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TALENT MANAGEMENT IN THE ERA OF THE FOURTH INDUSTRIAL REVOLUTION

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Purpose: The purpose of this article is to identify the trends and interests of researchers in the area of talent management in the era of the fourth industrial revolution.
Design/methodology/approach: The achievements and results presented in the article were obtained from bibliometric studies conducted in the Web of Science and Scopus databases. The study used dynamic literature analysis and knowledge visualization. semantic maps of keywords were created to identify the topics and context in which the research deals with skills, competencies and talent management. VoSviewer software (version 1.6.16) was used to create the semantic maps.
Findings: The results obtained in the bibliometric survey confirm that the interest of researchers, from all over the world, concerning the fourth industrial revolution is constantly growing. In the Web of science and Scopus databases, publications on this topic continue to increase, but the vast majority of them are devoted to technology, digitization and digitalization, thus topics relevant to building the technical architecture of the business model. A clear research gap was identified in the area of the social architecture of the business model, of which talent management is a component. Semantic keyword maps were created to identify the topics and context in which the research deals with talent management in the era of the fourth industrial revolution.
Research limitations/implications: The literature analysis was narrowed to peer-reviewed articles published in English, indexed in the Web of Science and Scopus databases, which is a limitation of the study.
Originality/value: Original achievements obtained during the research include obtaining valuable research results on key areas linking talent management and the fourth industrial revolution.

Keywords: talent management, Fourth Industry Revolution, business model.

Category of the paper: research paper.

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1. Introduction

The fourth industrial revolution raises numerous opportunities and possibilities for today's businesses, but also daunting challenges. It is most often seen as a technological change, which is wrong, as it is also a social and economic change brought about by digital transformation. It can be defined as an age in which modern technological solutions shape the industrial environment and affect the economy and society, intensifying the sustainable development of the world (Grabowska, 2021). The Fourth Industrial Revolution refers to the social, industrial and technological changes brought about by the digital transformation of industry, which are identified with the concept of Industry 4.0 (Adamik et al., 2023).

Industry 4.0 is essentially a trend toward automation and data exchange in manufacturing technologies and processes that include Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Cognitive Computing and Artificial Intelligence (Alvarez-Aros et al., 2021; Cezarino et al., 2021). Industry 4.0 is a combination of ICT technologies and MES (Manufacturing Execution Systems), which allow for reduced planning and lead times and ongoing resolution of quality problems (Wang et al., 2023). Industry 4.0 is a change in the way production is controlled, including dynamic retooling of production resources initiated by information carried in workpieces. A smart factory requires broadband communication, both at the level of individual sensors, devices and actuators, as well as in wide-area network environments that integrate geographically distributed intelligent resources in real time (Saniuk et al., 2019). The application of modern technologies involves understanding their usability and the impact they can have on enterprise processes. Each Industry 4.0 technology is characterized by specific benefits. As pointed out by authors G. Tortorella, T. Saurin, P. Hines et al. (2023) Industry 4.0 with flexible production systems is expected to change the operating conditions of societies that are increasingly comfortable with cyber technology and are very aware of their needs and expectations.

The currently observed increase in the implementation of Industry 4.0 pillars and the focus of companies on dehumanizing production systems have caused numerous concerns among workers, the public and even governments. In Industry 4.0, the work environment is determined by integrated and advanced manufacturing technologies equipped with sensors that track machine operation and communication systems that report data and perform advanced simulations. The role of today's workers is very rarely mentioned, which has caused public concern and resulted in discussions on expanding the boundaries of Industry 4.0 to Industry 5.0 with due consideration for the role of humans in a company implementing Industry 4.0 technologies. The concept of Industry 5.0 involves the return of the human factor to industry, i.e. increased cooperation between humans and intelligent production systems. Combining the best of both worlds - the speed and accuracy guaranteed by automation with the cognitive skills and critical thinking of humans - ensures the success of Industry 5.0 (Yordanova, 2021, Doyle-

Kent, Kopacek, 2019). Industry 4.0 puts technology at the center, while Industry 5.0 focuses on production workers who see progressive automation as a threat to job loss. Industry 5.0 recognizes the power of technology for industrial (business) development, but combines the achievement of business goals with social goals in the workplace and beyond (social and environmental responsibility) (Ghobakhloo et al., 2023). Cyber-physical systems intertwined with social and environmental frameworks underpin the manufacturing process. Today, CPS operating in smart factories lead to economic growth and put people at the center of collaboration with smart resources and a more robust perception of sustainability (Sachsenmeier, 2016; Demir, Cicibas, 2017; Raja et al., 2023).

