

Examining Industry 4.0 through the lens of human resource and knowledge management: Implications for SMEs

Tibor CSIZMADIA

University of Pannonia, Veszprém, Hungary

Nóra OBERMAYER

University of Pannonia, Veszprém, Hungary

obermayer.nora@gtk.uni-pannon.hu

Eszter BOGDÁNY

University of Pannonia, Veszprém, Hungary

Pál PURNHAUSER

University of Pannonia, Veszprém, Hungary

Zsuzsanna BANÁSZ

University of Pannonia, Veszprém, Hungary

Abstract. *The change caused by Industry 4.0 (I4.0) has fundamentally changed our lives and operations of organisations. The objective of the article is to reveal whether I4.0 implementation supports human workforces, knowledge sharing and knowledge storage in case of Hungarian small and medium-sized enterprises (SMEs). The data were obtained from 122 completed questionnaires out of 152 requests. The analysis is based on quantitative methodology, relationship analyses (Cramer's V) were used. The study was conducted in 2021 with the participation of Hungarian SMEs' leaders. Based on the results it can be concluded that the implementation of I4.0 technologies supports human workforces in SMEs. In addition, our study reveals that collaborative technologies and social media were implemented to support knowledge sharing in SMEs. At the same time, knowledge storage is not the primary purpose of implementing I4.0 technologies in SMEs. From a theoretical perspective, it contributes to enriching the empirical evidence on implementing I4.0 technologies and their impact on supporting human resources. From a practical point of view, the research identifies those I4.0 technologies that support SMEs in knowledge sharing. Collaborative technologies and social media can be implemented in order to advance the fields of Collaboration, Communication and Connecting. The originality of our research is given by the fact that, to the best of our knowledge, this is the first study that examines the aspects of I4.0 technologies in terms of human resource and knowledge sharing and storage in Hungarian SMEs.*

Keywords: industry 4.0, SME, human resource, knowledge management, knowledge sharing and storage.

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Introduction

For a decade, the concept of I4.0 has been arousing more and more research interest. The I4.0 movement (or new paradigm) is strongly techno-centric. Indeed, the primary driving factors are new technological applications, such as cyber-physical systems (CPS) (Xu et al., 2018), internet of things (Lu, 2017), cloud technologies (Lu, 2017), cobots (Bortolini et al., 2017), big data analysis (Wang et al., 2016), and additive manufacturing (Hofmann & Rüsch, 2017), which interconnects people, products and systems through real-time data exchange (Ghobakhloo, 2018). As a result of this interconnection, products, machines and processes with artificial intelligence (AI) will be able to adapt to changing environmental factors (Hecklau et al., 2016).

Consequently, many firms have begun a digital transformation journey, which encompasses potentially radical changes including physical infrastructure, process management and human resources (Gilchrist, 2016). Hence, on the one hand, some processes are expected to be simplified, and others to become much more complex and embedded. This is likely to lead to an increase in the number of higher skilled (digitally-skilled) jobs and a reduction in jobs requiring lower qualifications (Bălan et al., 2019; Némethy & Poór, 2018). The European Commission (2022) has been monitoring EU Member States' digital progress through the Digital Economy and Society Index (DESI) reports since 2014. The index is an effective tool for investigating the economic and social impact of digitalisation in the EU. Hungary ranks 22nd out of 27 EU Member States. The most challenging dimension for Hungary remains Integration of digital technology. The basic digital skills of Hungarian individuals and the basic level of digital intensity of Hungarian SMEs are still below the EU average, and the adoption of key digital technologies (e.g. big data, AI, collaborative cloud technologies) is very low. Thus the current research debate focuses, to a great extent, on the role of technologies in creating or destroying jobs (Weber, 2016). Recent works emphasise that machines and algorithms become the means for workers to continue to work instead of being replaced (Ferreira et al., 2014); means to accommodate issues related to ageing (Peruzzini & Pellicciari, 2016), disabilities or inexperience (Romero et al., 2015) and increase skill match, comfort and wellbeing (Fiasche et al., 2016).

