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Industry 4.0: Challenges and Opportunities for V4 Countries

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Visegrad Group Cooperation within the EU
Challenging the Rise of Euroscepticism

Executive summary

The paper describes the challenges, opportunities, developments, and policy recommendation of the V4 countries in Industry 4.0. It is necessary to emphasise that the recommendations were formulated for all V4 countries to cooperate.

Our basic V4 country-specific findings and recommendations are based on the following fundamental conclusions:

- Although significant progress has been made in several *Industry 4.0* areas of strategic importance to the V4 region, the V4 countries are not yet prepared for the transition *Industry 4.0* requires;
- Targeted industrial policies are needed;
- Since V4 countries offer much lower labour costs compared to other, more developed European Union member states, there is less pressure to realize a full transition to *Industry 4.0;*
- Labor shortages need to be addressed when designing social and regional development programs (such as comprehensive demographics) should be recognized, including specific regional policies and rethinking education;
- The excessive exposure of V4 to foreign-based automotive industry may engender drawbacks in industry-wide diversification possibilities;
- COVID-19-ridden socio-economic context requires fast improvement in areas such as employment, R&D, robotization, automation, education;
- Refining and redesigning the cooperation among the public sector, academia and the private sector can become a catalyser of change;
- Upskilling workers in many areas, especially manufacturing being affected by employment-saving *Industry 4.0* technologies, is a must;
- Targeted financial support should be channeled to areas such as education, reskilling, and digitisation.

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1. Setting the Scene – Industry 4.0 Developments

Through the development of information and communication technology over the past decade, *Industry 4.0* is used interchangeably with the fourth industrial revolution. It caused radical changes in the new stage of the industrial value chain. By enabling extensive data collection and knowledge acquired via the Internet, *Industry 4.0* altered economic, political, and sociocultural structures, broke down physical barriers, facilitated industrial optimization, and allowed more efficient, competitive value-creation. It brought about a new chapter in the capitalism of today, and based on technology and devices autonomously communicating with each other along the value chain, created a brand new way of the production process, a model of smart production and management of future where computer-driven systems monitor physical processes, create simulations, and make decentralized decisions based on self-organization mechanisms.

Industry 4.0 conquered the world by achieving outstanding progress in cybersecurity, new digital technologies like automation and robotization, Internet of Things (hereinafter: IoT), augmented reality, big data, autonomous robots, system integration, cloud computing, simulation, additive manufacturing, analytics, 3D printing, machine learning, or artificial intelligence. Based on Campos et al. (2019), *Industry 4.0* is sought to foster autonomous decision-making processes by enhancing interoperability, virtualization, decentralisation, real-time monitoring and interventions, service orientation, and modularity. By interoperability, it made it possible for cyber-physical systems to allow workers and smart factories to connect and communicate with each other. By virtualization, it created a virtual copy of the smart factory by linking sensor data with virtual plant models and simulation models. It realized decentralization through the ability of cyber-physical systems to make decisions of their own and to produce locally thanks to technologies such as 3D printing. By real-time capability, it created the capability to collect and analyze data and provide the derived insights immediately. Through service orientation, it made all services of cyber-physical systems and humans available internally or even cross-company. And finally, by modularity, it created a flexible adaptation of smart factories to changing requirements by replacing or expanding individual modules.

Industry 4.0 does not influence only the industry but permeates society as a whole as it brings great opportunities in case of successful involvement, yet threats otherwise. With the new twist of innovation and transformation of business models and processes, more and more decision-making bodies in the national, regional, and international sphere started to recognize the necessity to keep up with the accelerated pace of economic, political, and sociocultural changes. Authorities and politicians acknowledged the upcoming economic, political, and sociocultural challenges and started to reflect them in their actions and policies. In order to maintain economic competitiveness, reach market inclusion,

and realize geographic convergence, the regions of this European Union, such as Visegrad 4, started to embrace new digital technologies, and align them with its social values. The V4 carried out a set of policies to stimulate competitiveness in those technologies having the potential for being conducive to inclusive growth and economic convergence.

