

DIGITAL INNOVATION IN THE NORWEGIAN ECONOMY WITH THE INTRODUCTION OF NEW FORMS OF INFORMATION AND COMMUNICATION TECHNOLOGY

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Abstract. *The purpose* of the article is to substantiate the need for further development of the digital transformation of the Norwegian economy and to provide scientific and practical recommendations for improving its digital policy and concentration of high-tech information and communication technologies. *Methodology.* The research is based on modern methods of scientific research, in particular, general and special methods of analysis of economic phenomena and processes: historical-logical method; structural-comparative and graphical analysis (to analyze the digital level of Norway in terms of the Network Readiness Index, the Digital Economy and Society Index, the ICT Index and the Global Digital Competitiveness Index); structural-factor analysis; correlation and regression analysis; scenario approach (to justify the priorities of digital development of the Norwegian economy); methods of logical analysis, abstract and cognitive modeling. *The results* of the survey showed that along with the existing problems, there is significant potential for further digital development of the Norwegian economy. In order to assess the readiness of the Norwegian economy to implement new forms of ICT (5G and new IoT), the development of ISPs and digital services provided in cyberspace and blockchain systems, the factors characterizing the level of the Norwegian economy digitalization are identified. The study identified the shortcomings, risks, opportunities and advantages of using the latest information and Internet technologies. Based on the results of the analysis, scientific and practical recommendations for the further development of the digital economy in Norway and the prospects for their practical implementation were developed. A set of measures to enhance the potential of the Internet of Things, active subscription to mobile broadband, medium and high-tech industries and digital infrastructure were proposed. Opportunities are proposed as development points to accelerate the transition of businesses to digitalization, encouraging the use of digital technology, creating new business models that include new jobs; employee functionality that encompasses Internet skills, and good computer proficiency. *Practical implications.* Analysis of the features of the development processes of digital transformation of the Norwegian economy allows us to identify priorities for the introduction of innovative forms of information and communication technologies. It is concluded that the small number of concentrated large databases, low turnover of e-commerce and cross-border online sales of high-tech does not yet allow Norway to begin full coverage of its territory and water area, where industrial innovation fish farms are located, with 5G Internet. To improve its digital policy and concentration of high-tech information and communication technologies, measures are proposed that will incorporate and promote digital development. *Value/originality.* The presented scientific and practical recommendations take into account current trends and conditions of digitalization of the economies of developed and developing countries, and can be used by governments to improve digital policy and form a sustainable management system of the digitalization process.

Key words: information society, digitalization, information and communication technologies, digital infrastructure, the digital competitiveness index, IT integration, digital transformation of the economy.

JEL Classification: F21, F63, O11, O31, O33, Q55

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1. Introduction

The digital economy is growing rapidly on a global scale. It is the most important engine of innovation, competitiveness and economic growth in the world. European countries are making good progress in the digitalization of the economy, ranking high in international rankings.

Data-driven recovery efforts now offer a chance for governments to play a critical role that can pave the way for new technologies and infrastructure. The shift toward greater technological integration offers an opportunity to develop plans and policies that promote a more equitable distribution of benefits, and the outcomes derived from technology can help build a better and more connected future. As society enters a new era of accelerated digital transformation, every economy must consider whether global inequalities in access to and use of technology will diminish or continue to grow. The ability to harness the current digital climate can lead to more timely and accurate data, informed decision-making, and better living conditions (Portulans Institute, 2021).

Evolution and modernization of the mobile cellular or broadband system is necessary, if we form the appropriate infrastructure and link information and communication technologies with those sectors of the economy and industry for which there are the best conditions for development.

With the digitalization of the economy, there is a growing need for a strong coverage network capable of covering vast areas, especially those where urbanization, suburbanization and rural areas are taking place. The solution to this problem is the development and implementation of more powerful coverage systems – Internet stations and special towers. The third-generation mobile network is fully deployed throughout Norway, and more than half of the country is covered by the fourth-generation 4G mobile network, but the issue of 5G has not yet been put into practice and has only been legally prepared and signed off on by the Norwegian Government on Digital Strategy.

