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Decision Support Concept for Improvement of Sustainability-Related Competences

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Abstract: In this paper, we derived competences from previously developed competence models, ensuring the effective use of advanced technologies in future factories to improve the sustainability of their business models and strategies. Based on the analysis of the Hogan competence model and competence models for sustainability and leadership, we compiled a selection of competences for digitalisation, automation, robotics, artificial intelligence, and soft competences such as emotional intelligence and cultural literacy. We also included competences required for sustainability, corporate social responsibility, and circular economy. The selected competences formed the core for the conceptual development of a decision support tool for the individualised selection of training for employees. The concept was tested in customised training to improve employees' skills and motivation for lifelong learning at the selected industrial partner. The developed assessment algorithm was used to monitor the progress of individual employees' skills development before and after their training participation. The results of the assessment help human resource departments make decisions for selecting the most effective and optimal training for employees to improve their sustainability-related competences. Such a systematic approach can improve and evaluate competences that companies need to transition to a circular economy.

Keywords: circular economy; sustainability; competence development; employee training plan; decision support

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1. Introduction

In recent decades, it has become clear that our way of life is not sustainable, as we destroy and exploit natural systems more quickly than they manage to recover. Reducing the pressure on these complex natural systems will be quite challenging and will require a great deal of knowledge and cooperation among countries, companies, and society [1]. Sustainable development provides economic and social development while protecting the environment, thus including environmental, economic, and social aspects. There are different approaches to the implementation of sustainable development [2]. Recently, the circular economy (CE) has become very popular, since it promotes elimination of waste and the continued safe use of natural resources by reusing, remanufacturing and finally recycling waste. As such, it is in particular related to the European Green Deal [3]. That

document sets out measures to ensure that Europe becomes the world's first climate-neutral continent by 2050. Furthermore, the Industrial Strategy from 2020 sets a list of measures to support the green and digital transition of the EU industry. Recently, the path to the transition was strongly affected by the COVID-19 pandemic, which emphasised that companies working for sustainability and digitalisation are more likely to be among the leaders in the future. To achieve the established goals, the industry must have employers and employees with the right knowledge, competences and skills, ready to adapt to new circumstances in the event of sudden and unexpected changes.

The first competence research occurred in the 1970s when McClelland found that characteristics of individuals, including academically acquired knowledge and skills, were important indicators of performance [4]. There are many definitions of competence as studied in different fields (clinical psychology, vocational and general education) [5]. In recent years, however, the concept has been regularly applied in human resources (HR). Sandberg and some other authors determined the worker-oriented approach of competences, represented as knowledge, abilities, skills, personality traits, and many other factors that enable employees to accomplish their work as successfully as possible and bring added value to the company [6,7].

Usually, decision support systems (DSSs) are understood as computer systems which emulate the decision-making ability of relevant human experts. They have been used in education for decades and have proven valuable for competence evaluation and assistance in the selection of education, which contributes most to the improvement of competences [8]. Sánchez et al. presented an interesting system for the evaluation of students' curricula based on competences [9] and the European project ComProFITS assessed competences with help of the Expert System for Human Resource Management, HRM [10]. Conventional training is moving toward web-based training, especially in crucial conditions such as a pandemic, when the self-regulated and self-managed learning of individual learners is an important factor affecting learning/training performance [11]. Therefore, the DSSs that support HRM and individual employees as lifelong learners to monitor their learning attitudes and progress in competence development are becoming increasingly important.

The Fourth Industrial Revolution, also known as Industry 4.0, originates from a high-tech strategy of the German government [12]. It focuses on production systems, which can make intelligent decisions and enable flexible production of high-quality personalised products at mass efficiency with the support of artificial intelligence (AI). Similar strategies have been implemented around the world; for instance, in Japan it is known as Society 5.0. In this contribution, we reviewed and selected key competences needed for ensuring a future sustainable and circular economy. Furthermore, we prepared a critical comparative analysis of four competence models that include sustainability competences in addition to the Hogan competence model. We sought an intersection between these four competence models and the competence model for the factories of the future developed by the Competence Centre for factories of the future (KOC-TOP) at the Jožef Stefan International Postgraduate School (IPS), which we will discuss in detail later. Furthermore, we classify and evaluate key competences of leaders and other employees ensuring sustainability and a circular economy according to the Hogan model. Selected competences focusing on sustainability, circular economy, corporate social responsibility and leadership were included in the initial conceptual design of a decision support system, which assists human resource services in the selection of the most effective and optimal training for individual employees to improve their sustainability-related competences. The concept was verified using individualised tailor-made training for the enhancement of skills and motivation of employees for life-long learning in the selected industrial partner. The competence development progress monitoring of individual employees was performed with the developed assessment algorithm before and after their training attendance. By improving the KOC-TOP competence model with additional competences that ensure a sustainable, socially responsible and circular economy, we are a step closer to Industry 5.0, where "smart working" will replace the term "smart industry".

2. Circular Economy as a Sustainability Promoter

The linear model characterises the industrial age, which is entirely dependent on limited quantities of natural resources. The increasing global population, however, puts additional pressure on these resources [13]. Global consumption of resources in 1970 amounted to 23.7 billion tons, then increased to 70.1 billion tons in the next 30 years [14]. Therefore, the circular economy model offers a solution to harmonise the natural ecosystems, economic growth and social daily life with the reorganisation of our societies and business. According to the 2019 circularity gap report, our world is only 9% circular [15]. The European economies are thus exposed to risks and operating in an environment where commodity prices and supplies are becoming increasingly unpredictable [16,17]. The basis for economic stability is a thriving economy with balance. The economy's growth must be inclusive, green and must be based on high competitiveness and innovation. Companies need to integrate a corporate social responsibility into their work and business environment to improve the workers' well-being, the economy and the environment.

2.1. Circular Economy Model

The circular economy model has evolved in response to the risks associated with the linear model; it aims to create a more sustainable economy that breaks the link between growth and the constraints of natural resources [13]. Many countries and companies worldwide have realised the benefits of the circular economy and started integrating it into their system. In the last five years, we can see a growing trend globally that shows us an increasing search for a keyword phrase "circular economy" compared to a "linear economy" in Google Trends, which shows the popularity of a search term in Google search engine (Figure 1). The reason might also be due to the Circular economy action plan (CEAP), which was adopted by the European Commission in March 2020 and the Platform for Accelerating the Circular Economy (PACE) for public and private sector leaders to make commitments towards the Circular Economy, which was launched in 2017 by the World Economic Forum. Different countries have different possibilities for introducing a circular economy and may experience different results from its implementation.

