Article

The Impact of Industry 4.0 on Employees—Insights from Australia

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Abstract: Currently, Industry 4.0 (I4.0) is the most popular concept relating to changes in the functioning of industrial enterprises. Industry 4.0 has been discussed in the actual literature mainly from a technological perspective, overlooking social challenges regarding this fourth industrial revolution. The objective of this article is to diagnose the impact of I4.0 on employees. This aim will be achieved by (1) a literature review of existing research efforts, (2) conducting structured interviews, and (3) summarizing the current state of knowledge and providing a definition of further work. Scopus, Web of Science, and a set of specific keywords were used to select peer-reviewed articles showing evidence of the impact of I4.0 on employees/jobs in given countries or industries. After determining the current state of research in this area, it was decided to conduct structured interviews questionnaire in the country (Australia) and industry (horticulture), which had not been covered by the research in this topic so far. The main contribution of the article was the development and validation of a comprehensive research agenda on the impact of I4.0 on employees. The obtained results suggest that the impact of I4.0 on employees is significant, and the changes occur in many different categories related to human work. The impact of I4.0 was identified both at the macro (labor market) and micro (jobs) level.

Keywords: Australia; Industry 4.0; structured interview; horticulture; labor market; employees

1. Introduction

Each of the industrial revolutions, apart from technological changes, also brought economic and social changes. Due to radical technological changes, people's working conditions and lifestyle have changed [1]. Nowadays, mankind is a witness of the fourth industrial revolution, also known as Industry 4.0 (I4.0) [2,3]. I4.0 is currently one of the most popular research topics in management studies [4] and the relationship of I4.0 with such concepts as lean management [5], sustainability [6], or the circular economy [7] is examined here.

The term "Industry 4.0" was used for the first time in 2011 at the Hannover fair. In the same year, the main ideas of I4.0 were published [8]. They have become a strategic initiative of the German government and have been included in the "High-Tech Strategy 2020 Action Plan". The paper [9] suggests the existence of key I4.0 technologies such as cyber-physical systems (CPSs), Internet of Things (IoT), Internet of Services (IoS), big data, 3D printing and cloud computing. Embedded systems, sensors, semantic machine–machine communication (e.g., due to ontology engineering), CPS, and IoT enable the connection of the physical and virtual world, which is the main idea of I4.0 [2]. Due to I4.0 technologies with the support of ICT tools, it will be possible to comprehensively integrate machines, devices, production facilities and storage systems. This makes it possible to network the entire factory, creating an intelligent environment. This will impact entire supply chains, from inbound logistics to manufacturing, marketing, outbound logistics and services [10]. Fourth industrial revolution means changes not only in terms of technology, but also of employees. The purpose of the study is to analyze the impact of I4.0 on employees in the broadest possible context.

I4.0 technologies are presented as "disruptive" [11], but their impact is expected to be positive for all users (industrial enterprises, organizations, customers etc.) in terms of productivity gains, better and more customized products, better working environment, etc., [12]. The only problem seems to be employment. For example, according to the forecast of the Boston Consulting Group (BCG), the rate of automation of manual tasks will increase exponentially worldwide, reaching almost full saturation by the end of the 2020s [13]. The forecast is justified by the fact that robots are becoming "cheaper, smaller and more flexible" [13]. Governments and companies are expected to promote I4.0 technologies to reap the benefits of greater increases in productivity. Therefore, these entities should anticipate any consequences of implementing I4.0, e.g., by introducing or reforming training programs [14].

The significance of the issue of the impact of Industry 4.0 on employees and the jobs performed by them, results from the belief that the industrial revolution will translate into a rapid increase in the efficiency of enterprises [15,16]. Human capital is the main resource of each enterprise [17], and its proper use allows for the achievement of the enterprise's goals and meeting the current and future market requirements [18], as well as gaining a competitive advantage. The change in the functioning of enterprises in the era of I4.0 will be associated with significant changes in the process of educating future employees and developing the expected competences/skills. The labor market [19,20] and human resource management (HRM) [21] will also be subject to changes. The issue of the role of an employee in a smart factory and the related necessary changes in the qualifications and professional competences of employees [22] seem to be particularly important, especially in the area of digital skills and the process of continuous professional development.

The extensive use of automation, robotics, and digitalization will have serious implications for skills, competences, jobs and professions. The development of Industry 4.0 will be accompanied by a change in tasks and requirements for workers in the factory [23,24]. According to [25] I4.0 will offer many opportunities, but the risks associated with it should not be forgotten, such as the lack of structural changes in management on the labor market and the socio-ethical dimension of I4.0 implementation. The biggest challenge of I4.0 seems not to be technology, but people.

The concept of Industry 4.0 seems to be attractive to many countries and industries. This is evidenced by programs implemented by the governments of individual countries, such as "Industrie 4.0" in Germany, "Made in China 2025" in China, "Smart Factory" in United Kingdom, "Advanced Manufacturing Partnership" in USA and many others [11]. Many countries or industries are considering the implementation of I4.0 in the future. Nevertheless, the implementation of such advanced technologies as those brought by I4.0 is demanding and difficult, especially in the case of developing countries/industries or with insufficient technological advancement [26].

The paper is organized as follows. Section 2 presents the literature review on the impact of Industry 4.0 on employees/jobs. Based on the literature review, Section 3 presents the adopted research method with the description of the research object. Section 4 presents the results obtained during the structured interviews. Section 5 discusses the results, diagnosing the impact of I4.0 on employees in Australia, and compares them with studies available in the literature. Section 6 outlines final conclusions.

2. State-of-the-Art

State-of-the-art review was performed for Industry 4.0 and employees in order to find studies described impact of I4.0 on labor market/employment. Two scientific databases were chosen for the literature review, namely Scopus and Web of Science Core Collection (WoSCC). These databases are the most-common databases for conducing literature searches [27] and are also leading databases with their significant scientific impacts characterizing by a high level of quality of reported documents [28]. The keyword "Industry 4.0" and all effective terms, synonyms and abbreviations were used to capture the widest

possible sources [6,11]. One query (Equation (1)) was formulated for the search within titles, keywords, and abstracts with time restriction, namely papers published after 2011. The exact Scopus query was:

TITLE-ABS-KEY ("industr* 4*" OR "I4.0" OR (("fourth" OR "4*") AND "industrial revolution") OR "smart factory" OR "smart manufacturing" OR "advanced manufacturing") AND TITLE-ABS-KEY ("impact" OR "influence" OR "relation") AND TITLE-ABS-KEY ("human work*" OR "employ*" OR "labor" OR "labour" OR "job") AND DOCTYPE (ar) AND PUBYEAR > 2010 (1)

In the databases, after entering the created query (Equation (1)) on 16 December 2020, the following number of articles were found: Scopus—364, WoSCC—211. All non-English papers were excluded. Abstracts were screened, to choose documents that discuss relations between Industry 4.0 and human work, employment, labor or job. Particular attention has been paid to articles regarding the issue of I4.0 impact on human work environment and employees skills/competencies needed in smart factory. It was decided to select only those articles whose research results refer directly to a given countries or industries. This made it possible to determine in which countries/industries the research on the impact of I4.0 on employees was conducted, what kind of results were achieved (quantitative/qualitative) and which methods/tools were used. Only articles with available full-text version were included. The process of selecting papers for further analysis is presented in Figure 1. It contains the criteria used for exclusion/inclusion. Some of the selected criteria found their application in other literature studies related to Industry 4.0 [5,6]. The others are related to the discussed research problem.
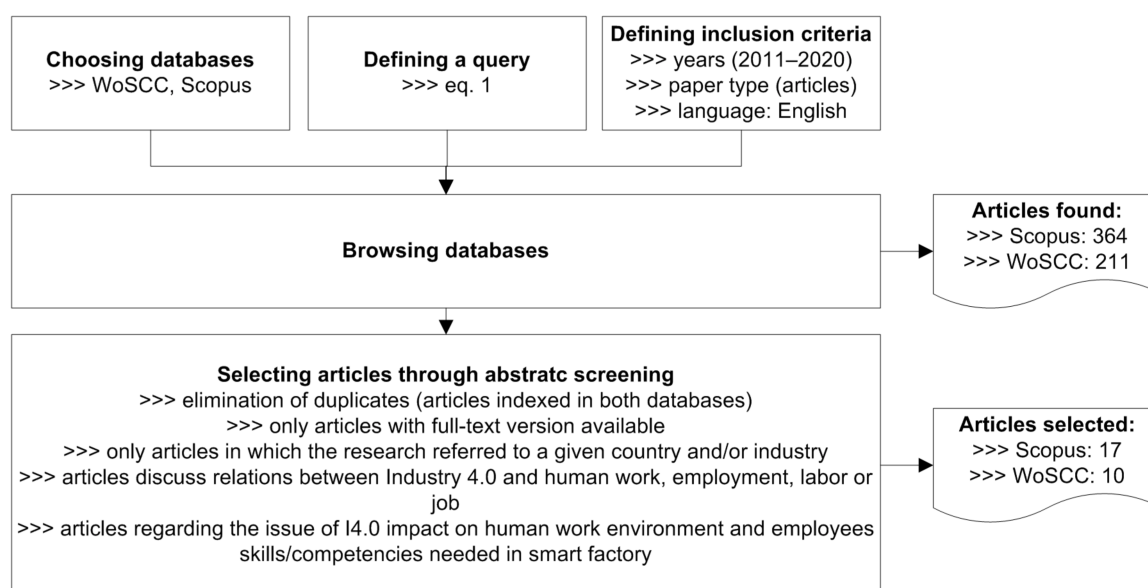

Figure 1. Scheme for selecting articles for analysis.

Finally, 27 articles were selected. A summary of each paper is presented in Table 1.

The results of basic bibliometric analysis are presented below, taking into account the year of publication, country and number of authors, keywords.

Figure 2 shows that interest in the topic of the impact of I4.0 on labor market/employment was very slight in 2016–2018. This may indicate that this research area was at the stage of creation. In 2019, there was a noticeable increase in interest in the discussed research topic (6 papers) in comparison to previous years (an increase of 100% compared to publications in 2017 and 2018). The growing interest in this topic may testify to its relevance, as well as the fact that more researchers are recognizing its importance. In 2020, 14 articles (more than all papers from 2016–2019) were identified, which emphasizes the growing importance of the topic and indicates the intensification of work in the field of impact I4.0 on employees.