The Fourth Industrial Revolution, underpinned by the technologies of Industry 4.0 and the assumptions of Industry 5.0, is, like the previous three revolutions, a challenge for the economy and society as a whole. Academics are engaging in discussions as to the essence of the transformation, and specialized research centers and consulting firms are carrying out studies on various aspects of the implementation of Industry 4.0 technologies and their effects not only on consumers and society as a whole but also on the future labor market. French and British economists P. Aghion, C. Antonin, S. Bunel and X. Jaravel, have provided a new perspective on automation, arguing that its direct effect can be an increase in employment, not a reduction. In their view, automation can help a company become more profitable and thus grow, leading to an increase in employment. Technology can also allow companies to enter new business areas or focus on products and services that require more labor (Aghion et al., 2022).

The concept of Industry 4.0 and Industry 5.0 are a huge challenge for enterprises not only because of the application of modern technologies (such as the Internet of Things, Big Data Analytics, Cloud Computing, etc.) associated with the creation of Cyber-Physical Systems, but also for the development of human resources. As a result of this concept, changes in production organization and employment structure are observed, which may even lead to the use of new forms of knowledge and skills (Hecklau et al., 2017). New theoretical knowledge and practical skills of industrial workers and managers are expected. In a world determined by the pillars of Industry 4.0, talent management will be an important aspect of human resource management. Under the conditions of Industry 4.0, there is increasing talk of the need for talent management. It is understood as a strategic process involving the identification of employees distinguished by above-average abilities and the creation of an appropriate organizational culture conducive to the development of this group. The competitive advantage of enterprises' business models depends to a large extent on an appropriately selected workforce (Huang et al., 2022). However, the biggest limitation of enterprise transformation in line with the Industry 5.0 concept may be the lack of appropriately qualified personnel, the inability to adequately train employees, and the difficulty in attracting knowledgeable people to enterprises. At the same time, digital transformation will also force employers to create entirely new positions, including in areas such as innovation, security and management of sensitive data, or cooperation with customers and suppliers (Ivanov, 2022; Leng et al., 2022). There are a great many challenges

awaiting employers in the area of finding employees for Industry 5.0. Identifying these challenges became the imperative for conducting a bibliometric analysis aimed at identifying trends and interests of researchers in the area of talent management in the era of the fourth industrial revolution (this is also the purpose of the article).

2. Materials and methods

The study adopted the Dynamic Literature Linkage Analysis method introduced by C. Colicchia and F. Strozzi (2012), as it combines Systematic Literature Review (SLR) and analysis with visualization of the bibliographic network. The search for scientific publications was conducted using the Web of Science (WoS) core collection, a database provided by Clarivate Analytics, and Scopus, a database provided by Elsevier. According to the methodology adopted in the study, the following research stages were carried out: planning, implementation and reporting.

The subject of the analysis was to identify trends and research interests in the area of talent management in the era of the fourth industrial revolution. Identification of topic/research areas is a critical step in the analysis. Its results may change if different search phrases and criteria are used. The search was conducted on January 15, 2023 in the Web of Science and Scopus databases. All results obtained were exported to .ods, .bib, .txt files for further use using VOSviewer software. The defined research area was converted into phrases:

- (TS=("industry 4.0")) AND TS=(talent management)),
- (TS=("industry 5.0")) AND TS=(talent management)).

The above phrases, in the Web of Science database, were searched in the "Topic" category, including title, abstract, keywords defined by the author(s) and keywords plus (so-called "KeyWords Plus" - words and phrases extracted from the titles of cited articles, as defined in the Web of Science database). The Scopus database was searched for title, abstract and keywords defined by the author(s). The time range of the search from January 1, 2011 to December 31, 2022 was adopted. 2011 was set as the beginning of the search, this was dictated by the fact that it was in 2011 that a group of German experts introduced a strategy for industrial development based on smart technology called Industry 4.0, while the term Industry 5.0 officially began to be used in 2021. Thus, the search timeframe 2011-2022 includes works in the field of the fourth industrial revolution, which is formed by Industry 4.0 and Industry 5.0. The results obtained were further narrowed down to scientific, peer-reviewed articles published in English.