2. Industry 4.0 – Challenges and Opportunities for V4 Countries

As *Industry 4.0* generally offers the possibility **to increase productivity, shift economics, foster industrial growth, and modify the profile of the workforce**, it further contributes **to boosting national economies and income, and to the** the disruption of a wide range of sectors from agriculture to the automotive industry and logistics. The V4 countries have a wide industry which accounts for around 25-30% of GDP, with high-quality **manufacturing,** electrical engineering, and automotive branch, employing a large part of the population, and mainly producing for export. Since the automotive sector is almost fully foreign-owned, and highly concentrated in certain regions of the V4, the risk of exposure to foreign-owned companies, and the dependence on their benevolence will continue to be high. *Industry 4.0* will require the modernization of manufacturing through **automation** and **robotization,** and the boosting of **research and development**. The latter would significantly contribute to the advancements in **artificial intelligence, augmented reality, big data, autonomous robots, system integration, cloud computing, simulation, additive manufacturing, analytics, 3D printing, digital transformation**k, **or machine learning**. *Industry 4.0* will require large financial contributions, investments in cross-cutting technologies, and digital transformation. SMEs would be more affected than large foreign-owned companies because most innovation in the V4 is generated by the latter. As expected, smaller firms are less productive, and have less resources, hence focus less on R&D. Thus **innovation** should be facilitated through a bottom-up approach, particularly in interoperable organizational structures, such as SMEs. The role of SMEs in the V4 should be completely reassessed as they are good examples of decentralized organizational structures where innovation can be best encouraged.

Industry 4.0 significantly impacts **employment.** With the ongoing industrial progress, digital skills and strong non-cognitive skills in employment will be needed. The highly skilled will be favored, the labor market will need a rapid change in size, structure, and qualification. In terms of the territorial challenges, due to the dynamics of urban and rural employment endowments and differences larger cities and capitals focusing more on services are going to be less affected than regions depending predominantly on manufacturing, agriculture, or mining. Services are expected to almost completely take over the part of manufacturing in the labour market, since demand will focus more on administrative, professional or ICT services and less on manufacturing

and production. On the other hand, since most automatable jobs are in the lower and middle income quartiles, inequality is expected to increase. The low and medium-skilled will be predominantly affected, significant investment in reskilling parts of the workforce will be required. As the growing employment need will absorb more and more workforce worldwide, emerging countries such as the members of V4 will not only tackle with the ever increasing needs of *Industry 4.0*, but with the labor pool migration and its economic implications. As the newly emerging professions will require highly qualified employees, mainly in the tertiary sector, advancements in **education and training systems** will be needed with a focus on knowledge and skills for modern technologies. Educational programs in information and communication technologies (ICT) will be particularly needed. The educational and **social** frameworks, as well as **healthcare** will be needing significant advancements.

3. Policy Developments at V4

The V4 excel in different areas: **scientific concentration** and **business agility** (Poland), **talent and capital** (Czechia) or **technological, and regulatory frameworks** (Hungary). On the other hand, they suffer from business agility and talent (Slovakia and Hungary), regulatory framework (Slovakia, Poland, and Czechia), adaptive attitudes (Hungary and Czechia), or training and education (Slovakia Hungary and Czechia). Apart from Czechia, all countries are lagging in terms of **future readiness.** In terms of **adoption to new technologies**, less than 7% of all V4 firms use **big data analytics**, compared to 12% at the EU level. Deployment of **cloud computing** is also quite low in Poland and Hungary. **Business digitalisation** and the **use of e-commerce** are relatively high only in Czechia, but Hungary and Poland are among the worst performers in the EU. Almost a quarter of all Czech SMEs sell online, compared to only 10 to 12% of all firms in the other three countries. As a result, around 18% of the turnover reported by the Czech SMEs comes from **eCommerce**, one of the highest rates at the EU level. In terms of future readiness, local initiatives should be encouraged and scaled-up as most of the developments take place in the capitals. As a result, companies in Prague are world leaders in **cybersecurity**, Warsaw is known for marketing **automation** technologies, while Budapest excels in **scaleups**. Bratislava is also witnessing some developments but proximity to Vienna seems to hinder some of its potentials, particularly regarding the capacity to retain highly skilled employees. **Regional hubs** are also contributing to the *Industry 4.0* transition. Brno, in South Moravia, has become a technological hub, focusing on **microscopy, nanotechnology,**