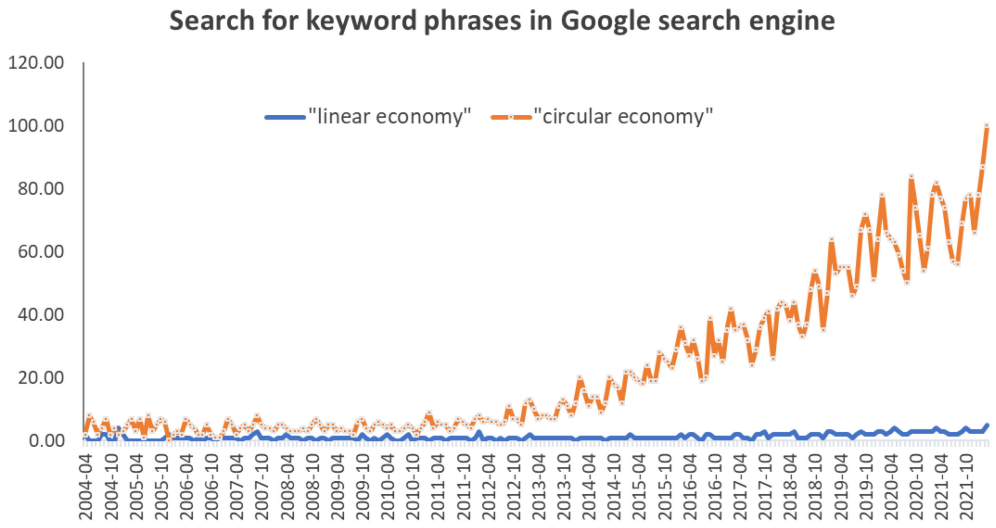

Figure 1. Comparison between the search terms "circular economy" (orange line with square marker) and "linear economy" (blue solid line) in the period from April 2004 to March 2022. Data for the whole world (Source: Google trends). Numbers represent search interest relative to the highest point on the chart for the worldwide and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular.

The circular economy is a regenerative system in which material, waste, emissions, and energy leakage are reduced by slowing, closing, and narrowing the material and energy loops. This can be achieved through longer-term design, maintenance, repair, renewal and reuse, recovery, and recycling. The circular model seeks to maximise the economical use of different resources and retain them if possible in the production and consumption cycles. In its operation, the circular economy requires fundamental changes in the value chain, from product design to manufacturing processes and new business models and consumer patterns, and thus, in addition, technological and social innovation [18,19]. A comprehensive view of the circular economy model has been developed by Cristoni and Tonelli [20]. They suggested a framework for circularity that can be incorporated into business strategies of industry, considering the most suitable areas in the value chain where CE actions can be implemented. They identified and grouped, according to the steps of a typical value chain, 17 areas of circular action that could most significantly modify business-as-usual operations.

Today's pre-production models and consumption patterns need to be transformed into more sustainable forms to achieve the transition to a green economy. We are also coping with a large amount of waste being discharged, which is greater than ever in the past. Due to current lifestyles, waste in all sectors is increasing. There is a need to change mindsets and focus society on waste prevention and reuse. Therefore, the circular economy can also be an opportunity that can offer long-term economic benefits. Globally, there is also increasing interest in the circular economy compared to the linear economy (Figure 1), which was, however, slowed down a little due to the COVID-19 epidemics.

For instance, Japan is a country with very limited natural resources due to its geological and geographical characteristics. As a result, Japan became the second country in 2000 to pass a law to promote the circular economy [18]. China is facing heavy resource consumption and degradation of the natural environment, so the government included elements of sustainability in its development strategy at the 18th Party Congress in 2012 [21]. The State Council, in 2013, released a national strategy for achieving a circular economy, which was the first such strategy in the world. As a result, resource intensity (resources used per unit gross domestic product, GDP) and waste intensity (waste per unit GDP) had improved by 34.7% and 46.5%, respectively, by 2013 [22]. The United States of America does not have separate legislation for the circular economy. Therefore, the US has many challenges in dealing with waste management.

Europe has tried for years to move towards a more sustainable system. The transition to a circular economy offers opportunities to develop new technologies and services, create new jobs and manage natural resources more efficiently. Moreover, better and more sustainable management of resources will ensure the sustainable growth of the European Union. To facilitate the transition to a more circular economy, the European Commission has presented a package of circular economy measures. This package includes a revised waste legislative proposal and a comprehensive action plan focusing on waste, setting out a clear and long-term vision for more recycling and less landfill waste. In 2019, the European Commission presented the European Green Deal, which sets out measures that would benefit European citizens and businesses. In 2020, the EC adopted the new circular economy action plan as one of the main building blocks of the European Green Deal. With these measures, Europe wants to reduce emissions, increase investment in research and innovation, and preserve Europe's natural environment [3] to make it cleaner and more biodiverse. The European Commission explicitly promotes the transition to a circular economy. They recommend creating new jobs, growth that improves resource efficiency, precise information, measures progress and supports new business models.

2.2. Competences Ensuring Circular Economy and Sustainability

We face a scarcity of natural resources and a growing population globally. The interdependence of different fields, industries, regions, and countries represent a challenge to which we have not been exposed before. As the roundabout process is systemic, we need

global leadership, inclusive management, and a target perspective. At the same time, we also need clear national priorities and targets that are as measurable and internationally comparable as possible.

Continuous changes in the global market, such as an increasing and aging population, continuous migration, unemployment, and increasingly demanding working conditions, require organisations to constantly adapt, change business approaches, and find new ways to cope with new market demands. Companies want to gain the competitive advantage they achieve with new approaches, adaptations, and innovation. To a large extent, this is achieved with employees since the success of the organisation depends on human resources. To improve the human workforce, we need to improve their competences. Competences are those characteristics of an individual that enable them to complete tasks and solve problems in a specific field of work. These include values, knowledge, experience, skills and other personality traits. When managing human resources, it is important to utilise the workers' competences optimally. Individuals with improved competences are more likely to identify problems and take actions that increase the economic and social well-being of the company [23].

The circular economy and sustainability are becoming increasingly important in the public and private sectors today. To improve our performance in these areas, we need to improve the competences of employees working in these sectors [24]. Leadership individuals are working hard to launch new initiatives to improve the quality of the environment. They do this through marketing initiatives that try to influence consumer behaviours [25]. The unsustainable patterns of human behaviour and the shifting of human activities towards sustainability require the enhancement of sustainability competences, as they allow the critical review of the prevailing values, policies, practices, and they help to make a difficult decision towards a better environment for all the people [26].

Properly equipped workers are key to green technological transition in the industry. Eco-innovations are innovative technologies that affect progression towards the goals of sustainable development with reduced environmental impact and increasing the industry's competitiveness. Eco-innovation can bring the European Union's economy to a low-carbon economy, reducing pressure on the environment. In the European Union (EU), the eco-innovation index shows the performance of individual Member States in the different components of eco-innovation compared to the EU average. It also represents their strengths and weaknesses.

3. Literature Review on Competence Models for Sustainability

A competence model is a tool that best describes the skill and ability to perform a job. It is a clearly defined and systematically presented system of general and specific competences [27] and assists in planning further education, employment, mentoring, and career development [28]. It defines the individual competences that an individual needs to work in a company. A clearly defined competence model needs to be updated regularly to provide employees with a clearly defined set of competences for successful work. The model facilitates the staff appraisal system, the selection of new staff, and the transfer of knowledge, and contributes to the overall improvement of knowledge [29]. There exist several approaches to collecting the required data to set up the desired competence model: personal interviews, questionnaires, job descriptions, and observations. The competence model must include the list of the competences and their detailed description, job profiles, and procedure on how to rate an employee's level of competence. We focus our analysis on the competences from the Hogan model, which includes intrapersonal, interpersonal, business, and leadership competences. Furthermore, we evaluate four competence models for sustainability and leadership. All four competence models were compared to the competence model for advanced technologies in factories of the future (KOC-TOP), which was developed within the competence centre for factories of the future established by Jožef Stefan International Postgraduate School (IPS) in 2018 as a national pilot project with the active participation of six Slovenian companies.

