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ICT-SECTOR IN GERMANY

Анотація. *Термін «індустрія 4.0» описує промислово-політичне бачення та концептуально базується на минулих промислових революційних процесах. Із застосуванням нових технологій відбулися масштабні структурні зміни в промисловості, виробничо-господарських процесах, культурі праці. Сьогодні без автоматизації та цифровізації неможливо отримати конкурентну перевагу в поточній ситуації на ринку, а особливо в телекомунікаційному секторі. Технічний прогрес дозволяє використовувати методи та процеси у сфері інформаційних технологій та телекомунікацій (ІКТ), які зменшують витрати виробництва та негативний вплив на навколишнє середовище. Сьогодні технологічні компанії прагнуть інвестувати в громади, в яких вони працюють, починаючи від постачання продуктів і послуг ІКТ і закінчуючи ширшими цілями забезпечення мобільного та оптоволоконного широкосмугового зв'язку для всіх і забезпечення цифрового залучення. Розташування цих технологічних компаній здебільшого розташовано в Німеччині, і вони сприяли зростанню країни та були двигунами економіки протягом останнього десятиліття. Однак провідні національні економіки Європи зазнали багаторазового тиску: швидке зростання цін на енергоносії сприяє інфляції, вузькі місця в ланцюгах постачання є серйозним викликом для промисловості, а наслідки війни в Україні ще більше посилюють усе це. Багато факторів останнім часом сприяли значному уповільненню продуктивності в Німеччині через досягнення цифровізації. Було зроблено висновок, що ринки фіксованого та мобільного зв'язку відіграють ключову роль у секторі ІКТ Німеччини, на них припадає 67%. Тим не менш, оборот транснаціональних телекомунікаційних компаній має тенденцію до зниження, а кількість людей, зайнятих у секторі, неухильно скорочується з 2007 року. Дефіцит робочої сили в ІТ-секторі досяг безпрецедентного рівня. За прогнозами, до 2023 року на ринку буде дефіцит до 26 000 ІТ-фахівців, що є величезним розривом між попитом і пропозицією. Автор прагне вказати на причину, чому, незважаючи на величезні зусилля з оцифрування та досягнення індустрії 4.0, зростання продуктивності в німецькій економіці значно сповільнилося.*

Ключові слова: *індустрія 4.0, телекомунікації, 5G, ІКТ-сектор, продуктивність.*

JEL Classification: L50, L80

Absztrakt. *Az „Ipar 4.0" kifejezés egy ipari-politikai jövőképet ír le, és fogalmilag múltbeli ipari forradalmi folyamatokon alapul. Az új technológiák alkalmazásával nagyarányú szerkezeti változások mentek végbe az iparban, a termelési és gazdasági folyamatokban, valamint a munkakultúrában. A jelenlegi piaci viszonyok között automatizálás és digitalizálás nélkül nem lehet versenyelőnyt szerezni. Ez főleg a távközlési szektorban tapasztalható meg. A technológiai fejlődés lehetővé teszi olyan módszerek és eljárások alkalmazását az információs technológia és a távközlés (ITT) területén, amelyek csökkentik a termelési költségeket és a környezetre gyakorolt negatív hatást. A technológiai vállalatok manapság igyekeznek befektetni azokban a közösségekben, amelyekben működnek, az ITT-*

termékek és szolgáltatások nyújtásától kezdve a szélesebb körű célokig valamint a szélessávú mobil és üvegszálas szélessáv biztosítása által mindenki számára. Ezek a technológiai vállalatok többnyire Németországban találhatók, és hozzájárultak az ország gazdasági növekedéséhez, hisz az elmúlt évtizedben a gazdaság motorjai voltak. Európa vezető nemzetgazdaságaira azonban többszörös nyomás nehezedett: a gyorsan emelkedő energiaárak fokozzák az inflációt, az ellátási láncok szűk keresztmetszete komoly kihívást jelent az ipar számára, az ukrajnai háború következményei pedig mindezt súlyosbítják. Számos tényező járult hozzá a közelmúltban a termelékenység jelentős lelassulásához Németországban a digitalizáció előrehaladása miatt. Arra a következtetésre jutottak, hogy a vezetékes és a mobil piacok kulcsszerepet játszanak a német ITT szektorban, 67%-kal. A multinacionális távközlési cégek forgalma azonban csökkenő tendenciát mutat, a szektorban foglalkoztatottak száma 2007 óta folyamatosan csökken. Soha nem látott szintet ért el a munkaerőhiány az IT-szektorban. Az előrejelzések szerint a piacon 2023-ra akár 26 000 IT-szakember hiánya lesz, ami hatalmas szakadék a kereslet és a kínálat között. A szerző arra keres választ, hogy a digitalizáció felé tett hatalmas erőfeszítések és az Ipar 4.0 elérése ellenére a német gazdaság termelékenységnövekedése miért lassult le jelentősen.