Table 1. Characteristics of articles on the impact of I4.0 on employees.

Paper	Country/Industry	Type of Results	Method/Tool	Contribution
			2020	
[29]	Brazil/plastic	quantitative	fuzzy TOPSIS	identifying I4.0 technologies with the strongest and weakest impacts on social aspects
[25]	Czech Republic	quantitative	survey	creating a pattern for employees who perceive/not perceive I4.0 as a threat
[30]	Germany	qualitative	literature review	analysis of how I4.0 affects the work environment and how work councils' or work unions prepare companies to implement I4.0
[31]	Hungary	quantitative	microsimulation modelling	impact assessment of I4.0 on the expected structure of employment, wages and inequalities
[32]	India	qualitative	literature review	debate on the impact of I4.0 on employment
[33]	India	quantitative	questionnaire	identification of the relationship between social parameters and I4.0 sustainability
[34]	Indonesia	qualitative	review of on-line media and blogs	impact of I4.0 and Society 5.0 on work/jobs
[35]	Italy	qualitative	case study	impact of I4.0 technologies on the new kind of job profile and competences
[36]	Malaysia/electronics	quantitative	literature review & survey	determining the competencies required from quality professionals in the era of I4.0
[37]	oil and gas	qualitative	systematic review	impact of IoT on occupational safety and health compliances, situational awareness, and personnel tracking
[38]	Poland	qualitative	survey	identification of opportunities and threats for consumers, producers and employees in the I4.0 environment
[39]	Poland/EU	qualitative/quantitative	literature review & cluster analysis	diagnosis of the current situation on the labor market and expectations towards employees as a result of I4.0
[40]	Slovakia	qualitative	survey	impact of I4.0 on jobs creation within the SMEs and family businesses
[41]	Slovakia	quantitative	survey	impact of I4.0 on labor productivity
			2019	
[12]	automotive	qualitative	literature review	analysis of the possible impact of I4.0 on work and employment
[42]	ceramic	qualitative	case study	impact of I4.0 applications on supporting the triple bottom line (TBL), including employees in the social category
[43]	logistics	qualitative	case study	impact of I4.0 on human work in logistics (Logistics 4.0)
[44]	mining	qualitative	literature review	impact of I4.0 from a workplace perspective
[45]	Poland/foundry	qualitative	questionnaire	identification of the necessary competences of a foundry engineer in the era of I4.0

Table 1. *Cont.*

| Paper	Country/Industry	Type of Results	Method/Tool	Contribution
[46]	supply chain	qualitative	systematic literature review/bibliometrics	impacts of I4.0 on human resource management (HRM 4.0) with implications for supply chain management (SCM)
2018				
[47]	Germany	quantitative	questionnaire & structural equation modeling	analysis of I4.0 impact in the context of environment, people, employee qualifications and acceptance
[26]	Iran and Japan	qualitative	SWOT analysis	analysis of the effects of I4.0 on the labor markets of Iran and Japan
[48]	mechanical & ICT	qualitative	interview	impact of digitalisation on changes in the labor market and employees' skills necessary in the future in manufacturing
2017				
[49]	China & Germany	qualitative	survey	discussion on the impact of digitization on future work and employees
[50]	hospitality	qualitative	semi-structured interview	analysis of the feasibilities of I4.0 in the context of jobs and employees
[51]	South Africa	qualitative	survey	impact of the implementation of I4.0 technology (collaborative robots) on workforce
2016				
[52]	Germany	qualitative	literature review	impact of digitization of industrial work on labor and jobs
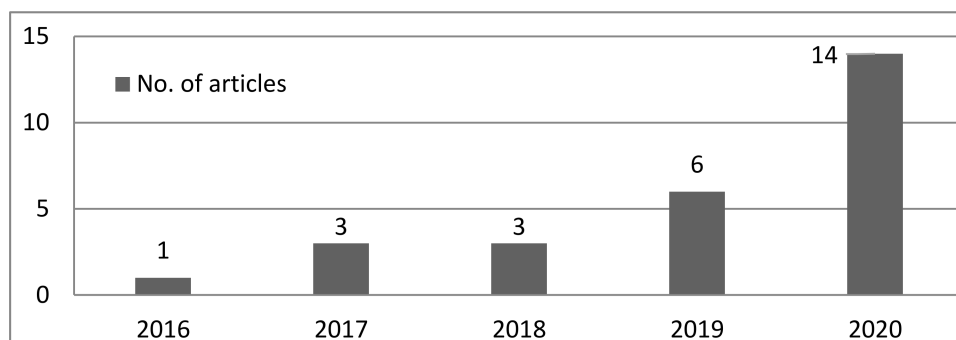
Figure 2. Number of selected articles.

As shown in Figure 3, the authors of the selected articles came mainly from Germany—15%, Italy—15% and Poland—11%. Other countries (a total of 13 out of 3 different continents) constitute a small percentage of the total. The dominance of authors from Europe should not come as a surprise, because this is continent where the concept of Industry 4.0 was created and is constantly being developed. A dispersion of authors' origins may indicate that the impact of Industry 4.0 on labor market/employment has been gaining international audience and interests. Therefore, it is globally significant topical area. An additional argument is the fact that many countries where the authors of the selected papers come from (e.g., Germany, Italy, Poland, China, Czech Republic, France, India, United Kingdom) are pursuing national strategies for the development of the Fourth Industrial Revolution (Industry 4.0) [11], of which the impact of I4.0 on the labor market/employment is a very important aspect.

Germany , 4	Italy , 4	Poland, 3	Brazil, 2	China, 2	Czech Republ... 2	France, 2	India, 2	Slovaki... 2	United Kingdo... 2

Figure 3. Countries of authors of selected articles.

The number of authors in the selected articles is 71. Only 6 authors (Cimini, Lagorio, Pinto, Grencikova, Kordos, Berkovic) appeared in more than one article (2 papers). This may indicate that many different scientists are researching the impact of Industry 4.0 on labor market/employment. Research teams have not yet formed and leaders in the discussed issues have not emerged.

The number of different keywords identified in all 27 articles was 112. Due to the fact that some keywords referred to the same term (e.g., Industry 4.0 or Industrie 4.0 or Industry 4) or differed in form or spelling (e.g., digitalization or digitalisation), they were standardized. The most common keywords are presented in Figure 4.
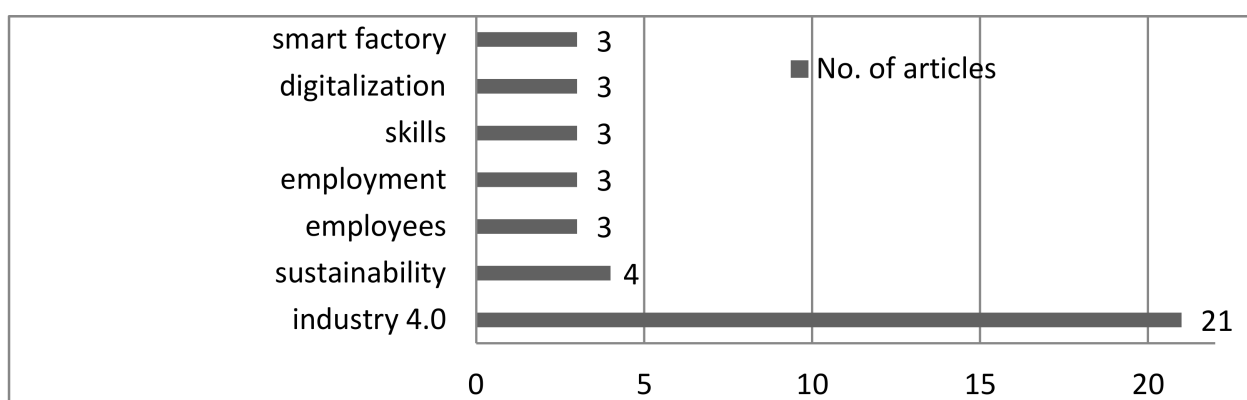
Figure 4. The most common keywords of selected articles.

The selected articles are dominated by one keyword: Industry 4.0 (21 papers). This proves that in most of the articles the authors were aware of the concept of I4.0 and its impact on the labor market/employment. The next most numerous keyword is sustainability (4 papers). This indicates that these publications focus on the impact of I4.0 on employees in the context of the social category, which is one of the three pillars of sustainability or TBL frameworks. Next up are keywords related to employees (3), employment (3) and skills (3). These articles analyze the impact of I4.0 on both employees and employment. The emphasis was also put on skills that are desired by employers and that employees should have in the era of I4.0. Equally numerous keywords are digitalization (3) and smart factory (3). The articles in which these keywords appear refer to the change of the role of an employee in a smart factory and put emphasis on changing the work environment to digital. The diversity of the keywords of selected articles indicates the interdisciplinary nature of research on the impact of I4.0 on the labor market/employment.

Based on the selected papers (Table 1), it can be concluded that the interest in the topic of Industry 4.0 impact on employees and jobs is significantly increasing. It is worth emphasizing that the research was conducted mainly in Europe (12) and Asia (6), and only in relation to a few industries. Qualitative studies (19) are dominant over quantitative studies (7), and the most frequently chosen research methods are literature reviews (9) and surveys (7).

The scope of conducted research (Table 1) is quite wide and can be divided into 3 main categories:

- I4.0 relation with sustainable development, sustainability and TBL, taking into account the social aspects [29,33,38,42,46,47].
- The impact of I4.0 on employees, employment, human work, jobs [12,25,30–32,34,37,41,43,44,49–52].
- The impact of I4.0 on the labor market, required worker skills and competences [26,35,36,39,40,45,48].