Research using bibliometric analysis applied knowledge visualization, which includes such issues as visualization of research results. Semantic maps of keywords were created to identify the topics and context in which the research deals with skills, competencies and talent management. VoSviewer software (version 1.6.16) was used to create the semantic maps.

3. Results and discussion

The topic area of talent management in connection with Industry 4.0 would be addressed by 125 researchers in the WoS database and 90 in the Scopus database. Researchers from 32 countries, representing 97 research centers, published 35 papers, which were published in 25 source titles and indexed in the WoS database. In contrast, in the Scopus database, 90 researchers from 18 countries, representing 51 research centers, published 26 papers that were published in 22 source titles.

Among the most active researchers in the WoS database are F. Aguayo-Gonzalez (2), M.J. A. Gutiérrez (2), M. Anshari (2); among the most popular titles are Mobile Information Systems (1), Sa Journal of Human Resource Management (1), Sensors (1); the countries from which the largest number of researchers come are England (5), China (5), Australia (4), India (4), South Africa (4); research centers to which the most papers are affiliated are Nottingham Trent University (2), Brunei Darussalam University (2), University of Johannesburg (2), University of Nottingham (2), University of Seville (2).

Among the most active researchers in the Scopus database are F. Aguayo-Gonzalez (2), M. Anshari (2), F. Aguayo-González (2); among the most popular titles are International Journal of Systematic Innovation (1), Journal of Legal Ethical And Regulatory Issues (1), Mobile Information Systems (1), SA Journal Of Human Resource Management (1), Sensors (1); the countries from which the largest number of researchers come are Malaysia (4), China (3), India (3), Indonesia (3), Spain (3); the research centers to which the largest number of papers are affiliated are National Taiwan University of Science and Technology (2), University of Seville (2), Brunei Darussalam University (2).

The topic of talent management in connection with Industry 5.0 was covered by 7 researchers in the WoS database and 14 in the Scopus database. Researchers from 3 countries, representing 4 research centers, published 3 papers, which were published in 3 source titles (Mobile Information Systems (1), Sa Journal of Human Resource Management (1), Sensors (1)) and indexed in the WoS database. On the other hand, in the Scopus database, researchers from 6 countries, representing 8 research centers, published 5 papers, which were published in 5 source titles (International Journal of Systematic Innovation (1), Journal of Legal Ethical And Regulatory Issues (1), Mobile Information Systems (1), SA Journal Of Human

Resource Management (1), Sensors (1)). Due to the small number of papers of this research area, at this point it is not yet possible to say which authors are leading.

Summarizing the analyses carried out, the basic statistics relating to the bibliometric database created for the research area "Talent Management" are presented in Table 1.

Table 1.
Basic bibliometric indicators of scientific articles from the research area "Talent Management"

Scientific articles from 2011 to 2022 from the field of research - talent management	**Base Wos**	**Base Scopus**
(TS=("industry 4.0")) AND TS=(talent management)		
Number of records	35	26
Number of researchers	125	90
Most active researchers	F. Aguayo-Gonzalez (2), M.J.A. Gutiérrez (2), M. Anshari (2)	F. Aguayo-Gonzalez (2), M. Anshari (2), F. Aguayo-González (2)
Number of source titles	25	22
Most popular source titles	Sa Journal of Human Resource Management (3), Applied Sciences (2), Energy Reports (2), Sustainability (2)	Sa Journal of Human Resource Management (3), Sustainability (2), Applied Sciences (2)
Number of countries	32	18
Countries from which the largest number of researchers come	England (5), China (5), Australia (4), India (4), South Africa (4)	Malaysia (4), China (3), India (3), Indonesia (3), Spain (3)
Number of research centers	97	51
Research centers to which most papers are affiliated	Nottingham Trent University (2), Brunei Darussalam University (2), Johannesburg University (2), Nottingham University (2), Sevilla University (2)	National Taiwan University of Science and Technology (2), Sevilla University (2), Brunei Darussalam University (2)
(TS=("industry 5.0")) AND TS=(talent management)		
Number of records	3	5
Number of researchers	7	14
Number of source titles	3	5
Most popular source titles	Mobile Information Systems (1), Sa Journal of Human Resource Management (1), Sensors (1)	International Journal of Systematic Innovation (1), Journal of Legal Ethical And Regulatory Issues (1), Mobile Information Systems (1), SA Journal Of Human Resource Management (1), Sensors (1)
Number of countries	3	6
Number of research centers	4	8

Source: own study.

