

Industry 4.0 technologies usage: motives and enablers

Industry 4.0
technologies
usage

Tomaž Čater

*Department of Management and Organization, School of Economics and Business,
University of Ljubljana, Ljubljana, Slovenia, and*

Barbara Čater, Matej Černe, Matjaž Koman and Tjaša Redek
School of Economics and Business, University of Ljubljana, Ljubljana, Slovenia

323

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Abstract

Purpose – The paper aims to contribute to a better understanding of the drivers for the use of Industry 4.0 technologies by investigating (1) what motivates companies to consider using I4 technologies and (2) what enables (or hinders) the intention to use I4 technologies to translate into their actual use.

Design/methodology/approach – The study uses survey data collected from a sample of export-oriented manufacturing companies with more than 10 employees. Final analysis is conducted on 124 companies.

Findings – The results show that companies are proactively approaching I4. Only efficiency motives and expected competitive advantage have a positive effect on the intention to use I4 technologies, which in turn positively influences their actual use. The external, legitimacy-based, motives do not play a significant role in explaining the intention to use. With respect to I4 technology enablers, employee competency positively moderates and availability of finance negatively moderates the relationship between intention to use and actual use.

Research limitations/implications – The work extends the existing knowledge base on I4 technology drivers in companies that are not major global trendsetters but are heavily embedded in the value chains of companies from the most industrially developed economies. The study is limited to manufacturing companies in a small European economy and should be retested in other contexts.

Practical implications – The study can help managers implement I4 technologies in their companies more successfully.

Originality/value – We take a novel research approach by proposing a framework that clearly distinguishes between motives and enablers for the use of I4 technologies.

Keywords Industry 4.0, Technology, Actual use, Intention to use, Enablers, Motives

Paper type Research paper

1. Introduction

The fourth industrial revolution known as Industry 4.0 (I4) brought about many new technologies in the field of business process digitalization (Ghobakhloo, 2018). The major advantages of introducing new technologies are increasing productivity and resource savings, process transparency, more profitable business models, higher quality and improved workplace conditions (Müller *et al.*, 2018b; Staufen, 2018; Nosalska *et al.*, 2019). Closely linking products and machines increases efficiency, reduces costs and saves resources. Intelligent surveillance and transparent procedures provide businesses with a constant overview of the business process, which enables them to respond quickly and with flexibility to changes in the market. Intelligent products and machines collect various data that help develop new products and services and enable optimization of production processes (Brettel *et al.*, 2014).



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Despite these advantages, it is still unclear what will be the impact of I4 on companies (Hermann *et al.*, 2019). There are many challenges, including issues related to information technology security and data protection, the organization of work, lack of skills, training of skilled workers and the development of uniform standards required in the digitized economy (Stanton Chase, 2017).

The awareness that I4 technologies' adoption and use not only brings forth advantages but also challenges (Johansson *et al.*, 2019; Szalavetz, 2019; Zheng *et al.*, 2019) poses a number of questions of which one of the most important is "What drives I4 technologies' usage?". While integrating and using a disruptive technology early can provide a small company with an opportunity to compete with larger competitors, the adoption of a poor-fitting technology may not lead to the subsequent use of such technology and is likely to leave the company at a competitive disadvantage (Tellis, 2006). Given the risk/reward trade-off inherent in new technology adoption, the need to correctly understand the drivers of adoption and use is evident (Obal, 2017). With the purpose of contributing to a better understanding of these drivers, this study aims to investigate (1) what motivates companies to consider the use of I4 technologies and (2) what enables/hinders (but not motivates) the intention to use I4 technologies to translate into their actual use.

The first intended contribution of this paper to the literature is therefore in conceptualizing and testing the research framework that clearly distinguishes between the motives and enablers of I4 technology usage. While internal and external motives help us understand why companies would use I4 technologies, sufficient finance, knowledgeable people, etc. do not motivate the use of I4 technologies but rather enable it. Although the literature already addresses the issue of the lack of enabling factors (or the existence of obstacles) that may hinder the use of new technologies (Neto *et al.*, 2017), these enablers have not yet been conceptualized as moderators in a structural model. This is important as such a perspective enables us to capture boundary conditions for transforming intentions into actual use, thereby providing researchers and managers with a more comprehensive framework of complex interactions between relevant variables leading to the actual use of technology.

Second, in delineating among motives and enablers and specifying their different roles in the model, our paper draws on different theoretical approaches and aims to contribute to developing a more cohesive and consistent theory in the field. More specifically, by combining the motivation perspective that builds on the transaction cost theory and institutional theory (Roberts and Greenwood, 1997; Grewal *et al.*, 2001; Son and Benbasat, 2007), the technology acceptance model (Davis, 1986; Davis *et al.*, 1989), the unified theory of the acceptance and use of technology (Venkatesh *et al.*, 2003) and the resource/capability-based view (Barney, 1991; Winter, 2003), our paper intends to add to the development of an overarching theoretical framework in the field of I4 technologies usage.

Finally, a number of studies have been carried out on the topic of I4 in developed economies, which are considered to be the leaders of the global economy (a more detailed review is provided in Liao *et al.* (2017), Piccarozzi *et al.* (2018), Mariani and Borghi (2019). On the other hand, much less is known about the progress of I4 in countries that are considered to be the followers of global development (Čater *et al.*, 2019). By setting our study in an open European economy, the third intended contribution of this paper is to add to the knowledge base on the drivers of I4 technologies in companies which are (more often than not) technological followers, strongly embedded in the global value chains of companies from the most industrially developed economies.

2. Theoretical background and hypotheses development

2.1 Industry 4.0 technologies

Industry 4.0 denotes a paradigm that makes an organization "smart" by applying advanced information and communication systems and future-oriented technologies (Sanders *et al.*, 2016).

The focus of I4 is on digital-technology-based solutions, which change the way companies create value (Oesterreich and Teuteberg, 2016), and the extensive interconnection of the physical and virtual worlds (Veile *et al.*, 2020). While the emphasis on new technologies means the I4 paradigm is strongly techno-centric (Cimini *et al.*, 2021), its interconnecting character suggests the full potential of I4 can only be leveraged across value chains of multiple organizations and not in the isolated environment of a single organization (Müller *et al.*, 2018; Veile *et al.*, 2019). Büchi *et al.* (2020) propose that a company's openness to Industry 4.0 can be measured in terms of breadth (the number of technologies adopted by the company) and depth (the number of stages in the company's value chain in which these technologies are implemented).

Compared to more traditional and simple digital technologies (electronic data interchange, administrative software packages, etc.), I4 technologies are significantly more complex, knowledge-intensive and heavily integrated into organizations' core processes (Kamble *et al.*, 2018). In addition, their common characteristics are the use of wireless networks, assistance in decision-making and interconnections between individual technologies (Dos Santos *et al.*, 2021). Frequently discussed I4 technologies in the literature (e.g. Posada *et al.*, 2015; Ghobakhloo and Ching, 2019; Bosman *et al.*, 2020; Büchi *et al.*, 2020; Dos Santos *et al.*, 2021) include additive manufacturing, artificial intelligence, augmented/virtual reality, (industrial) automation, big data, cloud computing/storage, cyber physical systems, cybersecurity, enterprise resource planning, industrial Internet, Internet of things and intelligent/autonomous robotics.