3.1. Hogan Competence Model (HCM)

The HCM [30] includes 62 different competences (a summary list is given in Table S1 in Supplementary Materials), which are organised into four domains. The first domain is intrapersonal skills. They are developed in the early years of human life (childhood) and occur within a person's mind. Examples of intrapersonal skills are achievement orientation, competitiveness, work ethic, and risk management. The second domain, interpersonal skills, refers to interactions with other people or personalities. Examples of interpersonal skills are active listening, building relationships, and negotiation. The next domain is work skills, which are least dependent on relationships with other people, are easiest to teach, the most cognitive, and the last to develop. Examples of work skills are presenting skills, problem solving, and written communication. The last domain is leadership skills. The leader must recruit talented people and retain them in his team. He must also know how to motivate the team. Examples of leadership skills are managing change and conflict, strategic planning, building teams, and talent management.

The HCM provides efficient and easy competence-based solutions. The HCM is designed to have minimal overlap between competences, as individual competence describes individual behaviours, which allows for better measurement of specific behaviours. Each area of activity has its specific competences, which allows better prediction of abilities. The HCM contains four domains: Leadership, Business, Interpersonal, and Intrapersonal. The four domains form a natural, overlapping sequence of development, with the last skills (e.g., leadership skills) being dependent on the proper development of previous skills (e.g., interpersonal skills) [30]. The overall model is based on an analysis of 21 other models used in academic, commercial, and governmental fields. In HCM, each competence is scored on a rolling basis. The evaluation is based on a five-point scale, where 0 indicates that competence is not relevant to a particular position and four means that competence is critically important to a particular function. Competences are also designed to be compatible with different companies' strategies and different positions. HCM is comprehensive and can be used in combination with other competence models. We took the framework of the Hogan competence models and compared it with various competence models for sustainability. With this comparative analysis, we attempted to identify the necessary sustainability competences which are critical to performing jobs in future companies in a sustainable manner to achieve a more sustainable and circular economy in line with planetary limits. Special attention is given to leadership competences that a sustainability leader should gain to lead the organisation, business and workforce in a sustainable way that supports both the well-being of workers and long-term economic growth.

3.2. Competence Models for Sustainability Implemented through Education

Since education plays an important role in the development of sustainability competences that future generations will need at performing their green jobs in a sustainable manner, we searched for findings on competences in sustainability education. First, we came across a document, prepared by the European Commission on a comprehensive literature review on existing definitions of sustainability, the development of sustainability competences in education and the identification of skills related to sustainable, green and circular jobs for society to be able to tackle sustainability challenges in the near future [31]. In this study, they differentiated between competences in sustainability and key competences in sustainability. The key competences equip individuals with the necessary competences to solve complex problems and challenges and exploit opportunities in favour of sustainability. These competences can be specific and interrelated, but critical and shall be acquired through specific courses in higher education. For sustainability in higher education, they suggested eight key sustainability competences, which could be related to sustainability-related jobs: problem-based learning, critical emancipatory pedagogy, eco-justice and community, action learning, participatory action research, community service-learning, environmental education and traditional ecological knowledge.

Among many educationally oriented proposals on competence models for sustainability, we selected a sustainability competency model (SCM) prepared by Eagan et al. [24]. We chose the SCM model because it was designed for companies and organisations (mainly developing and producing electrotonic devices) that want to develop institutional and individual capabilities to meet the needs of their customers and stakeholders. It focuses on engineering sustainability, which is needed to effectively lead and manage the work organisation, develop innovative solutions, and measure the impact of sustainable initiatives. The SCM model links the engineering academia curriculum with business practice. The eight competences dimensions covered by the SCM are: science and technology, business and economics, systems analysis, personal effectiveness, working across boundaries, management and planning, environmental justice and equity, and ideas and innovation. Each of them defines the knowledge skills, mindsets, and behavioural attributes in more detail.

In Figure 2, we show the areas of competences for the SCM model and the sustainability education model. We noticed the interrelations between them. For instance, both competence models address the environmental criteria, especially eco-justice. The SCM model focuses more on economic criteria, covering business and economics as well as management and planning. Since it originates from the company perspective, technological criteria are also more emphasised, e.g., science and technology as well as ideas and innovations. On the other hand, the sustainability education model focuses more on social criteria such as critical emancipatory pedagogy, problem-based learning, community service learning, action learning and participatory action research. Some social criteria are also included in the SCM model; for instance, personal effectiveness and working across boundaries. As mentioned in the section about the Hogan competence model, social skills affect the proper development of technological and economic skills. However, both models have one goal to equip professionals and citizens as employees through sustainability education with the right competences to move towards sustainable behaviour in their daily personal and professional lives.

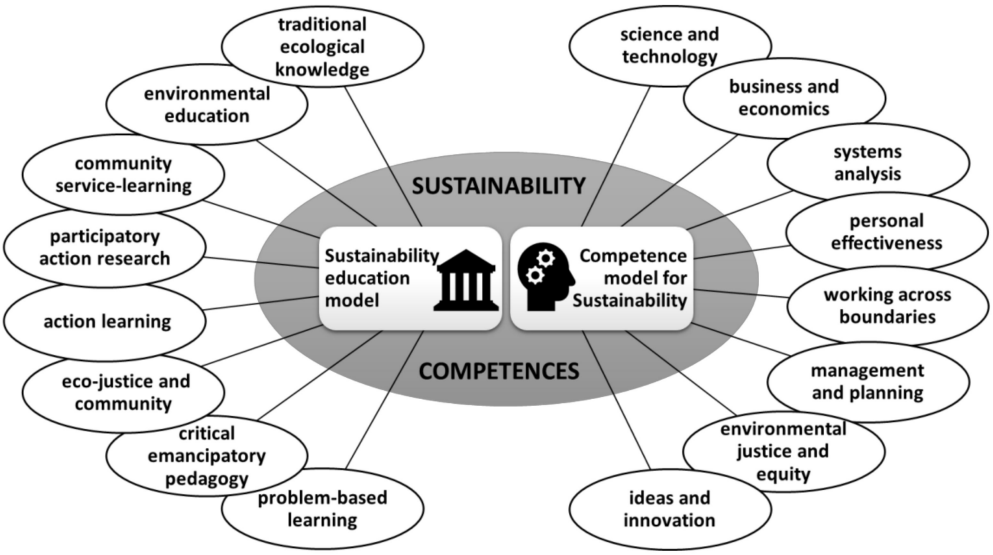

Figure 2. Interlink between competences in sustainability education model and SCM model.

3.3. Competence Models for Sustainability Implemented through Education

Today, more and more organisations are establishing sustainable strategies to address the complex issues associated with global population growth, decreasing economic growth and increasing environmental pressures. To implement these strategies, companies need a new expert, the sustainability leader. For this reason, we included in the comparative analysis two additional sustainability models focusing on leadership competences, which a person should gain for sustainably managing and leading the organisation: a behavioural

competence model for sustainability leadership (BCMSL) [25], and UNESCO competences for sustainability leadership [32].

A behavioural competence model for sustainability leadership provides the resources for more focused leadership with an emphasis on sustainability initiatives. It allows leaders to map their current behavioural competences and monitors their progress over time. The assessment of an individual's profile allows for the adaptation of development practices and can also be used as a recruitment tool. The competence groups included in this model are: Results Driven, A Visionary Thinker, Ethically Oriented, A Change Agent, and An Inclusive Operator [25]. The UNESCO competences for sustainability leadership [32] are more related to academic leadership style, i.e., system leaders, who are capable of recognising and understanding the larger systems, often even outside its primary organisations. These competences are systems thinking, anticipatory, normative, strategic action, (emphatic) collaboration, critical thinking, self-awareness, and integrated problem-solving.