On the other hand, gaining and sustaining competitive advantage is connected with the implementation of the I4.0 technologies and the emergence of knowledge-based systems in organisations (Sivathanu & Pillai, 2018; Martinez et al., 2017), where the effective acquisition, storage, and sharing of key information and knowledge predicts organisational success. In that sense, I4.0 technologies affect how knowledge is acquired, stored and transmitted (Ediz, 2018) and are calling for new managerial practises to facilitate knowledge management (KM) capabilities (Shamim et al., 2017). The implementation of I4.0 is changing the way of acquiring, transmitting and using knowledge. There are changes in the role of human workers, requirements for qualifications and new kinds of collaboration. New functionalities of KM, like the instant availability of knowledge and knowledge sharing between employees, become possible (Obermayer et al., 2022). Thus KM might become a key driver for assuring organisation's sustainability (Bratianu et al., 2020; Neumann & Evangelista, 2019).

In addition, academic investigation into I4.0 extensively focuses on large enterprises (Demeter et al., 2019; Losonci et al., 2019) and only marginally on SMEs (Estensoro et al., 2021). However, SMEs represent over 90% of the companies located in the EU and hire between 50-70% of the full-time equivalent of persons employed. Similarly, SMEs have been

the main players in Hungarian economic activities as they account for more than 99.8% of all companies and employ 69.7% of the Hungarian workforce (Szegedi et al., 2019). The impact of SMEs is also substantial; they create jobs, economic growth and ensure social stability (Wallsten, 2000). After facing the economic effects of COVID-19, digitalisation and moving toward I4.0 has become essential for organisations, including SMEs (Turkyilmaz et al., 2021, Horváth & Szabó, 2019). The COVID-19 has had a dramatic impact on SMEs (Bratianu, 2020), therefore it was expected that the post-COVID situation will force enterprises to disappear or to change their business and infrastructure management (Caballero-Morales, 2021). According to Zhang et al. (2020: 2227) "I4.0 technologies can enable firms to mitigate the risk of disruption so that they can continue their operations", moreover SMEs need to take actions in the I4.0 projects and to build the implementation strategies (Suleiman et al., 2021; Dima and Vasilache, 2009).

The aim of this study is to reveal whether I4.0 implementation supports human workforces, knowledge sharing and knowledge storage in case of Hungarian SMEs. Based on the arguments above, the present paper aims to provide answers to the following two research questions:

RQ1: Does the implementation of I4.0 technologies support human resources in SMEs?

RQ2: Does the implementation of I4.0 technologies support knowledge sharing and knowledge storage in SMEs?

The rest of this paper is organised as follows. Section 2 provides the theoretical background of the study. In Section 3, the research methodology is introduced, which is followed by the empirical findings in Section 4. Section 5 provides the discussion of the study addressing practical implications and limitations as well. The results are discussed in Section 5 and finally, the conclusions are presented in Section 6, along with suggestions for SME leaders.

Literature review

Industry 4.0

A generally accepted understanding of the term I4.0 does not exist (Hermann et al., 2016). I4.0, the fourth industrial revolution, is rather a multidisciplinary concept. It has been widely applied in the field of manufacturing (Piccarozzi et al., 2018) where it was first introduced, but a significant role can be seen in the propositions from technological perspective (Rüßmann et al., 2015; Gilchrist, 2016; Bibby & Dehe, 2018). Rüßmann et al. (2015) explain I4.0 as a new digital industrial technology that enables the connectivity and interaction among parts, machines, and humans and it can transform the manufacturing from single automated cells to fully integrated, automated facilities that communicate with one another.

All of the technological propositions acknowledge that I4.0 is a concept that embedded emerging technologies, but it is still not determined which of these technologies are under its umbrella (Gilchrist, 2016; Bibby & Dehe, 2018). In this paper, I4.0 represents the digital transformation in Hungarian SMEs referring to the following technologies, which came from the results of a previous qualitative research (Obermayer et al., 2022).

- Enterprise Resource Planning (ERP) systems: software package that pursues to integrate the complete series of a business's processes and functions to present a complete view of the business (Zeebaree et al., 2020).