Despite the growing interest in the topic, it can be noticed that there is a lack of research results relating to, e.g., North America or Australia, and in many important sectors of the economy, such as services or agriculture. There are also very few articles that use in-depth interview [48], semi-structured interview [50] or structured interview questionnaire [33,45] as research methods. Often the results in qualitative form are very general and do not describe specific issues, e.g., [34,40,43,44]. Based on the literature review (Table 1) in the author's opinion, it can be formulated hypothesis that the impact of Industry 4.0 on employees/jobs is different depending on the country/industry it relates to. On this basis, the main aim of the paper was formulated: conduct in-depth research in a country and industry in which such study was not carried out. The research will cover all 3 main categories mentioned earlier in the text. This will allow to supplement the current state of knowledge and compare the obtained results with the available results for other countries/industries. The results of the article may have theoretical (developing an in-depth research agenda) and practical (preparing organisations and employees for Industry 4.0 era) implications.

3. Materials and Methods

The pilot studies are part of a larger research to determine the impact of Industry 4.0 on employees/jobs and to examine the relationship between I4.0 and employment. It is planned to conduct similar studies in Asia (China, Japan), Europe (Spain, Italy, Finland, Switzerland), and North America (USA). The final research will allow to compare how the environment of a given continent, country or industry affects the obtained results.

The research method applied for this pilot study is structured interview questionnaire with a list of sought information. Two interview questionnaires were prepared: (i) general, consisting of key guiding questions as the basis for determining the current and future impact of Industry 4.0 on employees, operations and operational strategies (Appendix A), (ii) detailed, focusing on the potential impact of Industry 4.0 on human resources—with particular emphasis on employment, job profile, qualification requirements and skills of the workforce (Appendix B). The questionnaires have been prepared based on the available literature, e.g., [49], as well as based on the knowledge and experience of the author. Additionally, their structure was consulted with experts in a given research area. The main criteria in developing the questionnaires were universality, comprehensiveness and the inclusion of 3 main categories listed in the "State-of-the-art" section.

The point of the interview was to get answers to direct, indirect and ad hoc questions, as well as some advice and suggestions. Sometimes the discussion went beyond the prepared structure of interview and was desirable, as it allowed to expand the issues raised. The list of questions is provided in the Appendices A and B.

The research was carried out during the author's study visit to Griffith University (Brisbane, Australia) in August 2019. Three different types of organizations were invited to the interview to diagnose the impact of Industry 4.0 on employees in Australia:

- Manufacturing & service company (end user of I4.0 technologies)—Magnificent Pty Ltd. (Wamuran, QLD, Australia).
- Research hub (supporters of I4.0)—ARC Research Hub.
- Public university—Griffith University.

The exact characteristics of the organizations and respondents are presented in Appendix C. The interviews lasted ca. 2 h each, were conducted by the author in person and took place at organizations site, which enabled participant observation. The geographic location of the participating organizations is Queensland, Australia.

Due to the form and duration of the study, many organizations did not consent to participate in the study (approximately 40 invitations were sent). Four interviews were conducted, as the author have made contact with 3 organizations during a month-long study visit, and the respondents representing them agreed to take part in the study. The selected organizations should be considered as a purposeful sample. The number of interviews conducted (4) cannot be the basis for extrapolating the results to whole Australia, but it does provide a general picture of the impact of Industry 4.0 on employees, from the point of view of various organizations.

As part of the pilot study, it was decided to select a company operating in the agriculture sector. This is justified in terms of importance of this economy sector in Australia. Australian agriculture accounts for 58% of land use. In the years 2018–2019 it accounted for 11% goods and services exports, 2.2% of value added (GDP) and 2.6% of employment. The value of agricultural, fisheries and forestry production has increased in real terms by 19% over the last 20 years (adjusted for inflation), from around $58 billion in 1999–2000 to around $69 billion in 2018–2019. Agricultural productivity is growing faster than most other sectors of the Australian economy. This growth is driven by, e.g., technological improvements, access to better technologies, adopting new technologies and structural changes [53].

Australia's horticulture industry operates in a very competitive market, both domestically and internationally, and (excluding wine grapes) is Australia's third largest agricultural industry (behind the meat and grains industries). In 2014–2015 the gross value of production was estimated to $8.73 billion and more than 85% of this production was sold into the domestic market [54]. Horticulture is Australia's second largest rural production industry after wheat [55].

The pilot study also included research hub (implementation of projects related to I4.0 in e.g., agriculture) and public university (laboratories using I4.0 technologies, where students are educated and prepared to work in the conditions of the fourth industrial revolution), cooperating with Magnificent Pty Ltd.

4. Results

4.1. Current and Future Impacts of Industry 4.0 on Employees, Operations and Operations Strategies

4.1.1. Magnificent Pty Ltd.

Magnificent Pty Ltd. currently uses the following I4.0 technologies: machine learning, Internet of Things/Production Internet, intell. tracking technologies, intell. vision, smart sensors (computer vision), autonomic devices (vehicles, drones etc.). It is difficult to determine which technologies will be used in the company in the future. A lot depends on the problems that the company will have to face. According to the CEO "companies should start with precisely description of the problem that want to solve and then choose the right solution. Technologies are a kind of tool-box of different solutions. Sometimes of course company need specialists who are experts in a given problem". There is also no doubt that technology is constantly progressing and developing. Several years ago, some processes (e.g., synchronization of stations) were based on the usual Wi-Fi network, later it was 3G, 4G, and soon it will be 5G. A lot depends also on reliability and whether the company can afford the technology.

The main areas of application of I4.0 technologies in the company are: operations and planning control & servitization and ecosystemization. The application of genetics-related technologies is also very important for the company. It is very important for the company to be able to predict weather and plant conditions. It should be added that Australia has different standards/legal regulations than e.g., Europe. For example, other chemicals may be used.

Due to the workforce deficit, the key is application of robots supporting physical work such as: picking, packaging. In the case of control, exponential technologies are used to track many parameters in real time, such as the number of strawberries picked, plantation

efficiency, how many operators need to work on the plantation, etc. Thanks to this, the company can make the right decisions regarding the planning of operations in real time (e.g., how many employees should work on a given plantation). It is also important to track picking and packaging processes, as well as strive to maximize their performance. In the area of intelligent tracking technologies, the company tried to use some solutions, but they were not very effective. This mainly concerned operators tracking, so that e.g., on the basis of the basket/cost relationship, to know when to stop picking. The key area of application is also servitization and ecosystemization. It is crucial to observe the entire supply chain (from picking strawberries to their final recipient). The transparency of this process is also important. Another aspect is the division of strawberries according to their purpose. Strawberries intended for further processing (e.g., juices) are packaged differently than this for direct consumption. Different boxes and different packaging formats are used for this purpose. Tracking and knowledge of pallet history also plays a significant role in this process.

Every day the company tries to improve its processes and performance. The key aspect is to increase plantation efficiency. To this purpose, the benefits of genetics-oriented technologies are very important. The main benefits associated with genetics include improving the taste of strawberries or increased resistance to going long distances. I4.0 technologies can help better freeze strawberries. Automation and real-time tracking allow company to determine the right activities connected with cost, service or productivity. The benefits of improving quality are very important. For this purpose, technology based on the results of the project "Automated strawberry quality control using deep learning and computer vision" has been used. Thanks to the implemented solution, the quality of strawberries reaching consumers has significantly improved. The company also has a prototype solution that increases the efficiency of handling pallets. The benefits from I4.0 technologies are also seen in the inspection system.

In the area of new processes and functions, those related to big data are very important. Thanks to real-time tracking and collect data of the company's main processes, it has become possible to determine, e.g., the cost of strawberry collection, which plantation needs employees, and how many of them at a given moment. Operators can also be automatically billed for collected baskets without any problems. Benefits related to improving the level of control of employees, plantations, and strawberries are also important. Effects due to the collaborative/shared action (joint learning etc.) remain difficult to implement. The company has a lot of knowledge, but at the moment there is no idea how it could be shared.

The company is constantly thinking about introducing novel business models or competitive operations strategies. They mainly concern gaining an advantage in the main processes of the company: picking, packing, handling pallets.

The main benefits of using the I4.0 technologies in Magnificent Pty Ltd. are automatic robot in operation, automatic quality control, robotics in picking and packaging. The application benefits of genetic solutions and environmental control are also important. The company also cares about aspects related to clean/green production. It is very important to reduce pesticides, as well as to use clean water on plantations. Thanks to exponential technologies, it is possible to reduce the use of water (big issue in Australia) and diesel. Solutions that contribute to environmental pollution (e.g., trucks) are also not used.

It is very difficult to clearly determine the overall impact of I4.0 technologies on employees. This depends on the situation and kind of a job. A lot depends also on the type and function of the technology. According to the CEO "there is no doubt that exponential technologies will facilitate the work of manual operators". Exponential technologies can assist employees in many jobs—especially in physical work. As an example, one can mention weighing and reporting the number of strawberries, more accurate picking, and packaging, shortening the way. Due to the assistance of I4.0 technologies, work is easier, faster, less arduous, safer, ergonomic. "In the perspective of 5–10 years, many works can be completely automated and replaced with robots (e.g., picking, packaging, lifting). In the case of many technologies, humans will be only an assistant" the CEO said.

Based on the company's experience, the ability to use management systems, databases and software skills will be very important. Good knowledge of I4.0 technologies will also be important. Employees should understand how these technologies work, what functions they have, how to use them, etc. Knowledge of machine learning can also be useful.

The impact of exponential technologies on employees is increased mainly due to greater transparency of data and information, as well as the functioning of various networks. Thanks to real-time tracking, company immediately know what's going on. However, the impact of I4.0 also has its drawback: the employee is dependent on many technologies, and in the case of their failure/breakdown the consequences can be huge. Everything is stopped. Therefore, it is very important that the technologies are reliable and ready-proof. Work can also be more stressful, especially if employee need to be able to operate many different modern technologies.

To sum up, it can be stated that I4.0 technologies have an increasing impact on employees' work. Traditionalists say that this is a negative phenomenon and human addiction to technology. People who value progress and innovation want to implement new technologies and see many benefits from using them. In the opinion of the CEO, "the overall assessment of Industry 4.0 is positive, because thanks to exponential technologies, work is more efficient, cheaper, costs are lower, and the customer is more satisfied with the products".