But introducing and mastering new communication takes time and requires the right technological base (Goncharenko, 2018). These technologies have great advantages over others and can accelerate the digitalization and development of the state, including Norway. It is the question of the readiness of the technological and information base of Norway to implement innovative technologies and communication generations that makes the topic of this study relevant and timely. After all, against the background of a high level of human development, markets for goods, labor and finance, Norway has a relatively low level of investment and corresponding infrastructure development.

The deployment and implementation of innovative forms of information and communication technologies are devoted to the works of such scholars as: N. Goncharenko (2018), E. Cassetta, U. Monarca, I. Dileo, C. Berardino, M. Pini (2020), Q. Deng, Z. Xu, M. Shahab, A. Bris, K. Smith, E. Dietrichs, C. Cabolis, A. Mickolei. Considerable attention was paid to the development of digital economy in their works by such scientists as: N. Goncharenko (2020, 2021), O. Dovgal (2019, 2020, 2021), V. Honcharenko (2019), O. Reshetnyak (2021), G. Dovgal (2021), N. Danko (2021), T. Shuba (2019), V. Babenko (2019), V. Shultsceva (2018).

The purpose of the article is to justify the need for further development of the digital transformation of the Norwegian economy and to develop scientific and practical recommendations for improving its digital policy and concentration of high technology.

2. Norway's readiness to implement new forms of information and communication technology

Norway already has a reputation and image as a digital country in Europe. The digitalization of schools, which are fully connected to the Internet and digital devices, is about 100%, the mainstream economy, fisheries and seafood, digital biotechnology and more. But in order to accurately and objectively assess the country's readiness to implement a new generation of Internet coverage, a number of macroeconomic indices, which characterize the level of development of information and communication technologies, are used, namely: 1. Digital Competitiveness Rating – includes three sub-indices that define the regulatory framework (Knowledge), technological readiness (Technology), gadget ownership, and ability to coexist with artificial intelligence (future readiness) (Table 1).

Table 1
Norway's ranking in the world
on the Digital Competitiveness Index, 2021

Knowledge	Talents	Training and education	Scientific concentration
17	16	11	22
Techniques	Regulatory environment	Capital	Technology base
6	1	6	12
Future readiness	Adaptation	Business dexterity	IT integration
8	8	11	8

Source: (IMD, 2021)

The data presented show that the highest positions in the global ranking of digital competitiveness are occupied by education and training, and we should also highlight the subindex of the legal and regulatory framework, which takes first place, the indicator

of readiness for technology and the future, and IT integration. In other words, we can argue that the legal and regulatory framework is a catalyst for accelerating development, as well as the reason for the rapid adoption of the latest technologies. But it should be noted that knowledge and concentration themselves are holding back the development of 5G deployment at the level of practical use. It is the knowledge indicator that is generally above the average of other countries in the European region, but worse than all other Norwegian indicators, compared to technology and readiness for the future. It should be noted that Norway is one of the top ten digital economies in the world in terms of the overall level of digital transformation. Hong Kong and Finland are ahead of or on par with Norway (IMD, 2021) (Table 2).

The Digital Competitiveness Index report identifies digital and technology skills as having the highest value in the knowledge subindex, which increases the country's digital potential. In terms of the share of students and teachers in higher education, Norway ranks high on the ranking list of countries with a high intellectual base and concentration of highly qualified personnel. An alarming trend to note is the decline in the number of credentialed scientists, who are an important human resource for implementing technology parks and improving ICT (IMD, 2021).

The highest positions in Norway are, for example, contract enforcement – 3 place, which creates a positive image of the state, also leading positions are taken by communication technology and Internet users – 3 place, as well as the development of technological applications and intellectual property rights. This positive trend allows for the development of ICT and the creation of high-speed communications coverage.

In the subcategory of digital competencies, Norway shows particularly high rates for the percentage of people with basic digital competencies and the percentage of people with basic software competencies (IMD, 2021) (Table 3).

Regarding the subcategory of digital use in business and society, Norway shows strong results in terms of SMEs' use of basic digital services. These are important preconditions for the benefits of further digitalization (Table 4).