Kulcsszavak: *ipar 4.0, távközlés, 5G, IKT szektor, termelékenység.*

Abstract. *The term industry 4.0 describes an industrial-political vision and is conceptually based on past industrial revolutionary processes. With the application of new technologies, far-reaching structural changes have taken place in industry, production and economic processes, and work culture. Today, without automation and digitization, it is impossible to gain a competitive advantage in the current market situation, and especially not in the telecommunications sector. Technological progress enables the use of methods and processes in the field of information technology and telecommunications (ICT) that reduce production costs and negative effects on the environment. Nowadays technology companies are looking to invest in the communities in which they operate—from the supply of ICT products and services to the broader goals of enabling mobile and fiber broadband for all and enabling digital inclusion. The locations of these technology companies are largely located in Germany and they have contributed to growth of the country and were the engines of the economy during the last decade. However, Europe's leading national economies has come under multiple pressures: the rapid rise in energy prices is fueling inflation, bottlenecks in supply chains are a serious challenge for industry, and the effects of the war in Ukraine further aggravate all of this. Many factors has recently contributed to the significant slowdown in productivity in Germany due to the achievements of digitalization. It was concluded that the fixed and mobile markets play a key role in the ICT sector of Germany, accounting for 67%. Nevertheless, the turnover of multinational telecom companies is on a declining trend, and the number of people employed in the sector has been steadily declining since 2007. The labor shortage in the IT sector reached unprecedented levels. According to forecasts, up to 26,000 IT professionals will be in a shortage at the market by 2023, which is a huge gap between supply and demand. The author aims to point out the reason why, despite huge digitization efforts and industry 4.0 gains, productivity growth in the German economy has slowed significantly.*

Key words: *industry 4.0, telecommunication, 5G, ICT-sector, productivity.*

Introduction. The operation of economies in the 21st century is already unthinkable without information systems: online communication, international conferences and cross-country consultations, administrative processes that do not require personal presence and cloud-based data storage are now part of the working day for the global world (Nátz, 2020). The German sector of information technology and telecommunications (ICT-sector) has a key role to play in this, particularly the telecommunications sector, which is one of the largest employers in Germany.

The ICT-sector is a key driver of global digitalisation. The products and services of the sector have a significant impact on business processes in many sectors of the economy: cloud computing, big data, 5G or the Internet of Things (IoT) have given the sector a boost that has led to fundamental changes in many industries (Christofzik, 2021). The importance of the ICT sector is also shown by the fact that leading companies in the international industry such as Apple, Microsoft and Google are now among the most valuable companies in the world. Digital change is not only changing the business world, but also affecting almost every area of life. The triumph of smartphones, for example, has radically changed the way we communicate and consume information.

The telecommunications sector is a key part of the ICT sector. Germany's largest telecommunications software market is home to almost 22.3%. In second place is the United Kingdom with 21.6%, followed by France with 12.1%. The other countries in Europe together account for about 40% of this sector. In 2020 Germany is also the largest in Europe in terms of cloud services, with almost 25% of the market. According to German Statistics, the country was able to record 5.8 percent annual growth and more than € 27.5 billion in sales in the software market in 2021 (Statista 1a, 2021). The growth of software is mainly driven by the need for infrastructure optimization for big data analysis, especially when we think of the country's factories and telecom companies. It is not even possible to talk about traditional software segments, as software - especially enterprise information systems, which provide a significant part of the ICT sector - is increasingly being moved to the cloud - saving considerable costs and resources.