Based on the results obtained by searching the WoS and Scopus databases, Figure 1 shows the growth dynamics of researchers' interest in the skills area in conjunction with Industry 4.0, while Figure 2 shows the growth dynamics of researchers' interest in the skills area in conjunction with Industry 5.0.

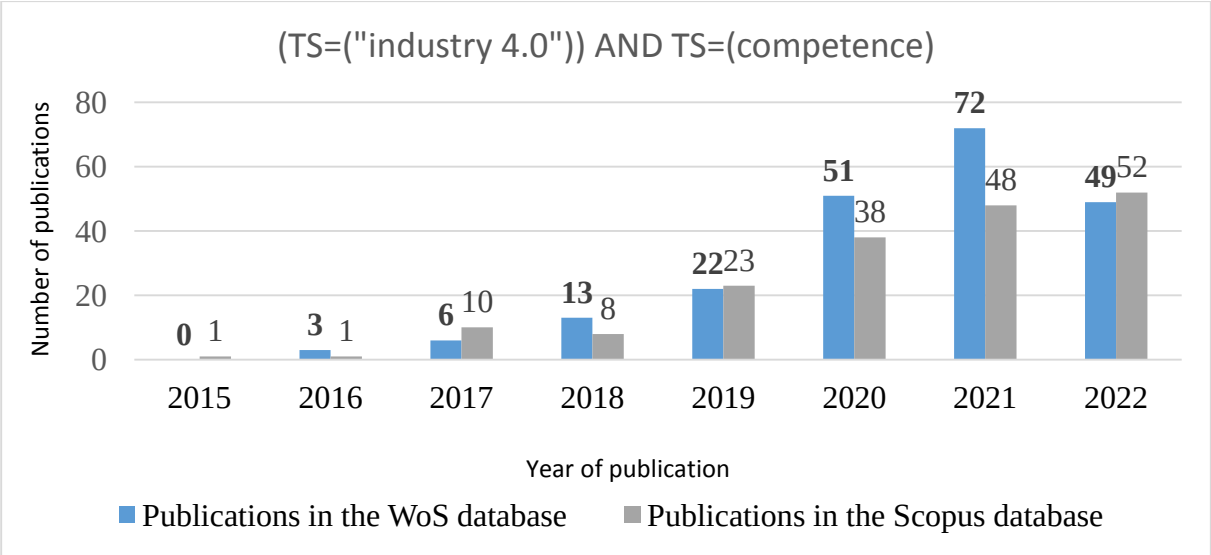

Figure 1. Growth rate of published articles in WoS and Scopus database from 2011 to 2022 for the phrase (TS=("industry 4.0")) AND TS=(talent management).

Source: own study.