- Collaborative technologies: use the Internet and remote servers to maintain shared documents and files through a cloud-based service that computers or mobile devices can access on demand (Lin et al., 2014).
- Social media: these computer-based tools facilitate the sharing of thoughts, knowledge and information through virtual networks and communities and offer great opportunities for collaboration (Obar & Wildman, 2015).
- 3D printing: creates three-dimensional objects based on digital models by layering or “printing” successive layers of materials using innovative inks including plastic, glass or wood (PWC, 2016).
- Big data: big volumes of data called “Big Data” (Rymarczyk, 2020).
- Autonomous robots: an autonomous robot is an intelligent machine capable of performing tasks without explicit human involvement (Gu et al., 2007).
- Cobot: collaborative robots are intended to work and physically interact alongside human workers in a shared workspace (Cohen et al., 2019).
- Data collection tools: methods of automatically identifying and collecting data without human involvement (Smith, 2016).
- Production planning and scheduling software: remote controlling and monitoring of the manufacturing through the automated systems without the need of human presence (Shen et al., 2021).
- Augmented reality (AR): addition of information to the physical world, through a graphics or audio overlay, in order to improve the user experience for a task or a product (PWC, 2016).
- Virtual reality (VR) devices: computer-generated simulation of a three-dimensional image or a complete environment, within a defined space, that viewers can interact with in realistic ways (PWC, 2016).

Several research concluded the barriers and challenges on implementing I4.0 technologies (Galati & Bigliardi, 2019; Mohamed, 2018; Németh et al., 2020; Obermayer et al., 2021a). The majority of organisations are hesitant to integrate I4.0 due to the uncertainty of financial benefits and a lack of knowledge and skills (Mohamed, 2018). Especially for SMEs, with increased levels of complexity, the real benefits and requirements are not clear (Galati & Bigliardi, 2019). SMEs are organisations that employ at most 250 people and have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million (European Commission, 2015). There is less research on investigating I4.0 in SMEs (Amaral & Peças, 2021; Szabó et al., 2020) and most of them deal with the hurdles and obstacles (Schumacher et al., 2016; Darnley et al., 2018). These reviews are related to the lack of financial resources, the lack of technically skilled labour and limited human capital.

Human perspective

While the implementation of I4.0 technologies exist together in the physical and digital world, human factors have only recently begun receiving increased attention (Nunes et al., 2015). The current research debate in terms of human factors focuses, to a great extent, on the role of technologies in creating or destroying jobs (Weber, 2016). Emmanouilidis et al. (2019) states for example, that I4.0 technologies can prevent cognitive overload for human operators, rather than replacing their function. Specifically, a human operator receiving a range of automated decision recommendations, needs to identify an appropriate

recommended action and apply it to physical assets. This can result in IoT-driven intelligence, where human and non-human actors' interaction greatly enhance human workers and their decision capabilities (Ma et al., 2017). Furthermore, Fantini et al. (2016) proposed human involvement in industrial environments including interaction with ERP, simulation, analytics, data management, as well as lower level shop floor activities delivering flexibility in CPS-enabled manufacturing environments. In addition, collaborative robots support assembly workers, exoskeletons empower production and logistics workers, and cloud-based software solutions for enterprises are emerging at a high pace (Osterrieder et al., 2020). These examples are just a few new forms of interaction between humans and I4.0 technologies within organisations, however, highlight the various and novel interactions humans are confronted with.

Moreover, from a different perspective, Berger and Frey (2016) have stated that I4.0 technologies have had a skill-biased effect on jobs, negatively impacting medium skill and routine jobs rather than low and high skill jobs. According to the analysis by Frey and Osborne (2017), jobs more susceptible to be substituted from technology are routine based, requiring no manual dexterity or social interaction. Other research supports that analytical, interactive, and problem-solving skills have become increasingly in demand (Berger & Frey, 2016). These demands will increase the cognitive load of workers and change the ratio between physical and cognitive load (Kong, 2019). However, Kagermann et al. (2013) suggested that these emerging changes will lead to benefits, such as greater job enrichment, more interesting working environments, and increased autonomy for the workers. However, there are studies like Obermayer et al. (2022) concluded that implementation of I4.0 technologies rather replaced workers' jobs.

To conclude, identifying appropriate ways to make such interaction more effective and better integrate humans with non-human actors is still open to research. Research identifying the relationship between humans and technology in SMEs is still even more limited. Based on the arguments above, the following hypothesis could be formulated:

H1: The implementation of I4.0 technologies supports human resources in SMEs.