From the analysis of the future readiness subindexes, we can conclude that Norway has an information society, the use of databases is accelerating, and new system blocks of information in certain areas are being created. Norway intends to become one of the leading players in the market for information services as early as this year. The competition in Big Data is becoming increasingly dynamic. Norway intends to become a leading data exporter. A prime example of this is the already operational, unique and largest data center in the world, built in the small town of Mili deep underground in an abandoned mine in Lefdal. It is 120,000 meters in size and has a potential total capacity of 200 MW. The first phase (30 MW capacity, \$30 million cost, 6 months lead time) is up and running (Innovation Norway, 2021).

The second important indicator of digital transformation and transition to new ICT technologies is the Network Readiness Index (NRI) – includes 4 sub-indices that consider the technological readiness of the country (Technology), the social aspect (People), the regulatory framework for ICT development (Governance) and the importance of information products in the socio-economic sphere – impact (Figure 1).

Table 2

Norway's ranking in the world for all components of the knowledge subindex, 2021

Components of the talent sub-index	Rating (global position)	Components of the Training and education sub-index	Rating (global position)	Components of the Scientific concentration sub-index	Rating (global position)
Educational Assessment – PISA – Mathematics	18	Employee coaching	10	Total R&D expenditure (%)	17
International experience	33	Total public spending on education	19	Total R&D personnel per capita	10
Foreign highly skilled workforce	12	Higher education achievements	21	Women researchers	24
City management	13	Student-teacher ratio (university education)	5	R&D output by publications	44
Digital/technological skills	7	Graduates in science	43	Scientific and technological employment	21
Net flow of international students	52	Women with diplomas	19	High-tech patent grants	28

Source: (IMD, 2021)

Table 3

Norway's place in the world rankings for all components of the technology sub-index, 2021

Components of the sub-index of the regulatory framework	Global position	Components of the capital sub-index	Global position	Components of the technology base sub-index	Global position
Setting up a business	14	IT and media stock market capitalisation	18	Communicating technologies	3
Enforcement of contracts	3	Financing of technological development	7	Mobile broadband subscribers	28
Immigration law	12	Banking and financial services	2	Wireless broadband access	32
Technological development and application	5	Country credit rating	1	Internet users	3
Research and development law	6	Venture capital	6	Internet bandwidth speed	10
Intellectual property law	5	Investing in telecoms	34	High Tech Exports (%)	16

Source: (IMD, 2021)

Table 4

Norway's global ranking on all components of the Readiness for the Future sub-index, 2021

Adaptive attitude	Indicators	Business agility	Indicators	IT integration	Indicators
E-participation	18	Opportunities and threats	12	E-government	13
Online retailing	9	Global proliferation of robots	42	Public private partnership	7
Tablet ownership	3	The agility of companies	14	Cybersecurity	18
Smartphone ownership	5	Use of big data and analytics	9	Software piracy	10
Attitudes towards globalisation	14	Knowledge transfer	10		
		Enterprising fear of failure	9		

Source: (IMD, 2021)

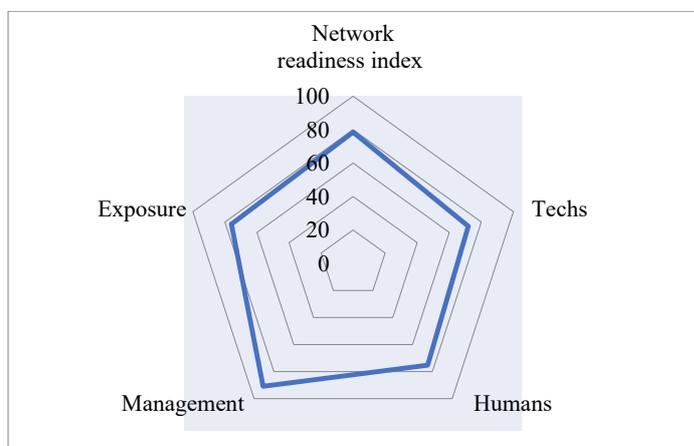


Figure 1. Norwegian Network Readiness Index in 2021

Source: (Portulans Institute, 2021)

As can be seen, Norway ranks best on the network readiness index for regulatory and legal environment, with effective existing laws and regulations on information laws, business use, and ICT policy. The social aspect and technological readiness are almost identical (Portulans Institute, 2021).