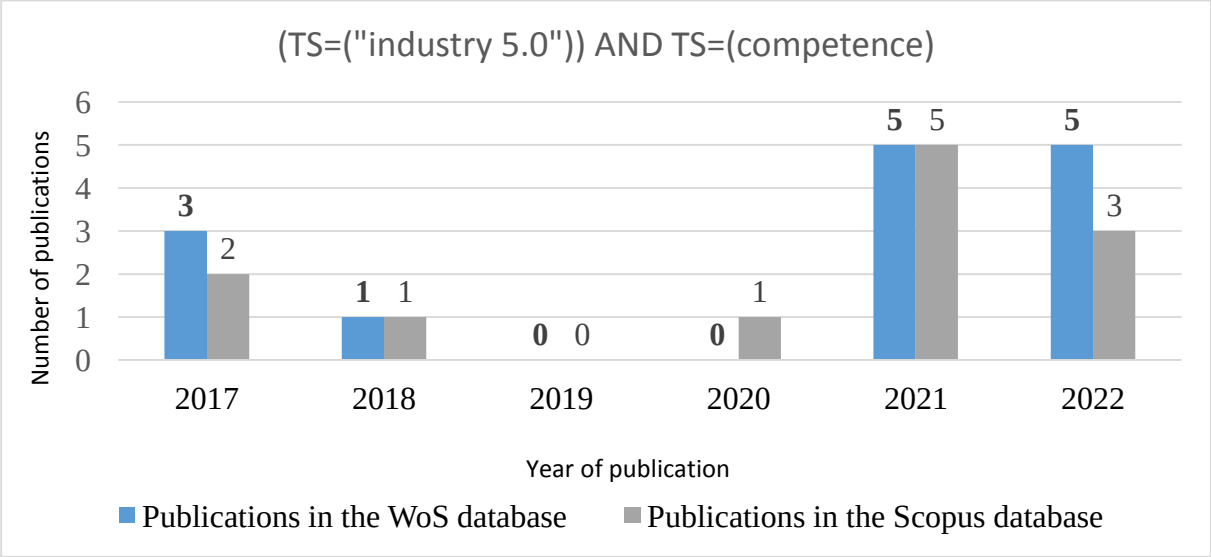

Figure 2. Growth rate of published articles in WoS and Scopus database from 2011 to 2022 for the phrase (TS=("industry 5.0")) AND TS=(talent management).

Source: own study.

A review of the dynamics of the number of published scientific papers in the area under study clearly indicates that these topics are still new and little researched. Researchers' interest in talent management is shaped as follows:

- Talent management + Industry 4.0 (TS=("industry 4.0")) AND TS=(talent management) - the first papers from this research area were indexed in 2015, at which time 3 articles appeared in the WoS and Scopus baize. In subsequent years, researchers successively published more papers in this area, but still not many. In 2022, 16 papers were indexed in the WoS baize and 11 in the Scopus baize.

- Talent management + Industry 5.0 (TS=("industry 5.0")) AND TS=(talent management) - this research area is in the very early stages of publication, with 2 articles appearing in WoS in 2021 and three in Scopus. In the following year, one article was indexed in WoS database and two in Scopus.

Table 2 shows to which fields of science articles in the WoS database are most often assigned. And Table 3 shows to which areas of knowledge articles are most often assigned in the Scopus database.

Table 2.
WoS fields of study to which retrieved works were assigned for the phrases Talent Management + Industry 4.0

Place in the ranking	Fields of science defined in the Web of Science database	Search results (number of documents)
(TS=("industry 4.0")) AND TS=(talent management)		
I	Management	19
II	Business	6
III	Environmental Sciences	5
IV	Engineering Industrial	4
	Environmental Studies	
	Green Sustainable Science Technology	

Source: own study.

Analyzing the data in Table 2, it can be seen that publications with the phrase (TS=("industry 4.0")) AND TS=(talent management) were assigned to the following WoS science fields: management (19), business (6), environmental science (5), industrial engineering, environmental research, sustainable science technology (4). With regard to publications in the phrase (TS=("industry 5.0")) AND TS=(talent management) it is not yet possible to determine to which fields of science they are most often assigned, due to their small number.

Table 3.
Scopus knowledge areas to which the retrieved works were assigned for the phrases competency + Industry 4.0/ 5.0

Place in the ranking	Fields of science defined in the Web of Science database	Search results (number of documents)
(TS=("industry 4.0")) AND TS=(talent management)		
I	Business, Management and Accounting	16
II	Computer Science	11
III	Social Science	9
	Engineering	
IV	Environmental Science	5
(TS=("industry 5.0")) AND TS=(talent management)		
I	Computer Science	3
II	Social Science	2
III	Business, Management and Accounting	

Source: own study.

As can be seen from the data in Table 3, publications with the phrase (TS=("industry 4.0")) AND TS=(talent management) were assigned to the following Scopus knowledge areas: business, management and accounting (16), computer science (11), social science, engineering (9), environmental science (5). On the other hand, publications in the phrase (TS=("industry 5.0")) AND TS=(talent management) were assigned to: computer science (3), social sciences, management business and accounting (2).