or biotechnology. Poznan, a city in between Warsaw and Berlin, is also developing its information industries, being focused particularly on **IT and business services.** Krakow is a hub for technologies such as **beacon solutions and the IoT**. There are currently **10 frontier research centres on artificial intelligence** in the V4 (5 in Poland) but most regions in the V4 is ranked low or very low at the EU level in terms of frontier research. Furthermore, defining digital security policies is also very much needed in a just transition to *Industry 4.0*. While firms in Czechia and Slovakia are doing rather well in defining a digital security policy (30% to 40% of all firms have one), Poland and Hungary are lagging behind (only 10%). The V4 and particularly Slovakia are also ranked low in the International Telecommunication Union's Global Cybersecurity Index (2017). However, the pandemic increased companies' interest in cybersecurity and gave an impetus to invest in this field. Moreover, some businesses plan to migrate to cloud computing in the next 2-3 years (Kołodziej, K. et al, 2021). As cybersecurity is a cornerstone for the banking sector, it is important to mention that Poland is one of the world leaders in e-banking, taking 4th place in the world ranking (Deloitte: Digital Banking Maturity 2020). In 2020 the number of transactions by the Polish mobile payment system BLIK exceeded the number of domestic payment card transactions made via the Internet (see Mazurkiewicz, 2001).

The European Commission's 2020 country reports complement the above excel areas of V4 countries with the **artificial intelligence sector in Czechia, the automation potential in Slovakia, or the digital transformation of Hungary.** There is a large scope **to increase research and innovation** in these countries. The V4 countries are at most moderate innovators according to the 2019 European Innovation Scoreboard. Apart from Czechia that ranks in the middle, the other three countries are at the bottom of the rankings. Public funding for research and innovation in ICT is also very low. The V4 contributes with only 4% to the overall EU public funding for research in ICT and with 7% to the EU funding for ICT research in industrial production and technology. While the allocations doubled in Poland, Hungary, and Czechia since 2006, in Slovakia they actually dropped. All V4 governments adhered to the **European Artificial Intelligence (AI) Strategy** launched in 2018 and the **High-Level Expert Group on AI** and joined the new **European AI Alliance**. In addition, the **V4 signed a declaration on economic cooperation with a focus on the transition to *Industry 4.0*** and issues such as **cybersecurity or 5G infrastructures**.

The ***Innovation Strategy of the Czech Republic*****,** developed in close collaboration with academia and business, adopted in 2019, and presented at a conference called *The Country for the Future*, aims **to make the Czech Republic one of the leading forces in science** and innovation in **Europe by 2030.** The strategy recommends to focus on developing high-capacity digital infrastructure and technologies, fostering digital skills and digital learning, and ensuring access to finance for innovative firms. The Czech Republic has **a unique opportunity to become one of Europe's innovation leaders by 2030.** For this real innovation potential, the country has a clear vision of what needs to be done for a change, as identified in the ten-point action plan, and nine key areas. These include new solutions for **evaluating science, supporting start-ups, spin-offs, and creation of patents, building smart infrastructure, preferential taxation of research and development, and the dissemination of the country's results abroad.** The strategy also consists of the political will to implement the above mentioned changes. The Czechian **AI Strategy however,** adopted in 2019, produced in collaboration with the private sector and academia serves the purpose to make the country a leading AI hub in the next decade.

