

Digitalization of SMEs and their perceptions regarding public interventions and supports of digitalization: Evidence from mining and iron industries

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Abstract

The developments in information technologies have stimulated the digitalization processes of enterprises. Since firms in the iron and mining industries also apply these technologies and IT (Information Technology)-based practices for their operations, their digitalization process is very crucial for their competitiveness against their rivals. In this regard, this paper investigates the differences in digitalization processes of Small and Medium-sized Enterprises SMEs operating in the iron and mining industries but in various age and size groups and their perceptions regarding digitalization policies, support of the governments, and the European Union (EU) Digital Europe Programme. 290 SMEs from the Czech Republic are analyzed in line with the research aim. An online questionnaire survey and semi-structured expert interviews were used to collect the research data. Moreover, the researcher used secondary data from the statistical office. The researcher also runs the Chi-square test and correlation analyses when analyzing the data. The comments of the interviewees were also used for analysis purposes. According to the results, the digitalization of SMEs does not differ depending on their size and age. Moreover, the perceptions of SMEs regarding public interventions and subsidies do not differ depending on their size, and SMEs negatively evaluate the digitalization policies of the government. To change SMEs' mind, policymakers need to reduce bureaucratic procedures regarding digitalization and provide education, including Information and Communication Technologies (ICT) and digitalization. The governments also need to support SMEs in creating effective systems and generating standards for those systems. Governments also need to make collaborations with trade associations and the chamber of commerce to stimulate the digitalization process of SMEs.

Keywords

Digitalization, SMEs, firm size, length of doing business, iron and mining industries, Czech Republic, EU Digital Europe Programme, public digitalization policies, interventions, subsidies.



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Introduction

Digitalization of SMEs has gained more importance, especially after the Covid-19 pandemic, since this issue has caused many unexpected conditions and financial problems for the majority of those enterprises. Although SMEs make significant contributions to the economic power of countries (Ključnikov et al., 2021a; Kot et al., 2018) by creating an increasing level of exports (Civelek & Krajcik, 2022), value-added products (Ključnikov et al., 2022), employment and its results increase (Kovacs & Vamosi Zarandne, 2022), tax income (Dvorský et al., 2020), macroeconomic stability (Tiutiunyk et al., 2021) having a lower amount of financial sources and operating in a sector such as iron and mining industries where there is a fierce competition and strong rivals, make those firms to have more competitive disadvantages against their rivals. On the other hand, the competitiveness that SMEs face might also stimulate their innovative posture (Belas et al., 2020; Gavurova et al., 2018, 2020); thus, they can apply advanced IT solutions (Buer et al.) and ICTs (Cuevas-Vargas et al., 2021) that are based on digitalization process. Such solutions are especially efficient in the case of e-business tool implementation (Bilan et al., 2019; Raišienė et al., 2021; Roshchik et al., 2022). Firms in iron and mining companies implement digital technologies and IT programs in their machinery to have better control over their operations, such as creating some alerts to minimize the failures in production processes. But depending on their characteristics and the location where they operate, their digitalization level might differ. For instance, since larger firms have more sales, profitability, and competitive advantages than their smaller rivals, they can also easily be adapted the processes related to digitalization (Arora & Rathi, 2019; Tkacova et al., 2017). In this regard, this research investigates whether differences exist between the digitalization of SMEs in mining and iron industries depending on their size and age (length of doing business). This paper analyzes 290 SMEs located in the Czech Republic to hit this target. The research question regarding this target are as follows: Does the digitalization of SMEs differ depending on their size and age?

Many researchers declare the fact that digitalization positively affects performance (Okfalisa et al., 2021; Joensuu-Salo, 2021; Bilan et al., 2017; Lahkani et al., 2020), marketing efficiency (Arora & Rathi, 2019), productivity (Okfalisa et al., 2021; Joensuu-Salo, 2021) and innovativeness of enterprises (Chierici et al., 2021). Firms' usage of information technologies provides easier access conditions for them when entering international markets (Arora & Rathi, 2019; Shuyan & Fabus, 2019). Digital technologies do not only make firms share and acquire important information regarding their operations but also protect their intellectual capital (Chierici et al., 2021; Rajbhandari et al., 2022). Moreover, digitalization enables businesses to reduce their costs (Okfalisa et al., 2021; Petruf et al., 2015) and to apply radical changes to their activities, including supply chain management, manufacturing, marketing, sales operations (Khalid & Naumova, 2021; Melnikova et al., 2016; Turisova et al., 2021). Some of the software and digital tools that SMEs use for those operations are 3D printers, Computer-Aided Manufacturing (CAM), Customer Relationship Management programs (Biclesanu et al., 2021), Artificial intelligence, Internet of Things (IoT), big data analytics (Khalid & Naumova, 2021; Buer et al., 2020; Türkes et al., 2019), cloud computing, cybersecurity (Okfalisa et al., 2021), business-to-consumer (B2C) and business-to-business (B2B) (Biclesanu et al., 2021), social media and e-commerce platforms (Victor et al., 2019; Virglerová et al., 2022). Inspirational motives in digitization processes to support decision-making processes can also be found in public administration and self-government (Kelemen, 2021), as well as in the implementation of cyber security policy in complex information systems of SMEs or other sectors of social and economic life (Kelemen et al., 2020).

Furthermore, incentives and subsidies that the governments provide stimulate the usage of digital technologies by its users (Ključnikov, 2020a). Therefore, depending on these factors digitalization of SMEs can be achieved at various levels. In parallel with this fact, this research analyzes the perceptions of SMEs regarding governments' digitalization policies, including governments' interventions and financial supports such as subsidized funds. In this context, another research question might arise as How do SMEs perceive governments' digitalization policies, and do their perceptions and needs for government interventions differ depending on their size?

