

What Fields of Management Are Affected by Industry 4.0 And What Changes Are Coming with It?

Lukáš KLARNER, Petr ŘEHOŘ*, Monika MAŘÍKOVÁ, Jaroslav VRCHOTA and Michaela ŠEBÍSTKOVÁ

University of South Bohemia in České Budějovice, České Budějovice, Czech Republic; klarnl00@ef.jcu.cz; rehor@ef.jcu.cz; marikova@ef.jcu.cz; vrchota@ef.jcu.cz; sebism00@ef.jcu.cz

* Corresponding author: rehor@ef.jcu.cz

Abstract: Organizations are facing increasing pressures from the external environment. New changes are constantly coming, and businesses must learn to respond to the changes. One of the most significant dynamic changes of the present time is Industry 4.0, bringing a huge number of new technologies, innovations and which fuels the issue of sustainability and sustainable development. The main aim of this paper is to conduct a systematic literature review of Industry 4.0, find out what changes are occurring, and which fields of management are most affected due to this. To fulfill this aim, the PRISMA 2020 guideline for systematic reviews has been used. It was found that most affected fields are process, change and human resources management. Issues of employee's skills, knowledge and development are highly discussed. Workplace 4.0 leadership skills and value chain is also mentioned. Last, but not least the keywords analysis has been done. It was observed that mostly occurred words are Industry 4.0, innovations, management, technology, CSR or workplace.

Keywords: Industry 4.0; management; change; change management; innovations; systematic review

JEL Classification: O31; O32; M10

1. Introduction

Industry 4.0 concept is developing more and more. In recent years, new technologies have been constantly emerging. Nowadays, this concept is not only about Big data, IoT, Artificial Intelligence, virtual reality, robotization, automation, digitization or Smart factories. As Kowalikova (2020) reminds, this concept was first mentioned in the strategies of developed economics, e.g. Germany, US or Japan. But very first this term was used in German in 2011 (Lenart-Gansiniec, 2019). Therefore, several perspectives on this concept are now offered. Some authors say that Industry 4.0 is purported to be a new paradigm of smart and autonomous manufacturing. (Bai et al., 2020). Ullah (2020) offers this attitude: In Industry 4.0, humans, technology, and organizations are integrated in both horizontal and vertical manners using advanced information and communication technologies. Obermayer et al. (2022) claims that Industry 4.0, a German strategic initiative, is aimed at generating a transformation from machine-dominant manufacturing to digital and intelligent manufacturing. As is quite evident, there are many definitions and contexts.

Industry 4.0 is not only about technology, the question of sustainability and sustainability development is being extremely discussed. Corporate social responsibility including triple bottom line is now inseparable part of social responsibility of companies. Companies are currently facing pressures to implement the principles of the social responsibility. The issues of waste-free and emission-free production, quality of working environment and work conditions are mostly addressed (Cohran & Rauch, 2020). These pressures are also strong from supranational groups such as the European Union. These new changes have to be implemented through number of fields of management. The basis of each change is successful change management, which can be effectively used in any functional field of the company (Paraschiv et al., 2019).

2. Methodology

The main aim of this paper is to find out what management fields are more affected by fourth industrial revolution called 'Industry 4.0'. This concept brought many great changes and as entry into research a review is conducted. It may help to understand what articles are dealing with and what topics are the most researched nowadays.

The Paper is based on PRISMA 2020 guideline for reporting systematic reviews (PRISMA, 2021) as it is required. The research was done on 5th December 2022. All articles were searched in the Web of Science database. Primary criterium for searching was the Topic which was stated as 'change management AND Industry 4.0'. This topic was chosen because the main aim of this paper is to find what changes is Industry 4.0 bringing and what management fields are affected by this concept. Other criteria were then applied. First of all, articles that were not available in Open Access were discarded. Afterwards records that were not article or proceeding paper and were not available in English were discarded. Last, but not least Citation topic was selected, and it was stated as 'Management'. In the end concrete fields were chosen and correct fields were defined as: Management, Business, Green Sustainable Science Technology, Economics, Industrial Relations Labor. According to the number of records it was not necessary to apply a restrictive criterion according to the year of publication. 26 papers were selected to full paper revision. Unfortunately, 10 articles did not fit the field, so it was necessary to discard them. In one case, only manufacturing reshoring was solved, and Industry 4.0 was only particular part of this paper. Then other paper solved only risk management and not management or Industry 4.0 as a topic. Third article did deal only with social change and not change as part of management. Fourth paper was focused on innovations at all, with no connection to Industry 4.0. Then, other paper did solve work conditions in manufacturing enterprises, but with no connection to management, change management or Industry 4.0. Two papers solved only particular economic impact and remaining two articles were focused on innovations dealing with Industry 4.0, but only in covid-19 pandemic time, so it was decided to discard them as well. One paper was discarded because of duplication.

