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A Research Agenda of Industry 4.0 from the Czech Perspective

Pavel Adámek

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Abstract

Although the Czech Republic ranks among the most industrialized countries in Europe, it is not prepared for the coming of technological changes. For a country to take advantage of emerging technologies and the GDP growth and jobs they bring, it must be highly digitalized. Therefore, the chapter is intended to provide the Czech Republic Industry 4.0 approach with the latest issues to the Fourth Industrial Revolution. The chapter aims not only to point out possible directions of development, to define proposals for measures that can support the economy and industrial base, but also to help prepare the stakeholders from the public and private sector for technological change. This chapter is based on information gathered through extensive documents using print media and research databases of European Commission focused on digital economy and society, and we also employed the available Digital Transformation Scoreboard, Digital Transformation Monitor, Europe's digital Progress Report, Digital Index of Roland Berger, and Czech strategic digital transformation documents to systematize a research agenda of Industry 4.0. The chapter is expected to help in reviewing national digital performance strategies, and an overview of the collected outputs may help other entities to the process digitizing a society efficiently.

Keywords: Industry 4.0, digitalization, digital transformation performance, national digital agenda framework, Fourth Industrial Revolution

1. Introduction

Europe is currently at digital crossroads, with a unique chance to either capture an immense opportunity or see the region fall behind other nations. The Fourth Industrial Revolution (FIR)

or Industry 4.0 is called to pull applications and push technologies enabling a high degree of sustainability needed in the factories of the future [1, 2]. As explained by [3], Industry 4.0 solves today challenges related with resources and energy efficiency, urban production, and demographic change, enabling continuous resource productivity and efficiency. The critical parameters in the introduction of Industry 4.0 are the design of the process landscape and the identification of the employee qualification profiles that will be required in the future. This is preceded by the development of a comprehensive Industry 4.0 strategy and an investment plan [4], both at a national and European level.

Due to the focus of the Czech “industrial” economy, the impact of Industry 4.0 is significant. Therefore, at a national level, the Czech government should develop digital agendas, to reach national competitiveness in leveraging digitalization and new technology to drive economic growth and job creation. A shift in response to materiality and development can be observed in the main pushed Internet-based technologies and Internet of Services, favored by new developments in computational power, leading to cloud computing and services. These technologies have the potential to give rise to a new generation of service-based industrial systems whose functionalities reside on-device and in-cloud [5]. In order to succeed developing these technologies and applications, talented personnel, comprehensive IT infrastructure, economic strength, and enlightened manufacturers will be needed [6]. Therefore, creating new agendas must cover areas such as the rapid digitization of business and government services, pushing national SME’s to become European regarding market ambitions, and improving digital skills, and they should be nurtured in a smart policy environment in which innovative technologies and business models can be developed and grown.

Being digital is a shift in mind-set [7]; therefore, we grabbed the issues of technological changes, because we have to prepare not only the industry but also the whole society for the economic and societal changes related to the FIR and to enhance the competitiveness of the Czech Republic. Digitization constitutes a transformative shift in technology across industry and society in general. While the positive impact of digitization is expected to benefit the entire continent, some EU nations stand to gain more than others and therefore should help pull Europe toward a more digitized economy for the benefit of all. These same nations also have more to lose from a lack of progress in European digitization. The Czech Republic is not represented among frontrunner countries nor Big 5 countries but plays a significant role when the Czech Republic has one of the highest shares of industrial production per GDP among EU countries (approximately 32% GDP) [8].

The aim of the current chapter is to provide the Czech Republic Industry 4.0 approach with the latest issues to the Fourth Industrial Revolution not only to point out possible directions of development, to define proposals for measures that can support the economy and industrial base, but also to help prepare the stakeholders from public and private sector for technological change. This chapter is based on information gathered through extensive documents using print media and research databases of European Commission focused on digital economy and society, and we also employed the available Digital Transformation Scoreboard, Digital Transformation Monitor, Europe’s digital Progress Report, Digital Index of Roland Berger,

and Czech strategic digital transformation documents to systematize a research agenda of Industry 4.0.

There is a considerable concern to the European digital single market (DSM) which encompass more than 500 million consumers and is expected to add €415 billion in annual GDP to the EU. The more digitized frontrunner nations (the group consisting of Denmark, Belgium, the Netherlands, Sweden, Estonia, Ireland, Finland, Norway, and Luxembourg) would see the most significant benefits from a more digitized European economy, with their average GDP growth rate potentially increasing by 40% until 2020, double the increase in the growth rate of EU Big 5 countries for the same period [8].

In this chapter, we summarize planned measures that will help the development of the digital economy in the Czech Republic, both regarding national factors in the Czech Republic and in terms of initiatives at the level of the European Union.

This chapter covers the following topics:

- How digitalization drives value
- The current state of the digital “emerging” economy in the Czech Republic
- Digital transformation performance
- A national digital agenda framework
- Policy practices and case studies

2. The Czech Republic in a nutshell

The Czech Republic displays a moderate level of digital transformation with a high position in the area of ICT start-ups. The Czech Republic’s performance is slightly under the average’s line of the EU member states in most of the dimensions. The fields of entrepreneurial culture, e-leadership, and supply and demand of digital skills provide scope for improvement. The Czech government launched several programs seeking to support digital transformation further. The measures aim to promote entrepreneurship, support new business ideas, provide assistance in obtaining new technology, and enhance cooperation and knowledge transfer.