This paper also considers the perceptions of SMEs regarding the EU Digital Europe Programme. The program is designed to bridge the gap between digital technology research and market deployment. It will benefit Europe's citizens and businesses, especially SMEs. Investment under the Digital Europe Programme supports the European Union's objectives regarding green transition and digital transformation while strengthening the Union's resilience and digital sovereignty. The researcher also analyzed inputs from the following national documents and areas; national documentation for the new EU operational program, analysis of the absorption capacity of the operational program focused on competitiveness for the period 2021-2027, relevant conceptual and strategic documents of the Czech Republic, sectoral and regional statistics, EU legislation for the programming period 2021-2027 and materials of the Ministry for Regional Development of the Czech Republic.

Although many studies examine the impact of firm size and age on the digitalization processes of SMEs (Ozsahin et al., 2020; Cirera et al., 2016; Žufan et al., 2020) and evaluate the government and municipal

websites from the perspective of their users (Horák et al., 2020; Ardielli, 2020; Strouhal et al., 2020), this study differs from them by having a wider perspective to analyze both firms' current digitalization status and governments' current approaches regarding digitalization. On the other hand, The European Commission publishes annual Digital Economy and Society Index (DESI) reports, and according to its report in 2021, the ranking of the Czech Republic is 15th regarding the integration of digital technologies. The Czech government also supports enterprises' digitalization by implementing initiatives such as Digital Innovation Hubs and Czechitas that encourage women to have better digital skills. Although the percentage of Czech firms employing digitalization strategies reached around 42% among all firms (DESI, 2021 Czechia), most firms still do not apply those strategies. The usage of big data analysis, cloud services, and e-invoicing by Czech firms is also lower than the average in Europe (DESI, 2021 Czechia). In line with the Digital Compass 2030 goal, a minimum of 90% of SMEs in the European Union need to have an ordinary level of digital intensity (DESI, 2021 Thematic chapters). Therefore, analyzing the digitalization of firms in this specific market, their perceptions regarding the government's and other institutions' approaches to digitalization, and the problems that they face when performing this process will also create value addition to the literature.

The remaining parts of the paper are structured in the following sequence: Material and Method section explain the theoretical background of this research and clarifies the statistical approaches that the researcher follows. The research also provides details about the findings from the analysis in the Results section. The results of the paper and policy implications will be discussed in the Discussion. In the last section, the researcher concludes the key points of the research.

Material and Methods

Material

Firm size is an important factor in determining enterprises' ICT capabilities and their adaptation to digitalization (Ozsahin et al., 2020; Arora & Rathi, 2019). Some studies declare the fact that due to having more resources, larger firms' propensities to use and adopt information technologies (Michaelidou et al., 2011; Taiminen & Karjaluoto, 2015; Vavrecka et al., 2021), including technological communication and social media tools also increase (Marion et al., 2016; Parveen et al., 2016; Grazzi & Jung, 2015; Mwantimwa, 2019; Cirera et al., 2016). Moreover, since larger enterprises have financial resources and abilities, their awareness of opportunities in various markets (Civelek et al., 2020a) and their knowledge related to information technologies (Ključnikov et al., 2021b; Barnes et al., 2012; Taiminen & Karjaluoto, 2015) enable them to implement innovative tools, new technologies (Delerue & Cronje, 2015; Civelek et al., 2020a; Fedorko et al., 2018; Vavrecka et al., 2021), information and communication technologies in their operations including social media channels (Kacker & Perrigot, 2016; Gerguri-Rashiti et al., 2015; Mwantimwa, 2019). Since larger enterprises have wider supply chains, they need to make investments in developing information technologies (Buer et al., 2020; Táncošová & Slaný, 2004). Larger SMEs have more customers, which gives these businesses more advantages regarding the usage of digital technologies for marketing purposes that increase their competitive power (Joensuu-Salo, 2021). On the other hand, having a lack of financial power also makes smaller firms not hire talented IT workers (Arora, & Rathi, 2019; Civelek et al., 2021a; Civelek et al., 2020a) that generate innovative projects or devices related to digitalization (Delerue & Cronje, 2015).

Some researchers also have opposing arguments against the studies that are mentioned above. According to these researchers, larger firms encounter more bureaucratic procedures and processes when doing their businesses (Pattitoni et al., 2014; Greve, 2011; Vavrecka et al., 2021). Moreover, their organizational structure is not flexible as smaller firms have (Pattitoni et al., 2014; Greve, 2011; Vavrecka et al., 2021), and their hierarchical levels can prevent them from implementing innovative activities for their operations quickly (Stockdale et al., 2012; Withers et al., 2011; Cucculelli, 2018; Ključnikov et al., 2021b). For these reasons, some studies also confirm the fact that smaller firms apply and use more innovative tools and digital services than their larger rivals (Yellow, 2018; Olanrewaju et al., 2020). By considering the arguments of the studies that are mentioned above, a research hypothesis might set as follows:

H1: There are statistically significant differences between the digitalization of SMEs depending on their size.

Having more years of business activities increases the experience of older firms in their operations. Thus, older firms can not only set their task functions and processes (Vavrecka et al., 2021) but also can have more workers with long years of experience in their businesses (Parveen et al., 2016; Mwantimwa, 2019; Žufan et al., 2020). Moreover, older firms are experienced when looking for innovative technologies and investing their resources in new technologies (Delerue & Cronje, 2015; Vavrecka et al., 2021; Cucculelli, 2018; Ključnikov et al., 2021b) since they have already gained information about how to implement and adopt information and communication technologies for their operations (Ključnikov et al., 2021b; Perrigot et al., 2012; Žufan et al., 2020). Their awareness of new trends also enables them to become easily adapted to ICTs (Grazzi & Jung, 2015; Cirera et al., 2016; Žufan et al., 2020). Long year operation also makes them improve their abilities to provide IT solutions (Buer et al., 2020), take more innovative actions (Exposito et al., 2019), and have better predictions in the usage of new technologies (Grazzi & Junk, 2015; Žufan et al., 2020). By doing business for many a long

year, businesses also set closer relationships with their subsidiaries, customers, and other players in their environment. Such a relationship also stimulates their innovative posture to develop new services (Exposito et al., 2019; Civelek et al., 2020a). For these reasons, many studies substantiate the fact that older firms have higher usage of the internet (Cirera et al., 2016; Žufan et al., 2020), information and communication technologies (Perrigot et al., 2012; Cirera et al., 2016) and social media platforms (Ključnikov et al., 2021b).