The **Slovakian Smart Industry concept** was first presented by the Slovakian Ministry of Economy at a high-level conference in March 2016 in order **to pursue the development of the local smart industry.** Consequently, the **Smart Industry Platform** was established to act as a central authority coordinating the various efforts and was comprised of a working group of multidisciplinary experts from industry, academic, and government. The initiative aims **to address the low levels of digital awareness amongst Slovak companies and to bring the nation's business community – particularly industrial companies – closer to the principles of *Industry 4.0*.** The focus is on collaborative **R&D cooperation with industry**, and eventually the **deployment of more advanced technologies** throughout the economy. While driven primarily by the government, the technology-focus of the initiative requires the engagement of stakeholders from industry and academic, and the expertise they bring on. The initiative is being financed by existing funding mechanisms, with no new funding currently allocated. Instead, the initiative is exploring ways to streamline funds already allocated from the state budget and **European Structural Fund** into **R&D support**. Furthermore, Slovakia included its national **AI-related policies** as part of the broader digitalisation strategy unveiled in 2019.

Within the framework of the new **Polish industrial policy**, **the country will be able to define precisely the problems and barriers of**

individual industries to propose concrete solutions using legislative and institutional instruments. The industrial policy is based on the following development axes: digitisation, security, location of industrial production, Green Deal, modern society, instruments used to implement the industrial policy, deregulation, industry contracts, research agendas/ sectoral programmes, supporting the competencies needed by particular industries, purchasing policy, support for export and foreign expansion, and contracts with international organizations. So far, Poland implemented **horizontal development policies** to improve the business environment for all enterprises. Moreover, Poland adopted a roadmap for reindustrialisation between low wages and GNP and GDP separately. This includes objectives such as economic strategies of market participants and pulling sectors, specialization of national aid, competitiveness and economic sector guidelines, management of clusters and industrial development programs, and foreign capital investment. The **White Paper on Industrial Development** made it possible to acquire knowledge directly from the particular industries. The Polish Government invited business, industry, and non-governmental organisations to participate in the consultation, so to identify barriers and suggest solutions to improve the situation of the industry, within an open dialogue and online consultation. Finally, Poland also prepared its **AI strategy,** focusing on AI, R&D, digital public services, and infrastructure.

The aim of the **Hungarian industrial policy is to support programs promoting the digitization of production.** Hungary also created a new **AI Coalition,** composed of more than 70 Hungarian and international firms, universities, and public bodies, to prepare the **national AI Strategy.** On the other hand, the government adopted the **Irinyi Plan to make Hungary one of the EU members where industry provides the largest share of gross domestic product, and to improve the quality of life in Hungary.** The national objective is to **further strengthen the economy**, and support developments and investments in fields that lack capital and belong to the sectors identified as priority sectors by the Irinyi Plan. The key points in formulating an industrial strategy were: facilitating technological innovation, to have economic and market potential, and to be of social and political importance. Along with these objectives, the Hungarian economic and industrial strategy was based on **seven pillars:** 1) to become **80 percent climate-neutral by 2030 and to make the country's 90% of electricity production decarbonized** in line with increasing **energy independence while guaranteeing clean, smart, and affordable energy;** 2) to build a **clean country**, and to **recycle as much of the waste as possible;** 3) **to build university-centered innovation ecosystems to strengthen the Hungarian knowledge**

creation and innovation capacities; 4) **to develop the country's digital core infrastructure and capabilities**; 5) **to develop transport infrastructure**; 6) **to transform the country's adult and vocational training systems**; 7) to foster **creativity.**

Policy recommendations

The participants at the V4 challenges in Industry 4.0 workshop formulated the following policy recommendations at V4:

⇒ **The V4 should strenghthen digitization, and close digital infrastructure gaps.** Measures should be taken to keep the V4's economy competitive. Companies should apply the know-how of foreign companies, and start dealing with the issues of strategy and transformation management. At present, competitiveness is increasingly characterized by technological progress, human capital, and ecological efficiency in industrial production. For this reason, the V4 should focus on modernizing its production in keeping up with its standard of quality by adapting production to global requirements. Digital transformations of businesses should be supported, great emphasis should be put on technologies aimed at transforming companies and industries, specifically by increasing the uptake of state -of-the-art technologies with a longer term view toward their use in digitising full production and operational processes.