The Czech Republic has one of the highest shares of industrial production per GDP among EU countries (approximately 32% GDP) [8]. Furthermore, the country has high industrial ties with Germany, which is its strategic business partner, thus integrating into the German industrial supply chain. The Czech economy duplicates its development in Germany according to its dependence, so it is necessary to respond quickly to the changes. Therefore, the national initiative “*Průmysl 4.0*” — P40 — (Industry 4.0) has arisen as a national approach aiming to maintain and enhance the competitiveness of the Czech Republic in the wake of the Fourth Industrial Revolution. The concept was first presented during the 57th *International Engineering Fair in*

Brno, September 2015, and approved by the Government of the Czech Republic on 24 August 2016. The *Ministry of Industry and Trade* (MIT) plays a vital role in the implementation process. However, there is a robust interdisciplinary cooperation between the ministries, social and industrial partners, and academia [9].

Objectives of the policy are based on the national strategy developing the vision of a fully digital economy toward the real cyber revolution within the Czech Republic. The conceptual proposal is based on data and information collected by the experts and provides recommendations for next steps in several areas. The focus is on building data and communication infrastructure, the adaptation of the education system, introduction of new tools in the labor market, adaptation of the social environment, and financial help for the companies related to the introduction of new technologies and know-hows. There are three primary objectives [9]: first, to enhance the ability of Czech companies to be involved in the global supply chain; second, the implementation of the Industry 4.0 principles will lead to more efficient manufacturing, meaning faster, cheaper, and resource-effective production; third, to enhance the cooperation with R&D and industry association, universities, and Academy of Sciences of the Czech Republic for the development of software solutions, patents, production lines, and export know-hows.

According to *Roland Berger Industry 4.0 Readiness Index* based on industrial excellence (production process sophistication, degree of automation, readiness workforce, and innovation intensity) and value network (focus on high value-add, industry openness, innovation network, and internet sophistication), the Czech Republic is included into “*traditionalists*,” that is, countries (for example Slovenia, Slovakia, Lithuania, and Hungary) that benefit from a high-quality industrial base but have not yet introduced initiatives to shift the industry to a new era [10]. Czech businesses benefit from active participation in online trade and belong to the countries with high manufacturing share, but with a low level of readiness to Industry 4.0. Moreover, a significant share of enterprises’ total turnover derived from e-commerce contributes to a stable position of the Czech Republic in the area of e-commerce among the EU member states. To sum up, according to Ref. [11], following dimensions show similar tendencies, including digital infrastructure, integration of digital technology, investments, and access to finance and ICT start-ups. On the other hand, Czech Republic faces challenges regarding entrepreneurial culture and the supply and demand of digital skills.

2.1. How digitalization drives value

The paradigm of Industry 4.0 is essentially outlined by three dimensions [12–14]: (1) horizontal integration across the entire value creation network, (2) end-to-end engineering across the entire product life cycle, and (3) vertical integration and networked manufacturing systems. Based on these dimensions, it can be defined that digitalization creates value for individuals, corporations, and society alike. On the corporate side, it can expand reachable markets for companies both domestically and internationally, increasing sales potential. The business also benefits from the productivity increase that comes with the digitalization of corporate processes, for instance, in digitized supply chains, automated production lines, and digitized distribution systems [8]. Digitalization is a challenge for each country, and Alm et al. [8] represents that

digitalization drives values for nations and is a crucial driver for GDP growth and also have a positive net impact on job creation. From a government point of view could be found positive effects in increasing productivity in government operations (for example, tax collection and data management), to identify and analyze societal trends with big data tools, and more efficient communication with citizens and businesses.

There are also identified values for companies in areas of access to the more significant market (increasing sales), though digitization of business processes and business models that increase productivity potential and also open access to government data can spur innovation and better access to talents (digital channels). Society, especially citizens, could drive values in increased competition (consumers can find the best products at the lowest price-point), in access to new types of products and services (sharing economy), in better employment possibilities, and in facilitating access through e-government services [8]. Based on these identified values follows the next part of the chapter that defines and identifies the current state of the digital economy in the Czech Republic.

3. The state of the digital economy in the Czech Republic

Regarding the current state of the digital economy in the Czech Republic, in *Digital Economy and Society Index 2016 (DESI)*, the Czech Republic has an overall score of 0.5 and ranks 17th out of the 28 EU member states (see **Table 1**). An international view of the state of the digital economy in the Czech Republic offers the *Digital Development Index*. The index focuses on the period 2008–2013 and takes into account the four sets of factors: supply, demand, innovation, and institutions [15].

The Czech Republic, according to this index, lags behind the average, especially in the area of innovation and quality of institutions; on the contrary, better than the average result is confirmed in the field of digital infrastructure. By individual countries' results, there is a risk of deepening stagnation in the context of international competition, which the Czech Republic is indeed threatening if the digital economy is not further developed and the state administration will not receive the appropriate attention on this topic.

Therefore, the crucial task is, to sum up, the way of government policy direction and the key measures that individual government officials take to prepare for the development of the digital market. Creating approaches in the form of strategic documents could not replace existing and approved conceptual documents, but preferably cover them. In some areas, the

	Rank	Score	Cluster score	EU score
DESI 2017	18	0.5	0.54	0.52
DESI 2016	17	0.46	0.51	0.49

Source: Europe's Digital Progress Report (EDPR) 2017, Country Profile Czech Republic.

Table 1. DESI ranking.

state administration has not yet been prepared, and therefore it will be necessary to prepare a situational analysis on some topics first, which will show which approach is best suited to select. One of the critical elements of the *Czech Digital Agenda* concept [16], which the Czech Republic is also promoting in the EU, is the emphasis on smart regulation based on quality data and arguments assessing the need for regulatory measures. Any state intervention in this sector must not hamper the dynamic development of digital technologies.