The growing demand for cloud services is closely linked to the country's digital transformation, with two out of three companies introducing cloud services in 2019, according to the Bitkom National Digital Association (Bitkom, 2020). The European Information Technology Observatory divides the ICT market into three broad segments: information technology, telecommunications, and consumer electronics (Nemeslaki, 2016). According to Statista, the country achieved a market turnover of € 178.3 billion in the field of ICT in 2020, making Germany one of the largest ICT markets in the world. The country's IT sector is the main engine of growth, with a turnover of more than € 101.8 billion (Statista 1b, 2021), while the telecommunications sector, which is partly examined by the author, boasts a turnover of € 67.5 million, or 1.4% compared to the previous year. While in terms of sales volume in the ICT market, the lowest turnover came from the consumer electronics segment with its 9 million euros.

Literature Review. The term Industry 4.0 itself has its roots in Germany, as most recently formulated in the High-Tech Strategy 2020 study initiated by the Federal Ministry of Education and Research. Industry 4.0 refers to the Fourth Industrial Revolution, which brings another extraordinary change in the manufacturing industry after industrialization, mass production, and automation. The long-term goal of Industry 4.0 is to ensure the competitiveness of manufacturing companies by successively promoting the digital transformation of production. Digitization creates intelligent, self-regulating socio-technical production systems whose resources, systems, employees, and products are networked and communicate in real time. Industry 4.0 embraces a multitude of innovative technologies. The challenge for

manufacturing companies is to identify those out of a multitude of technologies and trends that can ensure long-term competitiveness (Dillinger-Messmer-Reinhart, 2021).

Data exchange between companies requires interoperability (interoperability and integration of different information systems) and data sovereignty. An integrated approach involving both Industry 4.0 and International Data Space (IDS) technologies should therefore be considered and desired in industrial production applications, including telecommunications (Jacoby-Volz-Weißenbacher-Stojanovic-Usländer, 2021). International Data Spaces (IDS) is a data network that focuses on data sovereignty, the ability of a data provider to determine who can use their own data and how. The central component, the IDS connector, is a gateway to the network. These tools are constantly being developed to ensure data security and sovereignty. DIN SPEC 27070 defines requirements and reference architectures for security gateways that ensure reliable exchange of industrial data and services. The latter also includes the concept of the "digital twin" in Industry 4.0, which is a hot topic of discussion in any initiative aimed at developing and building service and data infrastructures for networked industrial production (Kritzinger, 2018). Although not new, as the term and concept have been used in the context of product lifecycle management for more than twenty years, it is gaining more and more attention in the ICT environment due to the digitization and thus virtualization of physical devices.

According to Paul Korte and Robert Kozinski, the elements of Industry 4.0 in the telecommunications sector that human and mechanical functions and products are combined, value-added networks are optimized, the products are personalized, developing new business models, and implement the SMART vision of the company, product, logistics and services (Korte-Kozinski, 2017).

SMART's vision includes the product as a service; real-time monitoring; remote maintenance; fault prevention maintenance; tracking and short supply chains (Figure 1).

According to Péter Csillik, *"industry 4.0 is characterized by the integration of machines and equipment, production units and suppliers into a single intelligent information system. Features: Internet of Things, machine-to-machine communication (M2M), custom mass production, industrial and service robots"*, larger and real-time data (BIG DATA) (Csillik, 2019).

Figure 1. Smart vision

Source: *Korte-Kozinski-Nátz (2017)*

According to Olivér Kovács, the synthesized interpretation of industry 4.0 also originated in Germany, referring to the technological revolution that began with the production of microprocessors from the last third of the last century and then unfolded with information and communication technologies (ICT) and automation (Olivér Kovács, 2017).