Knowledge management perspective

KM has a significant role in the era of I4.0 from both human- and technological perspectives (Ansari, 2019; Salvadorinho & Teixeira, 2021). It is one of the biggest challenges for organisations, and for SMEs, it is more important because they cannot afford financial investment needed to achieve a high business value from KM (Salvadorinho & Teixeira, 2021). KM is a systematic and organised approach to improve organisations' ability to mobilise knowledge to enhance performance (Obermayer & Tóth, 2020). The lifecycle of KM has four key elements, knowledge creation, knowledge sharing, knowledge storage and knowledge utilisation (García-Holgado et al., 2015). In the environment of I4.0 it is perceived that there is a lack of knowledge sharing and a lack of understanding of how organisations should integrate I4.0 technologies (e.g. knowledge storage) in order to improve their businesses (Hurst et al., 2019). Recent approaches identify knowledge sharing and storage as the main components of KM from I4.0 perspective (García-Holgado et al., 2015; Li et al., 2019; Ansari, 2019; Salvadorinho & Teixeira, 2021), thus these elements are in the centre of our paper.

Technology is a key element in KM, since it is able to integrate, disseminate and store knowledge (Abubakar et al., 2019), however, in the term of rapid knowledge change that

characterises I4.0, it is important to deal with managing these processes. I4.0 establishes new challenges and requirements to the KM (Salvadorinho & Teixeira, 2021). The high-performance and low-cost feature of the I4.0 suits for storage and sharing (Yang & Gu, 2021). It is also essential to establish the connection between humans and digital systems and to ensure the adequate sharing of technical information and knowledge (Mourtzis et al., 2019). North & Maier (2018) assumed that utilising digital technologies enhancing value creation through knowledge sharing.

I4.0 technologies have the possibility to simplify the sharing of knowledge in SMEs and support digitalisation like knowledge storage. According to the study of Ansari (2019) I4.0 technologies have been predicted as facilitators of KM, as digital technologies are able to create and share knowledge, thus KM in the context of I4.0 is an enabler to maximise competitive advantages and derive business values in organisations. In their study, Dassisti et al. (2019) state that SMEs are often characterised by poorly formalised processes and technology systems, and they lack IT competences and related technological knowledge and KM. There are studies (Turkyilmaz et al., 2021; Criado et al., 2020) dealing with the use of digital technologies to promote collaboration, dissemination of information and knowledge during the COVID-19. Turkyilmaz et al. (2021) states an insufficient understanding of the economic benefits of digitalisation and identifies a positive impact of I4.0 for SMEs that potentially facilitate the knowledge sharing environment. At the same time, Li et al. (2019) stated that there is a lack of SMEs having implemented I4.0 with the purpose of improving knowledge sharing activities. Criado et al. (2020) identified collaborative technologies and social media as the most important practises for knowledge sharing during the COVID-19. Obermayer et al. (2021b) also stated that social media tools bring knowledge sharing to a new level and benefits for businesses. Based on the arguments above, the following hypothesis could be determined:

H2a: The implementation of I4.0 technologies support knowledge sharing in SMEs.

H2b: The implementation of I4.0 technologies support knowledge storage in SMEs.

Research methodology

The target groups of the research are Hungarian SMEs because the authors were eager to know the implementation of I4.0 technologies in their own country. The aim of this study is to reveal whether I4.0 implementation supports human workforces, knowledge sharing and knowledge storage in case of Hungarian small and medium-sized enterprises (SMEs), where the number of employees does not exceed 250 people. The analysis is based on a quantitative methodology whereby descriptive and inferential statistics were applied. During the data collection process a pilot questionnaire was compiled, which was tested by SME leaders who had the opportunity to give feedback about the comprehensibility of the content. Based on the feedback, the questionnaire was finalised and sent out to the MBA students of University of Pannonia (152 people) who are leaders of Hungarian SMEs. The study was conducted between February and May 2021, during the period of COVID-19 with the participation of Hungarian SMEs' leaders via the LimeSurvey online system. Table 1 contains the questions examined from the questionnaire and their possible answers. All questions were asked related to I4.0 technologies listed in the last column: how often they were used, and whether the implementation of these technologies was intended to support human resources or to share or store knowledge. The frequency of application can be measured on an ordinal scale, the measurement levels of the other questions are nominal.