Furthermore, the keywords analysis has been done. It was done manually, and the result of this analysis was the word cloud, where the font size shows how often the concrete keyword occurs.

3. Results

Before the whole full paper review will be described, the results of keyword analysis are offered. For this analysis the method of word cloud was chosen. The font size shows how often the concrete keyword occurs (Heimerl et. al., 2014). For better imagination on all related topics, keywords from all originally filtered 26 articles were used for this analysis. According to this analysis, there can be identified topics that are the most connected with Industry 4.0. These topics are Innovations, Technology, TQM, Project/Project Management, SME´s, Management/Change management, ERP. As Figure 1 shows, there are many other topics connected with Industry 4.0. According to this keyword analysis, the own definition of Industry 4.0 had been made. Authors defines Industry 4.0 as “A constantly developing technological concept including a whole range of new innovations affecting a whole range of fields in management and economics with the potential for further growth”. It is obvious that this concept is connected to other modern trends like TQM or ERP, but it is clear these trends are not directly the result of Industry 4.0. Selected keywords that had a frequency of at least 2 are listed in Table 1 for ease of reference.

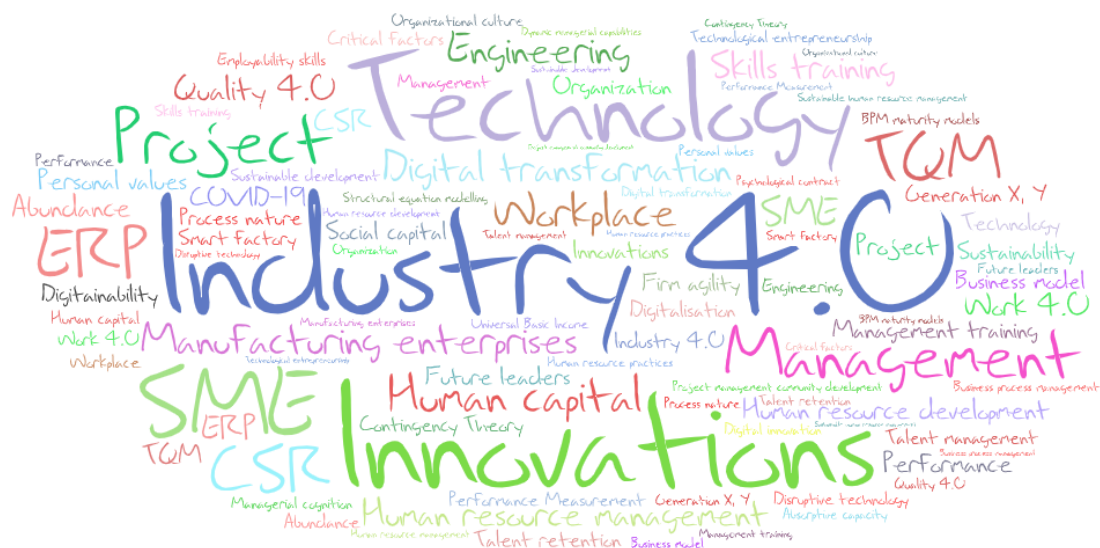


Figure 1. Keyword cloud

Table 1. Keywords frequency

Keyword	Frequency
Industry 4.0	11
Innovations	5
Management	4
Technology	4
Project	2
Manufacturing enterprises	2
Digital transformation	2
Human capital	2
SME	2

As it is mentioned in chapter Methodology, this review is based on PRISMA 2020 guideline. The review is made of 16 articles that were chosen from original 1,076 results. The whole process is illustrated by Figure 2 and described in chapter Methodology.