While most of the literature does not differentiate between levels of I4 technologies, Ghobakhloo and Ching (2019) distinguish between second-tier (cyber physical systems, Internet of things) and first-tier (all other) technologies. Although first-tier technologies need to interact with each other to deliver their full functionalities, they can still operate independently. In contrast, second-tier technologies are not "off-the-shelf products" because their use relies on the implementation of various combinations of first-tier technologies (Ghobakhloo and Ching, 2019). Similarly, Frank *et al.* (2019) divide I4 technologies into two distinct layers according to their main objective. The front-end technologies (smart manufacturing, smart products, smart supply chain, smart working) deal with operational and market needs and have an end-application purpose for the companies' value chain. The base technologies (Internet of things, cloud, big data and analytics) include technologies that provide connectivity and intelligence for front-end technologies.

2.2 The overarching theoretical approach behind the hypothesized model

Our paper follows the overarching theoretical approach whereby connections are achieved through a set of overarching ideas that comprise the model. The model can therefore be viewed as a combination of previously developed theoretical approaches (Cumming, 2014). In conceptualizing our hypothesized model, we build on the organizational motivation, resource/capability-based and technology acceptance literature, as well as their underlying theories, and propose the moderated mediation model depicted in Figure 1. The model's main part investigates the influence of external/reactive (competitor, supplier and customer pressures) and internal/proactive (efficiency and expected competitive advantage) motives on the intention to use I4 technologies, and the latter's influence on the actual use of I4 technologies. On top of these causal links which constitute the mediation model, we inspect the moderation effect of three enabling factors (finance, people and organizational fit) on the link between the intention to use and the actual use of I4 technologies. All links are hypothesized to be positive. The remainder of this section presents the theories we build on and provides detailed arguments for the proposed hypotheses.

2.3 Motives for using new technologies

2.3.1 Theoretical background.

In conceptualizing the motives for I4 technology usage, we build on the motivation perspective for innovation adoption in organizational markets, which

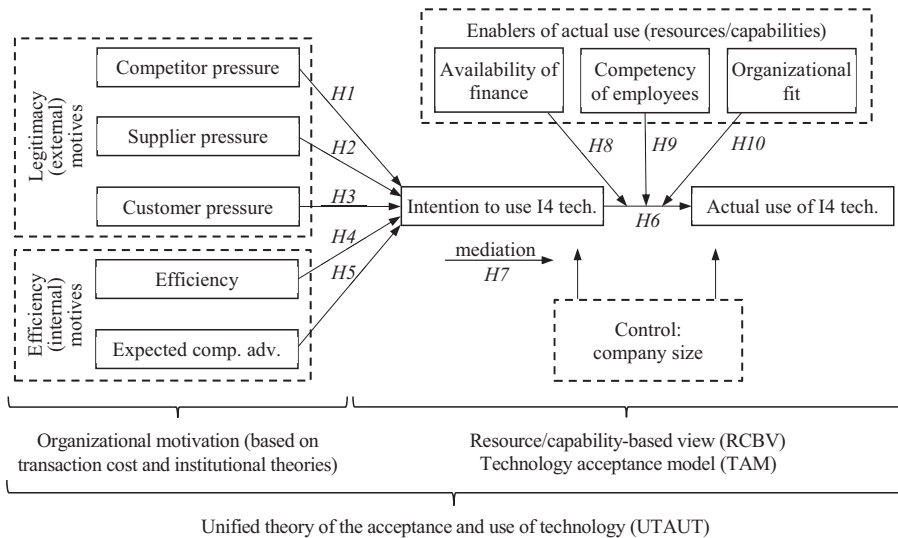


Figure 1.
The hypothesized model and its theoretical background

Note(s): All relationships are hypothesized to be positive

uses the transaction cost theory and institutional theory (Roberts and Greenwood, 1997; Grewal *et al.*, 2001; Son and Benbasat, 2007) as the main theoretical background, and propose efficiency and legitimacy as two primary motives for adopting I4 technologies.

Legitimacy as a motive is linked to external market pressure, i.e. the extent to which competitive and industry conditions force participants to pay close attention to each other's strategic decisions, including the use of innovative technologies (Gatignon and Robertson, 1989; Chwelos *et al.*, 2001). Legitimacy can further be divided into mimetic and normative pressures (Son and Benbasat, 2007). Mimetic (competitor) pressures are those caused by uncertainty which makes companies imitate the strategic decisions of leading competitors (Benders *et al.*, 2006). Of course, companies that have traditionally dominated the market may also face pressure as a result of innovative technologies introduced by new competitors (Linz *et al.*, 2017). On the other hand, normative pressures are those that make companies conform to the norms in the industry. These norms are usually under the control of established industry participants, such as suppliers (Benders *et al.*, 2006; Son and Benbasat, 2007; Obal, 2017). In our paper we default to mimetic *competitor pressure* and normative *supplier pressure* as two legitimacy-related motives according to Son and Benbasat (2007). However, we also include normative *customer pressure* as the third legitimacy-related motive for using I4 technologies. The arguments for this inclusion are twofold. First, in line with the political-economic framework (Stern and Reve, 1980) and stakeholder theory (Freeman, 1984), customers can represent a significant external force influencing the companies' strategic behavior (Banerjee *et al.*, 2003). Second, I4 technologies heavily rely on digitalization which typically demands the company's technologies to communicate with the suppliers' and customers' technologies.

Unlike legitimacy, *efficiency* motives are seen as an internal organizational drive to adopt a new technology (Obal, 2017) and are premised on the rationalistic expectation of enhancing efficiency of organizational processes (Son and Benbasat, 2007). The motivation to enhance company efficiency significantly motivates new technology adoption and the intention to continue with its use (Bhattacharjee and Premkumar, 2004). In addition to efficiency, our

paper proposes a more strategically-oriented internal driver of new technology usage which we define as the *expected competitive advantage*. We rationalize our decision based on the propositions of Müller *et al.* (2018b) and Ghobakhloo (2020) that the implementation of I4 technologies delivers both operational and strategic opportunities. A similar logic to define expected competitive advantage as a motive for companies' strategic decisions was also applied in other studies (e.g. Lee and Green, 1994; Banerjee *et al.*, 2003).

This study therefore discusses five groups of motives for using I4 technologies: competitor pressure, supplier pressure, customer pressure, expected efficiency and expected competitive advantage. While the first three are seen as external motives, the fourth and the fifth can be defined as internal motives (Momani and Jamous, 2017). In addition, competitor, supplier and customer pressure can be treated as primarily reactive motives, whereas efficiency and competitive advantage typically represent proactive motives.

2.3.2 Hypotheses development. A high level of competitive pressure among potential innovation users enhances innovation adoption because it is important for maintaining a good market position in highly competitive markets (Gatignon and Robertson, 1989; Chwelos *et al.*, 2001). Legitimacy-oriented motives, such as mimetic and normative pressures, may lead to more adoptions (Son and Benbasat, 2007; Ghobakhloo and Ching, 2019), but probably do not lead to continued technology usage (Karahanna *et al.*, 1999). It could be that when mimetic and normative pressures are strong, companies' intention to use increases although the adopted technology may not be a perfect fit which can lead to its passive post-adoption usage (Scott, 1987; Grewal *et al.*, 2001). Based on these arguments, our paper does not hypothesize a direct influence of legitimacy-based motives on the actual use but on the intention to use I4 technologies.