Table 1. Most related questions from the questionnaire

Section	Explanation	Level of measurement	I4.0 technologies
How often the following Industry 4.0 technology was applied?	Frequency: daily, weekly, monthly, less than monthly, never	Ordinal	ERP systems (Oracle, SAP, etc.), Collaborative technologies (GoogleDrive, SharePoint, etc.), Social media (Facebook, Skype, Viber, etc.), 3D printing, Big data, Autonomous robots, Cobot (Collaborative robot), Data collection tools (RFID, sensors, 3D scanner, etc.), Production planning and scheduling software (Asprove, etc.), Augmented reality (AR) (Microsoft Hololens, etc.), Virtual reality (VR) devices
Were the following Industry 4.0 technologies implemented to support human workers?	Multiple answers are possible	Nominal	
Were the following Industry 4.0 technologies implemented to support knowledge sharing?	Multiple answers are possible	Nominal	
Were the following Industry 4.0 technologies implemented to support knowledge storage?	Multiple answers are possible	Nominal	

Source: Authors' own research.

In the research, the explanatory variable is the frequency of application of I4.0 technologies, and the answers to the other questions are the indicators to be explained (supporting human resources and possibility of knowledge sharing and storage).

In order to reveal the association between variables Crosstabs' statistics and measures were applied. Cramer's V was used in order to measure the strength of the association ($0 < V \leq 0.2$ weak, $0.2 < V \leq 0.7$ moderate, $0.7 < V < 1$ strong association) (Sajtos & Mitev 2007). The relationship is significant, if the p-value of Cramer's V is less than 0.05.

Results and discussion

The data were obtained from 122 completed questionnaires collected. Table 2 presents the sample by sector and size (number of employees).

Table 2. Description of the sample

Variable	Type	Frequency	Relative frequency
Sector (Main activity)	Manufacturer	75	61.48
	Service provider	47	38.52
Size (Number of employees)	Micro and small-sized enterprise (<51 employees)	62	50.82
	Medium-sized enterprise (51-250 employees)	60	49.18

Source: Authors' own research.

The questionnaire was typically completed by manufacturing enterprises (61.48%) rather than service providers (38.52%). By the number of employees (as the proxy of enterprises' size) the sample is balanced concerning the micro and small-sized enterprises (50.82%) and the medium-sized ones (49.18%).

Empirical results

The results (the Cramer's V values) of the relationship analyses are summarised in Table 3.

Table 3. The values of the Cramer's V between explanatory variable and response variables

Explanatory variable	Response variables		
Implementation of I4.0 technologies	Were the following Industry 4.0 technologies implemented to support		
	human resources?	knowledge sharing?	knowledge storage?
ERP systems	<i>0.833</i>	0.431	0.470
Collaborative technologies	<i>0.746</i>	0.465	0.387
Social media	0.559	0.357	-
3D printing	<i>0.777</i>	-	-
Big data	<i>0.687</i>	0.486	0.498
Autonomous robots	0.629	0.573	-
Cobot	<i>0.699</i>	0.400	0.400
Data collection tools	<i>0.643</i>	-	0.393
Production planning and scheduling software	<i>0.756</i>	0.510	0.361
Augmented reality (AR)	<i>0.786</i>	<i>0.738</i>	<i>0.775</i>
Virtual reality (VR) devices	<i>0.845</i>	<i>0.779</i>	<i>0.813</i>

-: not significant results

For significant results (Cramer's V):

- type of letters: regular fonts mean moderate relationships, italic fonts mean strong relationships
- background color indicates typical answers (modes) to response variables
 - grey: the typical answer is 'yes'
 - white: the typical answer is 'no'

Source: Authors' own research.

Of the 33 relationships examined in Table 3, only 5 did not show significant results (marked with '-'). The 28 significant relationships were distinguished in two ways. On the one hand, the thickness of the letter indicates the strength of the relationship: regular fonts sign moderate relationships, and italic fonts denote the strong relationships. On the other hand, the background colour of the cells represents the modes of the response variables. Grey cells indicate if the specific I4.0 technology was implemented to support human resources or knowledge sharing or storage for most SMEs. In these cases, the response variable was typically answered 'yes'. For the other results (white background Cramer's V values) the majority of respondents answered 'no' to the response variables, i.e. the given I4.0 technology was not implemented to support the response variable.