Although some studies also confirm the differences between older and younger firms, they have opposing views to the studies mentioned above. For instance, Withers et al. (2011), Anderson and Eshima (2013), and Gati and Bauer (2019) state that younger firms have more flexible structures than older firms, and this fact makes them easily be adapted to new innovative tools and changes in the market. Facing lower bureaucracy and having fewer routines and less hierarchical levels in their organizations also make younger firms take quick actions when adapting to new conditions (Rosenbusch et al., 2011). For these reasons, the digitalization of SMEs might differ depending on their length of doing business. Thus, another hypothesis might be created as indicated below:

H2: There are statistically significant differences between the digitalization of SMEs depending on their length of doing business.

The amount of public funding and the measures to minimize the distortions in the market are important indicators of government interventions (Pech & Vrchota, 2020). As many theorists on public support recommend (Pisar et al., 2021), state intervention can be related to a gap identified in the market and to support target groups (especially in terms of equipping SMEs with digital technologies and competencies). Subsidy policies should include measures to minimize IT market distortions (Pupakova et al., 2004). In general, support in the form of financial instruments should only be provided where the market has failed in this aspect (Pisar et al., 2021). A preliminary assessment of this condition should therefore demonstrate that the market will not be distorted to the detriment of both private investors and the products currently available on the market. The use of public funds will make the implementation of quality SME digitalization projects possible (Coronel et al., 2020).

On the other hand, compared with larger enterprises, smaller firms are more fragile under complex situations (Civelek et al., 2021b). For instance, the digitalization process has been perceived as costly by SMEs (Arora, & Rathi, 2019; Buer et al., 2020) since it consists of complex and complicated procedures (Bley et al., 2016; Buer et al., 2020) such as generating and creating an IT infrastructure that increases initial costs a lot (Buer et al., 2020; Arora, & Rathi, 2019). Moreover, when smaller firms want to buy IT and software products, their lack of funds does not enable them to afford the costs of those components (Horák et al., 2020). Similarly, Türkes et al. (2019) state the fact that the expenses of Industry 4.0 are one of the barriers for small enterprises when using these technologies. Since the cost of digitalization is difficult to afford and lacks financial sources, small firms make lower investments in digitalization (Arora & Rathi, 2019). On the other hand, due to having lack of capital and financial resources, smaller firms have less likely to apply innovative projects and R&D activities (Arora & Rathi, 2019; Civelek et al., 2021a; Vavrecka et al., 2021) that increase their expenses and operational risks (Arora, & Rathi, 2019). Furthermore, hiring talented and well-experienced IT or R&D workers can increase the cost of SMEs (Buer et al., 2020) and their lack of financial resources limit them from hiring skilled workers (Horák et al., 2020). The non-existence of such workers in their business causes smaller enterprises to fall behind their larger-sized rivals that usually have departments related to digitalization and collaborate with universities and research centers (Mittal et al., 2018; Buer et al., 2020). The financial power of larger enterprises also enables them to have easier credit access conditions. Thus, they invest more resources in their information technologies. But having a lack of financial options and lack of financial sources makes smaller firms face more obstacles when implementing some technologies such as industry 4.0 in their operations. Thus, their need for public financial support and subsidies becomes much-needed (Ključnikov et al., 2020b; Civelek et al., 2020b). In this regard, another research hypothesis might be created as follows:

H3: The need for public interventions and subsidized funds by SMEs regarding digitalization differ depending on their size.

The idea of public funding for digitalization comes from the assumption that digitalization processes (Delina et al., 2006) are backed by public funding (Alvarez-Aros et al., 2021), and they are also an instrument to support digital structural changes in the national economy. The possible impacts of this support must be assessed in the phase of creating an instrument for financial purposes (Pech & Vrchota, 2020) because this impact might provide benefits for society as a whole. On the other hand, to minimize the cost of digitalization, governments can implement some strategies such as deductions from taxes, the implementation of subsidy programs, and the provision of consulting services (Strouhal et al., 2020). Governments also accelerate the digitalization processes of SMEs by creating an effective legal and regulatory framework (Khalid & Naumova, 2021). Moreover, the development of public services (Arora, & Rathi, 2019), financial support, and incentives of the governments and public institutions increase ICT and innovative capabilities and adoption of SMEs into the digitalization processes (Khalid & Naumova, 2021; Ozsahin et al., 2020; Okfalisa et al., 2021; Buer et al., 2020). For instance, the Czech government has implemented some innovative strategies for digitalization, such as Digitální Česko1 (Digital Czechia). European Commission also gives technical and financial support to member states to stimulate

the digital transition. By having these supports, governments also invest in the digitalization of some areas, including the digital economy and digital infrastructure (DESI, 2021 Thematic chapters). Although the governments and international organizations have provided some support and subsidies that are mentioned above, most SMEs still perceive the fact that financial support from the governments is lacking (Strouhal et al., 2020; Horák et al., 2020; Okfalisa et al., 2021) and obstacles regarding bureaucracy (DESI, 2021 Czechia; Okfalisa et al., 2021), government readiness for the adaptation of new technologies (Syamala & Srinivasa, 2017), and implementation of digital infrastructure by governments (Okfalisa et al., 2021) are still trouble for them. Thus, most SMEs might negatively perceive the governments' digitalization policies.

H4: SMEs negatively perceive the digitalization policies of governments.

Methods

This article aims to clarify the current situation in the digitalization processes of SMEs in various age and size groups and their perceptions regarding public interventions and subsidies such as the Digital Europe Programme. In line with this target, this paper analyses 290 SMEs that operate in the iron and mining sectors of the Czech Republic. The key tools for collecting the data were desk research, questionnaire surveys, and semi-structured expert interviews. With regard to the existence of a number of particular interests of individual representatives of SMEs, all data were subjected to the appropriate validation (triangulation). The desk research method consisted of collecting and analyzing secondary data, mainly from sources available from the Czech Statistical Office. The desk research approach is also included in the search, collection, retrieval, analysis, and evaluation of other current information and relevant documents at strategic European and national levels, specifically focusing on the EU Digital Europe Programme.