Consequently, to maintain the synergy effect, it is necessary to create the role of *coordinator* for the purpose to oversee and link governmental activities to support the digital agenda and to ensure intensive cooperation within public administration and communication with the professional and nonprofessional public. The following are among the umbrella principles that will be linked to all the activities of the coordinator and will be at the core of the entire coordination activity [16]: (1) digital by default—support for modern public administration, which takes priority of digital means of communication, both inside and outside of the authorities, (2) supporting the digital economy by setting up a legislative environment that does not impede the dynamic development of this sector promotes fair and equitable market conditions and protects consumers’ rights, (3) reduces administrative burdens for citizens and entrepreneurs, (4) openness of public administration, which the digital age allows well—making data accessible to the public not only helps to increase the transparency of the state apparatus but also supports the development of innovation, which builds on open state data.

3.1. Digital progress

We employed the results of the *Europe’s Digital Progress Report* [15] (EDPR) that tracks the progress made regarding their digitization, combining quantitative evidence from the *Digital Economy and Society Index* (DESI) with qualitative information on country-specific policies. A comparison of the subfactors is shown in **Figure 1**, which contains European countries, including the European average (EU). EDPR is structured around five chapters [15]:

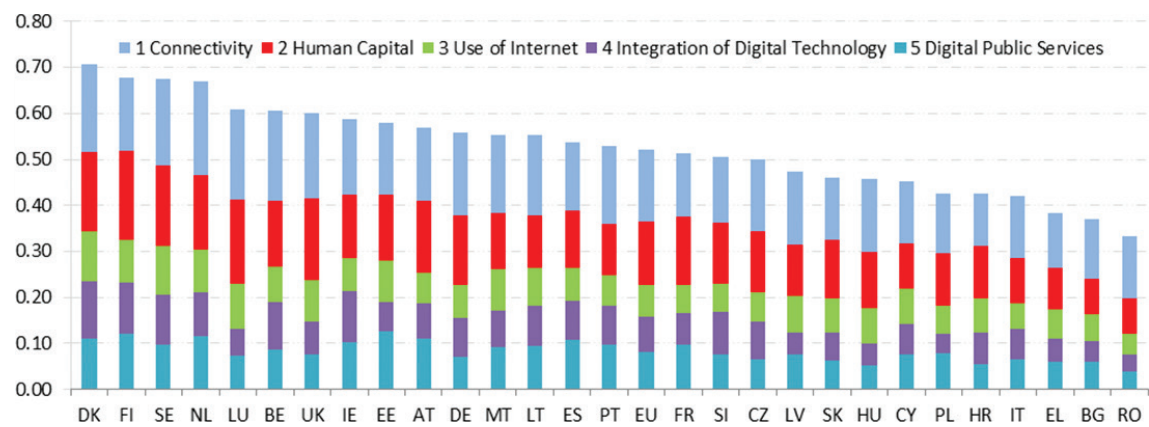


Figure 1. Digital Economy and Society Index 2017 ranking. Source: Europe’s Digital Progress Report (EDPR) 2017, Country Profile Czech Republic (CZ).

1. Connectivity—fixed broadband, mobile broadband, broadband speed and prices
2. Human capital—Internet use, basic and advanced digital skills
3. Use of Internet—Citizens' use of content, communication, and online transactions
4. Integration of digital technology—business digitization and e-commerce
5. Digital public services—e-government

Over the last year, the country progressed in *digital public Services*, remained stable in *human capital*, and worsened its ranking in the other dimensions. The country performs best in *integration of digital technologies by Businesses*, mostly because many SMEs embrace e-commerce. The Czech Republic is well positioned regarding *4G coverage* (94%), but overall performance in the *connectivity* dimension is stagnating. The country's highest challenge is to improve the use of Internet services, in particular for e-government, entertainment, and social purposes. These problem areas are the result of a not-too-active government that is supposed to create the conditions for broader use of the Internet and the digitization of public services. The Czech Republic belongs to the *medium-performing cluster of countries* (the group consisting of Latvia, Czech Republic, Slovenia, France, Portugal, Spain, Lithuania, Malta, Germany, and Austria) [15].

The Czech Republic's overall performance in the *connectivity* dimension has been stagnating relative to the EU average, with insufficient progress since the previous year. While the *fixed broadband* full coverage target has almost been met, *NGA coverage* has not improved much, keeping the Czech Republic in 20th position across the EU. The relative increase in the fixed broadband price might explain the decreasing number of fixed broadband subscriptions.

On a more positive note, the country is well positioned regarding *4G coverage* (9th place), and progress in the assignment of the harmonized spectrum is promising in this respect. Take-up is growing more slowly. The growth of subscriptions to fast broadband is achieved mainly in the (well-developed) urban areas. In the rural areas, the lack of infrastructure is expected to be tackled through structural intervention cofinanced with EU funds within the *Operational Program Enterprise and Innovations for Competitiveness* (OPEIC).

More generally, however, the actual level of competition has hardly stimulated *FTTB/FTTH* (fiber laid all the way to the building/home) deployment. While ESIF funds are used for deployment of NGA in rural areas, it remains to be seen whether the current approach is sufficient to achieve *digital agenda* targets. The regulatory support to NGA deployment is not entirely in place as the transposition of the *Cost Reduction Directive* is subject to significant delays. Finally, next to funding in areas of market failure, targeted policies and measures might also be useful to increase user demand.