Industry 4.0, summarized by Kovács based on the original German definition and OECD and EP recommendations (Acatech, 2013, 2015; OECD, 2016; EP, 2016 in Kovács), is a new manufacturing philosophy based on the Internet of Things and Services (IoT) and a mode of operation in which smart factories are created by connecting resources, machines, and even logistics systems into an online integrated system. In this way, we create independent and optimizing local production processes. Local means that through different technologies, the individual production units themselves (such as the sensors) become smart and local – ie. decentralized - control is implemented instead of a central one. The international literature lists nine interacting developments in the evolution of industry 4.0: 1. Big Data Analytics, 2. Autonomous Machines, Robots, 3. Simulations, 4. Integration of Horizontal and Vertical Systems, 5. Industrial Internet of Things, 6. cyber security, 7. cloud technology; 8. additive production and 9. augmented reality" (Kovács, 2017).

Industry 4.0 is often referred to alongside the concept of the digital economy. According to Yang, the digital economy is the part of total economic output that comes from digital input from the international dimension, which includes digital competence, equipment (communication tools, software and hardware), and intermediate digitized services and goods used in production. All of these are the foundations of the digitalized economy (Williams, 2021).

The production of IT sector products and the provision of related services integrate the product and service platform where the existence of manufacturing IT is essential, e.g., precision machining using computer numerical controls. The IT sectors that support the digital economy segment are services and goods in the IT sector, which are made up of three components of the digital economy: the computer networking industry, the computer manufacturing, and the IT consulting industry. The IT sector integrates communication tools, including communication services and cloud-based technologies (Williams, 2021). New digital services and technologies are provided by a smaller yet typical business sector, information, and communication technology (ICT or ICT). This industry is one of the main drivers of digitalisation.

In 1998, OECD countries agreed to define the ICT sector as a combination of manufacturing and service industries that electronically record, transmit and display data and information. This definition, which is based on an international standard classification of activities, was seen as a first step towards defining core indicators for the ICT sector.

The principles underlying the definition are as follows. In the manufacturing industry: It must serve the function of information processing and communication, including transmission and display. It must use electronic processing to detect, measure, and / or record physical phenomena or to control physical processes. For the service sectors: The function of information processing and electronic communication should be enabled (OECD, 2002).

Purpose of the study. The goal of the author is to explore the causes of declined productivity of the German economy in recent years and what extent the ICT sector, and within it the telecommunications sector, has contributed to this.

Methods and methodology. The research is based on the data from the German statistical office (Statista) for the German ICT sector. Within this, the next key indicators of telecommunications market have been examined: the number of companies and the size of their turnover, employment in recent years, the use of broadband Internet and the effects of 5G technology.

Fields of literature research: presentation of the ICT sector; analysis of the German economy and its international comparison at the ICT sector. Structure of secondary research: analysis of the German telecommunications sector based on Statista data.

The role that the German communications sector could play in declining productivity had been examined first and then it was compared the findings based on secondary data with the findings of other authors.

Presentation of research results. The telecommunication market can be divided into mobile, fixed and cable segments. While external revenues from the classic fixed network have declined in recent years in Germany, revenues from mobile communications are stable.

The German telecommunications market achieved sales of around € 57 billion in 2020. The largest telecommunications provider is Deutsche Telekom, which accounts for about 43 percent of total market turnover. In second and third place are the German subsidiaries Vodafone and Telefonica. In total, the turnover of the three major telecommunications companies in the German market amounted to more than 43 billion euros in 2020 (Statista 1c, 2021). The number of companies operating in the industry reached 3,849 and the number of employees reached 162,000.

Figure 2 shows the external sales of the German telecommunications industry in the areas of mobile communications, fixed network, and cable until 2020. About € 25.6 billion in mobile communications expected in 2020 (Statista 1d, 2021).