H1–H3. Competitor pressure (H1), supplier pressure (H2) and customer pressure (H3) are positively related to the intention to use I4 technologies.

Bharati and Chaudhury (2004) propose that increased efficiency as a result of new technology leads to higher satisfaction of the user. Further, companies with efficiency-oriented motives take greater effort to better understand a product/technology they intend to purchase. Therefore, they are more likely to have realistic expectations about the benefits from its use (Grewal *et al.*, 2001; Rask and Kragh, 2004), which may increase their intention to use the technology (Obal, 2017). With regard to the expected competitive advantage as a motive, several studies (Tsai *et al.*, 2005; Kim *et al.*, 2008, 2009; Ghobakhloo, 2020) also confirmed that new technologies may enable companies to secure competitive advantages. Following the above arguments, we hypothesize that a company's intention to use I4 technologies will increase if the company's motives are linked to the expected improvements in efficiency and competitive advantage.

H4–H5. Expected efficiency (H4) and competitive advantage (H5) are positively related to the intention to use I4 technologies.

2.4 Intention to use vs actual use

2.4.1 Theoretical background. With regard to the attitude to and actual use of I4 technologies, our paper builds on theoretical frameworks in the user technology acceptance, among which the most relevant for our study are the technology acceptance model (TAM) (Davis, 1986; Davis *et al.*, 1989) and the unified theory of the acceptance and use of technology (UTAUT) (Venkatesh *et al.*, 2003). The TAM is closely linked to the emergence of information-communication technology and builds on the “attitudes – intentions – actual behavior” paradigm. It assumes that attitudes toward new technology influence users' intentions to use the technology, while the intentions to use result in the actual technology usage (Lacka and Chong, 2016). The UTAUT brings motivational factors into the picture, positing that

performance expectancy, effort expectancy and social influence affect the behavioral intention to use a technology, while the behavioral intention and facilitating conditions influence the actual use of the technology (Escobar-Rodríguez and Carvajal-Trujillo, 2014).

Both the TAM and UTAUT provide strong theoretical support for our study by clearly distinguishing the *intention to use* from the *actual use* of technology. Intentions to use new technology explain its real usage measured in a subsequent period (Davis *et al.*, 1989), therefore providing theoretical support for studying the relationship between the intended and actual use of I4 technologies. Moreover, since the UTAUT also introduces motivational factors (such as performance expectancy and social influence) as antecedents of behavioral intention to use new technology, this also provides theoretical support for studying the motives behind the use of I4 technologies.

2.4.2 Hypotheses development. In the context of new technology usage, the positive link between the intention to use and actual use has mostly been argued by the advocates of the TAM and UTAUT models (Davis, 1986; Escobar-Rodríguez and Carvajal-Trujillo, 2014). Accordingly, vast empirical research (e.g. Davis *et al.*, 1989; Taylor and Todd, 1995; Venkatesh and Davis, 2000; Venkatesh *et al.*, 2000, 2003; 2012; Yi and Hwang, 2003) in the context of new technologies usage confirms this causal link as positive. Building on previous considerations that intentions act as a direct antecedent of actual use this is also the hypothesis we test in our model. Yet, based on the outlined assumptions of the TAM and especially the UTAUT theories, we additionally test the mediation hypothesis that motives indirectly affect actual use via intentions.

H6. The intention to use I4 technologies is positively related to the actual use of I4 technologies.

H7. The intention to use I4 technologies mediates the effect of motives on the actual use of I4 technologies.

2.5 Enablers of actual use

2.5.1 Theoretical background. The hypothesized positive relationship of the intention to use with actual use is both theoretically and empirically well supported. However, we cannot ignore the boundary conditions that may influence this relationship. According to Palmatier (2016), direct effect links that may turn out unrealistic if they ignore boundary conditions call for the inclusion of managerially controllable moderators in the model. In our case, the boundary conditions can be linked to different obstacles that may prevent the intention to use resulting in actual use. Neto *et al.* (2017) discuss several obstacles to the actual implementation of new technologies, namely cultural (related to the lack of intellectual capacity of employees and owners/managers), financial (related to financing new technology purchases), technical (resulting among other things from low-skilled labor), organizational and governmental (e.g. excessive tax burdens).

Theoretical support for the above conceptualization of boundary conditions in our model can be found in the resource/capability-based view (RCBV). The RCBV suggests that, in order to gain competitive advantage, firms need internal resources and capabilities that allow them to operate their chosen lines of business efficiently and effectively (Barney, 1991; Winter, 2003). Resources and capabilities therefore act as enablers (internal boundary conditions) that facilitate organizations to obtain beneficial outcomes and competitive advantage (Liu *et al.*, 2009; Park and Lee, 2011). By arguing that companies need resources/capabilities to be able to transform their strategic intentions into actual performance in the market (Biełkowska and Tworek, 2021), the RCBV can be used to turn the logic of the obstacles to I4 technology usage (Neto *et al.*, 2017) upside down and assume that nonexistent obstacles may act as enablers of the actual use of I4 technologies. Hence, sufficient finance, knowledgeable people, etc. are not

motives that positively influence the intention to use, but are resources/capabilities that act as firm-level boundary conditions (moderation factors) which facilitate the intended use to result in actual use.

A similar logic can also be found in the UTAUT model, which assumes that not only behavioral intention but also facilitating conditions influence the actual use of technology (Escobar-Rodríguez and Carvajal-Trujillo, 2014). Based on the above logic of moderation effects and the literature (e.g. Neto *et al.*, 2017) on the obstacles to or enablers of new technology usage, this paper discusses the moderation effect of three enabling factors (resources and capabilities). These are *availability of finance*, *competency of employees* and *organizational fit*. The following paragraphs summarize past research on the effects of these three enabling factors on new technology usage.

2.5.2 Hypotheses development. As found by Davila *et al.* (2003), companies with available finance are more likely to use new technology than financially weaker companies. This may be because financially sound companies perceive the same level of investment as a smaller sacrifice. Further, the availability of finance enables companies to better withstand negative consequences if the technology adoption fails (Gao *et al.*, 2012). Several other authors also argue that difficulties in accessing adequate financing (Gombault and Verstege, 1999) and consequently the lack of investment capital (Silvestre and Silva Neto, 2014) are the main barriers to using new technologies in SMEs.

With regard to the competency of employees, studies claiming a positive association between the prevalence of technical specialists within a company and receptivity to innovation (Gatignon and Robertson, 1989) emerged decades ago. Similarly, more contemporary studies also confirm that employees must be properly qualified to be able to use new technologies (Erol *et al.*, 2016; Veile *et al.*, 2019), which was also reported in the context of I4 technologies in manufacturing companies (Bauer *et al.*, 2015). Employees as technology users are therefore critical success factors (Müller *et al.*, 2018b) and their lack of competency is identified as the main obstacle to I4 implementation (Stanton Chase, 2017).

Finally, if the adoption of a new technology is not tailored to a company's organizational specifics, synchronization with the existing equipment, structures and processes can become complex and costly. This may be particularly challenging for smaller companies (Müller *et al.*, 2018a; Pirola *et al.*, 2019). Several other studies (Chau and Tam, 1997; Ramdani *et al.*, 2009; Ghobakhloo and Ching, 2019) have also shown the relevance of organizational fit for the implementation of new technologies.