The questionnaire survey was used to obtain primary data from the field, especially data of a quantitative nature. It mainly served to verify hypotheses formulated on the basis of desk research and to obtain additional quantitative (and qualitative) data from the respondents. An online survey (CAWI - Computer Assisted Web Interviewing) was carried out using the Internet, where the respondent filled out the questionnaire via a link directly on the website. The answers given by respondents were automatically recorded and continuously monitored during the data collection process. The questionnaire was optimally compiled so that the respondent did not take more than 15 minutes to complete it. The questionnaire survey underwent a pilot study on a selected sample of 20 respondents (March-April 2018), followed by adjustments to the scenario before the actual start. The final version of the questionnaire itself contained closed, ranked, and open-ended questions.

The expert interview was also a key method for obtaining information, especially for collecting primary data for analysis. The interviews aimed to obtain detailed information on the digitalization of SMEs. Furthermore, the interviews were used to verify the secondary data and initial hypotheses. Specifically, these were structured in-depth interviews. The structured interview was based on predefined questions (Topic Guide), whose wording and order was given and unchanged.

16 companies were selected for the semi-structured interviews, and 13 of them were taken for evaluation. The sample was selected on the basis of material from the Czech Statistical Office according to the expenditures on digital innovations by individual small and medium-sized enterprises. At the same time, this indicator was weighted by the criterion of ICT expenditures in the given companies and the success rate for grants from the programs ICT and Strategic Services and ICT in Enterprises. The companies that agreed to the publication of the data include Actis, s.r.o., ČD Telematika, a.s., EMCC s.r.o., FG Forest, s.r.o., K2, s.r.o. and Dyntec, s.r.o. The actual survey took place in January 2021. At the beginning of the interview, it was first necessary to clarify what the term digital enterprise means to the representatives of the SMEs and how they perceive it. The interview itself was conducted by trained interviewers from among university students and was recorded and subsequently evaluated.

A checklist containing a number of topics was prepared for the interview to serve as a uniform guide for the interviewers: identification of the organization, awareness of the enterprise's digital strategy, people and factors in the digitalization of the company, employee readiness for the digital transformation of the company, the business model and its connection to information systems in the company, the internet presence of the company, the digitalization of supply and demand chains (horizontal integration), and the digital identification of customers and their relation to smart digital production. Most of the interview was then focused on public interventions and the positions of the state towards supporting the processes and activities of the digitalization of small and medium-sized enterprises, especially in the knowledge of the individual subsidy programs of ICT support for companies and in the context of public interventions and the support of Digital Europe Programme. The conclusions from the interviews, including the identification of the opportunities and threats of the consequences and impacts of public interventions, are presented in the next part of the study.

The main question in line with the aim of the research was to verify whether the process of digitalization in SMEs is influenced by public interventions and the support of the Digital Europe Programme. The operationalization of this research question is represented by its analytical breakdown into individual sub-questions, measurable variables and their assigned data sources, and the methods by which these sources are to

be extracted. Thus, the actual preparation and implementation of desk research, the questionnaire survey, and semi-structured expert interviews are based on the stated objectives and verify the formulated hypotheses. The hypotheses were also set in accordance with the conclusions of the author's previous work (Pomffiová et al., 2018; Krajčák, 2018; Krajcik et al., 2019; Adamowicz & Machla, 2016; Rajnoha et al., 2017).

The chi-square test was used to evaluate the H1 and H3 hypotheses. The chi-square test is a statistical method that is used to determine whether there is a significant difference between various groups. The basic idea of the chi-square test is to compare the observed and expected frequencies. The observed frequencies were in the contingency table, while the expected frequencies were calculated. The p-value from the Chi-square test is used for hypothesis testing. If the p-value is less than 0.05, the researcher will reject the null hypothesis. The null hypotheses were set as the non-existence of significant differences between SMEs' digitalization and their need for public interventions and subsidies depending on their size. Other survey questions have already been examined regarding the verification of these hypotheses. To evaluate H1 hypothesis, the following statement is directed to the respondents in the questionnaire "Digital perspectives are prioritized in the strategies of our business". The following answers were used to scale the responses: "I fully agree, partially agree, or disagree".

The statistical method of correlation analysis was used to evaluate the H2 hypothesis. The current data set was scaled to the category of values 1, 2, 6 because it is an analysis of quantitative forms. The basic use of the normal correlation model shows the relationship between two variables. (Johnson & Wichern, 2007). This estimate is often called the Pearson correlation coefficient. It is a skewed estimate, but the deficiency is small when the number of data points is large. The Pearson correlation coefficient measures the strength of a linear association between two variables and is calculated according to the following formula (Hardle & Simar, 2015):

$$r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}}$$

The formula gives the value of the correlation coefficient between -1 and 1. A value of 1 indicates a strong positive linear relationship, and a value of -1 indicates a strong negative linear relationship. A result of zero indicates no linear relationship at all. Achieving +1 or -1 means that all data points included are the ones that best fit the line (Hardle & Simar, 2015). We usually interpret the Pearson correlation coefficient as follows: 0.1-0.3 weak correlation, 0.4-0.6 medium correlation, 0.7-0.8 strong correlation, and above 0.9 a very strong correlation. On the other hand, firms are categorized under two various groups regarding their age (up to 10 years and over 10 years old). This separation was necessary to evaluate the H2 hypothesis that SMEs' perceptions of digitalization processes differ depending on their age.

To evaluate the H4 hypothesis, the method of semi-structured interviews or a processed checklist according to the following thematic areas was used. The answers were scaled into individual areas of public interventions and subsidy programs aimed at supporting the digitalization of small and medium-sized enterprises. The answers were divided into groups of threats and opportunities and semantically processed before the H4 hypothesis was evaluated.