An important catalyst for 5G adoption is a stable digital electronic system. Norway ranks first in online access to financial accounts. This means that there is access to currency and transactions all over the country. And the fifth generation can only strengthen and accelerate the country's already established processes on the access side (Norway ranks 9th in mobile 4G Internet coverage). With the best providers such as VSAT Satellite Broadband, iDirect Evolution W6, Altibox Fiber Broadband and powerful 1000 mbps Internet, it allows and covers almost 85% of the entire Kingdom of Norway. This satellite and fiber optic connection allows you to watch video in 1060-2040 quality, i.e., 4K. Norway has a strong focus on cybersecurity, ranking 9th in the world for Internet security (ISP, 2021).

An indicator of digital integration in the country is the Digital Economy and Society Index (DESI), which consists of components such as human capital, connectivity, digital integration and digital government services (E-Government). In terms of overall fixed broadband usage by home-based businesses as of 2021, Norway as a whole is 90 percent utilized. Fast broadband coverage is in use and covers 87% of all households. In terms of very high bandwidth fixed network coverage, Norway has 74% coverage, compared to the European Union, where the figure is 59% (European Commission, 2021).

An important aspect to focus on is the Internet coverage of various types. 4G coverage is 99.9 percent

nationwide, i.e. all of Norway. Indicators for the digital economy and society show that on an economic, societal, legal and social level, readiness for 5G is only 50%. And the network coverage of this type is 5% of the whole, i.e. only small business incubators and technopolises with Smart-cities innovations are beta-tested. As for mobile broadband access, it is 91% in Norway, compared to 71% in Europe as a whole as of 2021. Also in Norway, public services for citizens are quite high, with a score of 86 out of 100 as of 2021. Digital government services for business are very well developed in this country, with over 90% as of 2021. The share of e-government users among Internet users is 94% as of 2020 (European Commission, 2021).

According to the Digital Economy and Society Index, Norway ranks 5th in the European region. The best and most pronounced indicators are digital integration and digital public services. But there are some bad characteristics of Norway's digitalization that this index points to. Cross-border online sales are only 6% according to the DESI index, and e-commerce turnover is also low at 14%. Large databases in industrial farms account for only 19%, and social networks for 20%. Electronic information exchange is not yet fully exploited, and the country's information capacity is high at 34% (European Commission, 2021).

According to the DESI index, Norway has a high score for SMEs, at least the baseline digital intensity is 82%, which is almost exactly the baseline compared to the European Union, where the figure is only 60%. Also the practical use of cloud networks in the economy in the tertiary sector is about 60%, indicating the digitalization of the Norwegian economy. The acceleration of the use of ICT for environmental sustainability is about 70%, indicating that such information and communication technologies are

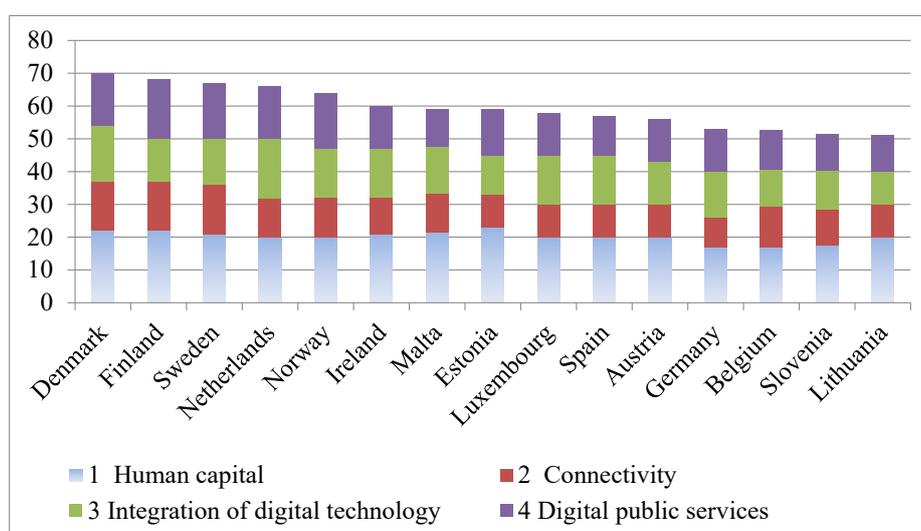


Figure 2. Digital economy and society index rankings in 2021

Source: (European Commission, 2021)