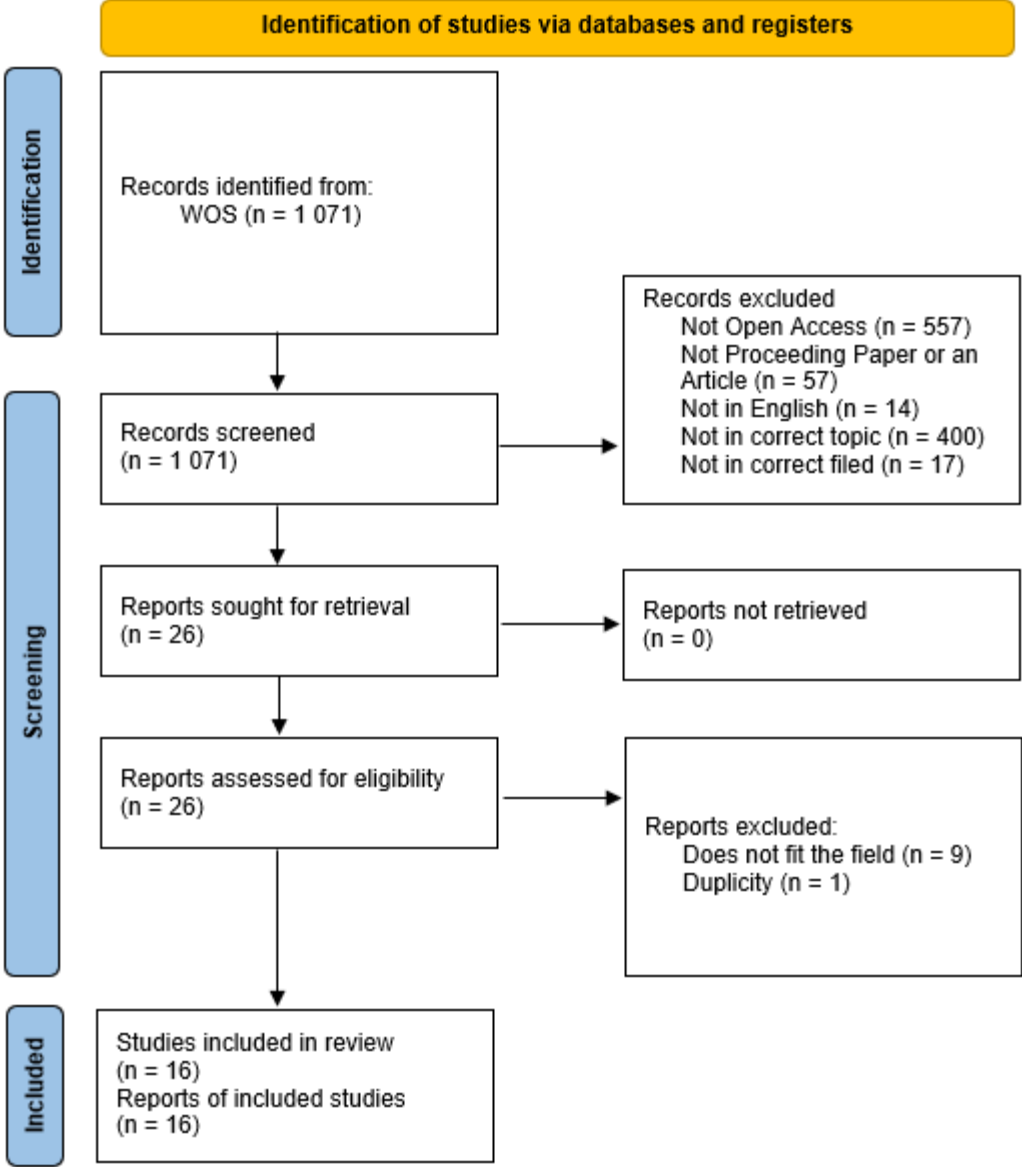


Figure 2. PRISMA 2020 diagram (PRISMA, 2021)

There were 1,076 original records. From this records, 557 records were excluded because they were not available in Open Access, 57 due to the wrong type of paper, 14 due to the wrong language, 400 due to the wrong WOS Citation topic and 17 due to the wrong field. 26 reports were selected for full paper review. Then, other 10 papers were discarded due to the wrong or not complete topic. Reasons for this discarding are described in Methodology. For this review 16 records were chosen. Basic characteristics (author, year, title, times cited and type of paper) are described in Table 2.