The determination of the sample of respondents was carried out in accordance with the research "Perspectives on thematic areas of research, development, and innovation responding to the context, content, and scope of the industrial revolution", while the focus on the size of the company was expanded by including the respondents from iron and mining industries. Thus, the author also used the purposive sampling method.

A database was created from an evaluation of data from the Czech Statistical Office, specifically the time series "Economic entities based in the Czech Republic according to legal form, institutional sector and the number of employees (https://www.czso.cz/csu/czso/res_cr). As of 30 December 2018, there were 2,889,422 registered economic entities in the Czech Republic. The data in the category "Numbers and size of enterprises" shows a proportional representation of 51.4% for micro-enterprises (number of employees 1-9): 24.6% for small enterprises (number of employees 10-49): 24% for medium-sized enterprises (number of employees 50-249). The piloting was performed as part of a research project in the Moravian-Silesian Region using methodological support from students at the University College of Business and the University of Business and Law. Formal adjustments and partial changes in the wording of the questions were made based on the piloting of the first version of the questionnaire. The second phase focused on the collection of data. It took place in two phases (November 2018 to January 2019 and January 2021). The respondent sample consisted of two groups. The first group was selected as a proportional representation of small and medium-sized enterprises in the concerned regions using material from the Czech Statistical Office. The baseline data revealed a total of 12,054 small and medium-sized enterprises in the Czech Republic. Three of the fourteen regions of the Czech Republic have more than ten percent each of the enterprises, namely Prague (15%), the South Moravian Region (12.8%), and the Moravian-Silesian Region (10.1%). Small and medium-sized enterprises were contacted by random selection according to the above percentages. The second group of respondents represented recipients of subsidies and interventions of the operational program Enterprise and Innovation and Enterprise and Innovation for Competitiveness. Specifically, the ICT and Strategic Services Programme focused on the development of the

information and knowledge of the company and was intended for all enterprises that seek to develop their own software solutions or create so-called strategic service centers and thus accelerate the development of this progressive sector in the Czech Republic. Through the ICT in Enterprises Programme, subsidies have made it possible for small and medium-sized enterprises to obtain funds for the expansion or introduction of information and communication technologies (hardware, software).

The questionnaire was distributed via a form in the Microsoft Forms environment (Office 365 Education) using a direct e-mail address from the database of the Czech Chamber of Commerce and a cover letter explaining the aim and description of the research. The third phase focused on the statistical evaluation, the interpretation of its parts, and the formulation of conclusions. The statistical analysis was performed in IBM SPSS Statistics. The questionnaire survey was divided into factual, closed, and open-ended questions. The factual questions aimed to identify the distribution of respondents by region, the date of the establishment of their company, the main distribution of their activities, the ownership of the analyzed entities, their ties to foreign entities, and identification of the means of digital communication used by the analyzed entities with their business partners. The analysis of the closed questions made it possible to examine the closer affinity of small and medium-sized enterprises in the Czech Republic for the digitalization of processes and the implementation of the company's digital strategy.

A total of 290 questionnaires were processed (12% return – 240 from the first group and 50 from the second group). The details about Sample Profile are also depicted below in Tab. 1:

Tab. 1. Sample profile

		n	Share
Firm size	Micro	140	52%
	Small	78	25%
	Medium	72	23%
Gender	Male	170	58.3%
	Female	120	41.7%
Age	Up to 40 years old	160	65.84%
	More than 40	130	34.16%
Total		290	100%

Source: Own process

Results

The factual questions in the questionnaire analyze the usage of subsidies or support by SMEs to carry out the digitalization activities. Only 14.7% of the respondents indicated that their company management had already implemented projects from grants focused on ICT and the Digital Europe Programme. At the same time, 6.9% indicated that their management had only prepared projects, but their applications were unsuccessful. Furthermore, 8% of the respondents are acquainted with the requirements of ICT grant calls (participation in conferences, the study of materials, etc.). The vast majority then stated that the awareness of the program to support the digitalization of small and medium-sized enterprises was scarce or non-existent.

*Tab. 2. The results from the χ^2 test regarding the H1 hypothesis
numbers (n) of respondents*

	fully agree	partially agree	disagree	total
<i>number of micro enterprises</i>	67	58	15	140
<i>number of small enterprises</i>	35	31	12	78
<i>number of medium enterprises</i>	52	15	5	72
<i>total</i>	154	104	32	290

Contingency table of expected frequencies

<i>number of micro enterprises</i>	74.34	5.37	15.44
<i>number of small enterprises</i>	41.42	27.97	8.60
<i>number of medium enterprises</i>	38.23	25.82	38.23
<i>P-value</i>	2.12E-14		

Source: Own processing.

The results of the Chi-square regarding the H1 hypothesis are presented below in Tab. 2. As seen from the table below, the p-value is higher than the 5% significance level. For this reason, digitalization does not depend on the type of business. In other words, there is not any significant difference between the digitalization of SMEs depending on their size. In this regard, this paper fails to support the H1 hypothesis.

Concerning the results for H2 hypothesis testing, the values from correlation analysis are illustrated in Tab. 3. The Pearson correlation coefficient is -0.04484, which is very weak, practically zero. Therefore, the correlation between firm age and the digitalization level of SMEs is not significant, and this fact makes this paper fail to support the H2 hypothesis. For this reason, there are no significant differences between the digitalization of SMEs depending on their age.

Tab. 3: The results from correlation analysis regarding the H2 hypothesis

Digitalization process level on a scale of 1-6	Enterprises up to 10 years old		Enterprises over 10 years	
	Number	%	Number	%
high (1)	15	11.7	24	15.3
relatively high (2)	22	17.2	26	16.6
slightly above average (3)	28	21.9	33	21.0
slightly below average (4)	33	25.8	43	27.4
relatively low (5)	13	10.2	14	8.9
low (6)	17	13.3	17	10.8
total	128	100	157	100
(1-6) Digitalization level variance		2,280	2,303	
Total Pearson value		-0.04484		

Source: Own processing.