In Figure 3, we show the competence areas covered by the BCMSL model and the UNESCO sustainability leadership competence model. As we can see, they overlap in some competences. For instance, both suggest that the sustainability leader should be a visionary thinker, or in other words, able to systematically and critically think. He or she should also be prepared to take the role of the inclusive operator and collaborate. Both models are also focusing on processes in the organisation, which should be continuously changed and lead to good results. These can be achieved if the leader is anticipatory, self-awareness, ethically oriented and normative as well as can solve challenging and non-routine problems by developing and implementing strategic actions.

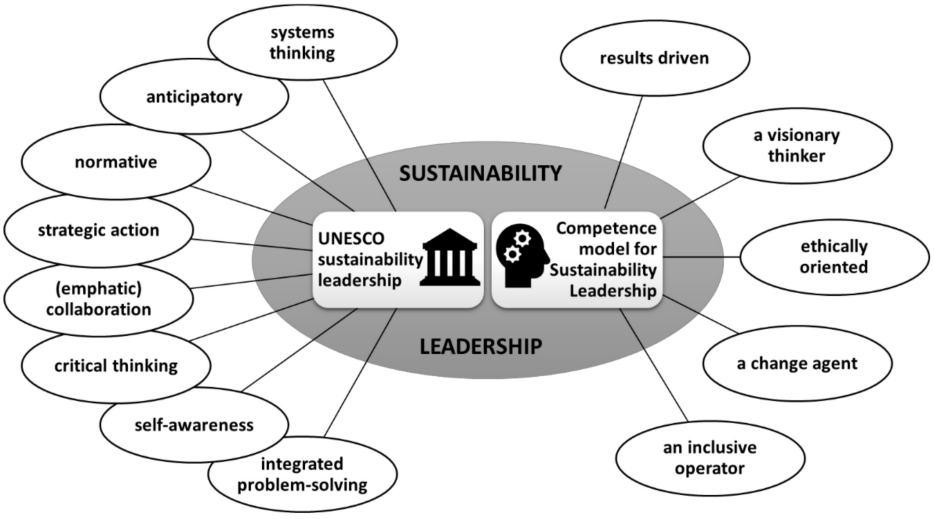

Figure 3. Interlink between the UNESCO sustainability leadership competences and Competence Model for Sustainability Leadership.

3.4. Competences for Sustainability from the Competence Model for Advanced Technologies in Factories of the Future

Within the Competence Centre at Jožef Stefan International Postgraduate School (IPS), we developed a competence model for advanced technologies in factories of the future (KOC-TOP competence model). The list of competences included in the KOC-TOP competence model is summarised in Figure 4. The document describing the KOC-TOP competence model is confidential and is stored at the IPS. The preparation of the competence model is based on the needs of the KOC-TOP Competence Centre industrial partners, SRIPs (strategic research–innovation partnership) action plans and the educational process in Slovenia. The competence model includes the knowledge, skills, expertise, abilities, and other characteristics that are required for successful performance in a particular workplace. The purpose of the competence model is to ensure that employees do the right things, do

them successfully, and bring maximum added value to their work and consequently to business success. The model describes (1) general competences that relate to the company culture and values; (2) specific vocational competences common to the particular profession; (3) key competences that are most relevant to each job and represent a competitive advantage for the company. Industrial partners of the project have made an analysis of key competences for a specific workplace. A set of reference groups for competences were identified as depicted in Figure 3. Within each group, several specific competences were identified. The required percentage of individual competence was defined for each work position. Herein, we just briefly explain the procedure of evaluation of the employee's competences. The next step was the preparation of an evaluation of the actual competences held by the employees occupying each position. There are different possibilities to evaluate the competences. While specialised tests can be developed for each individual competence, in our case the number of observed competences was too large for such an approach to be practical. The competences were therefore assessed by the peer evaluation by the supervisor and co-workers. The discrepancies between the required/desired job competences and the actual competences of individuals were identified. Where there is a greater discrepancy between the competences wanted and the actual competences, additional training is recommended to improve that competence.

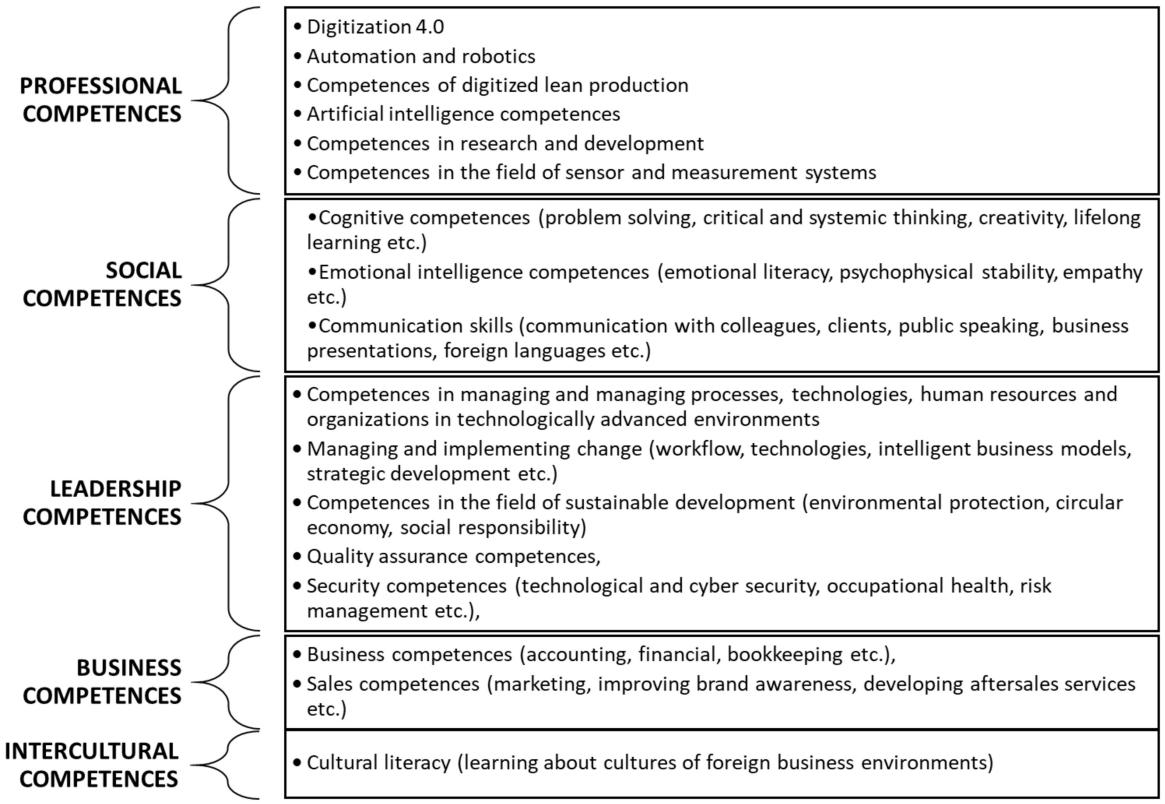

Figure 4. Competence list in the KOC-TOP competence model.

Because Slovenian companies, including those participating in the project KOC-TOP, are increasingly implementing sustainability strategies, we compare the developed KOC-TOP competence model with the four competence models for sustainability, which were previously described. Compared to other competence models, the KOC-TOP competence model can be evaluated from three aspects of sustainability. Considering social criteria, the KOC-TOP competence model includes the following competences for sustainability leaders, occurring also in the previous competence models: problem-solving, critical and systematic thinking, cooperation as communication with colleagues and clients, and innovation as creativity. We recognised that we included in the competence model various competences

linked with science and technology, especially those connected with digitalisation and automatisation. From the economic point of view, we focused on leadership competences needed for managing the processes, workforce and organisation, as well as to be ready to quickly adapt those processes and structures to changes occurring in the market to remain competitive. Under this criterion, other business and sales competences are also sorted, which are not necessary in the sustainability leader. In the KOC-TOP model, we included the competences in the field of sustainable development such as environmental protection, circular economy, and social responsibility. Behavioural competences for sustainability leadership can be found under social competences. We also observed that in the KOC-TOP model, some competences for sustainability are missing or they are not so emphasised. For instance, community participation, social inclusion and active citizenship can improve the KOC-TOP competence model and can be added under social competences as the "inclusion and moral competences" category.