⇒ **Companies and public institutions should utilize coordination on more levels.** As international, national, regional in the context of building interconnections across educations systems, technologies, and knowledge sharing, scaling-up all industrial, smart technologies will require wide-ranging international cooperation based on public-private partnerships.

⇒ **Manufacturing should be interconnected**. Domestic and EU projects support the digitization and modernization of manufacturing. Interconnected manufacturing will help in reaping the benefits of technology adoption by firms through to the equipment, technology, and service providers.

⇒ **Policies should be targeted to support industries with high development potential**. The V4 should recognize industries with high production complexity and high added value generated at the national links of the production chain, as well as representing significant export potential. A well-targeted support should give rise to development momentum in individual sectors, and the institutional environment, while permanent deregulation should help build competitive advantages of the economy.

⇒ **Innovation strategies would offer the potential to change, to promote innovative infrastructure and digitization.** University-centered innovation ecosystems should be built to strengthen knowledge creation and innovation capacities. Research institutes should be linked to universities and economic actors. The meeting of international and domestic companies through knowledge centers and innovation ecosystems, as well as with research institutes and universities, would also help the industrial dimension of the economy, supporting the integration of SMEs into international value chains and the international market. The SME sector should be connected to the world market directly or through the university-science sphere.

⇒ **Spending should be increased on research and development.** Investments in R&D would strengthen the V4's position in the world, especially in the field of artificial intelligence and digitization. Equal attention should be given to R&D, the labour market, and education. Science and research should be strengthened, in particular, the streamlining of existing funding mechanisms to shorten proposal development timelines and achieve faster, more coordinated R&D output. Companies implementing R&D projects during the pandemic face problems in finding funds to complete them. The V4 should increase funding for already started projects. Otherwise, there is a risk that these projects will not be realized at all, which would result in a waste of resources. The V4 is recommended to focus investments on the research and innovation framework and the digital infrastructure for schools.

⇒ **Financial support should be given to the most promising centers and research infrastructures, both centers of international importance and innovation centers.** Access to finance should be improved. Support should be given for endogenous V4 companies, spin-offs, and start-ups, which would emerge as a result of both academic research and the natural needs of businesses in all areas of societal needs. Several innovative, new funding mechanisms should be considered and the possibility of additional funds being earmarked from future state budgets. Funds should be used to expand capacity and product offerings, to market products, to carry out research and development, and to invest in energy efficiency and renewable energy. Financial support should be given for the ICT sector that may stimulate economy in the (post)COVID crisis. Assistance could take the form of technology loans.

⇒ **In particular, SMEs operating in traditional industries should be targeted for assistance.** SMEs generally lack the resources of larger firms to adapt to global trends, especially in terms of changes to supply chains. Encouraging and supporting investment in cutting-edge technologies would allow SMEs to be more efficient in production, creating higher value or lower cost products and services. In the industrial strategy program supporting the development and marketing of high value-added products that are competitive on international

markets, funds are available for SMEs.

⇒ **Systematic education, patent protection should be promoted**. The aim of the transformation of adult and vocational training systems is to prepare the workforce for the requirements of the present and the future. Focus should be put on educating the best educators. School curricula and the practical training of teachers should be redesigned. A demand-oriented and measurable training system can only be implemented with the involvement of companies. The new challenges would require an effective system of technical education, new teaching methods, digital education, support for technical education, and manual skills right from kindergarten. Digitalisation would not replace employees, but would rather require different skills and abilities. Education system should be restructured to prepare the workforce for the demands of future roles and positions. Activities should be conducted to raise awareness about the potential of *Industry 4.0*. The goal is to bring about a shift in the mindsets of both entrepreneurs and society as a whole, recognising that digitisation is inevitable while highlighting its benefits and opportunities and acknowledging the challenges it may pose. Future needs of the labour market should be identified, supported by education and skills-development.