Table 2. Selected papers

	Author and Year	Title	Times cited	Type
1.	Whysall et al. (2019)	The new talent management challenges of Industry 4.0	57	Article
2.	Efimova & Bris (2021)	Quality 4.0 for Processes and Customers	1	Article
3.	Klovienė & Uosyte (2019)	Development of Performance Measurement System in the Context of Industry 4.0: a Case Study	8	Article
4.	Stachowicz & Nowicka-Skowron (2019)	Opportunities and threats to the functioning of contemporary socially responsible enterprises organized according to the concept of 'Industry 4.0'	3	Article
5.	Lin & Wang (2022)	Talent Retention of New Generations for Sustainable Employment Relationships in Work 4.0 Era-Assessment by Fuzzy Delphi Method	1	Article
6.	Črešnar & Nedelko (2020)	Understanding Future Leaders: How Are Personal Values of Generations Y and Z Tailored to Leadership in Industry 4.0?	14	Article
7.	Pisar & Mazo (2020)	Controlling, communication and corporate culture – the opportunities for SME's	7	Article
8.	Sansabas-Villalpando et al. (2019)	CODAS HFLTS Method to Appraise Organizational Culture of Innovation and Complex Technological Changes Environments	10	Article
9.	Szelagowski & Berniak-Wozny (2021)	How to improve the assessment of BPM maturity in the era of digital transformation	1	Article
10.	Vrchota & Řehoř (2019)	Project management and innovation in the manufacturing industry in Czech Republic	9	Proceedings Paper
11.	Jerman et al. (2019)	The Influence of Critical Factors on Business Model at a Smart Factory: A Case Study	9	Article
12.	Sharma et al. (2022)	Analysing the impact of sustainable human resource management practices and industry 4.0 technologies adoption on employability skills	4	Article
13.	Perkins et al. (2022)	Analysing the impacts of Universal Basic Income in the changing world of work: Challenges to the psychological contract and a future research agenda	4	Article
14.	Heubeck & Meckl (2022)	More capable, more innovative? An empirical inquiry into the effects of dynamic managerial capabilities on digital firms' innovativeness	1	Article
15.	Tick et al. (2022)	Conscious or indifferent – concerns on digitalization and sustainability among SME's in Industry 4.0	0	Article
16.	Potoczek (2021)	The use of process benchmarking in the water industry to introduce changes in the digitization of the company's value chain	2	Article

Figure 3 shows publications and citations of 26 original searched records.

Potoczek (2021) solved a question of benchmark methodology for digitizing the value chain. This research identified that since 2006 the progress of digital maturity researches is significant. Especially last four years there is a dynamic increase of acknowledgement. The author defined a way how to improve the process of benchmarking according to digital technologies and how to obtain the higher digital maturity level. Author also mentioned the fact that digitization of value chain largely depends on digital skills of employees as well as AI, IoT or cloud computing. Economic and productivity growth is not forgotten. Process

management is the main topic solved by this study, especially focused on process maturity, digital maturity 4.0 and digitization of value chain. The paper did not bring any fundamental real-world utilization.