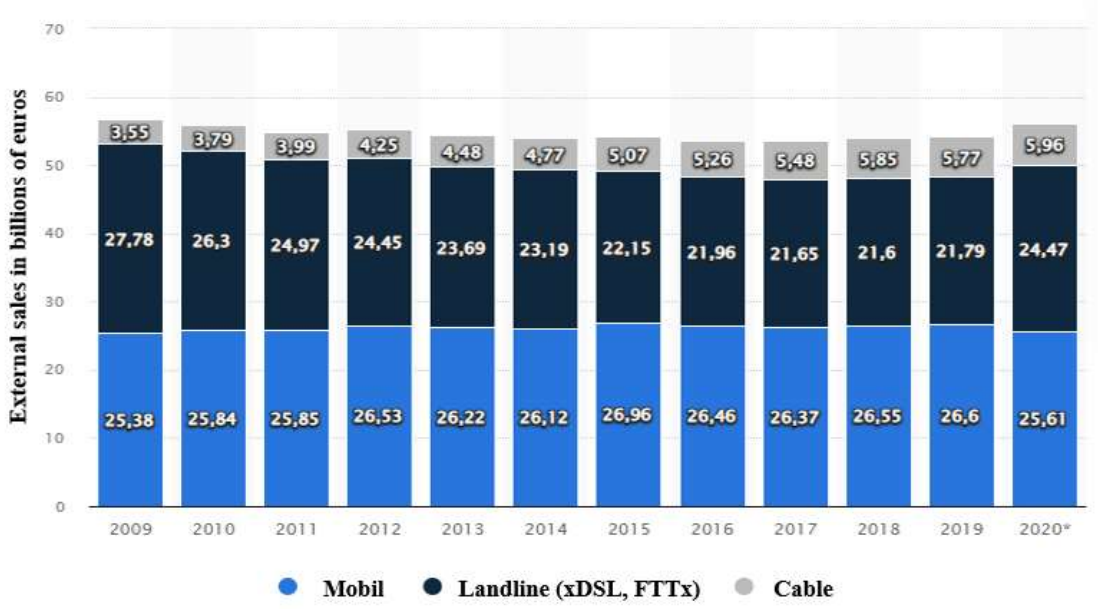

Figure 2. Sales in the German telecommunications industry: mobile communications, fixed network, and optical cable.
Source: Statista (2021).

From the viewpoint of Deutsche Telekom AG, more than half of the telecommunications turnover is attributable to this company. Thus, it is the most important player in the German telecommunications market, but also in the ICT market.

Figure 3 shows the external sales of the German telecommunications industry between 1998 and 2020.

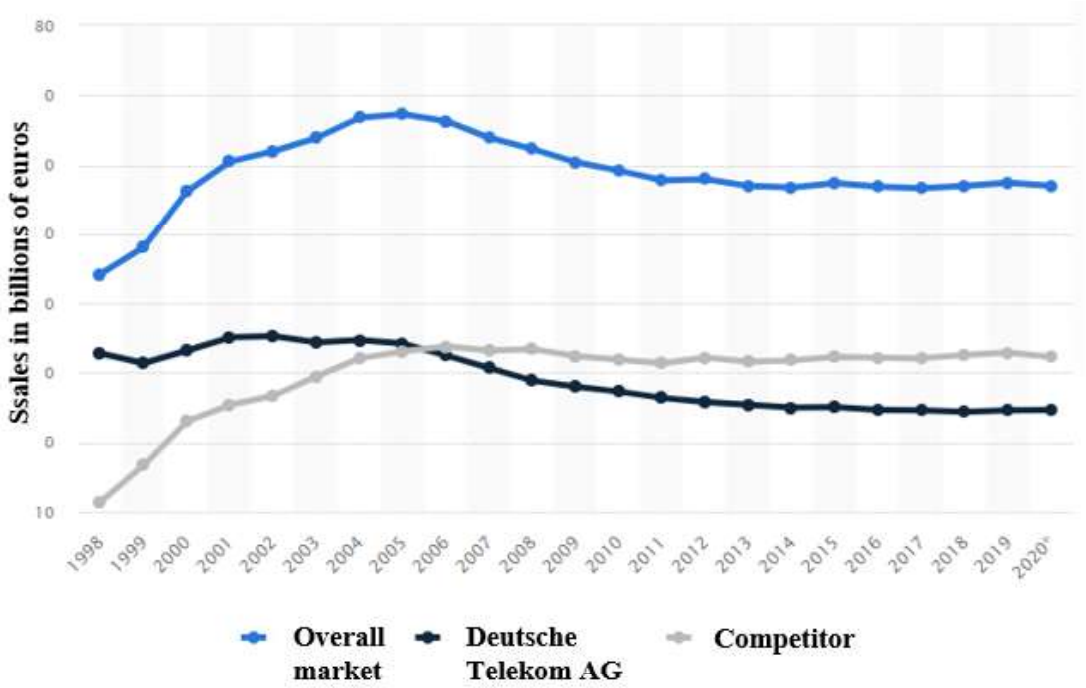

Figure 3. Turnover in the German telecommunications market from 1998 to 2020.
Source: Statista (2021).