The above discussion leads us to propose the following three hypotheses:

H8–H10. Availability of finance (H8), competency of employees (H9) and organizational fit (H10) positively moderate the relationship between the intention to use I4 technologies and their actual use.

3. Methodology

Variables for our model were operationalized based on operationalizations used in past research, with some adaptations. Scales for reactive motives (competitor pressures, supplier pressures, customer pressures) were based on Obal's (2017) scales for mimetic competitor pressures and normative pressures. As for proactive motives, efficiency was measured with statements based on Obal's (2017) scale for efficiency motives, while to measure expected competitive advantage we adapted the scale from Banerjee *et al.* (2003). With regard to the moderators, we measured the availability of finance with a scale created based on the findings of Neto *et al.* (2017). Organizational fit was measured with the scale of Müller *et al.* (2018b), whereas for the competencies of employees we used adapted statements for Obal's (2017) IT capabilities. Each statement was evaluated on a scale from 1 to 7, where 1 stands for

“strongly disagree” and 7 for “strongly agree”. In measuring the use of I4 technologies, our decision was similar to Büchi *et al.*'s (2020) idea of I4's depth and was based on Rachinger *et al.*'s (2019) observation that digitalization has influenced various business activities. Building on Rachinger *et al.*'s (2019) findings that the influence of digitalization on business model elements and the potential for optimization depends importantly on the company's industry, we decided to focus on the depth instead of the breadth in the use of I4 technologies. By so doing, we seek to balance the differences among various manufacturing industries. We initially listed the most commonly discussed I4 technologies in the literature (Posada *et al.*, 2015; Büchi *et al.*, 2020) (e.g. augmented/virtual reality, (industrial) automation, big data, cloud computing/storage, cyber physical systems, Internet of things, intelligent/autonomous robotics, 3D printing) and asked respondents in which areas of the value chain (nine business areas of the value chain were provided: planning and control, research and development, purchasing, logistics, production, marketing and sales, finance and accounting, HRM and communication) they have used several of these technologies. We applied a series of dummy variables coded as 0 where I4 technologies are not used or rarely used in the specific area of the value chain, and 1 if they are used frequently. These nine dummies were summed to obtain an indicator of actual use, ranging from 0 (when technologies have not been implemented) to 9 (when technologies have been used in all areas). After we checked the content validity, we adjusted the scales and tested the questionnaire on 10 companies.

Slovenian export-oriented manufacturing companies with more than 10 employees were defined as a population for this study. Slovenia is a small open European economy that is very export oriented. Its companies are strongly embedded in the value chains of companies from the most industrially developed economies. Therefore, it represents an interesting context to test results of the studies from the more developed economies. The sampling frame was developed from the Database of Slovenian Exporters (SloExport). Before starting with the data collection, companies were contacted by telephone to identify the most relevant respondent in the company (a person responsible for introducing new technologies or having the best overview of this topic). Upon obtaining their e-mail address, we asked for their consent to participate in the web-based survey. The target population was manufacturing due to the relevance and general intensity of use of new technology in this area. Due to the rationality of implementing new technologies and the ability to use them, the target population was companies with at least ten employees. Out of the population of 1,442 companies (the total number of manufacturing export-oriented companies in Slovenia with more than ten employees), we received the consent of 1,082 companies and 124 companies finished the survey. The demographics of our final sample are summarized in Table 1. Regarding the depth of I4 technologies use, the mode was 0 (19.4%), the median was 4 and the mean was 3.9 business areas. I4 technologies were most often used in finance and accounting (60.5%), planning and control (56.5%) and production (50.8%).

Before conducting the analysis of the measurement and structural model, we conducted an analysis of missing values (Little's MCAR test, using IBM SPSS 25), which indicated that missing values are missing completely at random. Therefore, we proceeded with the analysis.

4. Results

4.1 Measurement model

We tested the properties of the proposed research constructs with structural equation modeling (SEM). First, we performed a confirmatory factor analysis (CFA) to test the measurement model. The analysis was performed using Mplus version 7.3. Although we had used some previously validated scales, certain items turned out problematic, presumably due to translation or cultural differences. Therefore, we discarded the problematic items for each construct one by one based on low loadings on the designated construct. Table 2 shows the

Criterion	Group	Share (%)
Company's size	Small companies	54.7
	Medium-sized companies	23.9
	Large companies	21.4
Company's position in the value chain	Producers of end-products	45.0
	Suppliers of semi-finished products or components for end products	44.2
	Producers of machinery used by other companies in their production	7.5
Company's digitalization level	Suppliers of basic (raw) materials	3.3
	Digital novices (beginners in digitalization)	38.7
	Digital integrators (partly digitalized processes; using I4 technologies only internally)	47.8
	Horizontal collaborators (many digitalized processes; also using I4 technologies to cooperate with partners in the value chain)	11.7
Respondent's* position in the company	Digital champions (heavily digitalized processes)	1.8
	Members of management or department directors	32.5
	Directors (or chairpersons of the management board)	16.2
	Deputy directors (or members of the management board)	12.0
	Persons responsible for introducing new technologies	12.0
	Other (mostly middle-management) positions	27.3

Note(s): *On average, the respondents had 19.4 years (standard deviation 10.27) of working experience, of those 12.7 years (standard deviation 9.41) in the current company

Table 1.
Demographics of the sample

retained measurement variables and the proposed constructs. Overall, the fit of the measurement model ($\chi^2 = 453.63$, $df = 189$, $p < 0.01$, $\chi^2/df = 2.40$; RMSEA = 0.09, 90% CI is 0.08–0.10; SRMR = 0.068; CFI = 0.92; TLI = 0.90) is acceptable (Schermelleh-Engel *et al.*, 2003).

Results of the reliability analysis are presented in Table 2. All values for composite reliability are above the required 0.70. According to a complementary measure for construct reliability – the average variance extracted (AVE) all constructs have acceptable reliability (Fornell and Larcker, 1981).

The model was also tested for convergent and discriminant validity. In line with Anderson and Gerbing (1988), all *t*-values of the loadings of the measurement variables on the respective latent variables are statistically significant. Thus, convergent validity is supported. Discriminant validity was assessed with the approach proposed by Fornell and Larcker (1981). For all pairs of latent variables, values of AVE were greater than the square of correlation between the latent variables, thus supporting discriminant validity (Table 3). Reliability and validity for moderators (availability of finance (Cronbach $\alpha = 0.90$), competency of employees (Cronbach $\alpha = 0.94$) and organizational fit (Cronbach $\alpha = 0.89$)) that are going to be used in the second stage of hypotheses testing were established in a similar manner.