Analyzing the keywords from all searched publications in the WoS and Scopus database in the field of talent management and Industry 4.0 (Figure 3) and in the field of talent management and Industry 5.0 (Figure 4), two dominant research streams can be observed. The first trend is directly related to complex technology enabling cyber-physical networks and the use of robots in smart enterprises, while the second is related to managing employee development based on trust, exploring employee talent and nurturing a sense of job satisfaction.

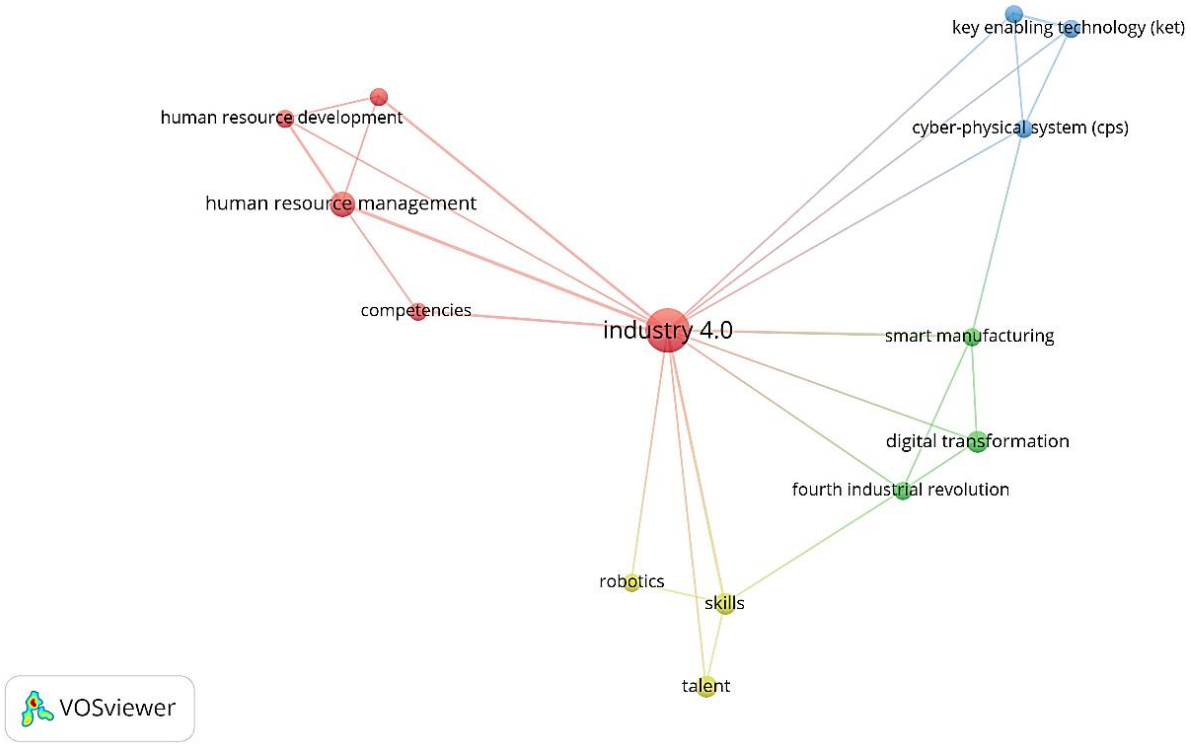

Figure 3. Keyword map for the phrase (TS=("industry 4.0")) AND TS=(talent management).
Source: own study.