As can be seen from Fig.3, the telecommunications market had a turnover of € 57 billion in 2020. The figures include revenues from the wired network, mobile communications, and cable TV infrastructure, which can be attributed to the activities of more than 3,800 companies.

Figure 4 shows the number of companies operating in the telecommunications sector in Germany between 2009 and 2019.

As of 2019, the industry registered 1,378 companies in the telecommunications hardware sector and 2,471 companies in the telecommunications services sector (Statista 1f, 2021).

Broadband internet use

Broadband internet provides fast access to the online world. Broadband internet is provided via a standard telephone line, cable connection, satellite technology or mobile network. Broadband connections over an optical cable are particularly fast.

In Germany, the availability of broadband internet has also improved significantly. About 96 percent of German households now have high-speed Internet access of at least 50 Mbit / s (end of 2020) (Statista 1g, 2021).

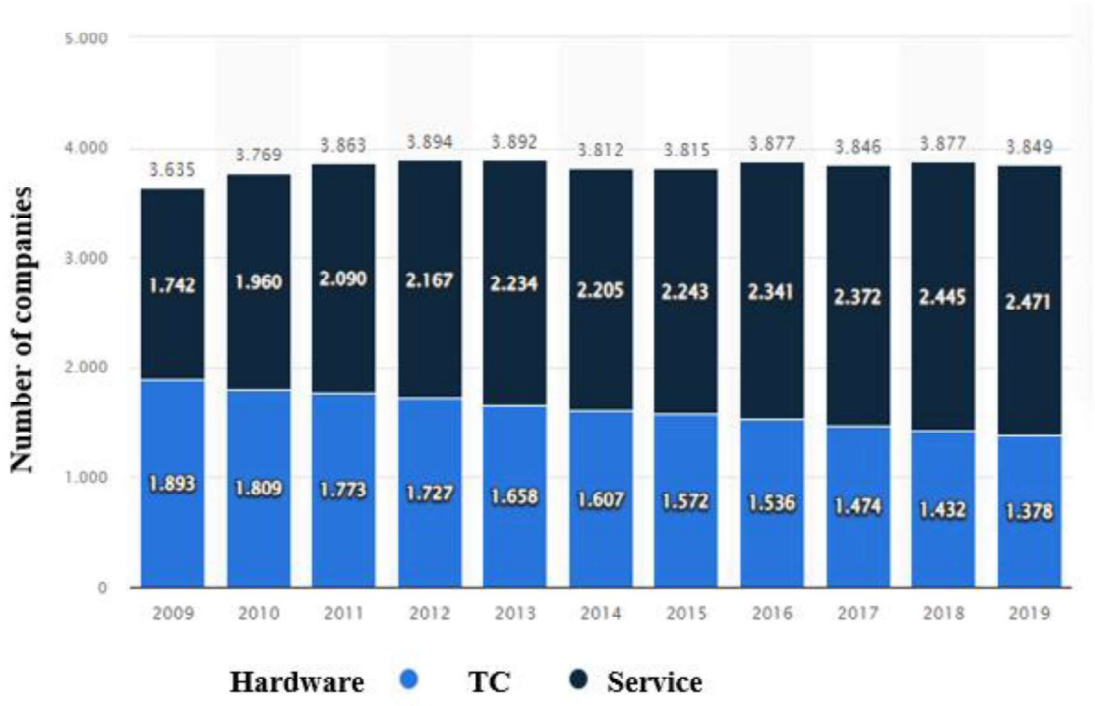

Figure 4. The number of companies in the German telecommunications market 2009-2019.

Source: Statista (2021).

However, distribution of internet access via optical cables is slow in Germany: only about 14 percent of households have access to an optical internet connection (end of 2020). (Statista 1h, 2021). Of the OECD countries, South Korea is the country with the highest rate of optical connections. In the East Asian country, about 85 percent of all broadband connections are made through fiber optics. Japan, Lithuania, Sweden, and Spain follow. Germany ranked 34th in the country with a fiber share of around 5.4 percent. Only four OECD countries have lower rates of fiber connections than Germany, including Austria and the United Kingdom.