⇒ **The V4 should aim to offer better access to STEM education in order to educate as many specialists with digital skills as possible.** In the face of profound social changes related to *Industry 4.0* effective programs should be run to STEM education. These can include scholarship programs and public-private partnerships supporting paid internships of STEM graduates. Failing to tap into the entire pool of available talent represents a missed opportunity for development in a sector with strong demand for professionals.

⇒ **Digitization of public administration services would improve the quality of life of citizens**. It would offer the possibility of communicating the citizens' data to the administration only once and being able to stay in touch through a single point of communication. Innovation-focused legislative frameworks should be created, and eGovernment. The V4 should continue consultations about industrial strategies, and the national strategic documents and strategies to help ensure a balanced and fair set of rules, by taking into consideration the European legal schemes, and guidelines, such as the European Green Deal, and the 2030-2050 EU climate policy framework

⇒ **Current and future infrastructure should cover not only roads, motorways, and railways, but also telecommunications infrastructure and related logistics**. Self-propelled transport methods, and new fuels should be introduced, taking into account the effects of climate change. Along with traditional industries, the key

policies for the next decade would be: developing clean, connected, and autonomous vehicles instead of the traditional automotive industry, new types of powertrains (eg hydrogen industry, battery production); products and services related to smart health instead of the general health industry, and economy; creating a low-carbon industry instead of a green economy in connection with the environmental goals; building services and building materials industry supporting energy efficiency in the field of energy; building a 5G (later 6G) system using artificial intelligence instead of infocommunication; special materials for special high-tech devices (manufacture of combat vehicles, manufacture of aircraft) appear in the defense industry; advanced surveillance technologies, the space industry will become of paramount importance as a primary user of state-of-the-art technologies and thus e.g. a sector for the possible transfer of technology to the defense industry and the automotive industry; new manufacturing, processing, and packaging technologies in the food industry to produce better quality, more durable food; innovation, digitalisation; utilization of circular, and climate-neutral economy, domestic material and energy resources; higher domestic added value; and value chain-based industrial development, which includes the procurement of raw materials, the production of raw materials, the development of suppliers, the production and sale of end products, and the recycling of waste.

⇒ **The V4 should skillfully use tools to stimulate the demand.** For instance, if cybersecurity spending qualifies as innovation spending, companies could get investment relief. Cybersecurity must be the subject of advanced government action because hybrid and cyber tools are among the most frequently used measures in pursuit of strategic goals.

⇒ **Targeted policies and educational initiatives in the field of the circular economy should be established.** Regarding the usage of resources, the efficiency of recycling secondary raw materials should be supported. In this sense, cloud solutions should also be promoted. In a data center, the energy cost and environmental impact of a single server are much lower than if each entrepreneur uses their servers on their premises.

⇒ **The supported technologies should be used to determine the direction of development of current sectors.** Technologies to be used: advanced manufacturing technologies; advanced materials;

nanotechnology; micro and nanoelectronics; industrial biotechnology — life sciences technologies; photonics; Artificial Intelligence and Machine Learning Technology; cyber security and connectivity; biotechnology, such as nanobiology, synthetic biology, genomics, and genetic engineering, or neurotech; AI cloud technologies; Position, Navigation and Timing (PNT) technology; microprocessor technology, such as chip systems (SoC), or stacked memory on the chip; advanced computing, such as memory-centric logic; data analytics technology; quantum information technology, such as quantum computing; distribution - based logistics systems (DBLS); manufacture of additives (eg 3D printing); robotics, such as micro-drone and micro-robot systems; molecular robotics; neurally controlled interfaces; and hypersonics.

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