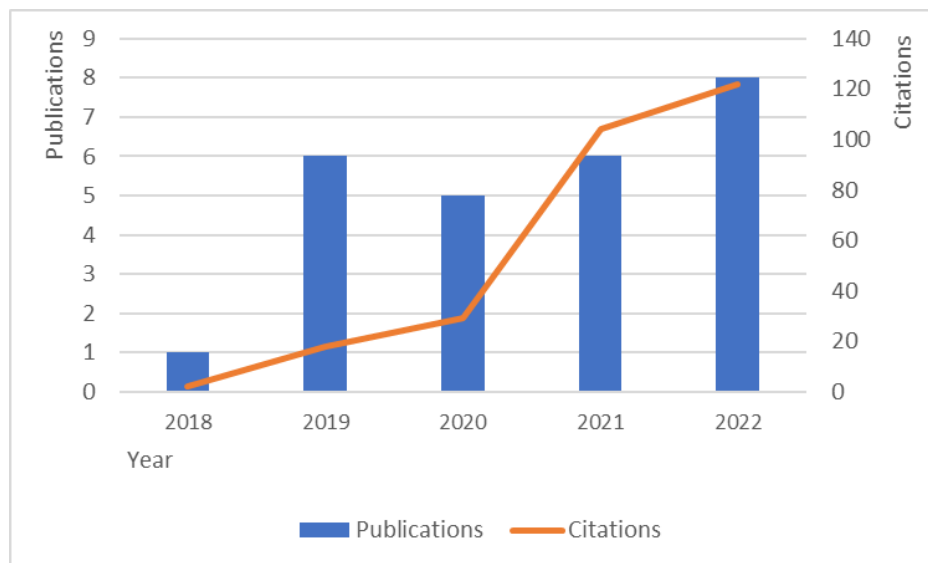


Figure 3. Publications and citations of publications

Vrchota and Řehoř (2019) are interested about a role of project management in a question on innovation and investment at all. In fact, companies applying project management are more innovative than other enterprises. There was found the dependence between project management and size of investment according to two-tailed Fisher test. Unfortunately, greater development of project management in enterprises is limited mostly by lack of skilled employees. Project management and particular HR management had been solved in this study. The research was done on 164 manufacturing enterprises in Czech Republic.

Pisar and Mazo (2020) made the research on 826 SME's enterprise from European Union. It was proved that change management and Industry 4.0 are one of the most affecting factors for companies controlling. This article highlights the importance of change management because nowadays the continuous improvement and changes are required. Also is mentioned that companies are usually ready to invest in technology etc., but investment in management and change management are low.

Whysall et al. (2019) study brought interesting findings. Industry 4.0 made a huge difference between actual employee capabilities or competencies and new requirements according to new technologies. It offers solution in way of transforming talent management. New skills-set are required, and companies HR departments are still not available to react adequately. It is necessary to made talent management more dynamic and become a part of strategic human resources management.

Jerman et al. (2019) at first describes concept of Smart factory and Industry 4.0 at all. Business models are characterized as well. Three main changes of the business model had been defined. It is automation (or digitization, robotization), integration of employees, products, and machines and last, but not least redefinition of roles of employees, machines, and products. The crucial factors for developing new business model are also mentioned. It

is leadership and top management, innovations, collective wisdom, and employee's motivation. It is important to note that this research was limited by only one case of a smart factory. The future research scenario is offered.

Heubeck and Meckl (2022) focused on dynamic managerial capabilities in connection with innovations and Industry 4.0. This research was done in 2019 on sample consisting of 2,920 German Industry 4.0 companies. Firm innovativeness was stated as dependent variable, the independent variables was stated as (i) managerial human capital, (ii) managerial cognition and (iii) managerial social capital. Six control variables were also defined. It was found out that managers with more dynamic managerial capabilities are supporting digital firms' innovativeness. Another question for HR departments had been offered.

Tick et al. (2019) investigates the dependence between digitalization on sustainability. 636 SME's companies from 6 countries participated on this research. Two partial results are offered. At first, it is confirmed, that SME's are not so open about question of sustainability or sustainable business models. More than half of a sample do not have sustainable goals in their long-term strategy. But according to second result, exploring or enabling of sustainable digitalization/digital sustainability had been proved. The authors defined term 'Digitainability'. The effect of digitalization and new technologies on sustainability had been proven. As authors mentioned, the results of this research cannot be generalized because of not enough representative sample.