The support of technology for genetics is very important. In the production and processing of food, genetics can help a lot and have massive applications. Then, it is important to use artificial intelligence, machine learning, and reuse of knowledge. Computer vision is also playing an increasingly important role, especially in control food quality. This is mainly due to better and cheaper cameras. According to the respondent "there is no evidence that genetics support technologies are dangerous for consumers. People are looking for evidence, but if it were, it would be forbidden. It is true that GMO are not used for strawberries (this is prohibited), but in the case of other food products it is used without any restrictions".

The sequence of actions for companies intending to implement I4.0 technologies should be as follows:

- The company should very precisely define the problem it wants to solve. To this purpose, it is necessary to specify the company's expectations and requirements, specify its needs.
- The company should familiarize with the technologies and solutions available on the market. It is very important that the chosen solution is able to solve the problem and also it is cost-effective. It is also worth determining the level of difficulty in implementing a given solution. Does the company have adequate technical infrastructure, workers etc.?
- The functioning of the solution should be verified, but not only in laboratory conditions, but also in the natural environment. Very often test solutions (e.g., pilots) work in artificial conditions, but the true challenge is functioning in real work. The technology should operate under specific conditions and on time, as well as be reliable 24/7.
- The implementation of technology and its maintenance. It is very good to first implement technology on a small scale (e.g., one plantation), and then on a larger scale. This is due to the huge responsibility of technology. Taking Magnificent Pty Ltd. as an example, when 200 employees work and technology fails, it is a loss of ca. $6000/1 h. Before it can be repaired and the service arrives, sometimes it takes several hours. In addition, strawberries have a short shelf life, and each hour in the sun causes certain losses.

In order to effective and efficient adaptation of Industry 4.0, industrial companies need:

- people with different skills and competences;
- appropriate technical infrastructure;
- openness to changes. Technology is moving forward and if the company does not adapt to progress, there is no chance to survive on the market.

It is very helpful if the company has a clearly defined policy (vision, mission, strategic objectives). Proper management as well as strategic decision-making and long-term planning are important. Listening to employees who know the specifics of their work and can have ideas of initiatives that can facilitate the implementation of I4.0 technologies can also be a great help (bottom-up approach). However, this is sometimes difficult (e.g., seasonal employees, large fluctuations). In this case, it is very important for the management of the company to take initiatives (top-down approach). Therefore, a combination of both approaches is recommended.

Summarizing the above considerations, the CEO of Magnificent Pty Ltd. stated that "Industry 4.0 technologies are not so much a choice as a necessity. Without their implementation and continuous technological development, it is not possible to compete on the market. Production costs will increase without implementation I4.0 technologies. In the case of small businesses, companies may be able to operate without these technologies, but in the case of large companies it is impossible".

4.1.2. ARC Research Hub for Driving Farming Productivity and Disease Prevention

In ARC Research Hub, researches are conducted related to the use and development of the following exponential technologies: artificial intelligence (AI), intell. visions & smart sensors, autonomic devices, big data. At this point, it should be emphasized that according to ARC Research Hub, AI consists of three basic components: (i) computer vision, (ii) language processing, and (iii) data analytics. All these 3 components are supported by machine learning. Based on the adopted understanding intelligent vision & smart sensors and big data are parts of AI, while intelligent vision & smart sensors enable the functioning of autonomic devices. It can be seen that the exponential technologies listed above mutually complement each other and are closely related.

The main areas of application of I4.0 technologies in the research center are: processing (agriculture & horticulture, health), operations and planning control (agriculture & horticulture), servitization and ecosystemization (horticulture and health). ARC Research Hub runs the following projects:

- Automated strawberry quality control using deep learning and computer vision;
- Improved sugarcane planter utilizing deep learning and computer vision;
- Robotic cleaning of lobster tanks;
- Using computer vision and deep learning to monitor and manage lobster production.

In addition, ARC Research Hub conduct research to detect skin cancer.

The respondent underlined why, in his opinion, agriculture industry is so important on the world and in Australia. It is projected that global agriculture has to increase food production by 70% according to the UN Food and Agriculture Organisation [56]. The world population is currently growing by approximately 83 million people each year [57]. The agriculture industry within Australia will double in size by 2030, making it bigger than the iron and coal industries combined [58]. These cited facts justify the development and use of I4.0 technologies in the agricultural sector, to drive its efficiencies and productivity. By using I4.0 technologies in the agricultural sector, it is possible to improve performance mainly by use UAVs to monitor the field and check the quality of seedlings. It's also possible to reduce the labor cost, improve the productivity and efficiency of farming, prevent loss.

New/better processes or functions due to I4.0 technologies can be considered for building an agriculture data collection, storage, and analysis platform based on cloud technology. This will enable farmers to collect data daily and thanks to cloud database help them to avoid disease, know the weather and growing conditions for a plantation, and implement farm control in real time. The ARC Research Hub improves farm profits by implementing machine learning based vision solutions. Research center expertise allowed to increase farm production and disease prevention by advancing and transferring new artificial intelligence technologies into industrial deployment. The technologies most referred to in the context of agriculture and horticulture are digital, those that provide

data, tools and knowledge, to assist in making informed, timely decisions that support productivity and profitability.

A novelty in the application of the I4.0 technology is also support to skin specialist to detect skin cancer. Technology developed by the ARC Research Hub, mainly based on computer vision, can lead to the development of mobile based innovative skin cancer detection devices. This will provide aid to the doctors in the cancer diagnosis process.

The key impacts of Industry 4.0, both observed and expected, on employees can be considered as:

- Employees need to understand how the exponential technologies operates, have an open-mind and capability of adapting to changes. There will be faster data retrieval and processing, which will increase the importance of analytical skills.
- There are many intelligent/smart technologies that can provide possible assistance to existing jobs to get better outputs and/or quality. An example can be the one developed at ARC Research Hub—smart trap technology, so the pests can be automatically detected and counted.
- I4.0 technologies will eliminate/replace repeatable and simple jobs. Employees will be primarily responsible for the surveillance and monitoring of the production process.

The sequence of actions for companies intending to develop/implement I4.0 technologies should be as follows:

- At the beginning, the needs of enterprises should be correctly determined. To this purpose, it may be helpful to conduct analyzes regarding problems, losses, etc.
- Find out what I4.0 technologies are available on the market, that can help company with a specific purpose. A business should evaluate the technology in terms of being fit on purpose. Below is a decision-making checklist to consider:
  - ➢ What's really the problem that company are trying to solve?
  - ➢ What's the motive for the purchase? Is it to make a task easier, automate an activity, or reduce a business cost?
  - ➢ Does the technology do what is supposed to do?
  - ➢ How compatible is the technology with existing systems? Can the technology interface with company existing equipment/programs?
  - ➢ Take it for a test drive or at least see some good case studies/testimonials to validate it.
  - ➢ How reliant is the technology on company connectivity and speed?
  - ➢ It is value for money? How does it compare with similar products and services?
  - ➢ How reliable is it? What is warranty and what's the back-up service like?
  - ➢ Who owns any data that is generated?
  - ➢ Is it a one off purchase, or are their ongoing subscriptions involved?
  - ➢ What other considerations does a company need to make before they purchase it?
- Establish collaborative project (jointly development, spin-off companies). In Australia, many projects are financed from both government money and industry funds. For example, in the case of ARC Research Hub functioning, the distribution of financing is as follows: Industries—$3.82 m, Griffith University—$1.5 m;
- Technology development and finding the right solution (tests, pilots, deliverables).
- Depending on the form of the concluded contract, in some cases company can apply for a patent.
- Commercialization.

In order to support the effective and efficient adaptation of Industry 4.0, industrial companies should have appropriate technical infrastructure. In addition to the basic requirements such as Internet access or computers, it also seems necessary to have machines and equipment adapted to implement I4.0. In the case of machines, these can be e.g., sensors or embedded devices. Employees are also a very important factor. They should be open to changes, take active part in courses and trainings. Want to constantly improve their skills. The skill of proper management in the era of turbulent and dynamic environment may also

facilitate. It is very important to be able to use the available technologies/solutions and to create the right business models using them.

Summarizing the above considerations, the researcher from ARC Research Hub stated that "the development of Industry 4.0 technologies in the long term I assessed positively. New opportunities emerging thanks to exponential technologies will increase efficiency and productivity of implemented processes. Of course, there will be various types of failures, problems, etc., but the benefits will definitely outweigh the losses here".

4.1.3. Griffith University, School of ICT, Institute for Integrated and Intelligent Systems

Griffith University laboratories conduct research work and have appropriate knowledge in the field of many I4.0 technologies. The research is mainly related to the use and development of the following technologies: AI, CPSs, IoT/Production Internet, interactive/collaborative robotics, advanced human-machine/robot interfacing, intell. tracking technologies, intell. visions & smart sensors, augmented reality, big data.

Research laboratories at Griffith University don't focus on specific areas of application, because the financier drives the objectives. Technology applications in a specific area are based on what founder (e.g., industrial company) expect from laboratories. Research work carried out in Griffith University can be used in many areas (e.g., processing, operations planning and control, maintenance, collaborative technologies, servitization and ecosystemization, smart and adaptable products). The type of works (mainly optimization) are very generic, therefore their results can be used in many fields e.g., to optimize production, operate semi-automated machines. Mostly the results of laboratories works/projects are used in: operations and planning control, servitization and ecosystemization.

Using I4.0 technologies, many significant benefits can be achieved (e.g., improved performance, new/better processes or functions, effects due to the collaborative/shared action, servitization, ecosystemization, novel business models or competitive operations strategies). A very important benefit is also the increase in the accuracy of many processes that would not be achievable for human workers. The type of benefits depends on the specific technology and the place of its application. It is also important what kind of benefits the technology user (end user) expects. Benefits can be noticed in many fields: resources, logistics, management, scheduling, assembly line etc.

Industry 4.0 will affect the work environment and employees. Work will be safer, ergonomic and effective. Occupational safety will also be improved, which will have an impact on higher competitiveness on the labor market. There will also be a reduction in costs, and it will become possible to find increasingly efficient solutions. I4.0 technologies will be able to cooperate with each other and with workers. Technologies will be more universal and will also serve as an intelligent assistant in the tasks performed by operators. They will also significantly facilitate the implementation of manufacturing processes.