5G technology

5G is the name of the latest generation of mobile communications standards. It follows 4G (LTE-A), 3G (UMTS, LTE) and 2G (GSM) standards. The 5G standard is designed for high data rates, reduced latency, and energy savings. The low latency of the new standard could play an important role, especially in time-critical applications such as autonomous driving or the operation of healthcare software.

By 2027, the number of 5G connections could reach 4.1 billion worldwide, of which nearly 587 million will go to Europe. Meanwhile, the German Bureau of Statistics estimates the number of smartphones using 5G at 539 million.

The auction of 5G mobile frequencies in Germany ended in June 2019, with a total revenue of around € 6.55 billion. Deutsche Telekom spent € 2.17 billion, Vodafone €

1.88 billion, Telefonica € 1.42 billion, and Drillisch Netz AG € 1.07 billion (Statista 1i, 2021). According to Figure 5, the share of 4G mobile connections in Germany in 2020 was around 75 percent. By 2025, the proportion of 4G connections is expected to fall to 48 percent, while the proportion of 5G connections will increase to 52 percent.

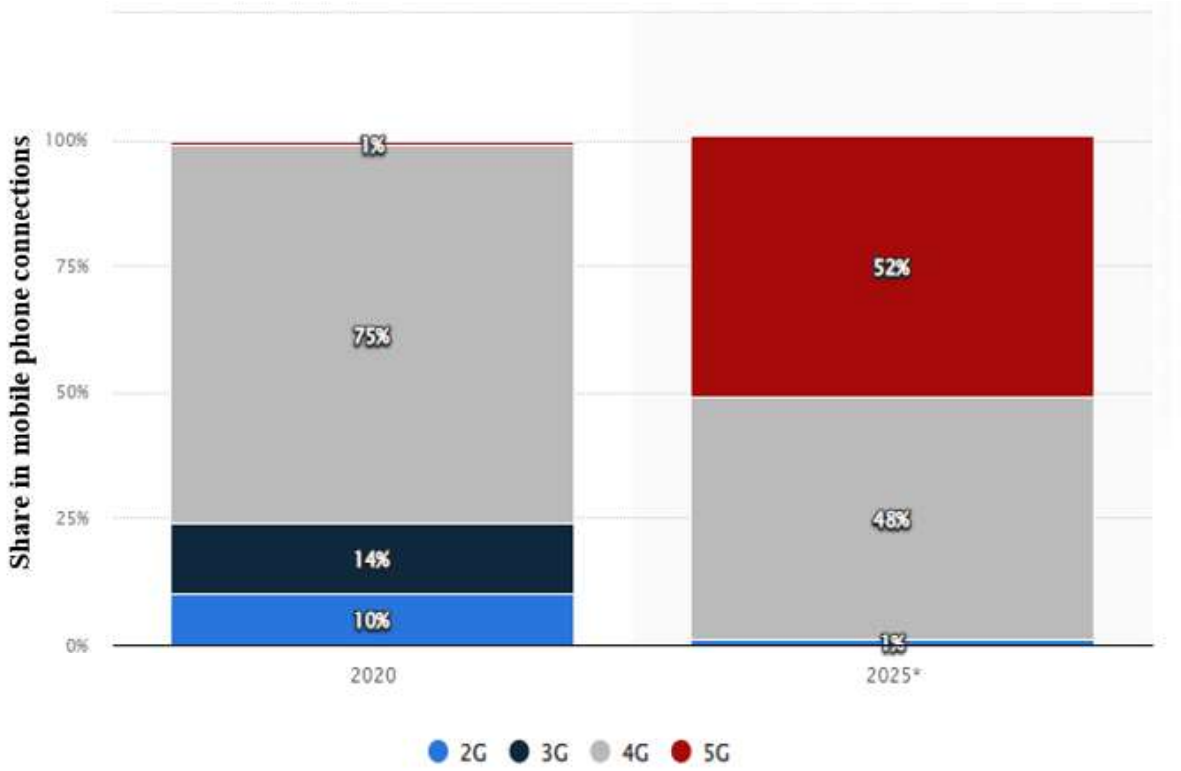

Figure 5. Distribution of mobile phone connections in Germany by mobile phone standard in 2020 and forecast for 2025