Because all variables in our research are based on same-source data, common method bias is a potential issue. We attempted to reduce the causes for common method bias at the response reporting stage using some procedural remedies suggested by Podsakoff *et al.* (2012). We allowed the respondents' answers to be anonymous and asked them to answer questions as honestly as possible. Further, we did not reveal the conceptual framework of our study and mixed the constructs in a way that reduced the respondents' possibility to guess how the researchers wanted them to respond. We also controlled for CMB with statistical remedies using the marker variable test suggested by Lindell and Whitney (2001). We used

Constructs and items	SFL
<i>Competitor pressure (EX, $\alpha = 0.91$, CR = 0.92, AVE = 0.78)</i>	
We consider using I4 technologies because our key competitors are using them	0.77
Our competitors that use I4 technologies benefited greatly	0.93
Our competitors that use I4 technologies are perceived favorably by others in our industry	0.94
<i>Supplier pressure (EX, $\alpha = 0.92$; CR = 0.91, AVE = 0.77)</i>	
We feel pressured to adopt I4 technologies by our suppliers	0.90
Large pressure is placed on our firm by our suppliers to use I4 technologies	0.95
We consider using I4 technologies because several industry sources, including our suppliers, promote them	0.78
<i>Customer pressure (EX, $\alpha = 0.92$, CR = 0.91, AVE = 0.78)</i>	
We feel pressured to adopt I4 technologies by our buyers	0.91
Large pressure is placed on our firm by our buyers to use I4 technologies	0.94
We consider using I4 technologies because several industry sources, including our buyers, promote them	0.79
<i>Efficiency (EX, $\alpha = 0.89$, CR = 0.89, AVE = 0.66)</i>	
We consider using I4 technologies because we think it would increase our efficiency	0.86
We consider using I4 technologies because we expect it to reduce the costs of running our business	0.91
We consider using I4 technologies because we think it would streamline our operations	0.82
We consider using I4 technologies because we believe it would reduce the cost of transacting business with our exchange partners	0.67
<i>Expected competitive advantage (EX, $\alpha = 0.91$, CR = 0.89, AVE = 0.66)</i>	
We expect the use of I4 technologies will lead to substantial cost advantages for our firm	0.75
By regularly investing in new I4 technologies our firm can be a leader in the market	0.80
Our firm can enter lucrative new markets by using I4 technologies	0.83
Our firm will increase market share by using I4 technologies	0.89
<i>Intentions to use (ED, $\alpha = 0.96$, CR = 0.96, AVE = 0.8)</i>	
We consider (further) utilizing I4 technologies in the future	0.93
We are in favor of (further) using I4 technologies in our firm	0.98
We are willing to (further) implement I4 technologies in the future	0.96
We intend to (further) digitalize business processes in our firm	0.81
<i>Actual use (ED, sum of use-areas)</i>	
<i>Moderators used in the PROCESS model</i>	
<i>Availability of finance (MO; $\alpha = 0.90$)</i>	
Our company faces problems investing in I4 technologies due to the absence of enough own investment capital (R)	
Our company faces problems investing in I4 technologies due to difficult access to adequate external financing (R)	
Our company faces problems investing in I4 technologies due to the high cost of investment capital (R)	
<i>Competency of employees (MO; $\alpha = 0.94$)</i>	
Our firm has employees with strong professional knowledge in the area of I4 technologies	
Our firm has strong technical support staff in the area of I4 technologies	
Our employees have relevant capabilities to work in the I4 environment	
Our employees are competent to work in the I4 environment	
<i>Organizational fit (MO; $\alpha = 0.89$)</i>	
For us, implementing Industry 4.0 is not reasonable (R)	
Customer demands are too individualized to implement Industry 4.0 (R)	
We have too little standardization to implement Industry 4.0 (R)	
Note(s): SFL = standardized factor loading; EX = exogenous construct; ED = endogenous construct; MO = moderator; R = reverse-coded item; α = Cronbach Alpha; CR = Composite Reliability; AVE = Average Variance Extracted	

Table 2.
Measurement model

Constructs	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. Competitor pressure	3.90	1.51	0.89 ^{**}									
2. Supplier pressure	2.94	1.34	0.52 ^{**}	0.88 ^{**}								
3. Customer pressure	3.30	1.46	0.71 ^{**}	0.72 ^{**}	0.88 ^{**}							
4. Efficiency	5.13	1.21	0.52 ^{**}	0.30 ^{**}	0.41 ^{**}	0.81						
5. Expected comp. adv	4.76	1.31	0.58 ^{**}	0.40 ^{**}	0.43 ^{**}	0.77	0.83					
6. Intentions to use	5.55	1.19	0.54 ^{**}	0.29 ^{**}	0.44 ^{**}	0.70	0.66 ^{**}	0.93 ^{**}				
7. Actual use	3.90	2.77	0.22 [*]	0.10	0.24 ^{**}	0.20 [*]	0.19 [*]	0.38 ^{**}	1.00			
8. Availabil. of finance	3.97	1.47	-0.05	** -0.26	-0.10	-0.12	-0.18	-0.05	0.18	0.92		
9. Comp. of employees	3.89	1.43	0.40 ^{**}	0.23 [*]	0.39 ^{**}	0.33 ^{**}	0.38 ^{**}	0.49 ^{**}	0.57 ^{**}	0.14	0.97	
10. Organizational fit	4.76	1.34	0.31 ^{**}	0.02	0.19 [*]	0.19 [*]	0.26 ^{**}	0.37 ^{**}	0.25 ^{**}	0.23 [*]	0.33 ^{**}	0.86

Note(s): *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed). Below the diagonal: zero-order correlations. On the diagonal: square root of AVE

Table 3.
Means, standard
deviations (SD) and
correlations

the construct ease of use (three items, Cronbach $\alpha = 0.82$) as a marker variable that was theoretically unrelated to most of our substantive variables. After adjusting the zero-order correlations by partialing out this proxy, more than 90% of correlations remained significant as a result of this adjustment. Therefore, we can assume that the relationships in our model are unlikely to be inflated due to common method variance.

4.2 Structural model

The structural model has an acceptable fit ($\chi^2 = 501.05$, $df = 214$, $p < 0.001$, $\chi^2/df = 2.34$; RMSEA = 0.089, 90% CI is 0.079–0.099; SRMR = 0.078; CFI = 0.91; TLI = 0.90). The results (Table 4) are in line with the proposed hypotheses for the relationships of efficiency motives with intentions to use I4 technologies (H4) and intentions to use with actual use (H6). For the other proactive motive (expected competitive advantage, H5), the relationships with intention to use are marginally significant and can be supported at $p < 0.10$. Contrary to our propositions, none of the hypotheses for the effects of reactive motives on intention to use (H1, H2, and H3) were supported. The control variable (company size) has a statistically significant effect on the intention to use, but not on actual use.

In addition, we tested the mediation effect of intention to use by conducting an analysis of bias-corrected bootstrap confidence intervals, as suggested by Preacher and Hayes (2008). Resampling 5,000 times and using a 95% confidence interval (CI) for the parameter estimates, the results indicate an indirect effect of the efficiency motives through intention to use on actual use (indirect $\beta = 0.359$, 95% bootstrapped CI = [0.064, 0.819]), while the indirect effects of other motives are not statistically significant. The mediation hypothesis (H7) is therefore supported only for efficiency motives.

4.3 Analysis of moderation effects

In the second step, we tested the moderation effects of the enablers (availability of finance, competency of employees and organizational fit) on the relationship between intention to use and actual use. We formulated a moderated mediation model (model 14) in PROCESS v3.0, where we used three main variables (efficiency as the independent variable, intention to use as the mediator and actual use as the dependent variable), moderators (each tested separately: availability of finance, competency of employees and organizational fit) and controls (all other motives, enablers and company size). The results (Table 5) indicate that the relationship between the intention to use and actual use is negatively moderated by the availability of finance (interaction effect is -0.42 , $p = 0.003$) and positively by the competency of employees (interaction effect is 0.31 , $p = 0.067$), while organizational fit does not significantly moderate this relationship.