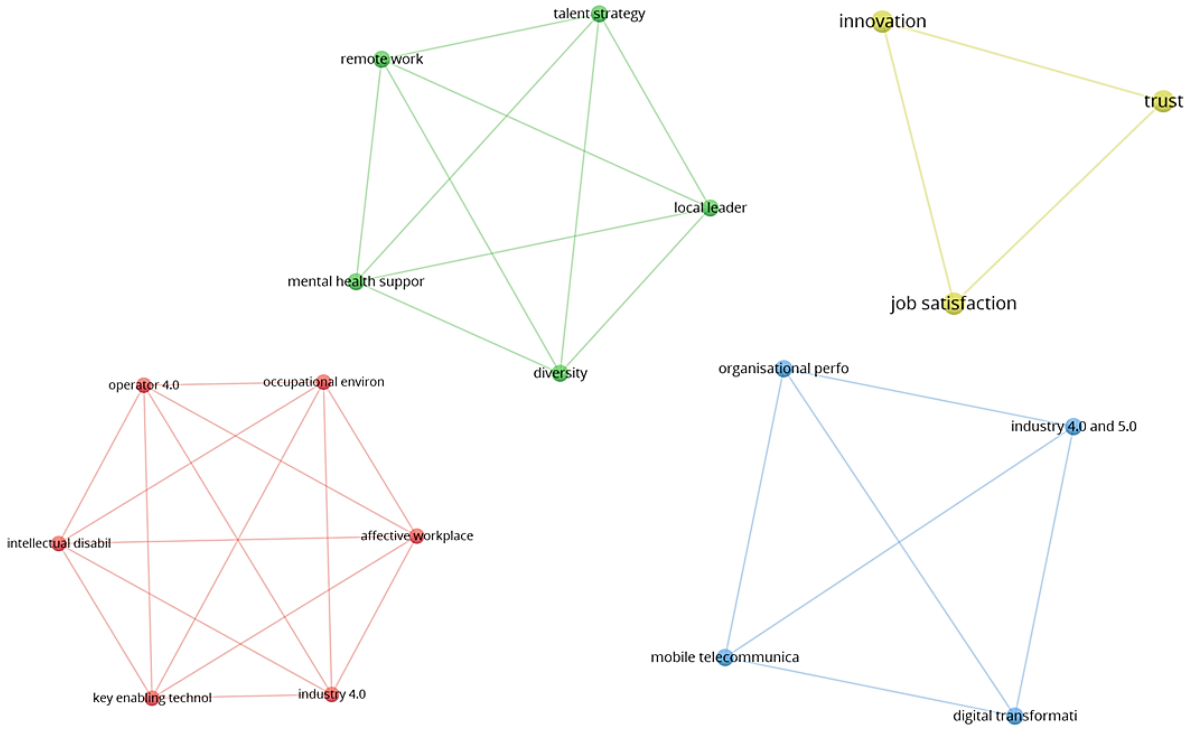

Figure 4. Keyword map for the phrase (TS=("industry 5.0")) AND TS=(talent management).
Source: own study.

For the subject area of talent management and Industry 4.0/ 5.0, from the set of publications indexed in the WoS database, articles marked as the most cited (Highly Cited Papers) were selected, while from the Scopus database, ten articles with the highest number of citations were selected and their content analyzed (for the research area of talent management and Industry 5.0 - all publications were analyzed) to identify what research issues are addressed in them. Many articles were duplicated in both databases, so the final five articles were selected for analysis:

1. Chang, Y.H., Yeh, Y.J.Y. (2018). Industry 4.0 and the need for talent: a multiple case study of Taiwan's companies. *International Journal of Product Development, 22(4),* 314-332. Talent is a key resource in the development of Industry 4.0. The purpose of this article is to analyze companies' need for and acquisition of talent.
2. Dhanpat, N., Buthelezi, Z.P., Joe, M.R., Maphela, T.V., Shongwe, N. (2020). Industry 4.0: The role of human resource professionals. *SA Journal of Human Resource Management, 18(1),* 1-11. The purpose of the article was to explore the role of human resource (HR) professionals in navigating Industry 4.0.
3. Galvan-Vela, E., Ravina-Ripoll, R., Tobar-Pesantez, L.B. (2021). A structural equations model of job disengagement from the constructs of organizational justice, job satisfaction, innovation and trust in the era of industry 5.0. *J. Legal Ethical & Regul. Issues, 24,* Employees play an important role in the performance of companies, so studying the elements of company behavior and climate is essential to retaining human

talent. This study aims to determine the impact of perceived fairness, job satisfaction, support for innovation and trust on employee turnover and the relationship between these variables. Digitalization in advanced industries such as mobile telecommunications emphasizes the agility required to attract talent in a dynamic environment in terms of marketing, competition, etc. This study aimed to investigate the mediating effect of digital process management on the relationship between talent management (TM) and organizational performance.