Efimova and Bris (2021) examined the concept Quality 4.0 and TQM in closely connection to Industry 4.0. Especially the Industry 4.0 influence on Quality 4.0 had been solved. Two research question were established. It was found out, that modern technologies can significantly increase the quality management. Modern technologies, like IoT, machine learning and Big data made available large data stores and these stores are driving force for quality management. Process management transparency is not forgotten. The important role of Quality 4.0 in new quality management system had been mentioned. Second part of research was focused on customer satisfaction according to quality management change. It was proven that new technologies can improve the relationship between company and its client/his satisfaction.

Klovienė and Uosyte (2019) discovered that firms are using Industry 4.0 technologies to improve internal (logistics, production) and external (customer satisfaction) processes. It was also analyzed that in different Industry 4.0 clusters the different technologies are applied. Four most important benefits resulting from Industry 4.0 were defined as (i) cost saving, (ii) resource saving, (iii) faster processes and (iv.) improvement of products. It is also mentioned that Industry 4.0 had a great impact on company's value and supply chain. Several fields had been described as crucial, e.g. logistics, supply chain.

Sharma et al. (2022) examined the field of sustainable human resources management and Industry 4.0. The main aim was to find out if these factors are affecting the employability skills. Four main practices of HR management were chosen as crucial – flexibility, training, employee participation and employee empowerment. 198 employees answered the survey which was limited to North India. It was proven that all 4 practices had significant efficiency on employability skills. But the most significant factor is Industry 4.0 with new technologies.

Great and fast changes in environment are the reason of changing working conditions and requirement for staff.

Perkins et al. (2022) discussed – as the only ones – new concept that is also related to Industry 4.0 and fourth industrial revolution – Universal Basic Income. New HR policies and development is being discussed. But this paper does not include any qualitative or quantitative research method. Only thoughts and ideas are offer and no data had been collected.

Stachowicz and Nowicka-Skowron (2019) primarily defined 6 advantages and 9 threats created by new technologies and their using in company´s processes. Concept of SMART organization is discussed. Authors formulated conclusions for management model based on Industry 4.0 on three pillars – (i) positive organizational scholarship, (ii) the team with leaders is main management entity and (iii) new technologies, values and methods including management instrument must be integrated.

Lin and Wang (2022) discussed a question of talent management, Work 4.0 and impacts of new technologies on talent retention across different generations. The main outcome of this study can be identified as a fact that different generations (baby boomers, X and Y) are differently affected by new technologies and by concept Work 4.0. Furthermore, it was obtained that impacts of Work 4.0 and Industry 4.0 is the highest for generation Y. Another interesting fact is, that talent retention and talent management is different among different generations. It will be necessary to change concept of talent management in near future because of new technologies. Knowledge management will become crucial skill as well.

Črešnar and Nedelko (2020) also examined workplace with effect of concept Industry 4.0 across different generations and future leader skills were discussed as particular topic. This study´s sample was created from 371 respondents. Result of this study can be slightly disturbing because it was obtained skills regarded nowadays are not reflected in Industry 4.0 workplace. There will be necessary to change approach of leadership in most companies. As authors mentioned, universal, benevolent, and self-transcendence personal values will be the most appreciated and in demand.

Sansabas-Villalpando et al. (2019) analyzed organizational culture in model involving Industry 4.0 technologies and innovations in six different management fields. Sustainable, developing, and innovative organizational culture was the result of this analysis. It was obtained that organizational management is the area with the greatest influence. Process management and knowledge management are also decisive elements. Based on this research it can be said that organizational culture taking into account new technologies and sustainability will be based on these three management fields.

Szelagowski and Berniak-Wozny (2021) as many other authors investigate the field of process and business process management in connection with Industry 4.0. Unfortunately, no real scenario is offered. But it is obvious that process management is inseparable part of new technology implementation.

All topics discussed are illustrated by Table 3. According to this, the most discussed topics are: (i.) process management, (ii.) human resources management, (iii.) skills of employees, (iv.) change management, etc.