Probing reveals that for low levels of availability of finance (-1 SD below the mean), the conditional effect size was 1.01 ($p = 0.015$; 95% CI [0.515, 2.100]). For medium levels of

Hypotheses	Proposed direction	Standardized path coefficient (t-test)	Hypothesis test
H1: Competitor pressure → Intention to use	+	0.08 (0.73, $p = 0.466$)	Not supported
H2: Supplier pressure → Intention to use	+	-0.02 (-0.12, $p = 0.897$)	Not supported
H3: Customer pressure → Intention to use	+	0.02 (0.14, $p = 0.868$)	Not supported
H4: Efficiency → Intention to use	+	0.40 (3.13, $p = 0.002$)	Supported
H5: Expected comp. adv. → Intention to use	+	0.25 (1.81, $p = 0.070$)	Supported
H6: Intention to use → Actual use	+	0.37 (4.59, $p = 0.000$)	Supported
<i>Control variables</i>			
Company size → Intention to use	/	0.19 (2.63, $p = 0.009$)	/
Company size → Actual use	/	0.12 (1.41, $p = 0.157$)	/

Table 4. Results of testing the hypotheses for the structural model

Variables	Actual use (moderator: availability of finance)	Actual use (moderator: competency of employees)	Actual use (moderator: organizational fit)
Constant	0.81 ($t = 1.78, p = 0.46$)	5.08 ($t = 2.54, p = 0.10$)	0.98 ($t = 0.54, p = 0.59$)
Efficiency (IV)	0.07 ($t = 0.21; p = 0.84$)	-0.13 ($t = -0.40; p = 0.69$)	-0.09 ($t = -0.27; p = 0.78$)
Intention to use (M)	0.72 ($t = 2.36; p = 0.02$)	0.73 ($t = 2.22; p = 0.03$)	0.52 ($t = 1.72; p = 0.09$)
<i>Moderators (tested separately)</i>			
Availability of finance (W1)	0.19 ($t = 1.17, p = 0.27$)	0.06 ($t = 0.33, p = 0.74$)	0.23 ($t = 1.29, p = 0.20$)
Competency of employees (W2)	0.89 ($t = 4.70, p < 0.01$)	0.78 ($t = 4.04, p < 0.01$)	0.87 ($t = 4.44, p < 0.01$)
Organizational fit (W3)	0.05 ($t = 0.28, p = 0.78$)	-0.03 ($t = -0.14, p = 0.88$)	0.01 ($t = 0.03, p = 0.98$)
Interaction effect	-0.42 ($t = -3.01, p = 0.003$)	0.31 ($t = 1.86, p = 0.067$)	-0.25 ($t = 1.66, p = 0.100$)
<i>Control variables</i>			
Competitor pressure	-0.23 ($t = -1.02, p = 0.31$)	-0.22 ($t = -0.92, p = 0.36$)	-0.18 ($t = -0.76, p = 0.45$)
Supplier pressure	0.05 ($t = 0.20, p = 0.85$)	0.11 ($t = 0.43, p = 0.67$)	0.07 ($t = 0.29, p = 0.78$)
Customer pressure	0.23 ($t = 0.86, p = 0.39$)	0.17 ($t = 0.62, p = 0.54$)	0.12 ($t = 0.43, p = 0.67$)
Expected comp. adv	-0.22 ($t = -0.77, p = 0.44$)	-0.20 ($t = -0.69, p = 0.49$)	-0.15 ($t = -0.52, p = 0.61$)
Company size	0.56 ($t = 1.16, p = 0.25$)	0.72 ($t = 1.45, p = 0.15$)	0.57 ($t = 1.14, p = 0.26$)
R^2	0.39	0.36	0.35
F	5.55	4.78	4.69
Conditional indirect (mediated) effect	0.33	0.34	0.24
95% BC CI	(LLCI 0.051, ULCI 0.728)	(LLCI 0.049, ULCI 0.753)	(LLCI -0.047, ULCI 0.597)

Table 5. Results of the moderated-mediation analyses with the PROCESS macro (Model 14)

Note(s): IV = independent variable. M = mediator. W = moderator. Unstandardized coefficients are reported. LLCI = lower-level confidence interval. ULCI = upper-level confidence interval

availability of finance, the conditional effect size was 0.72 ($p = 0.020$; 95% CI [0.114, 1.317]). For high levels of availability of finance (+1 SD above the mean), the conditional effect size was 0.12 ($p = 0.70$; 95% CI [-0.510, 0.757]). For low and medium availability of finance, there is a positive relationship between the intention to use and actual use, while with a high availability of finance there is no relationship between the intention to use and actual use. These results identify the availability of finance as a negative moderator of the relationship between the intention to use and actual use (Figure 2). Moderation exists, but is not in line with the direction proposed in H8.

Further, probing reveals that for low levels of competency of employees (-1 SD below the mean), the conditional effect size was 0.29 ($p = 0.378$; 95% CI [-0.355, 0.927]). For medium

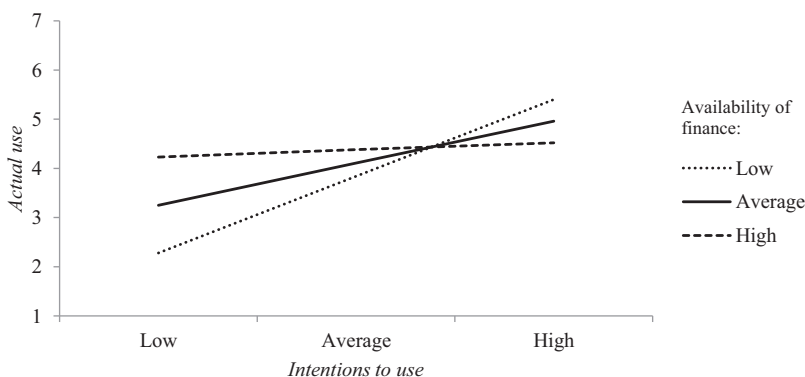


Figure 2. The moderating role of availability of finance in the relationship between intentions to use and actual use

levels of competency of employees, the conditional effect size was 0.73 ($p = 0.029$; 95% CI [0.077, 1.373]). For high levels of competency of employees (+1 SD above the mean), the conditional effect size was 1.16 ($p = 0.015$; 95% CI [0.231, 2.097]). For low values of competency of employees, there is no relationship between the intention to use and actual use, while for medium and high levels of competency of employees there is a positive relationship between the intention to use and actual use. These results identify the competency of employees as a positive moderator in the relationship between intention to use and actual use (Figure 3). H9 is therefore supported.

The final model, which shows all the statistically significant links among the constructs, is presented in Figure 4.

5. Discussion

5.1 Theoretical implications

The discussion of theoretical implications and contributions that follows is organized in three parts to ensure greater clarity: (1) contributions on motives, (2) contributions on enablers and (3) a combination of the two (the overarching theoretical framework).