In the *human capital* dimension, the Czech Republic ranks 13th, a stable position compared with last year. In 2016, more people are online and use the Internet regularly compared to 2015. However, there is a slight decline in the level of the population's digital skills. In an economy

close to full employment and where demand for professional profiles is high, recruitment of ICT specialists is increasingly tricky: in 2016, 66% of enterprises reported having had difficulties in hiring ICT specialists, the highest level in the EU and up from 47% in 2012.

Beyond formal and informal training, digital literacy of Czech citizens is also promoted through the *Digital Literacy Strategy* for 2015–2020 to prepare people to exploit the potential of digital technologies for their lifelong development. *The Action Plan of the Digital Literacy Strategy 2015–2020* was approved in 2016, and it details the thematic actions to be implemented by the end of 2020. These include equipping workers with the digital competencies needed to enter the labor market and retraining employees facing changes due to digitization and globalization. Actions also target training of employees of SMEs and self-employed, civil servants, as well as employers for the introduction of teleworking and remote work. The digital literacy strategy and in particular its strategic competitiveness goal count on employers' active collaboration for the implementation of the measures. On 24 October 2016, the "*National Coalition for Digital Jobs*" was signed by the Ministries of Education, Labor and Social Affairs, Industry and Trade and the Czech ICT Alliance (ICT sector representatives). The successful implementation of the actions above will significantly benefit the country's human capital.

Regarding the propensity of individuals to use *Internet services*, the Czech Republic over the last year made little progress and fell from rank 21 to rank 22. Although well above the EU average, in 2016, there were fewer Czech Internet users reading news online (82%) than in 2015. Czech Internet users performed banking transactions online more than other Europeans (63% compared to 59%) and increasingly shopped online, although still not in line with the EU average (57% compared to 66%). They used the Internet for entertainment (music and video) and communication (social networks) less than the average European. Video on demand use was unusually low, placing the country at the bottom of the ranking in the EU.

The Czech Republic over the last year made little progress in the dimension concerning the *integration of digital technology by businesses*. However, this is the dimension where the country performs best. Czech enterprises increasingly take advantage of the possibilities offered by online commerce: one-quarter of SMEs sell online, half of them cross the border, and they are second in the EU for e-commerce turnover. However, RFID, use of e-invoices, social media, and cloud are below EU average. To catch up with digital technologies, an open laboratory-testing facility will be established to support SMEs at the *Czech Technical University* (CTU). The representatives of Germany and Czech Republic met to sign an agreement on cooperation on the Industry 4.0 project. Czech Republic was represented by the *Czech Institute of Informatics, Robotics and Cybernetics*, while Germany was represented by the *German Research Centre for Artificial Intelligence* (DFKI).

The area of *digital public services* is the dimension where the Czech Republic has progressed the most, although it is still below average in all indicators: it ranks 22nd among EU countries. Online interaction between public authorities and citizens is one of the lowest in the EU: only 15% of Czech Internet users actively engage in the use of e-government services, although this figure has improved. The increase in the use of e-government services suggests that measures taken to improve their supply are having a positive impact: the availability of prefilled forms and the level of online service completion have indeed also increased.

The Czech government has launched in 2016 the *Initiative 2020*, which aims to make the Czech Republic one of the top 20 countries in Europe for the use of e-government services by 2020. The initiative—jointly run by the private sector and the Czech authorities—focuses on the promotion of existing e-government services and support for the development of new services. Despite the progress in both demand and supply of e-government services over the past year, the performance of *Czech Digital Public Services* remains below EU average. Also, the drawdown of available EU funds for the development of e-government services has been low so far. The actions put in place by the country to improve availability, quality, and promotion of e-government services could contribute to improvements in this dimension.

We also employed the *Digital Transformation Scoreboard* [11], which is part of the *Digital Transformation Monitor* (DTM). The DTM aims to foster the knowledge base on the state of play and evolution of digital transformation in Europe. A clustering analysis of enabling conditions and outcomes of digital transformation was performed with the objective of grouping countries based on their similarities regarding enabling conditions leading to digital transformation. This analysis helped define four principal groups of countries based on their enabling conditions: best enabling environment; good enabling environment; moderate enabling environment; modest enabling environment [11].

Geographic clustering of EU digital transformation enabling environments and the Czech Republic is included into “moderate” enabling environment (the group consisting of Cyprus, Estonia, Italy, Lithuania, Portugal, Slovakia, and Slovenia) [11]. Developed *Digital Transformation Enablers’ Index* (DTEI) indicates that, in general, the higher a member state ranks in the DTEI, the higher it is likely to rank in the *Digital Technology Integration Index* (DTII). In **Figure 2**, we can rank the Czech Republic with a higher score for the DTII and slightly lower DTEI, meaning that there is potential for development of enablers but needs to improve digital technology integration.