As illustrated in Tab. 3, 39 SMEs (15 younger and 24 older SMEs, around 13.7% of the total sample) have stated the fact that they have implemented many strategies regarding their digitalization process. Thus, their level of digitalization is high. These 39 firms can be characterized as companies that have a basic corporate information system and passive Internet presence (website only). Those companies also implement digitalization in some of their work processes, including production, maintenance, and product design. Although these businesses do not have a defined digital strategy, their ability to participate in information flows in the supplier-customer relationship is only partial. Their software allows them to communicate with certain government institutions.

When only considering younger SMEs that are up to 10 years old, 37 SMEs show a high level of digital maturity. Specifically, these are the types of enterprises that own digitalization platforms connecting the online and offline world into one fully integrated and economically efficient unit. Their digital platform offers its customers a unique personalized experience through virtual products/assistants communicating with customers throughout the life cycle of the partnership. Through the latest and most effective means (full automation, 3D printing, etc.), it employs a cyber-physical system that is capable of creating product individualization.

On the other hand, there are 61 older and younger SMEs that have a slightly above-average level of digitalization. The companies that own this level have a defined digital strategy and multi-channel online presence (website, mobile phones, tablets, social networks, etc.). The basics of a data culture in these companies are demonstrated by their data architecture integration projects, integrated real-time automation, and personalized products with a virtual component.

The results from the Chi-square test are presented below in Tab. 3. As indicated in this table, the p-value is (p-value: 0.18) higher than 0.05. Thus, this paper fails to support the H3 hypothesis that assumes the existence of differences between the financial needs of SMEs depending on their size. In other words, there are no significant differences between micro, small and medium enterprises' needs for public interventions and subsidies.

Tab. 3: The results from the χ^2 test regarding the H3 hypothesis

<i>(n) of respondents</i>			
	relevantly high	relevantly low	total
<i>number of micro enterprises</i>	132	8	140
<i>number of small enterprises</i>	74	4	78
<i>number of medium enterprises</i>	54	18	72
<i>total</i>	260	30	290

<i>Contingency table of expected frequencies</i>		
<i>number of micro enterprises</i>	118.34	7.17
<i>number of small enterprises</i>	66.34	3.59
<i>number of medium enterprises</i>	48.41	16.14
<i>P value</i>	0.18	

Source: Own processing.

Regarding the results from desk research, SMEs of various sizes perceive the digitalization process as very costly, especially regarding investments in technical, communication, and software solutions to achieve the company's digital maturity. Around 89.6% of SMEs declare that important investments in technical, communication and software solutions for the company's digitalization process are highly expensive and that a significant part of small and medium enterprises in the sector will not be able to afford to implement them from their own financial resources. 42% of firms state that their digital innovations or various improvements in products or services are financed by their own resources. Thus, most enterprises in the sector will not be able to afford them from their own financial resources. External sources of funding, especially EU operational programs, are therefore an important source. Moreover, none of the respondents indicated that they would implement the project without a subsidy, and more than 40% said that the company would not implement the project at all.

On the other hand, 72% of SMEs believe that they have a low level of IT equipment compared to large enterprises or foreign corporations. The evaluation of open-ended questions showed that there are potential areas where public resources and subsidy programs might support SMEs. Those areas are new functionalities or modules of existing systems, upgrading them to ensure compatibility with current solutions and systems, as well as creating cloud versions and mobile applications for their existing systems. Concerning business processes, 16.1% of them are related to process management, 19.1% engineering software, 9.7% education, 9.7% communications, and 6.5% cumulative industrial applications, accounting, and security.

As already mentioned, semi-structured interviews with representatives of SMEs were used to evaluate the H4 hypothesis. The questions and topics of the interviews focused on public interventions and the position of the state towards supporting the processes and activities of the digitalization of small and medium-sized enterprises. The documented results were semantically scaled and grouped into factual sentences. The conclusions from the survey and expert interviews can be summarized as follows:

S1: It can be stated that the state is developing a policy to support the digitalization of small and medium-sized enterprises, that it has created the appropriate organizational structure and tools, and has allocated funds from state and European resources. In this context, the representatives of SMEs confirmed that the state insufficiently projects information and knowledge requirements into digital education. The Chamber of Commerce and business associations have to be involved in these processes.

S2: The interviews confirmed the fact that the state has failed to set up a comprehensive management system for a digital enterprise support policy regarding small and medium-sized enterprises.

S3: The state supports the entry of SMEs into the concept of the digitalization only through "ad hoc" connectors; it also supports foreign and large investments and new technologies associated with the digitalization of enterprises

S4: The state directs a policy of standards and norms in the IT sector and has created an organizational structure, legislation, metrology, and testing for it. On the other hand, the state does not sufficiently motivate the involvement of small and medium-sized enterprises in creating new standards and norms for the digital

economy, which in turn leads to their ignorance in this sector of the business environment. The dissemination of these standards is linked to a new method of distribution, with licensing conditions that are very costly for SMEs. The protection of intellectual property in digital business is difficult for SMEs not only for financial reasons but mainly because SMEs do not have sufficient expert skills in this area and do not know the appropriate procedures to support their innovative activities.

S5: During the interviews, the state confirmed the concept of the digitalization of vocational education, which can be promoted legislatively and by employing many tools. On the other hand, a large part of instructive interaction is moving into the digital sphere, and huge volumes of educational digital data are being created. An algorithmic analysis of it promises new knowledge and access to new opportunities. Many threats to the labor market are likewise being created that cannot be sufficiently described in digitalizing education. There is room for negative views on the digitalization of teaching in the concept of the knowledge economy, which affects the digitalization processes of enterprises, including small and medium-sized ones.

S6: Respondents here indicated that the state does not look for a way to prevent the shortage of information and knowledge-oriented workforce nor specialists for digitally-oriented SMEs. The result is an outflow of this human capital to large multinational corporations. There is a complete lack of students and doctoral students able to fill positions involved in implementing the digital agendas of the company.

S7: There is also a consensus that the state is creating offers of research programs and support with a focus on digital business, suitable for SMEs and which can motivate SMEs to undertake research in this area. The interest in submitting an application for a program project is there on the part of SMEs. The administrative complexity of submitting the application is decreasing, and SMEs are able to prepare the projects themselves without an agency.