Related to the first research question (RQ1: Does the implementation of I4.0 technologies support human resources in SMEs?), the implementation of I4.0 was analysed whether it supports the work of employees in Hungarian SMEs. According to the results of Cramer's V, a statistically significant, moderate (regular) or strong (italic) relationships were identified between the implementation of the I4.0 technologies and supporting human resources (Cramer's V was above 0.55 in each case). There are moderate relationships between the implementation of several I4.0 technologies (social media, big data, autonomous robots, cobot, data collection tools) and whether these technologies were introduced with the aim of supporting human resources. This relationship is strong for the following technologies: ERP systems, collaborative technologies, 3D printing, production planning and

scheduling software, AR and VR devices. Focusing on the background colour of the results, it can be concluded that the implementation of each examined I4.0 technologies - except the autonomous robots - supports human resources in the Hungarian SMEs.

Based on Hypothesis 1 (H1: The implementation of I4.0 technologies supports human resources in SMEs), our research confirmed that implementing I4.0 technologies such as ERP systems, collaborative technologies, social media, 3D printing, big data, cobot, data collection tools, production planning and scheduling software, AR, VR devices supports human resources in SMEs.

Concerning the second research question (RQ2: Does the implementation of I4.0 technologies support knowledge sharing and knowledge storage in SMEs?), the implementation of I4.0 technologies was analysed whether it affects knowledge sharing and storage in SMEs. Related to knowledge sharing, statistically significant, moderate or strong relationships were identified between the implementation of I4.0 technologies and knowledge sharing. The Cramer's V values were between 0.3 and 0.8 in each significant results. Moderate relationships were detected for the following I4.0 technologies: ERP systems, collaborative technologies, social media, big data, autonomous robots, cobot, production planning and scheduling software. The relationship is strong in case of AR and VR devices. According to the results of Cramer's V there was no significant relationship between the frequency of using 3D printing and data collection tools and whether their implementation aimed to support knowledge sharing. Concentrating on the gray highlighted results, it was concluded that the implementation of collaborative technologies and social media were implemented to support knowledge sharing.

Based on Hypothesis 2a (H2a: The implementation of I4.0 technologies supports knowledge sharing in SMEs), our research confirmed that implementing collaborative technologies and social media support knowledge sharing in SMEs.

Finally, related to the relationships between the implementation of I4.0 technologies and knowledge storage, we found significant moderate relationships related to ERP systems, collaborative technologies, big data, cobot, data collection tools, production planning and scheduling software. Moreover, significant strong relationships were determined in cases of AR and VR devices. However, there were non-significant relationships in three cases such as social media, 3D printing and autonomous robots. Because none of the cells in the last column of Table 3 are grey, it means that the main goal of implementing any of the examined I4.0 technologies is not to support knowledge storage.

Based on Hypothesis 2b (H2b: The implementation I4.0 technologies supports knowledge storage in SMEs), our research proved that implementing I4.0 technologies is not aimed to support knowledge sharing in SMEs. Table 4 summarises the research results, their practical implications, and their economic impact.

Table 4. Summary of research results and implications

Research questions	Results	Implications	Economic impact
RQ1: Does the implementation of I4.0 technologies support human resources in SMEs?	The following I4.0 technologies support human resources in SMEs: ERP systems, collaborative technologies, social media, 3D printing, big data, cobot, data collection tools, production planning and scheduling software, AR, VR devices.	<p>I4.0 technologies simplify and restructure the work of human resources, and reduce the non-value creating activities (e.g. administration work, monotonous workflow).</p> <p>I4.0 technologies enable that workforces put more emphasis on value-added activities (e.g. decision-making, innovation capability).</p>	<ul style="list-style-type: none"> - increased efficiency - high investment: ERP systems, 3D printing, big data, cobot, data collection tools, production planning and scheduling software, AR and VR devices - high training cost - high operating expenses: e.g. administration expenses, software licence and maintenance
RQ2: Does the implementation of I4.0 technologies support knowledge sharing and knowledge storage in SMEs?	<p>We have investigated the following I4.0 technologies in terms of supporting knowledge sharing in SMEs: ERP systems, Collaborative technologies, Social media, 3D printing, Big data, Autonomous robots, Cobot, Data collection tools, Production planning and scheduling software, Augmented reality (AR), Virtual reality (VR). Our results show that only two of these I4.0 technologies, the collaborative technologies and social media tools support knowledge sharing in SMEs.</p> <p>We have investigated the following I4.0 technologies in terms of supporting knowledge storage in SMEs: ERP systems, Collaborative technologies, Social media, 3D printing, Big data, Autonomous robots, Cobot, Data collection tools, Production planning and scheduling software, Augmented reality (AR), Virtual reality (VR). Our results show that their implementation does not support knowledge storage in SMEs.</p>	<p>Collaborative technologies facilitate group work, both in office and remote.</p> <p>Collaborative technologies support the elimination of time and place dependency.</p> <p>SMEs' leaders can have immediate access to knowledge, information and data.</p> <p>Collaborative technologies and social media allow for accessible and low-cost interactive communication and information and knowledge sharing among customers, managers and employees decreasing the amount of emails and phone calls.</p> <p>Social media can increase the autonomy and influence the social networks of workforces.</p> <p>Collaborative technologies and social media boost operational flexibility.</p>	<ul style="list-style-type: none"> - reduced cost and time - increased efficiency low investment: social media and collaborative technologies low training cost low administration expenses low occasional costs: e.g. fixing a compatibility problem, influencer fee and marketing cost