The sequence of actions for companies intending to develop/implement I4.0 technologies should be as follows:

- At the beginning, the needs of company should be correctly determined. To this purpose, it may be helpful to conduct analyzes regarding problems, losses, etc.
- Find out what technologies are available on the market, that can help company with a specific purpose. Match the available technologies to the problem being solved. It is also worth contacting the relevant universities/research centers for opinions/consultations.
- Establish collaborative project (jointly development, spin-off companies).
- Technology development/implementation and finding the right solution along with its justification (tests, pilots, deliverables).
- Proposal of final solution + explanation. If it is good—final conditions, if not—back to previous stage.

In Australia, a serious problem for companies which want to implement I4.0 technologies is the large government interference as well as restrictive laws and regulations. Although there are some government organizations and programs that support innovation

and business development, there is still a lot to do in this area. The Australian Government should better support entrepreneurship and technological development of enterprises.

A significant facilitation for companies intending to effective and efficient adapt of Industry 4.0 is benchmarking concept. Companies should look at the best practices and solutions from other companies, and try not to make similar mistakes. Participation in consortia/clusters bringing together companies from various sectors may be helpful here. This will allow cooperation, and will not lead to competition. Observation of best practices combined with cooperation seems to be a great support. Collaboration programs and innovative actions, convincing for I4.0 values, are also important.

It is crucial to consider the human factor in the effective and efficient implementation of Industry 4.0. Employees are very afraid of all kinds of changes, showing resistance to the introduction of new solutions/technologies. Employees should be convinced that I4.0 is a chance for them to work more effectively and safely, and does not pose a threat of losing their jobs.

Summarizing the above considerations, the researchers from Griffith University agreed that "the development of Industry 4.0 technologies in the long term should be assessed positively. New opportunities emerging due to exponential technologies will increase efficiency and productivity of many industrial (and not only) processes. Of course, there will be various types of failures, problems, etc., but the benefits will definitely outweigh the risks here".

4.2. Potential Impacts of Industry 4.0 on Human Resources—With a Particular Focus on Employment, Job Profile, Qualification and Skill Requirements in the Workforce

At the beginning of the second part of the interview, the issue of impact of Industry 4.0 on employee's work was raised. According to the CEO of Magnificent Pty Ltd., the impact of I4.0 on the employees' work will depend on the type of work performed. Human work will be slightly more complex & stressful for highly qualified employees who supervising, supporting and interacting exponential technologies, and less complex & stressful for physical workers. According to the researcher from ARC Research Hub, the impact of I4.0 on the employees' work will be positive, and human work will be much less complex & stressful. The opinions of scientists from Griffith University regarding the impact of I4.0 on the employees' work are divided. The head of computational proteomics laboratory states that human work will be less complex and stressful. In turn, a researcher in the robotics laboratory states that human work will more complex due to more standards, interfaces and huge body of knowledge.

The confirmation of these opinions was reflected in the responses to the statements contained in Table 2.

The impact of Industry 4.0 on employees has not been clearly assessed positively or negatively. From the responses in Table 2, it can be seen that there are some concerns regarding the development and use of I4.0 technologies. The biggest doubts are related to the questions of whether I4.0 allows age-appropriate working environments and whether employees will have sufficient expertise with I4.0. However, the respondents were fully in agreement on 3 issues, which suggests that the overall assessment of I4.0 is rather positive.

Next, the question of what will be the most important competences of employees in the I4.0 era was raised. The list of competencies and their scale of validity are presented in Table 3.

Despite the discrepancies in the validity of individual competences (Table 3), the most important of them can be extract: technical skills, problem solving, coding skills, analytical skills, ability to work under pressure.

Table 2. Statements on the impact of Industry 4.0 on employees.

Statement	Answer [yes/no]			
	Magnificent Pty Ltd.	**ACR Research Hub**	**Computational Proteomics Lab.**	**Robotics Lab.**
I4.0 allows age-appropriate working environments	no	yes	yes	no
I4.0 allows a decrease in monotonous and repetitive work	yes	yes	yes	yes
I4.0 allows decreased waste and environmental impact	yes	yes	yes	yes
Our employees do not trust I4.0 technologies	no	no	yes	no
Our employees fear dependence on I4.0 technologies	no	no	yes	no
We expect nonacceptance of I4.0 by employees	no	no	no	no
We expect lack of I4.0 expertise among our employees	no	yes	yes	hard to say
Our employees fear data transparency due to I4.0	no	no	yes	no

Table 3. List of employee competencies with the level of their importance in the Industry 4.0 era.

	Scale of Validity			
	Low Important	**Moderately Important**	**Important**	**Very Important**
Magnificent Pty Ltd.	research skills, ability to be compromising and cooperative	media skills, creativity, entrepreneurial thinking, conflict solving, networking skills, ability to transfer knowledge, leadership skills, sustainable mindset, compliance	state-of-the-art knowledge, understanding IT security, decision making, efficiency orientation, intercultural skills, communication skills, flexibility, ambiguity tolerance, motivation to learn	technical skills, process understanding, coding skills, problem solving, analytical skills, ability to work under pressure, ability to create and use databases (e.g., SQL)
ARC Research Hub	media skills, ambiguity tolerance	process understanding, understanding IT security, conflict solving, intercultural skills, flexibility	state-of-the-art knowledge, entrepreneurial thinking, decision making, efficiency orientation, communication skills, networking skills, ability to be compromising and cooperative, leadership skills, sustainable mindset, compliance	technical skills, coding skills, creativity, problem solving, analytical skills, research skills, ability to transfer knowledge, motivation to learn, ability to work under pressure, failure handling, endurance

Table 3. *Cont.*

	Scale of Validity			
	Low Important	**Moderately Important**	**Important**	**Very Important**
Griffith University		media skills, ability to transfer knowledge	state-of-the-art knowledge, process understanding, coding skills, creativity, entrepreneurial thinking, conflict solving, analytical skills, research skills, efficiency orientation, intercultural skills, communication skills, networking skills, ability to be compromising and cooperative, leadership skills, flexibility, ambiguity tolerance, ability to work under pressure, sustainable mindset, compliance	technical skills, understanding IT security, problem solving, decision making, motivation to learn, openness to change

4.2.1. Magnificent Pty Ltd.

After implementing I4.0 technologies in the company, the organizational structure has not changed significantly (still is a flat structure). However, a new department has been created—IT section, in which 2 full-time employees are worked. Furthermore, the work environment and organization were computerized. Everything is coded, new machines appeared in the agriculture field, the work is also supported by computers and scanners. Wireless technologies became more important.

The employee's role in Industry 4.0 era has not changed significantly. Currently, however, there are real-time tracking and better measurement control capabilities, which means that employees are expected to achieve better performance.

There is a change in the functioning of various types of systems, processes, technologies, etc. The ability of employees to adapt to rapid and frequent changes is a very big problem. Employees should be able to keep up with changes. The ability to proper management is also crucial. The most important "soft" skills in the era of Industry 4.0 are communication skills and ability to understand and listen to others. Workers should also understand and respect the culture of other employees, because more and more often work takes place in multicultural teams. In turn, the most important technical skills in operating I4.0 technologies should be considered design, creation and maintenance of databases. In this context, any capacity related to the collection and processing of large amounts of real-time data collected is highly desirable. It is very important for job candidates to have knowledge of the technological solutions available (e.g., SQL) and to be able to operate them. Mobility and the ability to work in factories located in distant locations are also important.

It is difficult to clearly state whether it is better to hire new employees with appropriate qualifications/skills, or to train/retrain existing employees. It all depends on the specific situation and the work is to be done by the employee. In Magnificent Pty Ltd. we tried to run courses/trainings for current employees, but they were not very successful. This was due to the fact that workers had some specific skills, that were very difficult to develop/transform. The company does not organize meetings/trainings directly related to Industry 4.0.

At the beginning of using I4.0 technologies, the most problematic for employees was work related to the combination of all available data. Each workstation was equipped with a separate data base and the challenge was not to lose data. Communication between individual bases and the central base, was very important. So, the problem was supporting distributed databases. Currently, the problems mainly result from the changes taking place, regarding e.g., changes in the requirements for preparing parallels and reports. Due to the increasing amount of data, it is very important to prepare employees to work with databases and technologies that can support this work (e.g., small data). Of course, it is very important to use tools such as 5G enabled industrial systems. To this purpose, if there are appropriate courses/trainings, employees should participate in them as much as possible.

According to the CEO, in the next 10 years, robotics and fully automated technologies will have the greatest impact on changing the labor market and employment structure in companies. The biggest changes in production work due to implementation of I4.0 concern processes that are now fully automatic, and not manually as in the past e.g., packing, internal transport, settlement of payments etc.

Based on his knowledge and experience, the CEO agrees with the OECD forecast, estimated that 9% of jobs in OECD countries could be automated and 25% could change significantly as a result of the automation of 50–70% of the associated tasks [59]. "It is possible, and the changes could be even greater. It's hard to define. A lot depends on factors such as investment and the environment. The time horizon is also important". Simple physical work, such as picking or packaging, will be liquidated in the era of Industry 4.0. Parallel sections will also be significantly reduced. There will be new jobs positions related to the service and maintenance of machines/technologies. According to the CEO, the most important barrier in the sphere of employment in the functioning and development of I4.0 is access to money capital. All technological progress and the employment of specialists requires investment.

According to the respondent, the most desirable employees in the era of Industry 4.0 are graduates of the following fields of study: automation and robotics, informatics (software, IT, database), electronics. It is worth emphasizing, that other fields of study are also important, because the company needs people with different skills (holistic approach). University graduates are well educated and prepared to work with Industry 4.0 era. The Australian universities are well equipped and have appropriate laboratories.

The Australian Government could create programs that would help link people. It is very important to create equivalent networks that will connect people from many fields/industries. It is very important to share knowledge from different areas and to exchange experiences. The government could also facilitate access to funding. At the university level, it is important to adapt the courses to the constantly changing requirements of companies. For this purpose, universities can prepare new subjects, laboratories, or sets of desired skills. The most serious barriers to the implementation of I 4.0 principles are capital and the mindset of people.