S8: Respondents generally agreed that the state is not searching for a good systemic tool to support the digitalization of SMEs, nor a tool for the qualitative and quantitative evaluation of not only digital efficiency but also innovation and research activities in the digital economy. As a result, it will probably be necessary to adjust a number of information and management links between the quaternary (knowledge) sector and to face the threat of the improper creation of hedging conditions, motivations, and the establishment of priorities between individual sectors,

S9: During the interviews, the SME representatives confirmed that the state had so far not provided sufficient information on relevant research solutions that focus on specific impacts and case studies of SME digitalization. SMEs do not have enough information on those digital solutions that digital SMEs could use. In particular, new economic and knowledge models and solutions are missing, such as research support for ICT and shared services and ensuring SMEs' cyber security.

S10: In conclusion, it was stated that the state is still not alleviating unnecessary bureaucratic burdens, while the number of its employees who are insufficiently prepared to understand the support of the digitalization of small and medium-sized enterprises is increasing. The digital agendas and support programs for small and medium-sized enterprises are difficult to introduce and implement. This increases the reluctance of SMEs to accept and use aid programs to support and build digital businesses.

An analysis of the outputs S1-S10 makes it possible to declare the H4 hypothesis confirmed. The policy of public interventions and attitudes of the state toward supporting the processes and activities of the digitalization of small and medium-sized enterprises is ineffective, and it is possible to identify more significant deficiencies in interventions undertaken through aid programs. The use of the potential of small and medium-sized enterprises in the ICT sector is low and does not sufficiently contribute to the digital competitiveness of the economy. Thus, SMEs' perceptions regarding the government's digitalization policies are negative.

Discussion

According to the result, this paper does not confirm any significant differences between the digitalization of SMEs depending on their size. In this regard, the result of this research is not compatible with the studies of Ozsahin et al. (2020); Arora and Rathi (2019); Michaelidou et al. (2011); Marion et al., (2016); Parveen et al. (2016); Grazzi and Jung (2015); Mwantimwa (2019); Cirera et al. (2016); Civelek et al. (2021a); Civelek et al., (2020); Delerue and Cronje (2015); Yellow (2018) and Olanrewaju et al. (2020) since these papers confirm the differences among SMEs' usage and adaptation of some digitaliza

tion processes including ICT and Industry 4.0 etc. On the other hand, this paper finds similar results to some studies since these researchers also substantiate the similarities in the usage of online tools (Vavrecka et al., 2021) or SMEs' social media channels by SMEs (Žufan et al., 2020; Ključnikov et al., 2021b).

One of the reasons for similarities in the digitalization process of SMEs of various sizes might be related to the Czech market's competitiveness. This is because most of the analyzed SMEs in this research come from the regions where the biggest cities of the Czech Republic, namely, Prague, Brno, and Ostrava are located. Although digitalization is a costly process, especially for smaller SMEs, the analyzed firms in this study might have performed some activities regarding digitalization to compete with their larger-sized rivals. On the other hand, the sector in which SMEs operate might be another argument to explain the similarities between smaller and larger SMEs' digitalization. This is because firms' usage of ICT and other technologies might differ depending on their sectors (Taiminen & Karjaluoto, 2015; Žufan et al., 2020; Civelek et al., 2020), and firms in different sectors apply different strategies regarding digitalization (Khalid & Naumova, 2021). Since most of the smaller SMEs operate mining and iron industries that highly use digital technologies, this fact might have made smaller SMEs indicate similar attitudes in the digitalization processes to larger SMEs.

Concerning the length of doing business and digitalization of SMEs, this study does not confirm the differences between the digitalization of younger and older SMEs. Thus this paper finds opposing results with the studies of Ključnikov et al. (2021b); Perrigot et al. (2012); Grazzi and Jung (2015); Cirera et al. (2016); Buer et al. (2020); Exposito et al. (2019); Civelek et al. (2020); Withers et al. (2011); Anderson and Eshima (2013); Gati and Bauer (2019); and Rosenbusch et al. (2011), since these researchers declare the differences between older and younger enterprises regarding their usage of internet, information and communication technologies, and social media platforms. However, the result of this paper regarding firm age is consistent with the studies of Žufan et al. (2020) since these researchers do not substantiate the differences between older and younger SMEs regarding the usage of digital platforms such as social media usage. The age of the respondents might provide evidence to explain the differences between older and younger SMEs. As indicated in Tab. 1, most of the respondents are young (up to 40 years old). Compared to older people, younger people are more likely to use new technologies (Giunchiglia et al., 2018; Mazarrol, 2015). For this reason, having higher numbers of younger workers or executives might have made older, and younger SMEs differ in the digitalization process.

When it comes to public interventions and subsidized funds, the needs of SMEs regarding these factors do not differ depending on their size. Therefore, the result of this paper is not compatible with the arguments of Ključnikov et al. (2020b) and Civelek et al. (2020b) since these studies highlight the fact that small firms require more government support than larger enterprises. The reason why smaller and larger SMEs have similar needs regarding digitalization supports might be related to the similar approaches of the Czech government for SMEs of various sizes. For instance, the Recovery and Resilience Plan (RRP) of Czechia includes many reforms and investments to accelerate the digitalization of SMEs and the usage of Artificial Intelligence (AI) or blockchain technologies by these enterprises. Digital Innovation Hubs (DIH) also carry high importance for the digitalization of SMEs since they give some educational and consultation support for SMEs to generate digital infrastructure. Czechia also has memberships from some of the European digital initiatives. National Centre for IT innovations also gives laboratory services for SMEs by collaborating with EuroHPC. The government also cares about the digitalization of startups through the support of Czechinvest. Czechia also plans to create a facility, namely, European Reference Testing and Experimentation, to help the digitalization of SMEs (DESI, 2021, Czechia). Since the government has provided all these supports for micro, small, and medium-sized enterprises, their perceptions and needs for the government's interventions and subsidies might have been similar.