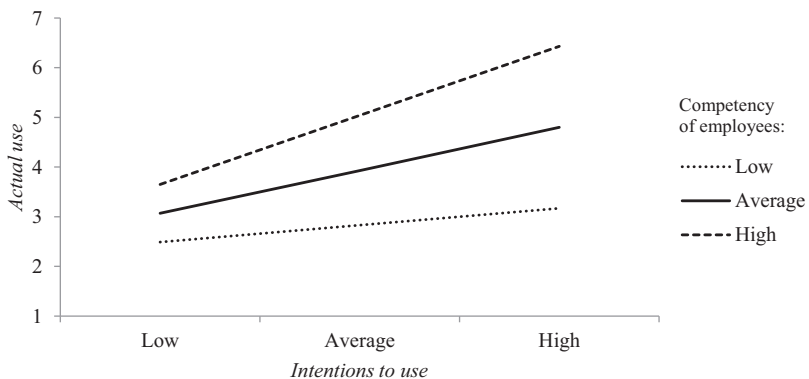


Figure 3. The moderating role of employees' competencies in the relationship between intentions to use and actual use

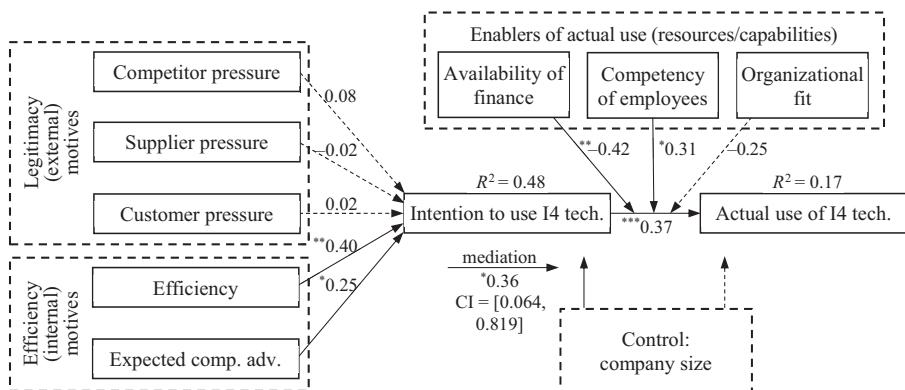


Figure 4. The final model with results

Note(s): Solid arrows = supported hypotheses. Dashed arrows = unsupported hypotheses.

* $p < 0.1$. ** $p < 0.01$. *** $p < 0.001$

(1) Implications/contribution related to motives

Regarding motives (the antecedents in our model), we find that companies' intentions to use I4 technologies are significantly influenced by the expected increase in efficiency and competitive advantage and not by external normative pressures from suppliers or customers or even by mimetic pressures from competitors. This means that legitimacy (external) motives do not play a significant role in developing the intention to use I4 technologies, which runs counter to the propositions and findings of certain previous studies (Chwelos *et al.*, 2001; Son and Benbasat, 2007; Ghobakhloo and Ching, 2019). Instead, the motivation to consider adopting I4 technologies seems to be driven by efficiency (internal) motives, as also indicated in several earlier studies (Grewal *et al.*, 2001; Tsai *et al.*, 2005; Son and Benbasat, 2007; Kim *et al.*, 2008, 2009; Obal, 2017). We believe two main reasons explain these results. The first may be that companies with efficiency-driven motives better understand new technology and therefore have more realistic expectations about its benefits (Rask and Kragh, 2004), which may increase their intention to use. The second reason may be that customers and suppliers of many of the surveyed companies were still not using I4 technologies, which means the surveyed companies had felt no pressure from external parties to start using I4 technologies.

In any case, the greater importance of the efficiency over the legitimacy factors leads us to conclude that companies are approaching I4 proactively instead of reactively. This means they are trying to introduce initiatives ahead of their competitors, seize market opportunities, take the lead in the market and build competitive advantages, instead of focusing on adapting to the stakeholders' requests/needs, reacting to the changing environment or responding to competitors' challenges (Chen *et al.*, 2012). The above results are in line with the technology adoption life cycle framework (Moore, 2006), where the first three groups (technology enthusiasts, visionaries and pragmatists) represent proactive technology adopters, while the latter groups on the adoption curve (conservatives and skeptics) are reactive adopters. Visionaries seek out technologies that offer the biggest scope for benefitting the business (competitive advantage), while pragmatists look for proven products and care for effectiveness and efficiency. Given that in the examined market firms are still in the relatively early stages of adoption, our findings are consistent with Moore's (2006) framework.

Our results related to the motives are important because they help us understand in a more structured way why companies consider introducing I4 technologies. Although the UTAUT (Venkatesh *et al.*, 2003) model already includes motives for technology acceptance in the discussion, this inclusion has been on the individual level, whereas our research discusses motives on the organizational level (i.e. instead of individual-level performance expectancy and social influence in the UTAUT, we are focused on firm-level efficiency and legitimacy motives). By linking the motivation perspective based on the transaction cost and institutional theories (Roberts and Greenwood, 1997; Grewal *et al.*, 2001; Son and Benbasat, 2007) with the political-economic framework (Stern and Reve, 1980) and stakeholder theory (Freeman, 1984), our theoretical contribution is therefore linked to more systematic inclusion of external/reactive vs internal/proactive organizational-level motives in the technology acceptance literature.

(2) Implications/contribution related to enablers

As for the link between intended and actual use and the enablers that moderate it, our study finds that intentions to use are significantly related to actual use. This is no surprise and consistent with several previous studies (Davis *et al.*, 1989; Taylor and Todd, 1995; Venkatesh and Davis, 2000; Venkatesh *et al.*, 2000, 2003, 2012; Yi and Hwang, 2003). However, the way our study contributes is by adding enablers that moderate (thus answering Palmatier's (2016) call to include moderators) the link between intended and actual use. Although the literature

(e.g. Neto *et al.*, 2017) has already discussed the lack of enablers, such as competent employees, sufficient finance and organizational fit, these enablers have not yet been conceptualized as moderators in a structural model.

This study confirms competency of employees to be an important enabler of actual use, which is in line with several previous studies that show employees play a decisive role in new technology implementation (Stanton Chase, 2017; Müller *et al.*, 2018b; Ghobakhloo and Ching, 2019). Not only does the competency of employees have a direct positive effect on the actual use of I4, they also function as an enabler of implementation, meaning that the more competent the employees are, the stronger the effect of the intention to use on actual use is. On the other hand, availability of finance impacts this relationship in an opposite manner. In conditions with lower and medium finance availability, the relationship between intentions to use and actual use is strengthened; however, after a certain point (high availability of finance), this relationship is not significant. This could mean that companies which have enough financial resources do not see finance as a critical enabler of their actual use of I4 technologies. The direct effect of this enabler on actual use is also not statistically significant. This is in contrast to findings of some previous studies (Davila *et al.*, 2003; Silvestre and Silva Neto, 2014) and could be context-specific. Organizational fit does not act as an enabler or barrier to actual use of I4 (which is in contrast with Ghobakhloo and Ching (2019) who found it to be an important factor of I4 adoption), meaning that companies do not perceive difficulties in integrating I4's novel manufacturing paradigm into existing organizational and production systems.

Our results related to enablers confirm that the intended-actual use relationship may be more complex, i.e. it may include boundary conditions (moderators) for transforming intentions into actual use. By confirming resources/capabilities as firm-level boundary conditions in our model, our study integrates the RCBV framework (Barney, 1991; Winter, 2003) with the TAM (Davis, 1986; Davis *et al.*, 1989) and UTAUT (Venkatesh *et al.*, 2003) models, therefore providing a theoretical contribution to the technology acceptance literature. The RCBV adds an important perspective to the fact that motives leading to intentions are only a necessary (but not a sufficient) factor in achieving actual use and that transforming intentions into implementation first requires adequate resources/capabilities. This perspective is in line with the UTAUT (which also assumes that actual use is influenced by behavioral intention and facilitating conditions (Escobar-Rodríguez and Carvajal-Trujillo, 2014)), but still different by conceptualizing the facilitating conditions as moderators.