In the proposed KOC-TOP competence model for the factories of the future, we focused on identifying training needs and employee development. Once the training needs for each employee are identified, it is necessary to fill the gap through a comprehensive training plan. Herein, the model presents support to select the appropriate training according to the lack of competences, the key competences required for a selected workplace, and supervisor network. With the KOC-TOP model, it is possible to define the priority of competences to predict the content, form, and range of training. It can include multiple trainings covering several competences even for a group of employees with the same needs in comparison to the traditional training. The competence model aims to invest in those competences of the employees which bring competitive benefits not only in the local environment, but also in the global market. The success of each instance of training and employee skills development is monitored by short questionnaires before and after each training event [25]. In the KOC-TOP model we used a standard five-step organisational learning process, which is presented in the flow chart in Figure 5. Further development of the KOC-TOP model will consider the European classification of Skills, Competences, Occupations and Qualifications (ESCO), which was prepared by the European Commission. The last published version of the ESCO database contains 13,890 skills/competences, which are distributed into four sub-classifications (Knowledge, Skills, Transversal skills, Language skills and knowledge).

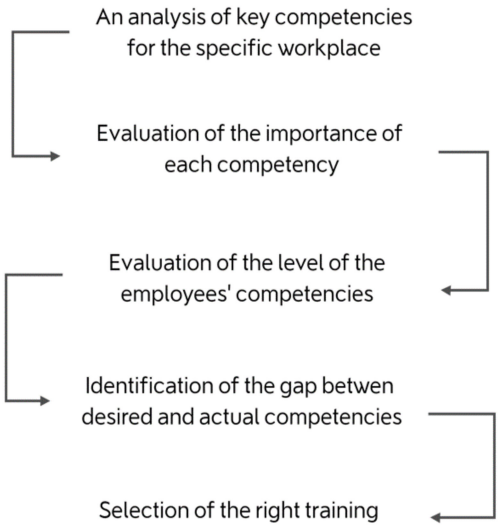

Figure 5. Flow chart of a standard five-step organisational learning process applied in the KOC-TOP competence model.

3.5. Comparison of Competence Models for Sustainability as a Basis for Developing a Competence Models for Industry 5.0

Many companies have already started to implement the principles of Industry 4.0 regarding automatisation, digitalisation and artificially intelligent production. Lately, a new strategy has been introduced as Industry 5.0 [12], which recognises the power of an industry to focus on achieving societal goals and not only the goals of a company and economic growth. The last industrial revolution respects the boundaries of our planet and the workers' well-being. Therefore, the companies must focus on developing competences such as sustainability, circular economy and corporate social responsibility. The "smart industry" will be sooner or later replaced by the term "smart work". To achieve this goal, human capital should be first well-equipped with the proper competences ensuring future sustainable and inclusive economic growth, productive employment and decent work for all.

Herein, we focused on four competence models for sustainability, two of them originated from education and two of them linked with the leadership. The sustainability competences from these models were extracted and are summarised in the first column in Table 1. We also found related competences in the Hogan Competence Model and KOC-TOP model. If no similarity was found, NA (not available) was marked. The Hogan competence model includes almost all competences from both competence models (the X mark means that the competence model contains that competence). Table 1 shows a list of selected competences that are suitable for the circular economy and sustainability, with their inclusion in the Hogan and KOC-TOP models. We found that most competences are included, except for Science and Technology, Business, and economic and Working Across Boundaries, included in the Hogan competence model. The KOC-TOP model contains almost all competences except results-oriented competence, community participation, social inclusion and active citizenship. The last three competences can improve the KOC-TOP competence model and can be added under social competences as the "inclusion and moral competences" category.

The advantage of the Hogan model is that it provides a good comprehensive structure, which can also be used for the assessment of other competence models because it was developed based on twenty-one competency models used in the academic, commercial, and government environments. Furthermore, the overlap between competences was minimised, so that it is possible to better measure specific behaviours. In addition, the competences are designed in such a way that they allow to target specific areas of performance. These benefits are retained by all four competence models for sustainability and sustainable leadership, which focus on specific sustainability-related competences that make the person more effective in each of the pillars of sustainable development.

In comparison to the Hogan model, the KOC-TOP competence model made an additional step and adjusted the competences for the immediate application in selected factories of the future, which participated in the project KOC-TOP. The competence model originated from the analysis of the current state-of-the-art in the participating factories. It considered the mission, vision, values, and strategic goals leading to interconnections between the participating factories and the institutions of higher education. It also developed a training plan, which was implemented in all participating factories and monitored by the indicators of progress. The KOC-TOP competence model was primary based on the Hogan competence model, and by this study, had improved with the best competences from each of the other listed competence models. An added value allowed the participating companies to test the competence model at specific training events for their employees. As such, the KOC-TOP competence model served as a foundation for the development of the decision support system for competence development as well as a basis for preparing the competence models for Industry 5.0.

Table 1. Overlapping of sustainability competences from different competence models for sustainability with the competences from the Hogan model and the KOC-TOP model.

Sustainability Competence	Definition	Competence for Sustainable Leadership	References	Hogan Competence	KOC-TOP Competence
Results oriented	Focuses on the outcome rather than process, has a passion for learning, is confident, and action-biased.	X	[25]	18	14
A Visionary Thinker	Is strategic in their vision with an ability to visualise the future and endure through difficulties, and also knows various disciplines.	X	[25]	22	15
Ethically Oriented	Is honest and has strong moral principles, is ethical and builds trust-based connections.	X	[25]	37	7
A Change Agent	Generates original ideas, takes advantage of opportunities and accepts the changes with enthusiasm.	X	[25]	55	10
An inclusive operator	Understands the motivations of others, has a caring attitude and a collaborative approach that engenders trust in their leadership.	X	[25]	54	8
Systems thinking	Has the abilities to recognise and understand relationships; to analyse complex systems; to understand how systems are embedded within different domains and different scales; and to deal with uncertainty.	X	[32]	55	
Anticipatory	The abilities to understand an evaluate multiple futures: possible, probable, and desirable; to create one's own visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes.	X	[32]	1	14
Normative	The abilities to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions	X	[32]	59	15
Strategic action	The abilities to collectively develop and implement innovative actions to further sustainability at the local level and further afield.	X	[32]	57	10
Emphatic collaboration	The abilities to learn from others to understand and respect the needs, perspectives, and actions of others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving.	X	[32]	60	15
Critical thinking	The abilities to question norms practices and opinions; to reflect on one's own values perceptions and actions; and to take a position in the sustainability discourse.	X	[32]		14
Self-awareness	The abilities to reflect on one's own role in the local community and global society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.	X	[32]		15