Corresponding to the perceptions of SMEs regarding the government's digitalization policies, this paper clarifies various comments of SMEs that are mostly negative. According to the interviewees, governments do not only need to provide more detailed education regarding digitalization (including ICT and cyber security training, etc.) for SMEs but also provide more protection regarding firms' intellectual properties. Although 25% of enterprises provided ICT training among all businesses in 2020 in the Czech Republic (DESI, 2021, Thematic chapters), to increase the number of enterprises, the educational support of the government is also required. Moreover, the interviewees suggest that the government should support SMEs to create standards and norms regarding the digital economy, and digital support and digital efficiency support systems might be created by the governments when supporting those enterprises. The interviewees also recommend the fact that governments also need to reduce bureaucratic obstacles to the digitalization of SMEs. Furthermore, the collaboration of governments with The Chamber of Commerce and other business associations is a prerequisite for the digitalization of SMEs, according to the interviewees.

On the other hand, SMEs also lack experts when implementing complicated procedures in their operations (Kolková & Ključnikov, 2021; Hudáková et al. 2019; Urbancová et al., 2020; Cihelková et al., 2020). Another important issue that SMEs encounter in the Czech Republic is hiring skilled workers for digital platforms. One of the reasons for this problem might be related to the places where ICT specialists live. Many ICT specialists live in Prague (DESI, 2021, Czechia). Therefore, it might be difficult for SMEs in other cities to persuade these experts to work for their companies. The human aspect is also one of the most common reasons for the failure of expansion abroad (Safrankova et al., 2020). The attractiveness of shared services centers in the Czech Republic has been waning in the eyes of investors due to rising labor costs. To cope with this issue, a *pari passu* approach

can be followed (Finch, 2009), where a private investor bears the same risks as the public investor. The preferential remuneration of private investors in business digitalization processes ought to be enhanced by mechanisms to reconcile private interests with policy objectives.

Certain unexpected effects in support of the digitalization of SMEs have been observed in several areas (Nwaiwu, 2018). These include new potential in terms of the qualifications and growth of employees, new impulses in the company, the prevention of stagnation, access to new markets, and improved internal communication through project preparation. Many negative phenomena are associated with administrative complexity, which is surprising for innovative companies. To overcome these problems, the governments need to take some effective actions. For instance, there are some limits that governments set when providing funding for target groups. Examples of these measures are setting a threshold for the amount of support for business digitalization; establishing limits for target groups (e.g., age of the enterprise, number of years of operation on the market, operating in iron and mining industries), and setting criteria that distinguish low-quality digitalization projects of SMEs from better-quality plans that are unattractive for the private market without public funds to back them (Pisar et al., 2021). In this regard, governments can loosen those limits to provide more support, such as providing subsidies for SMEs in various age groups, iron and mining industries, etc. Using subsidies from intervention programs might promote the digitalization policy of small and medium-sized enterprises (Kanovska et al., 2019). Moreover, most of the supported projects for creating new ICT solutions are focused on new functionalities or modules for existing systems, upgrading them to ensure their compatibility with current solutions and systems, and creating cloud versions and mobile applications for existing systems. The level of outsourcing is not sufficiently used in companies, and it could be developed further.

Conclusions

Due to having a low amount of financial sources, most SMEs face problems in digitalizing their operations. But, somehow, SMEs in the iron and mining industries need to differ from their rivals because firms operating in those industries face strong competition. In this regard, firms performing effective digitalization strategies can perform better than their rivals to get competitive advantages. However, their digitalization strategies and activities might differ depending on their size, age, and perception. For this reason, this research tries to find out whether the differences exist between the digitalization of SMEs depending on their size and age or not. Moreover, this study also analyzes the perspectives of micro, small and medium-sized enterprises regarding states' digitalization strategies, including public interventions, support, and subsidies.

This research analyzes 290 Czech SMEs operating in iron and mining industries in parallel with the selected purposes. This paper also employs an online questionnaire, semi-structured interviews, and secondary data from national statistics to collect research data. To analyze the collected data, Chi-square and correlation analyses have been performed by the researcher. In addition to doing that, the researcher pays regard to the interviewees' perceptions that are gained by semi-structured interviews.

The results regarding firm size confirm the fact that digitalization procedures do not differ between micro, small and medium-sized enterprises. The competitiveness in a specific market and the sector that SMEs operate in might be the reasons for the similarities in SMEs' digitalization process. Moreover, this paper does not confirm the differences between older and younger SMEs' (firms operating for more than 10 years and up to 10 years) digitalization. The age of the respondents might be an argument to explain similarities in the digitalization of older and younger SMEs.

Concerning the need for public interventions and subsidized funds from the perspective of micro, small and medium-sized enterprises, this research does not substantiate differences among those firms. Similar initiatives, approaches, and government activities for SMEs in various size categories might be the reason for this result. Moreover, this paper confirms the fact that most SMEs negatively perceive the government's digitalization policies. SMEs in the iron and mining industries ask governments to implement effective digitalization strategies, including comprehensive ICT and digitalization training, more financial and administrative support, and reductions in bureaucratic procedures related to the digitalization of firms. Governments also need to make collaboration with the Chamber of Commerce and other institutions to improve the digitalization of SMEs. In the case of following these strategies, governments can develop the digitalization of SMEs in the iron and mining industries and improve their performance. Moreover, educating IT experts in various regions of a nation and employing them in all different regions might be other solutions to stimulate the digitalization process among SMEs in these industries.

Since this research focuses on a specific industry and analyses the perceptions of SMEs regarding state approaches and their digitalization levels, it makes significant contributions to the academic literature. However, this research is limited to some extent. For instance, this paper only investigates firms from the Czech Republic and SMEs segment that operate in the iron and mining industry. Moreover, this research only compares SMEs' digitalization regarding their size and age. This paper also only considers the perspectives of SMEs when

evaluating the digitalization policies of governments. In this regard, further studies can also look at other institutions' and public organizations' perspectives when reviewing the digitalization policies of governments. Moreover, firms of larger size, with various characteristics and from various countries and industries, might be included in the analysis to compare the digitalization of businesses in a more comprehensive manner.

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