4.2.2. ARC Research Hub for Driving Farming Productivity and Disease Prevention

Industry 4.0 allows for more convenient and faster processing of many jobs, which are also characterized by higher quality of workmanship. Manual labor is converted into digital work.

The biggest problems observed in the area of employees' competences in the context of I4.0 are: (i) technical skills are not good enough, (ii) communication capability to work with specific users, (iii) competition from the market: industry attracts more highly qualified people. The most important "soft" skills in the era of Industry 4.0 are critical thinking, motivated to learn and develop new technology, communication inside the group. In turn, the most important technical skills in operating I4.0 technologies should be considered knowledge of AI (computer vision, machine learning, pattern recognition), and programming (C/C++, Python, MATLAB, CUDA).

The most important expectations of employers towards candidates for work in a company using I4.0 should be mentioned diligence, knowledge and skills, problem-solving orientation, activity in finding solutions.

In the era of Industry 4.0, new employees with appropriate qualifications/skills should be recruited, but also training/retraining current employees should take place. For this purpose, companies can, for example, organize an annual symposium, or encourage potential and current employees/collaborators to participate in workshops and training programs.

The most problematic for employees is work related to the following I4.0 technologies: computer vision and pattern recognition. In order to better prepare employees to support exponential technologies, training and participating in the actual research and development process should be organized. It is also important to encourage self-learning.

According to the respondent, the technology that has the greatest impact on changing the labor market and the employment structure in companies is AI. The latest advances in AI are increasingly used in daily work. There is also faster and easier access to technology.

Based on his knowledge and experience, the respondent agrees with the OECD forecast quoted earlier [59]. Most jobs that can be done with a small amount of training will be replaced. As a result of the digital transformation, new jobs positions will be created, such as AI engineer, AI conservator, industrial data handler. The attitude is the most important barrier in the sphere of employment in the functioning and development of I4.0. Whether employees are prepared for the changed and is willing to learning new things.

According to the researcher from the ARC Research Hub, the most desirable employees in the era of Industry 4.0 are graduates of the following fields of study: computer science, engineering, math, biology, and medicine. Graduates of universities are sufficiently educated to meet the requirements of the labor market in enterprises implementing the ideas of I4.0. However, graduates need to do life-long learning because the technology and industry are changing very fast.

Introducing more programs related to I4.0 was proposed for actions/initiatives enabling employees to acquire appropriate competences and skills. The Australian Government should take the initiative to facilitate the training and adoption of Industry 4.0. The most serious barrier to the implementation of these postulates is money, as well as doubts as to whether the society is positive towards adopting new technologies.

4.2.3. Griffith University, School of ICT, Institute for Integrated and Intelligent Systems

Employees should be more engagement to their work. Problems related to insufficient assistance to other employees are also very important. All "soft" skills mentioned in Table 3 are equally important and needed, depending on the situation. These skills are: creativity, conflict solving, intercultural, communication, networking, ability to be compromising and cooperative, leadership, and ability to work under pressure. The most important are, however, teamwork, openness to change, and a motivation to learn. Collaborative building solutions from incomplete data/information is also becoming more and more important. The most important technical skills in operating I4.0 technologies should be considered as coding and understanding IT security.

Employers expect from job candidates primarily high productivity, job satisfaction and commitment to the duties entrusted. It is also appreciated ability/desire to learn eagerly what employees don't already know. In the era of I4.0 it is preferred train/retrain existing employees, but it all depends on the particular case and a combination of both is recommended (training + from time to time the recruitment of new employees). A lot depends on whether the company wants to change and what career path is preferred.

Employees have the biggest problem with learning how to operate and use modern technologies. It is also difficult to master various types of interfaces. In order to prepare employees to work with I4.0 technologies, various types of courses and trainings should be conducted. Practical acquisition of skills is very important, and this is only possible through training based on real exponential technologies. Communication, case studies, and benchmarking are also important aspects.

According to the respondents, the technologies that will have the greatest impact on changing the labor market and the employment structure in companies are AI and advanced data analysis. Cost of living and employee overhead costs will also be important factors in the labor market. The most important changes in production work due to the implementation of Industry 4.0 will concern the functioning of physical work, workplace and ICT infrastructure. Health & safety will improve due to tighter requirements on material handling/logistics.

Based on their knowledge and experience, the representatives of Griffith University agree with the OECD forecast quoted earlier [59]. The "logic of the forecast is sound, but I can't speak to the given numbers. Worth notice is that it will be the same core tasks of a job, but the interface will improve" a researcher from the robotics laboratory said. Many professions will be liquidated or will be significantly reduced: drivers, lawyers, doctors. The following jobs will disappear in the production area: physical workers (e.g., picking, packaging, placement, soldering), cleaners, quality control inspectors. Much will depend on capability, capacity, capital cost and financial indicators (e.g., ROI). There will be new jobs positions that will require knowledge and skills based on connection: IT, coding and cloud computing. Jobs requiring a lot of creativity and involving customer/market development, will also be created. Increased expectations and the level of customers will be the most important barriers in the sphere of employment in the functioning and development of I4.0. A very important barrier also seems to be the fear of job reduction for a part of the society, especially the less qualified. The economy of scale in the Australian market will also be an important phenomenon.

The most desirable in Industry 4.0 era are graduates of the following fields of study: industrial engineering, AI & machine learning, optimization, operations research, data science. According to the respondents, graduates are not sufficiently prepared to work with the I4.0, because in large part the studies are not practical enough. The work is done on general problems. There is a lack of work on real industrial data. Australia is still developing. The Australian Government don't seem to have a clear vision of where Australia is going, also in the area of higher education.

Companies should follow in the footsteps of large companies and corporations (e.g., Google) and create their own employee training programs related with I4.0. The idea of this solution is that a person without any education/qualifications can come to the company, and everything that is needed to perform a given job will be learned in the company. Universities in Australia are being driven to become technical colleges, with too much linkage to industry needs. In Australia, only mining companies have no problems with implementing I4.0. The most serious barrier to the implementation of I4.0 principles is a lack of willingness to invest in big projects in Australia, namely by native Australians.

5. Discussion

The first part of the interview (Appendix A) was to find out what is the current (or intended) state of using I4.0 technologies in the organizations whose representatives were interviewed. The respondents answered which I4.0 technologies they use, what are their key application areas and benefits. Respondents also presented their observations on the impact of Industry 4.0 on employees, described the sequence of actions related to the implementation of I4.0 technologies in organizations and what facilities could help in an effective and efficient adaptation of Industry 4.0. The synthesis of the obtained results is presented in Table 4.

Table 4. I4.0 status in the analyzed organizations—summary.

I4.0 field	Magnificent Pty Ltd.	ACR Research Hub	Griffith University
Technologies	machine learning, intell. tracking technologies, intell. computer vision, autonomic devices (vehicles, drones etc.)	AI, intell. visions & smart sensors, autonomic devices, big data	AI, CPSs, IoT, robotics, intell. tracking technologies, intell. visions & smart sensors, augmented reality, big data
Key applications	operations planning and control, servitization and ecosystemization	processing, operations planning and control, servitization and ecosystemization	optimization, operations planning and control, servitization and ecosystemization
Key benefits	automatic quality control, robotics in manual jobs, improving efficiency	reduce costs, improve productivity and efficiency, prevent loss	increase accuracy of many processes
Key impacts on employees	facilitate manual operations, many jobs can be automated and replaced with robots, work can be more stressful, operators dependent on I4.0 technologies	eliminate/replace repeatable and simple jobs, employees will be primarily responsible for the surveillance and monitoring	work will be safer, more ergonomic and effective, intell. assistant in tasks performed by operators
Facilitations to effective/efficient implement	appropriate technical infrastructure, workers with different skills & competences, strategic management	appropriate technical infrastructure, proper management, skilled workers	benchmarking, participation in consortia/clusters, collaboration programs, skilled workers
Overall assessment	necessity for big companies	positive in long term	positive in long term

Summarizing the obtained responses (Table 4), it can be stated that the scope of the I4.0 technologies used is quite wide and their key applications area are operations planning & control, servitization & ecosystemization. The main benefits of I4.0 are improvement in efficiency and quality of the implemented processes. Among the impact of I4.0 on employees, both its positive and negative effects were indicated, which confirms the validity of further research in this area. The appropriate technical infrastructure, proper management and skilled workers were indicated as facilitations to effective and efficient implementation of I4.0. Based on the responses, it can be concluded that Industry 4.0 in Australia is developing, despite the lack of a government program [11]. According to the respondents, I4.0 is perceived as a necessity and assessed positively in the long term.

Based on the interviews, it was possible to develop a recommended sequence of steps that should take place during implementation I4.0 technologies:

1. Define precisely what problems or needs company has, and on this basis define the purpose of implementing a specific technology.
2. Make an overview of I4.0 technologies available on the market and verify their suitability for the purpose defined in step 1. Does the company have adequate resources for its implementation?
3. Verification of the selected technology in a natural work environment.
4. In the case of positive validation results, the implementation of the technology and its use. In the case of a negative assessment, return to point 2.

The second part of the interview (Appendix B) concerned the impact of I4.0 on employees from a broad perspective. Many issues were raised, including: the impact of I4.0 on human work, changes in the functioning of companies/jobs, desirable skills and competences of employees, expectations of employers towards workers, preparation of employees for I4.0, changes in the labor market, the role of universities in I4.0 transformation, initiatives and barriers to employment in the I4.0 era. The synthesis of the obtained results and their comparison with the literature are presented in Table 5.

Table 5. Impact of Industry 4.0 on employees in Australia and literature reference.