Table 1. *Cont.*

Sustainability Competence	Definition	Competence for Sustainable Leadership	References	Hogan Competence	KOC-TOP Competence
Integrated problem solving	The overarching ability to apply different problem-solving frameworks to complex sustainability problems; and develop viable inclusive and equitable solution options that promote sustainable development.	X	[32]	13	14
Science and technology	Has the knowledge to understand natural laws, sustainability issues (locally and globally) and relationships between human actions and the environment.		[24]	5, 43	5
Business and economic	Understanding how sustainable development impacts economics.		[24]	4	9
System Analysis	Ability to plan, analyze, model and design.		[24]	55	8
Management and Planning	Ability to efficiently communicate with stakeholders to achieve sustainable goals, proper application of management systems models, and possess understanding of accounting.	X	[24]	39	10
Environmental justice, community and equity	Incorporating perspectives on equity, poverty, environmental justice and consumption into professional practice.		[24,31]	28	7
Ideas and Innovation	Uses and understands different tools and methods that incorporate creativity and ideas in innovative design and management practices.		[24]	2	14
Personal Effectiveness	Demonstrates leadership, ethical behavior and ability to express himself or herself through verbal and written communication.	X	[24]	26, 37	10
Working Across Boundaries	Ability to integrate and work in intercultural organisational structures, as well as social and business practices.		[24]	59	17
Traditional ecological knowledge	Knowledge bases built by local or traditional resource users, as opposed to “experts”.		[31]		7
Community service-learning	Integrates service in the community with intentional learning activities.		[31]		15
Participatory action research	Refer to involvement of participants in the research process, commitment to social change, and that include aspects of social learning		[31]		17
Action learning	A form of experiential learning that enlists peers in helping learners question their assumptions and (optimally) experience a paradigm shift before applying their learning in new situations.		[31]		14
Critical emancipatory	An ideology for learning facilitation that arises from an emancipatory tradition, focusing on equity amongst classes, races and genders		[31]		7
Problem-based learning	Learning that is focused, experiential and organised around investigation of real-world problems. Authentic experiences foster active learning, support knowledge construction and integrate school learning and real life.		[31]		14

Today, many companies are preparing and implementing sustainability strategies, which demand new functions and workplaces in existing business environments. One such concept is the effective sustainability leader, who needs special behavioural competences such as impressing, convincing, valuing and directing people as well as being ready to take actions and embracing change. Leadership is the ability to influence people to achieve their goals. A leader influences the behaviour and performance of an individual or group within a company, thereby directing their actions toward the set goals. A good leader must also plan, organise and control well. An employee leader uses their power, which derives from their position or personality traits. Improving a leader's sustainable competences can provide the long-term and short-term benefits of a business in the form of cost savings in resource efficiency, enhancing brand reputation, and generating revenue from new products and markets. In Table 1, we added a column showing which sustainability competences are recommended for sustainability leaders.

4. Decision Support System Conceptual Design for Sustainability Competences Development

Systematic and self-inclusive human resource development is very important in companies that rely heavily on the competences of their employees in innovative endeavours. However, human capital is not only a resource needed to perform tasks in an individual workplace, but it is also a generator of end products in the industry. Human resource managers and work mentors have an important role to play in choosing an optimal training program considering both current and future requirements regarding the individual's qualifications for certain jobs and other financial and non-financial goals and constraints of the company. For this purpose, at the KOC-TOP Competence Centre we started with the development and introduction of an appropriate multi-criteria system to support decision-making in the development of competences. The system first determines the set of necessary competences for the individual according to the requirements of the job and his experience and generates an effective program or set of training that helps the individual to fill the gap in competences. Similar decision support systems have also recently been used as e-Human Resource Management (e-HRM). Shippmann et al. provide an interesting overview of competence modelling [5], Aguilar Lasserre et al. developed an expert system for competence evaluation using fuzzy logic [8] and Stummer et al. introduce a multicriteria decision support system for competence selection in the Electronic Commerce Competence Center in Vienna [33]. These types of systems significantly contribute to the reduction of costs for companies as well as to the efficiency of human resources.

4.1. Employee Optimal Training Plan Creation Procedure

In our competence model KOC-TOP, we have incorporated the concept of decision support in the form of web-based software. The decision support system (DSS) can help HRM in selecting appropriate training for each employee to improve the desired competences that are optimally required for each workplace based on their previous knowledge and experience as well as job requirements. Basic requirements for the proposed DSS are:

- selection of an appropriate list of competences, usually based on the selected competence model and the workplaces in the company,
- assessment of the required level of each competence for a selected workplace,
- measures to assess the level of achievement of each competence for employees,
- a series of trainings to gradually improve the levels of competences, and
- evaluation of the impact of the trainings on the employee's competences.

Figure 6 shows an entity–relationship model, also called an entity–relationship (ER) diagram. This is a graphical representation of the entities and their relationships to each other within the proposed decision-making process that is used in computing regarding the organisation of the data in the information system databases. The most important data entities for the development of a decision support system are:

- Competence type: the Hogan classification of the competence types is used, where competences are divided into intrapersonal, interpersonal, business, and leadership categories.
- Competence: the competences are taken from the list of 62 Hogan competences and 17 KOC-TOP competences, both of which are listed in the supplement.
- Workplace: this entity is open to companies' human resource managers to make their own input, which consists of the company ID, name of the workplace and a short description of the workplace.
- Employee: for each employee, only name and email address are stored, while other information about the employees and their competences is stored in the Competence—Workplace—Employee entity.
- Competence—Workplace: this entity collects information about the required level and importance of each competence for any given workplace.
- Competence—Workplace—Employee: this is a very important entity, which stores information about the achieved level of each competence for a particular employee at his/her workplace.
- Training: this entity stores basic information about each training in the database, namely its name, date, duration, and location.
- Competence—Training: this is the entity that evaluates the effectiveness of each training in improving a specific competence.

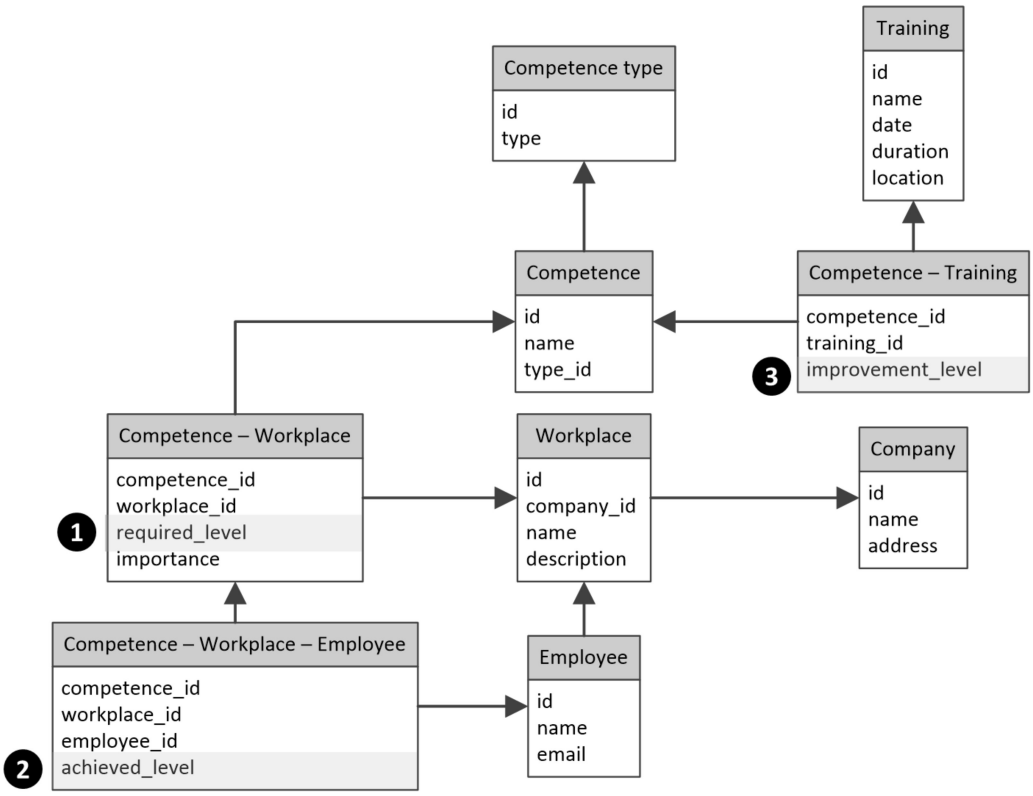

Figure 6. Database entity–relationship model for education planning based on competences. Three black circles with numbers from 1 to 3 are depicting places, from where the competency gap is determined.