Source: Authors' own research.

Discussion

Overall, our findings revealed that the implementation of I4.0 technologies supports human resources in SMEs. Results indicate the significant role of digital technologies in SMEs. I4.0 technologies simplify and restructure the work of human resources, to create a more comfortable working environment. Moreover, as a result of implementing digital technologies, the workforce can be redeployed towards reducing the non-value creating activities. This result is in line with the findings of Ma et al. (2017) and Osterrieder et al. (2020), who concluded that human and non-human actors' interaction greatly supported human resources and their decision-making capabilities. It is interesting to note that our research confirmed that implementing autonomous robots does not support human resources in SMEs, which is consistent with the determination of Gu et al. (2007), as an autonomous robot can perform tasks without human resources, in other way, these robots rather replace human resources.

Our research indicates that the implementation of I4.0 technologies is being diverged. Our results, corroborating the findings of Dassisti et al. (2019) and Li et al. (2019) demonstrate evidence that the primary aim of implementing most of the I4.0 technologies is not knowledge-sharing. However, most of our outcome is contrary to that of Turkeyilmaz et al. (2021) who found an essential role of utilising I4.0 technologies for knowledge sharing in SMEs. In addition, our findings indicate that in case of collaborative technologies and social media, the aim of their implementation is to support knowledge sharing during the COVID-19, which seems to be consistent with Criado et al. (2020). This indicates the outstanding role of collaborative technologies and social media in SMEs during COVID-19. Furthermore, no evidence was found for implementing I4.0 technologies as a main purpose to support knowledge storage. Taken together, these results also demonstrate that related to the lifecycle of KM (García-Holgado et al., 2015) in terms of I4.0 technologies, the knowledge-sharing has already appeared, however the knowledge storage has not been in the focus yet in SMEs. Table 5 summarises examples for SME managers.

Table 5. Examples of using collaborative technologies and social media in SMEs

I4.0 technologies	Category	Types
Collaborative technologies	Collaboration	Groupware - GoogleDrive GoogleDrive, as a free groupware supports collaborative creation and sharing of knowledge. It can be used for sharing the documents without sending them via e-mails, but only sharing the link of the document. Who have access to the GoogleDrive have the chance to modify the documents (text documents, spreadsheets, forms and presentations can be created, edited, stored and shared). GoogleDrive is useful when SME's colleagues - with Internet access - want to collaborate on the creation and maintenance of files and easily share them with others online.
		Communities of practice - Meetup Business meetups provide a forum for professionals to share knowledge and experience in a supportive, learning-centric environment. This online social networking portal allows SMEs to find and join groups of people who gather around a common interest. There are thousands of entrepreneurs who gather together to learn and support one another through Meetup groups.

I4.0 technologies	Category	Types
Social media technologies	Communication	Instant Messaging Service - Skype/Teams/Zoom Facilitate near real-time text based or video communication and knowledge sharing between two or more colleagues over a network. SMEs can use it for quick questions and clarifications, for coordinating and scheduling tasks or social meetings. Moreover, it has additional features like the immediate receipt of acknowledgment or reply, group chatting, conference services (including voice and video) or conversation logging and file transfer. It is also possible to save a conversation for later reference. There can be numerous negotiations take place across national borders, and this tool means a cost-effective solution for SMEs.
		Video Sharing - YouTube Using video to share knowledge brings a visual aspect that can quickly convey ideas that may take much longer in text. SMEs can use it for demonstration of something (procedure) or to capture of a live event to share widely out on the web to those who could not be there.
	Connecting	Social Networking Services - Facebook SMEs can create a Facebook profile with the aim to share information and knowledge to the followers. By focusing on the SME's internal communication, the specific information is shared only with the members. By focusing on the wider audience, the page is accessible for all the potential clients, partners and shared information is informative, commercial, focusing on latest news, achievements and so on. Facebook can become as part of the SME's webpage.