Category	Australia Perspective	Reference to Literature
impact I4.0 on human work	depends on type of work (less complex & stressful for physical workers; more complex & stressful for qualified workers)	[12,33,34,43,44,46,49,51]
change in functioning of organizations	greater digitization and robotization	[35,40,47,49,50,52]
employee's role in I4.0	not changed significantly	[43,44]
the most important skills/competences in I4.0	technical skills, problem solving, coding skills, analytical skills, ability to work under pressure	[25,35,36,39,42,44–46,48]
employers' expectations towards employees	diligence, problem-solving orientation, activity in finding solutions, ability to learn, openness to change	[36,39,48]
employees' fluctuations	both hiring new employees and training the existing ones will take place	[39]
preparation employees for I4.0	courses & trainings related to I4.0, self-learning	[36,50]
technologies with the greatest impact on labor market	AI, automatics & robotics	[29,33]
impact of I4.0 on labor market	simple physical/manual works will be replaced or liquidated, health & safety will improve, possibility of job loss by low-skilled workers	[12,26,31–33,38,39,41,42,48,52]
new jobs positions	related to the combination of technical skills and technologies I4.0 (e.g., AI engineer, AI conservator)	[35,40,41]
the most important barriers in the sphere of employment in I4.0	access to money capital, willingness to adapt to change and learn	[26,37]
the most desirable graduates of study	industrial engineering, informatics, electronics	[32]
initiatives that can help adjust employees to I4.0	Australian Government programs; companies should create own employee training programs related to I4.0	[30]

Based on the conducted pilot studies, it was possible to develop a comprehensive framework for the impact of I4.0 on employees in Australia (Table 5). In the literature, there

are several areas within the raised issue that are very little explored. The most frequently described topics are related to the impact of I4.0 on the human work or labor market, the desired skills/competences and change in functioning of organizations in the I4.0 era. There are articles that discuss several issues related to the impact of I4.0 on employees [33,35,36,39,44,48] and those that deal with only one issue [25,29,30,34,37,38,45,47,51]. However, there is no publication that covers all the issues contained in Table 5. A comparison of the results obtained during the interviews in Australia with those available in the literature is presented below.

The available literature studies confirm that the impact of Industry 4.0 on human work will depend on the type of work performed [49], and that organizations will change their functioning mainly as a result of greater digitization [35,40,52] and robotization [49]. In these categories, the results presented in the literature are consistent with those obtained in Australia. During the interviews, the respondents stated that the role of the employee in the era of I4.0 will not change significantly, while there is a common belief in the literature that there will be a radical change in the role of the operator [43,44]. The most important skills/competences in I4.0 in literature are divided into three main categories: technical, personal, social [46]. The methodological category was also added in [36]. Other divisions of categories can be found in [45]: hard (professional) and social. The skills/competences indicated by the respondents mainly relate to the technical and hard categories. Employers' expectations are strictly determined by the type of work performed and the industry [36]. In this case, it is difficult to compare the results obtained in Australia, as there are no similar studies in the literature. Changes in the labor market, including the issue of employees 'fluctuations are described in [39]. It can be concluded that the fluctuation will be increasing, so the activities indicated by the respondents related to hiring new employees and training the existing ones will be desirable. Trainings as the basic activity preparing employees for work in I4.0 are discussed in detail in [36]. The respondents also believed that courses & trainings are necessary in order to properly prepare employees for new industrial revolution. Among the most important/main technologies of I4.0 described in the literature [29,33], there is a lack of those indicated by the respondents (AI, automation, and robotics). The difference may be due to the fact that the indicated technologies are not classified by most scientists as I4.0 technologies and constitute separate categories. There is full agreement in the literature that the impact of I4.0 on the labor market will be significant [26,39]. All statements provided by respondents found confirmation in the selected articles: simple physical/manual works will be replaced or liquidated [32,38,41,52], health & safety will improve [38,42], possibility of job loss by low-skilled workers [38,52]. There is agreement in the literature that I4.0 will contribute to the emergence of new professions [35,40,41]. However, only one article gives a specific example: coacher robot [38]. Thus, the professions given by the respondents (AI engineer, AI conservator) can be considered as a new. The last three categories presented in Table 5 have not been described in the literature so far. There are only single papers that deal with this topic in a general way. For this reason, the results from Australia can be considered new. Industrial engineering, informatics, and electronics were recognized as the most desirable fields of study in the era of I4.0. This is consistent with the technical skills recognized as the most important. The most important initiatives that can help in preparing employees for work in the era of I4.0 were government support and the creation of own employee training programs by companies. They are closely related to defined barriers: access to money capital, willingness to adapt to change and learn.

Summarizing the above considerations and the results contained in Table 5, it can be concluded that in many categories of the study the results obtained in Australia are consistent with those available in the literature. However, there are categories in which the results differ significantly or are completely new, which is the undoubted value of the article. It also initially confirms the thesis that the impact of Industry 4.0 on the labor market/employees is conditioned by the country/industry to which the research relates.

Industry 4.0 increasingly affects the way organizations and entire supply chains operate. It is very important that entities operating on the market are properly prepared for the upcoming changes, and that they correctly define the role of man in the era of I4.0. The research results presented in this article do not allow for a clear assessment of the impact of I4.0 on employees. Some of the results obtained indicate the possibility of improving the working environment and the need to develop specific skills and competences, while others point to the progressive process of replacing human work with new technologies and machines. According to the respondents, Industry 4.0 may be an opportunity to build a new, better work environment, at the center of which will be a human with his needs. A negative scenario is also possible, which assumes the domination of technology over man, a decrease in employment and an increase in the complexity of human work. The article may be an incentive for further activity of scientists and practitioners in this area, as it indicates that in many aspects there is still a lack of in-depth research and initiatives that could prepare the employees in the I4.0 era.

The issues raised in the interviews are a collection of topics that have so far been studied and described in the literature. However, it should be emphasized that many issues were discussed only in the basic scope during the conducted interviews. Although the questionnaires contained about 30 questions, many topics should be more elaborated (e.g., employee fluctuations, the role of universities in I4.0, initiatives that can support employees in I4.0). It would also be advisable to examine some issues in a quantitative form (e.g., change in the employment level in companies using I4.0, % change in people working in particular professions, etc.). The disadvantage was that the questions related to quantitative data was not included in the questionnaires. The interview questionnaires consisted mainly of open-ended questions, which would make it very difficult to carry out statistical analyzes of the results in the case of a larger-scale study. Apart from the disadvantages related to the construction of the questionnaires, it should also be noted that the literature analysis is limited to peer-reviewed articles only, and omitted e.g., conference papers or book chapters, which may also be a valuable source of information.

Therefore, it can be assumed that the completed study contributes to further works and shows in which areas further research can be conducted. Although the obtained results do not differ significantly from those described in the literature and obtained in other countries, they may encourage scientists and practitioners to carry out more in-depth research and work aimed at preparing organizations and their employees for Industry 4.0. Based on the responses obtained, it can be concluded that in many areas there is no clear statement on the impact of I4.0 on employees.

6. Conclusions

Industry 4.0 is currently a very popular research topic. Most of the available papers relates to its technological aspects, insufficiently considering social aspects. There are areas related to the human resources where in-depth research is still lacking: (1) none of the studies proposed a comprehensive research methodology regarding the impact of Industry 4.0 on employees; and (2) there was no comparative analysis of the impact of I4.0 on employees due to geographic/industry differentiation. Moreover, the available works are only relevant for certain countries and industries. There is no doubt that the fourth industrial revolution, like the previous ones, will have a significant impact on the whole of society, including the labor market and employees [60]. This study has attempted to fill the identified research gaps. The main academic contribution of the work and innovation/originality in relation to the existing literature should be considered the development of an original, comprehensive research agenda on the impact of Industry 4.0 on employment and the presentation of results obtained in the country (Australia) and industry (horticulture) so far not covered by this type of study. The method of conducting the research, i.e., in-depth structured interviews with a list of sought information, should also be considered a novelty in relation to the existing literature.

In the first part of the article, an analysis of the literature was carried out, which presents the current state of knowledge regarding research on the impact of Industry 4.0 on employees in individual countries and industries. There are few papers in the literature that describe this issue in detail. No publication has been identified that would present a comprehensive research plan covering all the most important aspects regarding the impact of I4.0 on the future of employees/jobs.

Based on a literature review, the second part presents a structured interview questionnaire method that can be replicated to different industries or countries. This is due to the universal nature of the developed questionnaires, as well as the fact that the questions concern the main areas of the Industry 4.0 impact on employment. The questionnaires do not contain detailed questions that relate, for example, to a given geographic region or the specifics of a particular industry. In order to verify the proposed method, pilot studies were carried out in Australia. The obtained results of interviews conducted with representatives of three different types of organizations (manufacturing company, research center, and university) using the I4.0 technologies allowed to obtain a preliminary picture of the impact of I4.0 on Australian employees and to compare them with other countries/industries. The obtained results relate to a specific country and industry, although due to the small number of interviews conducted, they cannot be extrapolated to the entire population. Also, it cannot be concluded from the study that the results obtained during the interviews will be similar in other countries/industries. Based on the literature review (Table 1), it can be stated that a given geographic region/industry strongly determines the degree of impact of Industry 4.0 on employment. Due to the research, it was possible to verify the original and comprehensive research agenda (two structured interview questionnaires). The proposed research plan can be a good starting point for further research to determine the holistic impact of I4.0 on employees/jobs.

The main theoretical implication of this study is to broaden the knowledge of research conducted in the area of the impact of Industry 4.0 on the labor market/employees in given countries or industries. A literature analysis made it possible to extract the most important categories in which research is conducted. An additional contribution is the identification of the most important articles and systematization of the available knowledge, as well as the presentation of the research agenda (questionnaires) that may facilitate the application of the adopted approach in other countries/industries.

The article also has practical implications. It is the first study to propose a comprehensive research plan on the impact of Industry 4.0 on labor market/employees. Due to the conducted interviews, it became possible to validate the questionnaires, as well as to indicate in which direction the scientific community may go, in order to enable further, more in-depth research in this field.

The main limitation of the conducted research is the number of interviews (4). Furthermore, this study is limited to the horticulture sector in Australia. Further research is needed in other industries and other geographic locations with larger sample sizes to increase the generalizability of the results. Although it is not possible to draw conclusions for a larger population based on the obtained interview results, it seems that organizations related to I4.0 can benefit from the results presented in the article. Based on them various entities can e.g., develop policies for organizational and human aspects. It is also possible to develop training programs to improve the skills and qualifications of employees using I4.0 solutions. Companies can also observe the direction in which the functioning of the organization is changing in the era of Industry 4.0, and how they can prepare for this change from employment point of view. Another limitation is that the data for literature analysis were taken from two databases, namely Scopus and WoSCC, which, although extensive and prestigious, account for only a small part of all scientific publications. In addition, selected papers were limited to articles, omitting proceedings or books.