The proposed conceptual model of the decision support system includes knowledge (expertise, work experience, and functional knowledge), skills, abilities, and other characteristics required to successfully perform at the individual workplace, as well as systematic procedures for improving them. It also draws on the culture and values of the organisation. The proposed model aims to ensure that employees successfully do the right things and deliver as much value as possible to the organisation. The conceptual model starts from job systematisation and classification, where workplaces are listed, including their description

and role in the organisation. Thus, a list of competences for the company's workplaces is created with the assessment of the level of each competence for each workplace (black circle with number 1 in Figure 6).

Another goal of the DSS is to offer support in the process of training selection for employees to invest in the most promising competences for the future. Therefore, the required competences for workplaces are well defined; the actual achieved levels of the competences for each employee are quantified and evaluated (black circle with number 2 in Figure 6). Mapping of competences of employees is performed both with objective indicators such as standardised tests and by subjective indicators such as the employee self-evaluation, evaluation by their supervisors and the so-called 360° evaluation, where self-evaluation is amended by evaluation of their supervisors, peers and persons they supervise, after which the self-evaluation is repeated. In such a way, the system can identify competences that employees are lacking and recommend training for employees based on their lack of competences. Before and after each of the training events, the attendants of the training fill in questionnaires, which measure the impact of training on employees' competences (black circle with number 3 in Figure 6). A typical workflow of the proposed decision-making concept is shown in Figure 7. The proposed conceptual model of the DSS is planned so that it can be used in real case scenarios of the factories of the future within their human resource management departments. In this way, the system scans the competences of each employee, after which the lack of competences is evaluated for each employee. In parallel, available trainings are evaluated for their propensity to improve the selected competences.

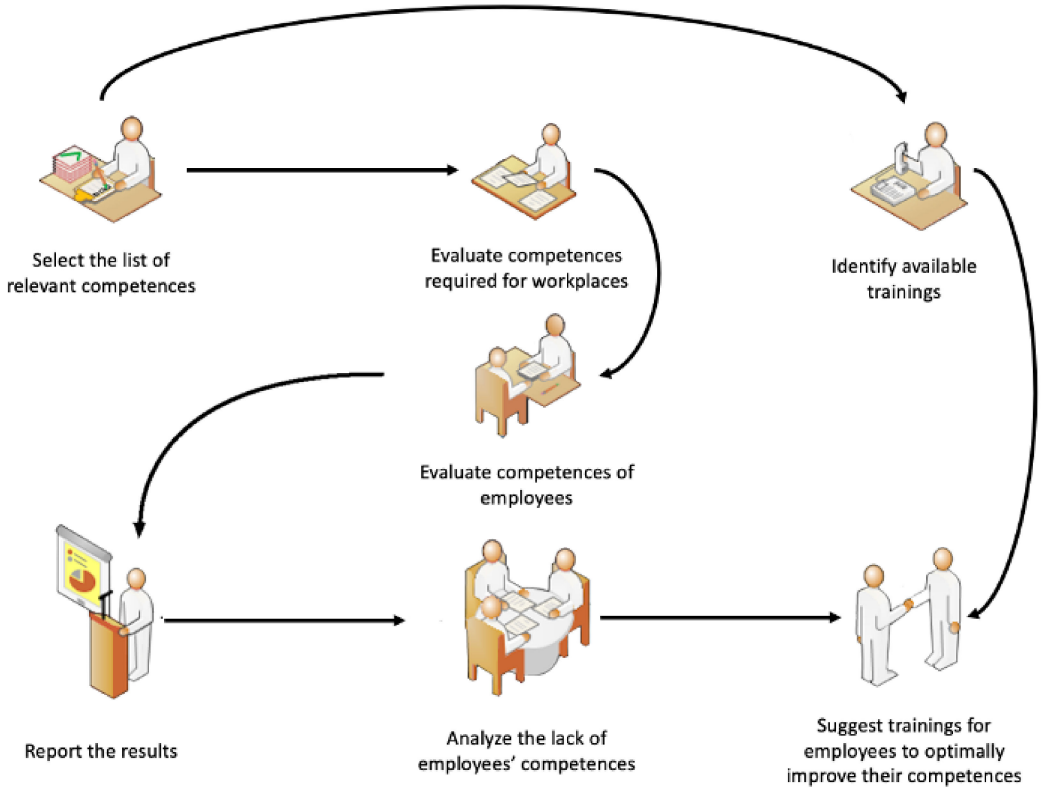

Figure 7. Workflow for the evaluation of workplace's and employee's competences and suggestion of the optimal education for employees.

4.2. Algorithm for Assessment of Competences

Processes of assessment are combined into the workflow to evaluate workplaces and employees' competences and suggest the optimal education for employees in a typical factory, as shown in Figure 7. The evaluation is based on a hundred-point scale, where 0 indicates that competence is not relevant to a particular workplace or employee and

100 means that competence is critically important to a particular workplace. Competences are also designed to be compatible with different companies and different workplaces. Firstly, the importance of each competence for a workplace, a, is rated on a scale of 0 to 100. Secondly, the required level of each competence for a workplace, b, is also rated on a scale of 0 to 100. Finally, the measured level of each required competence for an employee, c, is given on a scale of 0 to 100. The difference b—c shows absolute lack (or "excess") of competences for an employee.

In this workflow, several algorithms were tested to optimise the benefit of the training to each employee and the whole company. In the first version of the DSS, some simple artificial intelligence algorithms were used and compared among each other for a small testing company with three employees and a simple organisational structure. The first algorithm searched for the maximal absolute lack among the employee's competences to be addressed first. The second algorithm was very similar; however, instead of the maximal absolute lack, it was searching for the maximal relative lack among the employee's competences. The third algorithm addressed also the importance of the competences that lack the required level. Each algorithm, therefore, adds useful information to the decision-making process and therefore improves the selection of the employee's most important competences that need improvement. An example of assessment is given in Figure 8 for an anonymous employee in the workplace of the managing director. In this way, the best algorithms for the assessment of competences can be selected for each company, based on its organisational structure, mission, vision, and core values. The system results in this small sample were compared with the evaluation of the human experts, and no significant difference was found. Since the human experts in human resource departments have a limited amount of time, they can invest in the selection of training for employees, and the DSS has considerable potential to improve the effectiveness of the training, so that employees acquire better skills with less effort, time and cost.