Source: Statista (2021)

Conclusions and prospects for further research. Regarding the German telecommunications sector, a broad government commitment is essential to improve optical fixed network and mobile phone coverage. This area is a pioneer in the industrial segment in allocating the local spectrum required for 5G applications. The state-owned cell phone company plans to expand coverage. The fixed and mobile markets play a key role in the ICT sector, accounting for 67%. Nevertheless, the turnover of multinational telecom companies is on a declining trend, and the number of people employed in the sector has been steadily declining since 2007.

Despite huge digitization efforts, productivity growth in the German economy has slowed significantly. Elstner and Christofzik's research team have explained why the German economy has slowed significantly in productivity growth in recent years, despite the general perception that increasing digitalisation is causing rapid technological change.

1. There are only small spill-over effects of technological change in the United States on German labour productivity. This suggests that the German economic situation appears to be special compared to other developed economies.

2. The slowdown in German productivity growth has been largely driven by labour market performance since 2005. The successful integration of five million people into the labor market has had a moderating effect on productivity growth, as many of these new workers have shown relatively low productivity.

3. Technological developments in the ICT manufacturing sector have had a significant positive impact on GDP and employment. However, the net effect on labour productivity is modest. Consequently, increasing digitalisation will result in higher production and employment, but will not lead to significantly higher productivity.

4. In the years after 2012, technological development in the ICT-producing sectors appears to be low, which may also explain the German productivity paradox.

The publication by Christofzik et al. Drew similar conclusions and traced the explanation for this development back to three factors. First, based on a novel quarterly utilization-adjusted total factor productivity measure for the German economy, it was found that the slowdown in U.S. productivity growth since the mid-2000s had a negligible impact on the German productivity trend. Second, the structural shift towards services in the German economy explains a significant part of the weaker aggregate productivity growth. This transformation process is accompanied by strong labour market performance. Third, based on a novel identification procedure, it has been shown that technological development in the German ICT sector stimulates the growth of aggregate employment. However, its impact on aggregate productivity is small (Christofzik, 2021). According to the author, it is also worth examining whether IT-outsourcing or IT outsourcing can be a realistic alternative for companies to their own employees. It is expected that the development companies would be able to handle several clients in this way and would be able to use their capacities to the maximum. It would also mean that in some cases they could be much more efficient in terms of the overall picture than the employees could.

The term industry 4.0 describes an industrial-political vision and is conceptually based on past industrial revolutionary processes. With the application of new technologies (mechanization with hydro and steam power, mass production with assembly lines and electricity, use of electronic and IT knowledge to further automate production) far-reaching structural changes have taken place in industry, production processes, economic and work culture caused by industrial societies, principles in recent centuries.

Industry 4.0 therefore means the full digitization and integration of the industrial value chain. Combining information and communication technology with automation technology, the Internet of Things and Services, enables an increasingly high level of networking within and between manufacturing plants, from supplier to customer.

The global availability of almost all information from production processes allows for the integration of customer and supplier processes and creates unimaginable flexibility and efficiency in production processes and logistics. The backbone of the industrial vision is high-bandwidth Internet, RFID, IPv6, and cloud and big data technologies for processing huge amounts of data. Virtualization and self-control of production processes fundamentally change industrial business models and ultimately create the opportunity for global, real-time access to production resources.

Despite huge digitization efforts, productivity growth in the German economy has slowed significantly. That is why German telecom companies are currently working on austerity measures that can ensure continuous improvement of 5G networks and serve the growing feature needs of customers in big data and cloud services. In this way, however, they will hardly have a framework for a post-inflation wage increase.

Future research should focus on examination which other factors influence the productivity of the telecommunications sector and thus of German industry. There is a need to explore areas where telecommunications companies can gain more market share in the ICT sector than, for example, in smart management. Therefore, with the help of estimation models, it is possible to examine which software technologies help to make the examined industry more profitable and which ones have no perspective in the future period.

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