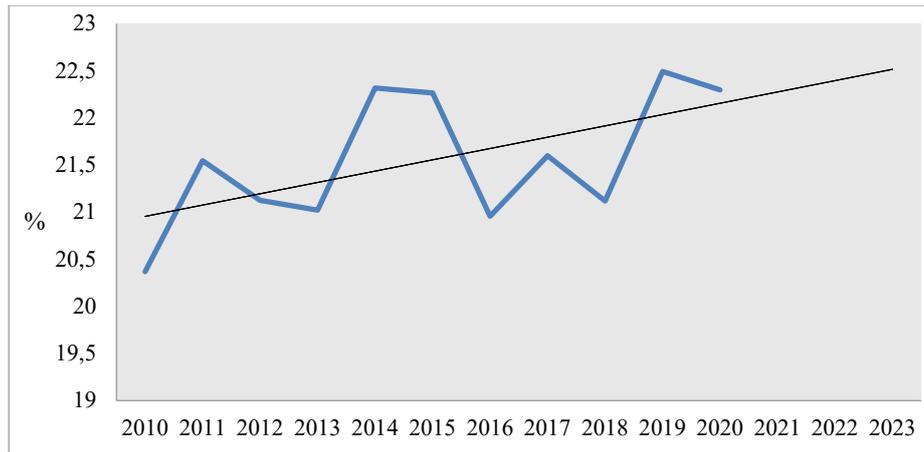


Figure 3. Trends in Norwegian high-tech digital exports, 2010–2023

Source: (The World Bank, 2020)

created and actively implemented and used in the energy sector of the country, especially in the green economy, in the alternative renewable energy sector (European Commission, 2021).

3. Integration of Norway into the global digital space

Dynamic fluctuations of digital exports are influenced by a number of external and internal economic factors. In 2020, the level of digital exports reached 22.3% (The World Bank, 2020). Despite the low level of capital availability for new industries, Norway has also fostered numerous high-tech companies with global reach, especially in video conferencing, semiconductors and web technology. Names such as Tandberg, Pexip, Energy Micro, Chipcon, Fast Search & Transfer, Opera Software and Visma and these companies have formed competence clusters across Norway. They played an important role in the development of a new generation of technology startups in these industries (Figure 3).

Norway has a positive image, which has been shaped by dynamo-institutional factors, especially Norway's image has grown in the digital subspace. The IoT system, high-tech and digital exports have greatly accelerated Norway's digitalization process.

To identify the close relationship between Norway's digital exports and foreign investment, we conducted a correlation analysis and calculated the multiple correlation coefficient, which is 0.581733 (Table 5), indicating the absence of a significant correlation and confirming the "Norwegian paradox". Research and investments in Norway focus on safe deep offshore oil and gas drilling and the development of energy reserve monitoring systems. Advances in these areas are driving the development of shipbuilding, clean technologies, renewable energy, information and telecommunication technologies.

Table 5

Correlation analysis of digital exports, GDP and foreign investment in Norway

	GDP per capita	Digital export	Foreign investment
GDP per capita			
Digital export	0.738124		
Foreign investment	0.773051	0.581733	

Source: calculated by the authors according to (The World Bank, 2021)

The correlation coefficient between GDP per capita and the share of population with Internet access was also calculated, which was 0.71392, as well as the correlation coefficient between the NRI and DESI indices, which was 0.937513, indicating a significant relationship between these characteristics and confirming the presence of interdependence between the indicators and the level of digital development in Norway.

As points of development and further effective integration of Norway into the global digital space, we can suggest creating capabilities that accelerate the digitalization of business, encouraging the use of digital technology, creating new business models that include new jobs; employee functionality that includes Internet skills and good computer skills to make requests and process them quickly and without much difficulty.

4. Goals and perspectives of the Norwegian government's digital country

The Norwegian government has identified the following goals for future e-policies: Mobile and broadband access to growth and attractiveness.