Source: Authors' own research.

Conclusion

This empirical research indicated a variety of novel conclusions. The novel side of this topic is related to the dynamic nature of implementing I4.0 technologies, however, previous research was more focused on large enterprises rather than SMEs. This paper contributes to filling this gap by providing empirical evidence on implementing I4.0 technologies in terms of human resource and knowledge management perspective in SMEs. Among others, our research concludes that the implementation of I4.0 technologies supports human resources. In addition, the implementation of collaborative technologies and social media can lead to survival of SMEs during COVID-19.

Verification of hypotheses

Our results show that two of the hypotheses are accepted. The implementation of I4.0 technologies such as ERP systems, collaborative technologies, social media, 3D printing, big data, cobot, data collection tools, production planning and scheduling software, AR, VR devices supports human resources in SMEs, so Hypothesis 1 is accepted. We find that two I4.0 technologies, collaborative technologies and social media support knowledge sharing in SMEs, it means that Hypothesis 2a is accepted. Our research proves that implementing I4.0 technologies does not support knowledge storage in SMEs, thus Hypothesis 2b is not accepted.

Theoretical, practical and social implication

This research contributes to the existing literature in two ways. First, it identifies those I4.0 technologies that support human resources in SMEs. Thus this paper has shed some light in one of the most important questions related to Industry 4.0 and human resources, i.e. I4.0 supports or replaces human resources. Our results show that the implementation of I4.0 technologies such as ERP systems, collaborative technologies, social media, 3D printing, big data, cobot, data collection tools, production planning and scheduling software, AR, VR devices supports human resources in SMEs. Second, it draws attention to those two technologies, social media and collaborative technologies, which are considered a knowledge sharing technology for Hungarian SMEs. The result highlights the importance of social interaction and cooperation in the knowledge-based society.

From a managerial point of view, our research offers managers and executives of SMEs with a clear indication as to which I4.0 technology ought to be adapted in order to support human resources. I4.0 technologies increase efficiency, thereby simplifying and restructuring the work of human resources, reducing the non-value creating activities and enabling that workforces put more emphasis on value-added activities. Our findings also demonstrate that the role of two studied I4.0 technologies, namely collaborative technologies and social media has been intensified during COVID-19. Collaborative technologies are designed to better facilitate group work, both in office and remote, and in the meantime reduce costs and time. Hungarian SMEs supported human resources working towards common goals and projects online and allowed them to use their time more effectively, as digital collaborative tools could automate many project management, communication, and administration tasks. Social media tools could bring knowledge and information sharing, communication and marketing to a new level and benefit both SMEs and their customers. It provided a great opportunity of high exposure at low cost; it offered a possibility for an interactive communication with customers and to gather more information on their needs.

Our research results also have a social impact. The ability of citizens and workforces to acquire digital competence is a high priority. Supporting and encouraging workforces at Hungarian SMEs to use I4.0 technologies will also improve their digital competence, which will contribute to achieving a better place based on the DESI index. It means that more of the citizens will have basic digital skills and the basic level of digital intensity of Hungarian SMEs will grow.

Limitation and future research

As with most studies, this research offers interesting insights, but it is also affected by some limitations. As the paper focuses on the implementation of I4.0 technologies and its impact on human resources and knowledge sharing and storage in Hungarian SMEs, a comparison with other countries would be an interesting option for further research. Moreover, it would be interesting to conduct structured interviews with leaders of SMEs in order to better understand the issues raised by our empirical investigation. In view of the many contingencies that might affect SMEs' engagement in implementing I4.0 technologies, we have only started to scratch the surface of the issues that need to be investigated. Nevertheless, we hope that our examination will encourage other scholars to tackle some of the promising future research avenues, paving the way for studies at the intersection of I4.0 technologies and human aspects.

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