4. Mian, S.H., Salah, B., Ameen, W., Moiduddin, K., Alkhalefah, H. (2020). Adapting universities for sustainability education in industry 4.0: A channel of challenges and opportunities. *Sustainability, 12(15),* 6100. Despite the global recognition and realization of Industry 4.0, its holistic adoption is limited by specific skill requirements among the workforce. Personnel are expected to acquire adaptive thinking, cognitive and computational skills, mainly in the areas of information technology, data analysis, etc. As a result, universities that have laid the groundwork for future talent or trends in society must adapt and modernize existing programs, facilities and infrastructure. This transformation of higher education in line with the vision of Industry 4.0 has its opportunities and challenges. There are, of course, many factors involved, and these need to be judiciously evaluated in order to strategically plan for this metamorphosis. The purpose of this article was to explore and analyze the various factors that influence the progress and implementation of Industry 4.0 in universities in terms of sustainable education.
5. Whysall, Z., Owtram, M., Brittain, S. (2019). The new talent management challenges of Industry 4.0. *Journal of management development, 38(2),* 118-129. The transformational changes in business environments brought about by the fourth industrial revolution create a perfect storm for strategic human resource management, prompting an examination of the implications of this context for talent management theory and practice. This article aims to discuss these issues.

4. Conclusion

The bibliometric analysis of global scientific works in the area of talent management in conjunction with Industry 4.0 and Industry 5.0 represents an effort to rationalize and systematize existing knowledge in the field of selected aspects of the social architecture of business models of companies operating under the conditions of the fourth industrial revolution. The analysis made it possible to show, in terms of time, the reconstruction of scientific productivity effects in the studied areas.

The results obtained in the bibliometric study confirm that the interest of researchers, from all over the world, concerning the fourth industrial revolution is constantly growing. In the Web of science and Scopus databases, publications on this topic continue to increase, but the vast majority of them are devoted to technology, digitization and digitalization, so topics relevant to building the technical architecture of the business model. Authors pay a great deal of attention to the technological aspects and digitization in the context of challenges for businesses. A clear research gap has been identified in the area of how to manage the development of employees' career paths through talent management.

A search of academic publications in the Web of Science and Scopus database in the field of talent management, represents only a fraction of the total body of publications on the fourth industrial revolution. Although it is still an under-researched topic, this does not mean that it is unimportant for building the business models of the enterprise of the future, particularly for human resource management. For many years, scholars and business practitioners have stressed that a company's most valuable resource is its motivated and well-qualified employees. So it is surprising to see so little attention paid to the social architecture management aspects of the business model. This may be due to the fact that the foundation of the Industry 4.0 concept, which has its origins in 2011, is technology, only the Industry 5.0 concept (from 2021) restores the rightful place of humans in businesses.

The countries from which the researchers working on this topic come are: England, China, Australia, India, South Africa, Malaysia, Indonesia and Spain. A review of the dynamics of the number of published scientific papers from the area under study clearly indicates that these topics are still new and little researched, the area is at a very early stage. By 2022, 38 articles have been indexed in the Wos database, and 31 in the Scopus database (noting that some articles are indexed in both databases simultaneously). These publications were assigned to management, business, environmental sciences, industrial engineering, environmental research and sustainable development technologies. None of the publications were assigned to computer science and related sciences as in the case of publications containing the keywords skills and/or competencies. Two dominant trends can be seen in these publications - a trend directly related to complex technology enabling cyber-physical networks and the use of robots in smart enterprises, and a trend related to managing employee development based on trust, exploring employee talent and nurturing a sense of job satisfaction. The topics covered in these articles in relation to talent management are:

- Demand for talent and talent acquisition by companies implementing Industry 4.0 technologies;
- The role of human resources (HR) professionals in navigating Industry 4.0;
- The impact of perceived fairness, job satisfaction, support for innovation and trust on employee turnover and the relationship between these variables;

- The mediating effect of digital process management on the relationship between talent management (TM) and organizational performance;
- An analysis of the factors that influence the progress and implementation of Industry 4.0 in universities for sustainable education;
- Implications of strategic human resource management for talent management practice.

In theoretical terms, the conducted study contributes to the identification of the current state of knowledge on talent management in relation to Industry 4.0 and Industry 5.0, by analyzing the evolution of the state of knowledge and trends. An interesting direction for future research may be the further exploration of this topic with its extension in relation to the formation of skills and competencies of employees of enterprises of the future.

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