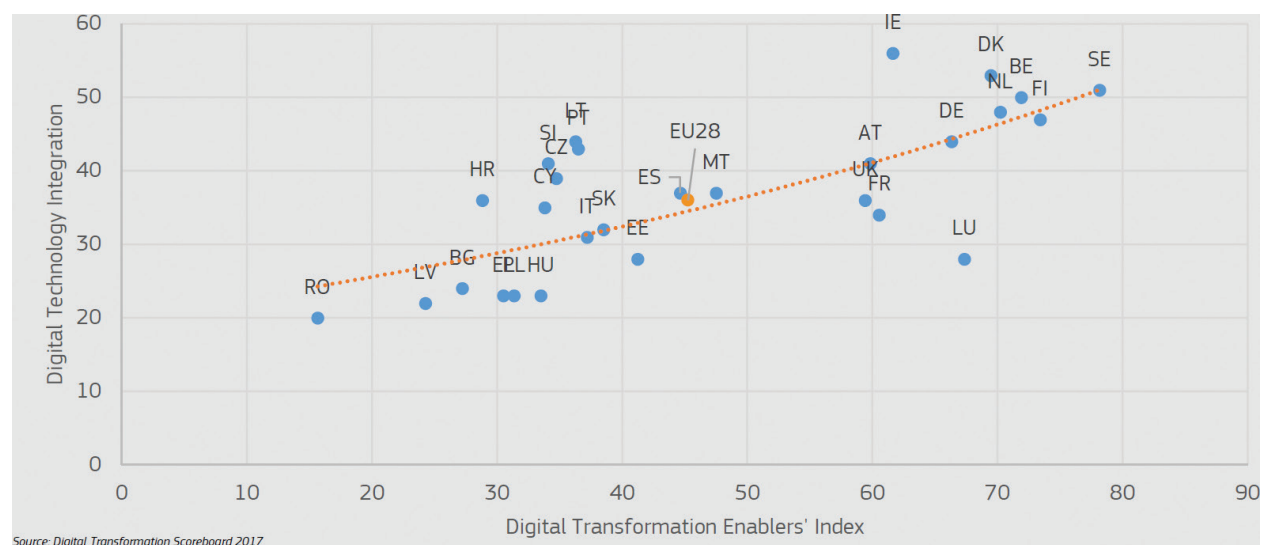


Figure 2. Digital transformation scores as a function of enabling condition cores.

The Czech Republic performs in line with the EU member states average in three (*integration of digital technology, changes in ICT start-up environment, and investments and access to finance*) out of seven dimensions (the remaining four ranks are *entrepreneurial culture, supply and demand of digital skills, e-leadership, and digital infrastructure*). Despite high marks in *e-leadership* at the national level, in comparison to the EU partners, the country is still slightly below the EU average. In the dimension *entrepreneurial culture*, the country scores significantly below the average of EU member states, to be precise 36% lower. Similarly, there is a shortfall regarding *supply and demand of digital skills*, the country's performance is around 18% below the EU average. The Czech Republic scores slightly above the average of the EU member states regarding *investment and access to finance*. Overall, the country performs broadly in line with the EU average. However, there is room for improvement in *entrepreneurial culture* and *supply and demand of digital skills*.

4. A national digital agenda framework

The subchapter is subdivided from the general definition of requirements for the creation and the national digital agenda framework, where the main areas are presented: enable digital and technology innovation; stimulate entrepreneurship; improve access to capital; regulate for the future, and build the skills and talent of tomorrow [8]. Then the *Czech Digital Agenda* is introduced in primary areas of focus, and then we employed the policy practices for practical reflection on what could be with what exists.

According to Ref. [8], enabling digital and technology innovation is based on the support of the development of innovation clusters with digital infrastructure, connecting start-ups to leading national companies and universities and attracting leading technology multinational corporations to establish national operations through tax subsidies.

In all introduced areas are stated the strategic priorities. In enabling digital and technology, innovation plays a role [8]:

- *Enable digital and technology innovation*—fully digitize government processes; invest in IT, telecommunication, and digital infrastructure; drive the SME transition to digital and mobile-first; support digital and technology clusters; attract leading technology MNCs; invest in IoT and big data; harmonize ICT standards for new technologies.
- *Stimulate entrepreneurship*—tax stock options as capital gains, steer public tenders and procurement toward SMEs and start-ups, link up tertiary education and start-up communities, introduce digitization and technology vouchers for SMEs, recognize and promote significant entrepreneurial activity at national level.
- *Improve access to capital*—attract world-leading and regional venture funds, introduce tax breaks on angel investments, simplify public funding structures, use public funds for matching venture capital investments, shift a significant part of pension funds' investment mix to established venture capital funds.

- *Regulate for the future*—review data protection legislation, push for a European digital single market, promote and creatively approach the sharing economy and new business models, increase labor market flexibility, simplify legal conditions for SMEs and start-ups, support and allow for experimentation with new technology.
- *Build the skills and talent of tomorrow*—rethink primary and secondary education, promote equality and integration throughout the educational system, differentiate tertiary education and launch cross-disciplinary programs, launch visa programs aimed at entrepreneurs, perform strategic workforce planning for digital at the national level.

Many of these topics could be implemented on a cross-national basis, either as agreed upon best practices or with one nation taking inspiration from another. This recommended overview for the creation of national digital agenda framework is then added by a realistic reflection that already exists in the Czech Republic.

4.1. Czech digital agenda

The updated *Action Plan on the Development of Digital Market* [16] includes the initiative “*Society 4.0*,” which is an umbrella for the various sectoral strategies, e.g., in education, labor, and industry. The emergence of the so-called FIR will increasingly lead to significant changes not only in manufacturing but also in an intertwined way in the labor market, education, and other areas. These changes are associated with the development of the Internet of things, the use of digitization, and the Internet in all areas of economic and social life.

Therefore, innovation in each of the above sectors must be carried out simultaneously and in a coordinated manner, and it is necessary to examine the issue in its social dimension, as “*Society 4.0*.” On 15 February 2017, the Government approved the establishment of the Alliance Society 4.0, whose primary task will be to ensure coordination of agendas related to FIR. The *Alliance* will act as a coordination mechanism allowing the involvement of economic and social partners and representatives of the academic and scientific communities. At the end of June 2017, the *Alliance Society 4.0* will submit to the government an *Action Plan for Society 4.0*, which will include actions in specific areas of industry, education, and the labor market. Regarding priority areas, the *Digital Agenda* identified six headings under which individual measures are identified and developed, namely the following six areas. The first is so-called cross-cutting priorities, including, for example, legislation on legislation and assessment of its impact on the *Digital Agenda* for the *Company's activities 4.0*. Other priorities are e-skills, e-commerce, e-government, and e-security. The last round is e-challenges that include open data or shared economy measures.