In conclusion, the impact of Industry 4.0 on employees is still a relatively unexplored topic. There are many countries and industries where such research has not been conducted at all. There is also no comprehensive research methodology developed. The available

publications do not present an unequivocal assessment (positive or negative) of the impact of I4.0 on employees, so further in-depth research is warranted.

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Appendix A

Key guiding questions. For research of current and future impacts of Industry 4.0. On employees, operations and operations strategies.

1. **What kind of exponential technologies have been adapted, or are intended to be implemented, by your company?**
   - (a) Artificial Intelligence
   - (b) Cyber Physical Systems
   - (c) Internet of Things/Production Internet
   - (d) Interactive/collaborative robotics
   - (e) Advanced human-machine/robot interfacing
   - (f) Intelligent tracking technologies
   - (g) Body/brain scanners and similar
   - (h) Intelligent vision, smart sensors
   - (i) Augmented reality
   - (j) Autonomous devices (vehicles, drones, etc.)
   - (k) Big Data
   - (l) 5G enabled industrial systems
   - (m) Blockchain

2. **What are the key applications of exponential technologies, in your company or at all, whether existing, intended or imaginable?**
   - (a) Processing?
   - (b) Operations planning and control?
   - (c) Maintenance?
   - (d) Collaborative technologies: human & robot etc.?
   - (e) Servitization and ecosystemization?
   - (f) Smart and adaptable products?
   - (g) Other?

3. **What are the key benefits that were recorded or are aimed from the implementation of the above listed technologies?**
   - (a) Improved performance (quality, service, cost, productivity, greening, etc.)?
   - (b) New/better processes or functions?
   - (c) Effects due to the collaborative/shared action (joint learning etc.)?
   - (d) Servitization, ecosystemization, novel business models or competitive operations strategies?

(e)   Other?

4. **What are the key impacts of Industry 4.0, both observed and expected, on employees?**

    (a)   New competences and skills required by employees (what kind of?)
    (b)   Possible assistance to existing jobs to get better outputs and/or quality?
    (c)   Elimination/replacement of labour force or some functions by smart things?
    (d)   Other?

5. **How would you prioritize implementation of particular technologies in specific areas? Would you indicate any sequences required in this regard?**

6. **What kind of facilitation is required by industrial companies in reference to effective and efficient adaptation of Industry 4.0?**

Appendix B

Questions regarding potential impacts of Industry 4.0 on human resources—with a particular focus on employment, job profile, qualification and skill requirements in the workforce—which can have implications for organizational structure, the way that companies operate, and finally—new operations strategies.

1. **The impact of Industry 4.0 on the employees' work. Their work will be:**

☐   Much more complex & stressful
☐   Slightly more complex & stressful
☐   No change
☐   Less complex & stressful
☐   Much less complex & stressful

2. **Do you agree with the following statements?**

Industry 4.0 allows age-appropriate working environments. [Y/N]
Industry 4.0 allows a decrease in monotonous and repetitive work. [Y/N]
Industry 4.0 allows decreased waste and environmental impact. [Y/N]
Our employees do not trust Industry 4.0 technologies. [Y/N]
Our employees fear dependence on Industry 4.0 technologies. [Y/N]
We expect nonacceptance of Industry 4.0 by employees. [Y/N]
We expect lack of Industry 4.0 expertise among our employees. [Y/N]
Our employees fear data transparency due to Industry 4.0. [Y/N]

3. **After the implementation of Industry 4.0 solutions, has the organizational structure of your company changed? If yes, what has changed?**

4. **How does the organization and work environment look after the implementation of Industry 4.0?**

5. **What is the role of an employee in a company after implementing Industry 4.0?**

6. **Which employee competencies are the most important in the Industry 4.0 era?**

(Please insert the 'X' sign in only one relevant field in each category)

Specification (Category)	Scale of Validity				
	Not Important	Low Important	Moderately Important	Important	Very Important
State-of-the-art knowledge	☐	☐	☐	☐	☐
Technical skills	☐	☐	☐	☐	☐
Process understanding	☐	☐	☐	☐	☐
Media skills	☐	☐	☐	☐	☐
Coding skills	☐	☐	☐	☐	☐
Understanding IT security	☐	☐	☐	☐	☐

Specification (Category)	Scale of Validity				
	Not Important	Low Important	Moderately Important	Important	Very Important
Creativity	☐	☐	☐	☐	☐
Entrepreneurial thinking	☐	☐	☐	☐	☐
Problem solving	☐	☐	☐	☐	☐
Conflict solving	☐	☐	☐	☐	☐
Decision making	☐	☐	☐	☐	☐
Analytical skills	☐	☐	☐	☐	☐
Research skills	☐	☐	☐	☐	☐
Efficiency orientation	☐	☐	☐	☐	☐
Intercultural skills	☐	☐	☐	☐	☐
Communication skills	☐	☐	☐	☐	☐
Networking skills	☐	☐	☐	☐	☐
Ability to be compromising and cooperative	☐	☐	☐	☐	☐
Ability to transfer knowledge	☐	☐	☐	☐	☐
Leadership skills	☐	☐	☐	☐	☐
Flexibility	☐	☐	☐	☐	☐
Ambiguity tolerance	☐	☐	☐	☐	☐
Motivation to learn	☐	☐	☐	☐	☐
Ability to work under pressure	☐	☐	☐	☐	☐
Sustainable mindset	☐	☐	☐	☐	☐
Compliance	☐	☐	☐	☐	☐
Other (which?)					

7. **What are the biggest problems in the area of competencies held by employees?** (e.g., ability to use modern IT tools)
8. **Which of the so-called "Soft" skills are particularly desirable in your company?** (e.g., critical thinking, creativity, ability to manage people) Soft skills are the ability to effectively manage yourself and communication skills in relationships with other people—personal and interpersonal skills.
9. **What technical skills are particularly useful in operating Industry 4.0 technologies?**
10. **What are the most important expectations of employers regarding job candidates in the enterprise using Industry 4.0?** (e.g., knowledge of foreign languages, knowledge of technological solutions, ability to set priorities, improve team skills, time management)
11. **Do you prefer to hire new employees with appropriate qualifications/skills or to train/retrain existing employees? Why?**
12. **Does your company organize meetings/trainings related to Industry 4.0?**
13. **Support for which technologies of Industry 4.0 gives your company's employees the biggest problems?**
14. **How do you prepare your employees to work with Industry 4.0 technologies?**
15. **What will most affect the change of the labor market and the structure of employment in your company?** (e.g., Artificial Intelligence, Robotics, Cognitive Automation, Advanced Data Analysis, Internet of Things)

16. **What are the biggest changes in production work due to the implementation of Industry 4.0? Which areas/processes of the company have changed the most?**
17. **The OECD estimated that 9% of jobs in OECD countries could be automated and 25% could change significantly as a result of the automation of 50–70% of the associated tasks. Do You agree with this forecast? Why?**
18. **What jobs have been/will be liquidated in the era of Industry 4.0?**
19. **What new jobs positions will be created as a result of digital transformation?**
20. **What can be the most important barriers in the sphere of employment in the functioning and development of Industry 4.0?** (e.g., no qualified staff, no adequate training of employees, difficulties in recruiting people who have appropriate knowledge to companies)
21. **Which graduate fields of study are the most desirable in the context of working with Industry 4.0?** (e.g., electrotechnics, mechatronics, mechanical engineering, material engineering, automation and robotics)
22. **Are university graduates sufficiently educated to meet the requirements of the labor market in enterprises implementing the ideas of Industry 4.0?**
23. **What actions/initiatives would enable access of employees with appropriate competences related to Industry 4.0?** (e.g., support of the government for companies in education and retraining of employees, new definition of the list of professions together with the required competences, put more emphasis on building competences around programming/IT)
24. **What are the most serious barriers to implementing Industry 4.0 principles?** (e.g., lack of suitably qualified specialists, lack of sufficient skills of the staff in the field of new technologies)

Appendix C

Table A1. Characteristics of the organizations participating in the study.

Name	Description	Respondent
Magnificent Pty Ltd. Wamuran, QLD, Australia	International private company founded in 2002 operating in the horticulture industry. The main product offered by company is strawberries and employs around 200 workers during the season. Magnificent Pty Ltd. is focused on developing a commercial strawberry harvesting robot [61] that will significantly improve strawberry harvesting productivity. This will be achieved by integrating low-cost robotics on an autonomous platform [62].	position: CEO/Manager gender: male years of work: 17
ARC Research Hub for Driving Farming Productivity and Disease Prevention Brisbane, QLD, Australia	The Hub is a public research institution established in 2019 with a national operating range. Hub operates within the Australian Research Council (ARC) which is an entity established by the Australian Government [63]. The basis of its activities are scientific projects and the provision of research and engineering services. Hub integrates world-leading capabilities in machine learning, machine vision, software quality control, biology, engineering, and farming industries to invent and adjust technologies to build more intelligent systems that can automatically determine what objective to achieve in a dynamic/turbulent environment and the most effective plan to achieve it. Hub's research results are expected to enable higher farming productivity, lower production costs and reduce disease risks, giving the Australian industry a major advantage in global competition and creating new business opportunities [64].	position: Researcher, Associate Professorgender: male years of work: 7

Table A1. *Cont.*

Name	Description	Respondent
Griffith University, School of Information and Communication Technology (ICT), Institute for Integrated and Intelligent Systems Brisbane, QLD, Australia	Griffith University is a public research university founded in 1971 in South East Queensland on the east coast of Australia. Griffith University is among the top 2% of universities in the world with ca. 50,000 students on six campuses [65]. Research projects carried out at the School of ICT focus on data analytics, big data, machine learning, autonomous systems, computer vision and signal processing, software engineering and software quality, cybersecurity and network security. The Institute of Integrated and Intelligent Systems (IIIS) is the research platform of School of ICT, which is interested in robotics, drones and other technology-based systems [66].	position: Professor, Head of computational proteomics laboratory gender: male years of work: 27
		position: Researcher in robotics laboratory, PhD candidate gender: male years of work: 6

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