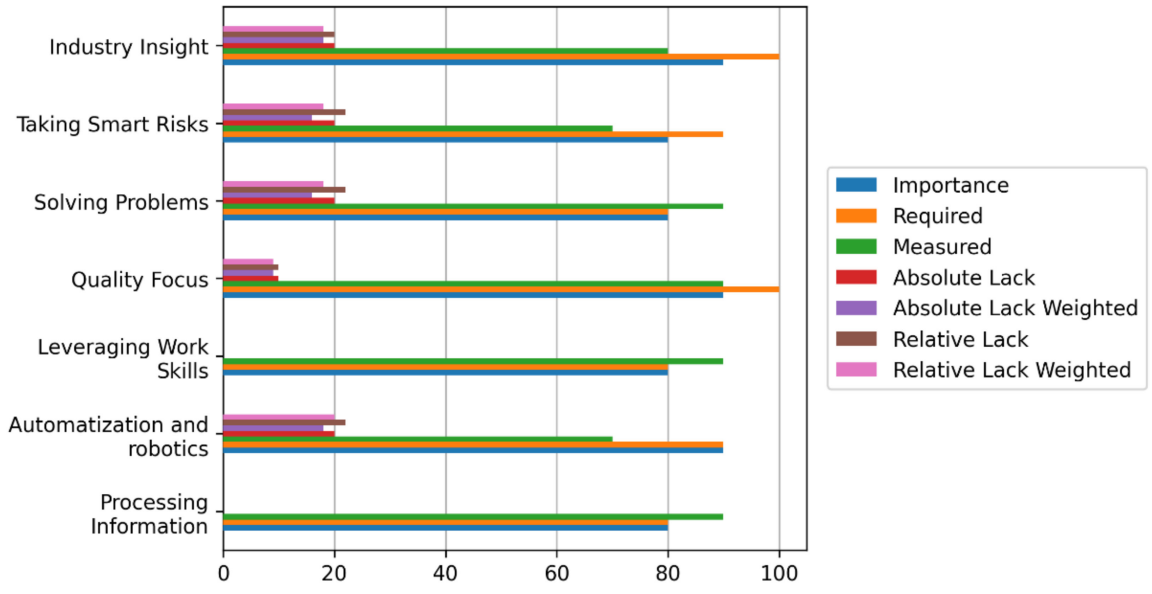

Figure 8. Example of assessment of competences for anonymous employee at workplace of managing director.

The next version of the DSS will also contain an algorithm, which will consider the learning and forgetting rate for employees for each competence [34]. Lately, multi-skilled workers prepared to operate in many workplaces are increasingly desirable in the industry. Such workers should constantly learn new skills and be ready to adapt to sudden changes. Therefore, one of the next versions of the system will also consider an option that one worker can occupy multi workplaces. Such a DSS is also important because better sustainability-related skills of employees allow them to find new and innovative approaches to reduce

their activities' economic and environmental costs while simultaneously finding new ways to improve the quality of life. In addition to the development of new technologies and conservation of resources, environmental sustainability can also be improved by addressing the skills and competences of employees, who in this way become empowered to seek new possibilities for improvement of technologies, work processes and conservation of natural resources, which are important for sustainability and circular economy.

The leadership model of Heifetz & Linsky is also very interesting and could provide additional opportunities in the development of the expert system [35]. Namely, this model calls one to think about why we should lead. In this way, the Heifetz & Linsky leadership model encourages the leaders to put their ideas on the line in such a way that this creative interaction improves the potential to enrich the lives both of the leader and those that the leader influences [35].

4.3. Simple Case Study at Industrial Partner

The process of assessing the competence of an anonymous employee at the workplace of the managing director of a small IT company is further illustrated in Table 2. Given the identified competence deficiency, appropriate training may be suggested to the employee to reduce or possibly eliminate the deficiencies in the selected competence. Generally, the competence with the highest score in the absolute deficiency, weighted absolute deficiency, relative deficiency, and weighted relative deficiency columns is selected as the target for improvement. For example, in Table 2, the company selected the "Automatisation and Robotics" competence and indicated the weighted relative deficiency as 20 to recommend follow-up training and education to the tested employee. After the training was completed, the targeted competence levels were reassessed; the training was considered successful if no gap was identified for the targeted competence.

Table 2. Competence assessment for the workplace of the managing director of a small IT company.

Competence	Importance	Required Level	Measured Level	Absolute Deficiency	Weighted Absolute Deficiency	Relative Deficiency	Weighted Relative Deficiency
Processing Information	80	80	90	0	0	0	0
Automatisation and robotics	90	90	70	20	18	22	20
Leveraging Work Skills	80	80	90	0	0	0	0
Quality Focus	90	100	90	10	9	10	9
Solving Problems	80	80	90	0	0	0	0
Taking Smart Risks	80	90	70	20	16	22	18
Industry Insight	90	100	80	20	18	20	18

5. Conclusions and Future Work

The most important findings of this paper are related to an improved way to manage sustainability related competences using a decision support tool. As observed in the case study of a small IT company, the necessary data on competences can be obtained that will help to assess the best training for an individual and for an organisation. In this way, the training becomes more effective, so that the company can achieve better results with less effort. In this way, the company can move closer the Industry 5.0 concept.

Many companies have already started to implement the principles of Industry 4.0 regarding automatisation, digitalisation and artificially intelligent production. Lately, a new strategy has been introduced as Industry 5.0, which recognises the power of an industry to focus on achieving societal goals and not only the goals of a company and economic growth. The last industrial revolution respects the boundaries of our planet and the workers' well-being. Therefore, the companies must focus on competences such as sustainability, the circular economy and corporate social responsibility. "Smart working" will replace the term "smart industry", but to achieve this goal human capital should be first well-equipped with the proper competences ensuring future sustainable and inclusive economic growth, productive employment and decent work for all.

Sustainability and the circular economy as a sustainability promoter were briefly introduced. We reviewed several competence models for sustainability and sustainable leadership and selected key competences needed for ensuring a future sustainable and circular economy by leaders and other employees. We sought an intersection between these competence models and the competence model for the factories of the future developed by the Competence Centre for factories of the future at the IPS, which was also presented. Selected competences focusing on sustainability, the circular economy, corporate social responsibility and leadership were included in the initial conceptual design of a decision support system, which assists human resource services in the selection of the most effective and optimal training for individual employees to improve their sustainability-related competences. The conceptual model for developing a decision support system used to systematically monitor and develop sustainability-related competences of employees was also presented. The proposed system helps employees to select the most valuable training to reduce their largest gap in required competence levels. Companies can thus effectively improve the skills of their employees, which contributes to their competitive advantage in knowledge and skills. By improving employee competences, companies efficiently contribute to their future sustainability by equipping their employees with the key skills they will need in the future. A systematic approach to the development of competences can be helpful for both the competitiveness and business sustainability of the companies. By improving the KOC-TOP competence model with additional competences that ensure sustainable, socially responsible and circular economy, we are a step closer to Industry 5.0, where "smart working" will replace the term "smart industry".

We plan to verify the conceptual model of the proposed DSS in various settings, including lifelong education and higher university education. Emphasis will be placed on the sustainability competence frameworks in education, which will produce the future workforce, who are catalysts for change and will only be able to address complex sustainability issues if sustainability is incorporated into education inside and outside the classroom. This requires the development of a common framework for integrating key sustainability competences into our education systems. The expansion of the competence database will provide new opportunities for the application of various artificial intelligence techniques in the further development of the decision support system that accompanies the competence models and study outcomes. This is promising for the optimal selection of educational programs, and thus a promising approach for the improvement of both individual and organisational knowledge, skills, and competences, considering the future needs of the labour market and societal demands. Future work will also consider the ESCO skill hierarchy while preparing a unified competence model for future factories.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su14148539/s1, Table S1: List of competences from the Hogan Competence Model; Table S2: List of competences from the KOC-TOP competence model.

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