For the coordinator's role, the following priorities were set [16]:

1. Cross-border priorities

- Analytical activity—cooperation in updating Study Czech Internet Economy; extending the membership of relevant working committees on law professionals and digital agenda processes; extension of the RIA membership base; creating a submethodology for drafting legislation and assessing the impact of regulation from a digital agenda point of view.

- Company 4.0—establishment of Alliance Company 4.0; introducing the Work Initiative Study 4.0; developing Education Initiative 4.0; research projects within Company 4.0; action plan for Company 4.0.
 - Measuring the evolution of the digital economy.
2. *E-skills*—creating a platform for discussion on digital education; mapping of digital education projects
 3. *E-commerce*—organizing a conference on e-commerce; mapping market players active in the field of e-commerce to communicate with the state administration and to set up a functional communication channel; coordination of the activities and opinions of individual national gestors in the area of e-commerce
 4. *E-government*—developing an analysis of procedural legislation; setting up an internal methodology for using digital tools within ministries and other central government authorities; research of already functional and planned digital services; communication with economic and social partners, ministries, the European Commission, and the public; collaboration with self-government in e-government project development and implementation
 5. *E-safety*—privacy and privacy protection; cybersecurity
 6. *E-challenges*—open data; shared economy and online platform; smart cities

We also involved the following sector priorities [16]:

1. *Infrastructure development*—Internet networking, revision of the EU regulatory framework for electronic communication networks and services, digitization of television broadcasting, ensuring cybersecurity.
2. *The development of digital competences*—initial education, improving digital literacy of citizens.
3. *Access to goods and services*—online data protection, copyright revision, reducing administrative burdens for businesses.
4. *Development of electronic public administration*—electronic communication with authorities, electronic health service, electronization of social services, and electronization of justice.
5. *New trends*—Company 4.0, Open Data, Smart Cities.

By the areas mentioned above, it can be stated that the Czech Republic has set the assumptions in the theoretical level, but on the practical level, it is common that the partial steps are only in the “progress report” state but lack the achieved outputs that have been set. There is also a shift away from the desired (for example, the framework of digital agenda presented above) from reality.

4.2. Policy practices

The long-term goal of the initiative *Industry 4.0* is to maintain and enhance the competitiveness of the Czech Republic at the onset of the Fourth Industrial Revolution. The measure was introduced by the *MIT* and approved by the *Czech government* in 2016. The initiative aims to indicate possible

trends and outline measures that would not only boost the economy and industrial base but also help prepare the entire society to absorb this technological change. The document contains mapping and measures to promote investments, applied research, and standardization and deals with issues related to cybersecurity, logistics, and legislation. The measure serves as a regulatory framework providing information on the need for urgent changes related to the FIR for the government, ministries, and social partners to promptly apply specific measures. The initiative *Industry 4.0* simultaneously aims to mobilize the business community and the stakeholders to become actively involved in the implementation process.

In January 2017, the government established the *Alliance Society 4.0* as a coordination platform working on the Action Plan (Society 4.0). The platform was established under the *Digital Coordinator of the Czech Digital Agenda*, established by the government office. The platform brings together economic and social partners, representatives from the academic and scientific communities, and experts from private and public sectors. The *Action Plan Society 4.0* is a practical implementation of several agendas related to P40 to coordinate activities of individual ministries and other relevant governmental bodies. Moreover, the *Alliance* is also developing a system of information and feedback in public administration to promote and disseminate the implication of the Fourth Industrial Revolution. Simultaneously, this is an opportunity to inform and educate the general public about the topic and related changes [9].

Society 4.0 will include in particular new approaches in the field of new technologies, industry, manufacturing and services, energy, healthcare, SmartCities, regional development, e-government, broadband infrastructure, the Internet of Things, and Services. Implementation of new technologies in these areas and overall digitalization on all levels require particular attention on cybersecurity to be included in the *Action Plan*. Similarly, the strategy will address the necessary modifications linked to the labor market, education, R&D, and fiscal and monetary policy. The *Alliance* is structured into strategic, managerial and working, and coordination level.

Regarding barriers to the implementation of P40, two main aspects were identified. So far, a positive development of the Czech industry leads to a reluctance to change, even though it is only a short-term perspective. The Fourth Industrial Revolution cannot be stopped, and its implications are irreversible. Furthermore, the society is not entirely familiar with the concept of Industry 4.0, and the misleading, insufficient knowledge about the subject is reinforcing the reluctance to change [9]. There is a deficient coverage of the broadband connection in some of the regions in the Czech Republic. A high-speed broadband connection across the whole country is a necessary condition for the smooth implementation of P40.

4.3. Public financing via existing operational programs

Public funding is based on the financial tools already in place. The *operational programs* and subsidy programs of the ministries and the *Technical Agency* are available to support P40-related projects. The government is currently looking into making changes to investment law for the benefit of the initiative. The financial resources allocated in the program OP PIK (€4.5 billion) administrated by the MIT already offers several suitable programs to support P40 activities. Several programs focus on the promotion and funding of scientific activities and the building of partnerships between the business sphere and R&D organizations, e.g., *Potenciál*

(Potential), *Aplikace* (Application), *Partnerství znalostního transfer* (Knowledge transfer partnership), and *Proof of Concept* for commercialization of the research results. *Služby infrastruktury* (Infrastructure Services) and *Spolupráce* (Cooperation) support development of the clusters, technology platforms, cooperation networks, innovation centers, and incubators [9].