(3) Overarching theoretical framework

As discussed, our study combines several theoretical approaches with the aim to develop a more comprehensive framework of the complex interactions between relevant variables that lead to the actual use of I4 technologies. First, a combination of the transaction cost and institutional theories (Roberts and Greenwood, 1997; Grewal *et al.*, 2001; Son and Benbasat, 2007) is used to contribute to the UTAUT (Venkatesh *et al.*, 2003) literature by more systematically analyzing the motives for technology usage. Then, the RCBV (Barney, 1991; Winter, 2003) is applied to add to the TAM (Davis, 1986; Davis *et al.*, 1989) and UTAUT models by offering sound argumentation of enablers that moderate the link between intended and actual use. By combining these theoretical approaches, we develop an overarching theoretical framework in the field of I4 technology usage (a kind of extension of the UTAUT model) and, hopefully, contribute to the construction of a more cohesive and consistent theory on technology acceptance.

5.2 Practical implications

Our empirical findings hold several practical implications. While some are general (i.e. not context-specific), some should be interpreted with respect to the specific geographical and

contextual setting of the study (i.e. a small open Central and Eastern European (CEE) economy in which companies are strongly embedded in the global value chains of large international players).

From the *managerial perspective*, I4 technologies' providers and partners along the global value chains should first keep in mind that (contrary to our expectations) value chain pressure is not an important motive for using I4 technologies. Instead, potential technology users seem motivated by internal rational factors and initially wish to understand measurable gains before they develop an intention to use the technology. Consequently, even if the use of I4 technologies is expected by the main global value chain players, they should still primarily point out the measurable efficiency and competitive gains for other value chain participants instead of just applying normative pressure to them. Second, potential I4 technology users should strengthen their search efforts and concentrate on finding technologies that can help them improve their competitive position and avoid lagging as a result of a geographically specific "doing business as usual" approach. Third, understanding how the motivation for technology adoption works promotes cooperative approaches to building mutually beneficial and experience-sharing-based long-term relationships between the main global players and their (CEE-based) value chain partners. Fourth, the results reveal the importance of employees' competencies as an enabler of I4 technology usage, which implies that a complementary investment in training is needed to enable employees to work with new technologies and fully utilize their potential.

In addition, our study has important *policy implications*. First, policymakers not only have a pivotal role to play in promoting awareness about the need for digitalization but also hold the power to tailor financially supported national development programs that support technology modernization. Second, policymakers should rethink human capital development on the national level and focus on the identified need for complementarity between investment in technology and human competencies. Third, education and training with future knowledge and skills needs in mind is also important in view of broader labor market challenges, including an ageing population, and should adopt a comprehensive approach to skills matching and skills shortages through formal education, life-long learning and on-the-job training.

As this is the first such systematic study on drivers of I4 technology usage in this geographical/contextual setting, managers and policymakers can learn from our conclusions to improve the use of I4 technology on both organizational and economy levels. This is especially critical in small emerging economies were being part of international value chains is not only important for internationally oriented companies but also for the survival of domestic supply chains along with whole clusters of small local companies.

6. Conclusion

Our paper adds to the body of knowledge on I4 technologies by clearly distinguishing between the motives and enablers of I4 technology usage. While the motives play the role of antecedents of the intention to use I4 technologies, the enablers moderate the link between the intended and actual use of these technologies. Motives therefore only provide a necessary (but not a sufficient) factor of actual use, whereas enablers (resources/capabilities) are needed to leverage intentions into actual use. The results show that only efficiency motives have a positive effect on the intention to use I4 technologies (which in turn positively influences their actual use) and that employee competencies act as a key enabler that positively enhances the relationship between the intended and actual use of I4 technologies.

The main limitation of our study is connected to the relatively small population that is dependent on the size of the economy. Due to the survey being lengthy, the number of companies that finished it was relatively low. With a larger sample size, the results would be

more stable and possibly more effects would be statistically significant. Therefore, future studies should test our model by using a focused survey questionnaire in other contexts/economies which would enable us to provide more conclusive evidence on how and why I4 technology is adopted (in general and in countries that are followers of the global development). If the sample was larger, we could also analyze subsamples and create some sort of typology for industries. Given the differences between manufacturing industries, it would be beneficial to conduct industry-specific studies, which would then allow us to examine both the depth and breadth of I4 technologies usage as outcome variables. Future research is therefore welcome to continue advancing our understanding of motives and enablers for I4 technology adoption in specific industries and different contexts.

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About the authors

Tomaz Čater, Ph.D., is a Full Professor of Management at the School of Economics and Business, University of Ljubljana, Slovenia. External to the faculty he was a member of the management board of the European Academy of Management (EURAM) and the president of the Slovenian Academy of Management (SAM). His main fields of research are competitive advantages of firms and corporate social and environmental responsibility. He has also worked as a visiting professor at universities in Indiana (USA), Chemnitz and Regensburg (Germany), and Dubai (UAE), among others. He is the author or co-author of 60 scientific articles in journals, including the award-winning article in the prestigious journal *Organizational Research Methods*. Tomaz Čater is the corresponding author and can be contacted at: tomaz.cater@ef.uni-lj.si

Barbara Čater, Ph.D., is a Full Professor of Marketing at the School of Economics and Business, University of Ljubljana, Slovenia. During her doctoral study she spent three months at University of

Nottingham (UK) and she completed her master study at Drury University (USA). She was a visiting scholar at University of Regensburg (Germany). Her main research interests lie in business-to-business marketing and sustainable issues in marketing. Her articles have been published in several international journals, such as *Industrial Marketing Management*, *Journal of Small Business Management*, *International Journal of Contemporary Hospitality Management*, *Journal of Business and Industrial Marketing*, *Service Industries Journal* etc.

Matej Černe, Ph.D., is an Associate Professor of Management at the School of Economics and Business, University of Ljubljana, Slovenia. His research interests include non-technological innovations, creativity, organizational behavior and psychology, human resource management, leadership, and multi-level issues in management. His research was published in top management journals, including the *Academy of Management Journal*. He serves as editor-in-chief of the *Dynamics Relationships Management Journal*, associate editor of *Economic and Business Review*, and an editorial board member at *The Leadership Quarterly*, *Human Resource Management Review* and *Human Resource Management Journal*.

Matjaž Koman, Ph.D., is an Associate Professor of Economics at the School of Economics and Business, University of Ljubljana, Slovenia. He was visiting researcher at Columbia University (USA) and National University of Singapore. His research focuses on economics of transition and labor economics, with special emphasis on firm behavior and firm's productivity issues. He published a number of articles, among them also in *Journal of Comparative Economics* and *Eastern European Economics*. He was also involved in several national and international projects. He teaches microeconomics, managerial economics and mathematics for economists.

Tjaša Redek, Ph.D., is a Full Professor of Economics at the School of Economics and Business, University of Ljubljana, Slovenia. She studied at the University of Ljubljana and at the London School of Economics. Her research focuses on different development and sustainability-related topics, such as intangible capital, new technologies, firm development, competitiveness and sustainable socio-economic development, primarily in the context of labor markets. She published a number of publications and has been involved in several national and international projects. She teaches development economics, competitiveness policy and microeconomics.