E., Fernandez-Ferrin, P., 2017. Is executive coaching more effective than other management training and development methods? *Manag. Decis.* 55, 2149–2162. <https://doi.org/10.1108/MD-10-2016-0688>.
- Renwick, D.W.S., Redman, T., Maguire, S., 2013. Green human resource management: a review and research agenda*. *Int. J. Manag. Rev.* 15, 1–14. <https://doi.org/10.1111/j.1468-2370.2011.00328.x>.
- Santandreu-Mascarell, C., Canós-Darós, L., Pons-Morera, C., 2011. Competencies and skills for future Industrial Engineers defined in Spanish degrees. *J. Ind. Eng. Manag.* 4 <https://doi.org/10.3926/jiem.2011.v4n1.p13-30>.
- Sarkis, J., Zhu, Q., 2018. Environmental sustainability and production: taking the road less travelled. *Int. J. Prod. Res.* 56, 743–759. <https://doi.org/10.1080/00207543.2017.1365182>.
- Schmidt, S.W., 2007. The relationship between satisfaction with workplace training and overall job satisfaction. *Hum. Resour. Dev. Q.* 18, 481–498. <https://doi.org/10.1002/hrdq.1216>.
- Sharma, R., Jabbar, C.J.C., Lopes de Sousa Jabbar, A.B., 2020. Sustainable manufacturing and industry 4.0: what we know and what we don't. *J. Enterprise Inf. Manag.* <https://doi.org/10.1108/JEIM-01-2020-0024> ahead-of-p.
- Shen, J., Zhu, C.J., 2011. Effects of socially responsible human resource management on employee organizational commitment. *Int. J. Hum. Resour. Manag.* 22, 3020–3035. <https://doi.org/10.1080/09585192.2011.599951>.
- Shen, J., Dumont, J., Deng, X., 2018. Employees' perceptions of green HRM and non-green employee work outcomes: the social identity and stakeholder perspectives. *Group Organ. Manag.* 43, 594–622. <https://doi.org/10.1177/1059601116664610>.
- Sims, R.R., 2006. *Human Resource Development: Today and Tomorrow*. Information Age Publishing Inc., Greenwich.
- Singh, S.K., Singh, A.P., 2019. Interplay of organizational justice, psychological empowerment, organizational citizenship behavior, and job satisfaction in the context of circular economy. *Manag. Decis.* 57, 937–952. <https://doi.org/10.1108/MD-09-2018-0966>.
- Singh, S.K., Del Giudice, M., Tarba, S.Y., De Bernardi, P., 2019. Top management team shared leadership, market-oriented culture, innovation capability, and firm performance. *IEEE Trans. Eng. Manag.* 1–11. <https://doi.org/10.1109/TEM.2019.2946608>.
- Singh, S.K., Giudice, M., Del Chierici, R., Graziano, D., 2020. Green innovation and environmental performance: the role of green transformational leadership and green human resource management. *Technol. Forecast. Soc. Change* 150. <https://doi.org/10.1016/j.techfore.2019.119762>.
- Smaliukienė, R., Bekesienė, S., Chlivickas, E., Magyla, M., 2017. Explicating the role of TRU in knowledge sharing: a structural equation model test. *J. Bus. Econ. Manag.* 18, 758–778. <https://doi.org/10.3846/16111699.2017.1317019>.
- Spermann, A., 2016. *Industrie 4.0 = Mehr Roboter = das Ende von Routinejobs? Wirtschaftspolitische Blätter* 63.
- Stankevičiute, Ž., Savanevičiene, A., 2018. Designing Sustainable HRM: The Core Characteristics of Emerging Field. *Sustain. Times* 10 (12), 4798. <https://doi.org/10.3390/su10124798>.
- Statistics Poland, 2017 (Warsaw). *Characteristics of Continuing Vocational Training in Enterprises in 2015*. Statistics Poland, Warsaw.
- The Gallup Organization, 2010. *Employers' Perception of Graduate Employability*. The Gallup Organization, Hungary.
- Tian, M., Deng, P., Zhang, Y., Salmador, M.P., 2018. How does culture influence innovation? A systematic literature review. *Manag. Decis.* 56, 1088–1107. <https://doi.org/10.1108/MD-05-2017-0462>.
- Tiwari, P., Sadeghi, J.K., Eseonu, C., 2020. A sustainable lean production framework with a case implementation: practice-based view theory. *J. Clean. Prod.* 277, 123078. <https://doi.org/10.1016/j.jclepro.2020.123078>.
- Tohidi, H., Jabbari, M.M., 2012. The important of innovation and its crucial role in growth, survival and success of organizations. *Procedia Technol* 1, 535–538. <https://doi.org/10.1016/j.protcy.2012.02.116>.
- Trompsich, P., 2017. Industrie 4.0 und die Zukunft der Arbeit. *E I Elektrotechnik Inf.* 134, 370–373. <https://doi.org/10.1007/s00502-017-0531-1>.
- UNEP - United Nations Environment Programme, 2014. *International Declaration on Cleaner Production: Implementation Guidelines for Facilitating Organizations* (Paris).
- Volberda, H.V., 1998. *Building the Flexibility Firm. How to Remain Competitive* (New York). Oxford University Press Inc.
- WCED - World Commission on Environment and Development, 1987. *Our Common Future*. Oxford University Press, Oxford.
- Weber, E., 2016. *Industry 4.0 – job-producer or employment-destroyer?* Nuremberg.
- Whetten, D.A., 1989. What constitutes a theoretical contribution? *Acad. Manag. Rev.* 14, 490–495. <https://doi.org/10.5465/amr.1989.4308371>.
- Whysall, Z., Owttram, M., Brittain, S., 2019. The new talent management challenges of Industry 4.0. *J. Manag. Dev.* 38, 118–129. <https://doi.org/10.1108/JMD-06-2018-0181>.
- Wilson, J.P., 2015. The triple bottom line. *Int. J. Retail Distrib. Manag.* 43, 432–447. <https://doi.org/10.1108/IJRDM-11-2013-0210>.

- Yang, R., Wong, C.W.Y., Miao, X., 2021. Analysis of the trend in the knowledge of environmental responsibility research. *J. Clean. Prod.* 278, 123402. <https://doi.org/10.1016/j.jclepro.2020.123402>.
- Zaugg, R.J., Blum, A., Thom, N., 2001. *Sustainability in Human Resource Management* (Berne).
- Zibarras, Lara D., Coan, P., 2015. HRM practices used to promote pro-environmental behavior: a UK survey. *Int. J. Hum. Resour. Manag.* 26, 2121–2142. <https://doi.org/10.1080/09585192.2014.972429>.
- Zoogah, D.B., 2011. The dynamics of green HRM behaviors: a cognitive social information processing approach. *Z. für Pers.* 25, 117–139. https://doi.org/10.1688/1862-0000_ZfP_2011_02_Zoogah.
- Zych, B., 2017. Kompetencje przyszłości – jakie umiejętności rozwijać, by odnosić sukcesy na rynku pracy? *HRStandard* (pl).