The program *Pro-Commercial Public Procurement* provides funds and subsidies for innovative solutions for the public sector. Business entities can benefit from the program *ICT a sdílené služby* (ICT and shared services) providing financial aid to support data center operation and development of software or *Inovační vouchery* (Innovation vouchers) for obtaining know-hows. The *Operational Program OP VVV* (Ministry of Education, Youth, and Sports) and the *Operational Program OP Z* (Ministry of Social Affairs) are planned to finance the activities related to the education and social system.

In the light of facts, we have identified the program *Technology* [17] targeting beneficiaries such as start-ups, microenterprises, and SMEs; the program focuses on the acquisition of new machinery and technological equipment. Regarding the territorial dimension, the program focuses on the economically troubled regions and areas with high unemployment rate and urban areas with presumed participation in the integrated territorial investments [17]. The main objective of the program is to provide support to increase the number of new business projects implemented by start-ups and microenterprises. The program falls under the SME support programs for the period of 2015–2020, implemented by MIT of the Czech Republic with a cooperation of *Czechinvest* (Investment and Business Development Agency). The total budget available for the program is 220,795,917 EUR. The subsidy for each project may vary from 3700 EUR (microenterprises) and 37,000 EUR (SMEs) up to 740,000 EUR. The maximum aid intensity is equal to 35% (medium enterprises) or 45% (small and microenterprises) of the eligible costs. *Technology* is a support program within the *OPEIC* (Operational Program Entrepreneurship and Innovations for Competitiveness) [17]. Further programs *Trio* (€140 million), *Gama*, and *Epsilon* administrated by the MIT are considered as other options of the funding for the realization of the P40 activities. These programs aim to improve knowledge transfer between the industry and R&D institutions. At this stage, no model for private financing is in place. The government is planning to explore different possibilities.

The next part introduces selected companies, best practices, and their related issues with Industry 4.0 in the Czech Republic. We have identified many examples of companies that are very active in the area of Industry 4.0 that we have made a categorization of selected companies with a level of penetrating technological development.

5. Best practices in the Czech Republic related to Industry 4.0

In the Czech Republic, concrete examples of the implementation of Industry 4.0 elements are observed in many industries, but the Industry 4.0 deployment rate is very miscellaneous, reflecting the diverse structure of the industry. Robotics and automation are the fastest in the automotive and electrotechnical, pharmaceutical, or chemical-technological industry or services. Technology development and robotization of human activities are progressively

reflected in other sectors. While it was primarily about replacing manual work, robotization is currently taking place in other segments, such as replacing work with accounting software solutions, automated logistics, maintenance, IoT, or customer approaches (chatbots, software solutions in banking, managed CRM approaches, etc.). A number of examples of companies were identified with a different level of industry introduction rate of 4.0 or their business is directly related to Industry 4.0 and we give examples.

First, we introduce the leaders in digitization, automation, and robotics (the most advanced technologies, in collaboration with technical research centers, they determine trends, they give direction), and companies are characterized by the implementation of Smart Manufacturing systems leading to Smart Factory. As an example in these high-tech issues is *ABB Czech Republic*—a leading supplier of industrial robots, modular manufacturing systems, and services. The company focus is on manufacturers to improve productivity, product quality, and worker safety. ABB has installed more than 250,000 robots worldwide, e.g., in Zetor Kovárna a.s., where hot materials are processed by a robot; at Composite Components a.s., where a fully automated workplace for milling fiberglass parts is installed; and the installation of the YuMi robot at the Low Voltage Plant in Jablonec nad Nisou. YuMi is the world's first robot enabled to work with people. The company is a partner of the Czech Institute of Informatics, Robotics and Cybernetics.

As a leader in automotive is *ŠKODA AUTO, a.s.* which implemented approaches in a big data analysis (visualization of the processes across platforms, lean process management, security principles); strategy, methods, and standards for IIoT in production; sensitive robotics—robot KUKA iiwa; system integration; predictive maintenance, system integration, additive manufacturing, and augmented reality. The company's leading projects implemented are: *Smart Maintenance* upgrade in the PKT/4 Central Maintenance Department: this innovation relates to the maintenance of machinery and equipment; *Mobile solution* with installation of *Smart components* that track their own status and report an error or failure; *Transparent Factory*—an automatic data acquisition system (processing and evaluating large data requirements) from all workplaces; *Digital Factory*—using digital models, simulations, methods, and 3D visualizations to efficiently plan, implement, manage, and continuously improve all processes and resources within the plant; and the TECNOMATIX and Siemens digital solutions portfolio that enables simulation, testing, and studies.

Second, the following companies represent the high progress in software solutions, maintenance, and high technology development areas, for example, *SIMPLECELL NETWORKS a.s.*—the first Czech public mobile operator of the SIGFOX technology network for the Internet of things; *SERVODATA a.s.*—focused on business and technology solutions, with the main domain of the portal solutions (e-shops, e-commerce, and portals), project and IT management, business process management, Intranet, Extranet, DMS, (CRM, E-contracts), and business intelligence. The leader in electrical power solutions is *ELCOM a.s.* with drivers, power inverters, industrial power systems, automated test systems, visual inspection, monitoring systems and electrical network analyzers, and activity in software development (instrument drivers and application development).