Table 3. Discussed topics

Author (Year)	Value chain	Process management	Process maturity	Skills of employees	Project management	HRM	Change management	Controlling	Industry 4.0 workplace	Talent management	Business model	Smart factory	Leadership	Managerial capabilities	Sustainability	Quality management	Universal Basic Income	Knowledge	Organizational culture
Potoczek (2021)	✓	✓	✓	✓															
Vrchota & Řehoř (2019)				✓	✓	✓													
Pisar & Mazo (2020)							✓	✓											
Whysall et al. (2019)				✓		✓			✓	✓									
Jerman et al. (2019)							✓				✓	✓	✓						
Heubeck & Meckl (2022)						✓								✓					
Tick et al. (2019)		✓									✓				✓				
Efimova & Bris (2021)		✓					✓									✓			
Klovienė & Uosyte (2019)	✓	✓																	
Sharma et al. (2022)				✓		✓	✓		✓						✓				
Perkins et al. (2022)						✓											✓		
Stachowicz & Nowicka-Skowron (2019)		✓											✓						
Lin & Wang (2022)				✓		✓			✓	✓								✓	
Črešnar & Nedelko (2020)									✓				✓						
Sansabas-Villalpando et al. (2019)		✓													✓			✓	✓
Szelagowski & Berniak- Wozny (2021)		✓																	

4. Discussion

First, this paper was limited by one database source which was Web of science. It provides number of quality articles, but it is worth mentioning that number of relevant sources can be found in other databases. Main aim of this article is to evaluate actual knowledge about what Industry 4.0 technologies are changing in various management fields. There are number of possibilities for further research. This theme can be further developed in different directions, for example by focusing on a specific field such as human resources or talent management with the implementation of specific research.

Authors believe that the following can be identified as the main fields that are undergoing major changes – process management, change management, talent management, human resources management. These topics are closely related to other solved areas like Industry 4.0 workplace, skills, leadership, and sustainability.

Many authors see the main way of implementing Industry 4.0 and its impacts through process management. Process maturity is a strongly discussed topic, e.g. Potoczek (2021). On the other hand, connection between process management and quality management related to customer satisfaction is being discussed (Efimova & Bris, 2021). Klovienė and Uosyte (2019)

does not neglect the fact that processes are internal and external and that both types need to be improved and changed. Tick et al. (2019) does not forget to mention that the issue of sustainability must also be addressed in connection with processes and the business model. However, some authors perceive process management rather as a supporting field, e.g. Sansabas-Villalpando et al. (2019).

It is possible to find author who see the biggest changes in the field of work, e.g. Lin and Wang (2022). There will be much more different skills in demand, as Whysall et al. (2019) mentioned. The whole HR field will undergo drastic changes in near future. The leadership area will be very affected, as well as the area of talent management. Heubeck and Meckl (2022) analyzed very thoroughly the impact of Industry 4.0 on dynamic managerial capabilities. It was proven that major changes in the world of work will be needed.

All these changes and their implementation is based on quality change management. This fact was mentioned by Pizar and Mazo (2020).

5. Conclusions

The main aim of this paper was to find out what management fields are more affected by fourth industrial revolution called 'Industry 4.0'. This aim was met as several fields of management which are highly affected were identified. An analysis of the literature on the topic was also carried out. The main contribution of this paper can be characterized as a systematic overview of knowledge on the given topic. The paper can serve for further research, either in the theoretical area, or it can be used as one of the basic theoretical starting points for further empirical research.

First, process management is highly affected. Digitalization is especially process question and high-quality processes, and their arrangement is currently at the forefront of managerial interest. Question of digital process maturity (or process maturity as well) is also a very important topic. Second, change management is important field because new changes need to be implemented all the time. This field of management is connected to everything in company, from organizational structure, through corporate culture and strategy, to human resources management and innovation management. These are main reason for being interested about the topic of Industry 4.0 and change management as main instrument for its implementation.

Enormous changes in fields of process management, human resources management, change management and talent managements are being expected. Last, but not least it is relevant to discuss topics like business model, value chain, new skills demanded or project management field.

It is obvious that connection on Industry 4.0 and change management or process management is becoming more important. More and more research is being done on this topic and the issue of implementing new technologies is crucial for business managers.

Sustainability pressures can be expected to intensify in the future. It is also worth mentioning that especially the field of human resources management and digitization has been significantly accelerated by the Covid-19 pandemic.

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Conflict of interest: none.

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