- 90% of all households will have access to at least 100 Mbps, on the basis of commercial technology deployment in the market;
- the long-term goal is for all households to have broadband high-speed internet access;

- stable online coverage where people living, working and travelling;
- good electronic communications networks should be a competitive advantage for business and industry across the country;
- regulations for laying broadband cable along urban district roads should be as uniform as possible;
- electronic communications service providers need to have fast access to the following frequency resources to meet their needs.

Regarding freedom of choice for Internet users, users of electronic communications should have access to Internet content and programs of their choice. Norway will work internationally to ensure that the Internet remains open and non-discriminatory (OECD, 2021).

Also, in the main provisions that the Norwegian government has identified to promote digitalization, it states the need for at least three competing cell phone networks. The government has also presented a strategic plan to create a favorable investment climate in the electronic communications industries so that it is cost-effective for investors to allocate financial resources (OECD, 2021).

Thus, the government has legislated and implemented all direct action tools and future policy goals related to new types of ICT, artificial intelligence, and fifth-generation-5G mobile and satellite communications. The best implementation of regulations, the effectiveness of which in this state is very intensive, gives grounds for the growth of the information component in the economy of the country in the era of globalization (OECD, 2021).

5. Conclusions

The aftermath of the COVID-19 pandemic crisis should serve as a signal to countries that need to embrace digitalization. Encouraging companies to move to digital entrepreneurship, investing in ICT development and in digital skills are the challenges of the near future. There are two immediate implications for economic recovery from this. First, technology will move forward faster than before. Private sector spending on technology declined only briefly in 2020, but it is expected to rise sharply in 2022, with companies nearly doubling their investment in digital transformation. Countries that have been able to modernize their ICT infrastructure and increase digital adoption will be better prepared for the recovery phase. Second, digital transformation must take place in parallel with the development of human capital and the legal framework. As technology advances, the growth of economic productivity depends on the ability of companies to take advantage of new technologies. On the other hand, legal codes must meet the requirements of the digital world and provide certain and simple rules for

digital business models (e.g., e-commerce, financial technology, etc.).

The readiness of the Norwegian economy to implement 5G and the Internet of Things, the new ICT at the regulatory level is quite high. But the widespread adoption and practical use of 5G in the Norwegian economy is not yet ensured by some indicators of information technology, which somewhat hinders the state's accelerated implementation of the new information technology paradigm. Indicators such as the issuance of high-tech patents, the density of robots and the spread of artificial intelligence are slowing the rapid adoption of the new generation of the Internet.

It can be concluded that the small number of concentrated large databases, the low turnover of e-commerce and cross-border online sales of high technology does not yet allow Norway to proceed almost very quickly to full 5G Internet coverage of its territory and water area, where the industrial innovation fish farms are located. Norway has an active legal and government policy to implement 5G, a strategy designed for the long term in the coming years. Currently, the coverage of this network is 5% – it is information and research centers, developments and technology parks that are testing it, so it can be said that in the next few years, Norway will begin to implement this network of mobile cellular communication and broadband Internet access throughout the country.

To improve digital policy and the concentration of high-tech ICTs, it is possible to propose a number of measures that will act comprehensively and contribute to digital development. The first priority is to increase the demand for science graduates whose specialization will be related to artificial intelligence and modern Internet communication technologies. Training of highly qualified personnel and retraining in sectors of the economy related to digitalization.

The second is to attract foreign direct investment and international expertise to create conditions for investors to build large business incubators and startups, this will improve the image and state of economic development. The third is the formation of a budget and financial opportunities for the innovation industry and the new generation of ICT, the development and creation of public projects, increasing the number of technology development bases and technopolises within the program "Smart Sites Norway" and the Internet of Things "IoT". The fifth recommendation would be to increase the turnover of e-commerce and the introduction of big databases in the industrial sector of the economy. Sixth, the state should work on international Internet power. A seventh equally important recommendation would be to continually update the digital state of the Norwegian telecommunications system. Norway is one step

away from a major 5G production, as the regulatory framework is fully effective and flexible, there is 3G internet coverage in rural areas and almost complete

4G coverage – all that is needed is a transformation and transformation of transmission lines and new equipment to make Norway a 5G country.

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