The *CERTICON a.s.* company is involved in the innovation and development of software and hardware solutions for the areas of healthcare, telecommunications, and the automotive and

aeronautical industries. This company very closely cooperates with top technical universities and research laboratories throughout the EU. Focused areas of interest are: SmartCity (analysis of images from security cameras, detection of parking spaces, marketing of shopping centers); automotive (software for vehicle diagnostics—e.g., D-PDU API, RP 1210, ODX, OTX, and automotive SPICE); healthcare (monitoring of patient safety, analysis of biosignals, EPIQA smart scheduler for healthcare, and physiotherapy tools); telecommunication; and industry (predictive maintenance, capacity planning, and crisis plan).

The biggest Czech steelmaking company with domestic capital and produce the largest amount of steel in the Czech Republic are *Třinecké železářny* together with *Moravia Steel*, ranks among the most significant industrial groups in Middle Europe. The company implements production lines and units at a high degree of automation therefore mainly data are automatically available on systems, SCADA (InTouch), Manufacturing Information System (MIS), ERP (SAP); advanced planning system (APS); maintenance planning and management—ERP and MES; data interconnection between production facilities and nonproduction facilities—central data management system, system wireless coverage, machine-readable product marking, automatic nondestructive tests, modern security technology for IT perimeter.

A company with high progress is *Brisk Tábor* using, for example, automatic welding machine for side electrodes, burning of the insulator, 3D measurement, and modular assembly line for final assembly of the spark plugs. The company is preparing for the gradual transition of all company processes to fully electronic digital platform by bidirectionally linking the flow of information from production technologies to the information system to create fully new control systems and robotic workplaces.

Best practices are identified and there are hundreds of successful examples in the Czech Republic, but they share the fact that these companies use modern technology, know-hows, and large capital investment and dispose of the “will” of the CEOs to closely cooperate and implement issues to Industry 4.0. Also we include companies such as: *AVG*; *Avast* (software security); and *Minerva*—leader in ERP in EMEA region; and automotive and electronic leaders (*Continental Automotive Czech Republic s.r.o.*, *Siemens*, *Bosh*, and *Toyota Peugeot Citroën Automobile* [TPCA]). According to EY [18], 76% of Czech manufacturing companies continue to see Industry 4.0 as an opportunity to grow business. Czech companies associate the benefit of the new industrial revolution most often with productivity gains (51%), efficiency gains (47%), or the provision of data for production control (40%). One-third wants to allocate more than a tenth of its total investment spending over the next 3 years in Industry 4.0 technologies and tools and 57% of companies considered lack of qualified staff the biggest obstacle to implementing Industry 4.0. (*A total of 102 major Czech manufacturing companies took part in the survey.*)

6. Conclusions

For an industrial country like the Czech Republic, Digital Technologies and the Fourth Industrial Revolution represent an opportunity and should be taken as an advantage for the next development. The Czech Republic ranks 18th in DESI 2017. Compared to last year, the country progressed in Digital Public Services and remained stable in human capital but

worsened its ranking in other dimensions. The country performs best in integration of digital technologies by businesses, mostly because many SMEs embraced e-commerce. The country's most significant challenge in digitalization is to improve the use of Internet services, in particular for e-government and entertainment and social purposes.

Overall, however, the Czech Republic is at the start of the road to Industry 4.0. As was demonstrated, since 2015, the FIR has become more significant and was also reflected in crucial strategic documents from the Ministry of Industry and Trade and Alliance Society 4.0 for spreading policy practices supporting operational Programs. It can be argued that the debate about Industry 4.0 brought a new stimulus in the spreading and usage of new technologies in society. But there are two levels of view—many companies in the manufacturing, financing, and service sectors see great potential, but there is currently a still significant “hesitation” of companies (e.g., SMEs) with Industry 4.0.

The Fourth Industrial Revolution also brings some problems, such as shortage of skilled workers. Companies call for the reform of the education system. Many Czech companies already use and fulfill some of the elements of the Industry 4.0 concept. In addition to companies in the automotive industry (as top leaders in technological and digitalization in the country), we mention, for example, the electrotechnical, pharmaceutical, or chemical-technological industries. Technology development and robotization of human activities are progressively reflected in other sectors. While it was initially primarily the replacement of gross manual work, robotization is currently taking place in other segments, such as replacing work with accounting software solutions. In summary, a trio of German companies in the Czech Republic is leading the way with the 4.0 revolution. They are Volkswagen-owned Škoda Auto, Continental, and Siemens.

In this chapter, we have explored that the Czech Republic comprised in the moderate enabling group and is in a position of catch-up and convergence. The Czech Republic performs well in the dimension of ICT start-ups. The success lies in the country's extensive access to IT skills obtained through formal education or offered by inwork ICT skills training. Czech businesses benefit from active participation in online trade. Moreover, a significant share of enterprises' total turnover derived from e-commerce contribute to a stable position of the Czech Republic in the area of e-commerce among the EU member states.

We considered some of the basis of the low performance in the area of entrepreneurial culture derives from a negative image of entrepreneurship in the Czech Republic. Recent data show a preference toward employment rather than self-employment. Also, the majority of the population has a low interest in setting up a business or taking over an existing one. Overall, the country tends to have a negative perception of entrepreneurship. The demand for digital skills also provides an opportunity for further enhancement, particularly regarding the demand for ICT skilled personnel.

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Author details

Pavel Adámek

Address all correspondence to: adamek@opf.slu.cz

School of Business Administration in Karvina, Silesian University in Opava, Karvina, Czech Republic

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