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Information and Communication Infrastructure as an Important Tool for Developing the Three Seas Initiative

Keywords: Three Seas Initiative, telecommunications, information and communication infrastructure

Introduction

In the scientific literature in the field of regional economy and economic policy, the concept and subject of the Three Seas Initiative is often described. However, the borders of the Three Seas Initiative are not always clearly defined. It is most often indicated that this area covers 12 countries: Austria, Bulgaria, Croatia, the Czech Republic, Estonia, Lithuania, Latvia, Poland, Romania, Slovakia, Slovenia, and Hungary, located between three seas: the Adriatic, the Baltic and the Black Sea.[1]

The third annual conference of the Three Seas Initiative countries, which took place in September 2018 in Bucharest, was focused on the need to accelerate the development and interconnection of the infrastructure of the Three Seas Initiative countries,

1 Kai-Olaf Lang, "Die Drei-Meere-Initiative:wirtschaftliche Zusammenarbeit in geostrategischem Kontext," *SWP-Aktuell* 16 (Febr. 2021): 2. DOI:10.18449/2021A16; George Soroka, "Was Polen in der Drei-Meere-Initiative sieht," *ZOiS Spotlight* 28 (2019): 1; Christoph Hasselbach and Rosalia Romaniec, *Berlin wertet Drei-Meere-Initiative auf*. DW: Nachrichten & Analysen, 05 June 2019, accessed on 08 January 2023, https://www.dw.com/de/berlin-wertet-drei-meere-initiative-auf/a-49063402; Sarah E. Garding, and Derek E. Mix, "The Three Seas Initiative," *Congressional Research Service*, accessed on 28 December 2022, https://aquadoc.typepad.com/files/crs_infocus_3si_26april2021.pdf.

in particular infrastructural energy, transport, and digital information and communication networks.

Analysing the emerging scientific publications on the development and connections of infrastructural networks of the Three Seas Initiative countries, it is visible that the issues of developing digital information and communication networks of these countries are given less space.[2] Considering this situation, this scientific article is devoted to:

– Presenting the essence of information and communication infrastructure,
– Selecting the basic criteria, by which modern information and communication networks should be assessed,
– Making a comparative assessment of the information and communication network of the Three Seas Initiative countries, using the previously proposed criteria for assessing these networks,
– Presenting the desired directions of development and linking these networks.

To present these issues, the authors primarily used a critical analysis of domestic and international literature in the field of regional policy and economic policy, the method of logical reasoning, the method of synthesis and statistical methods. In particular, the authors used information presented by the statistical offices of the 12 surveyed countries of the Three Seas Initiative, international statistical offices and international telecommunications organisations in the conducted statistical research.

The essence of modern information and communication infrastructure

When attempting to characterise the information and communication infrastructure, it needs to be pointed out that this is an important attribute of the telecommunications market. The importance of network infrastructure for the telecommunications market is strongly emphasised by the four-layer model of telecommunications presented in the so-called Bangemann report, in which the network infrastructure was recognised as the basic layer. This model is presented in Figure 1.

2 Óscar Méndez Pérez, *The Three Seas Initiative: Configuration and Global Geopolitical Consequences*, Opinion Paper, IEEE 48/2021, accessed on 12 January 2023, http://www.ieee.es/Galerias/fichero/docs_opinion/2021/DIEEEO48_2021_OSCMEN_Tresmares_ENG.pdf; Sarah E. Garding, and Derek E. Mix, "The Three Seas Initiative," *Congressional Research Service*, accessed on 28 December 2022, https://aquadoc.typepad.com/files/crs_infocus_3si_26april2021.pdf; Marek Górka, "The Three Seas Initiative as a Political Challenge for the Countries of Central and Eastern Europe," *Politics in Central Europe* 14 (2018), 3: 55–73, DOI: 10.2478/pce-2018-0018, accessed on 10 January 2023, https://sciendo.com/pdf/10.2478/pce-2018-0018; Velina Tchakarova, and Livia Benko, *The Three Seas Initiative as a Geopolitical Approach and Austria's role,* accessed on 10 January 2023, https://www.aies.at/download/2021/AIES-Fokus-2021-11.pdf.

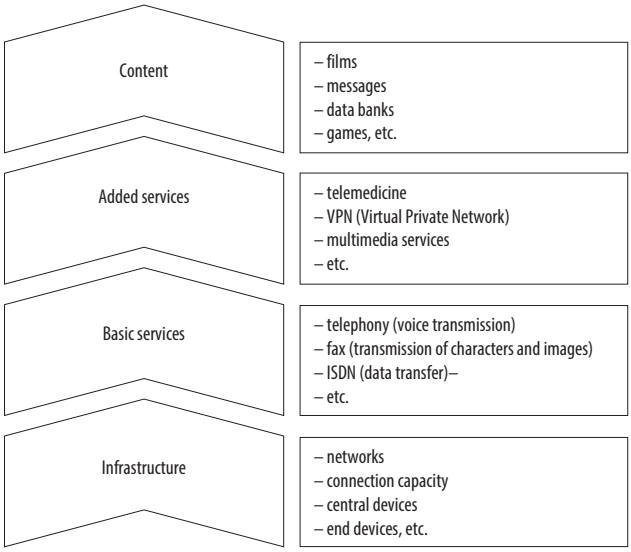

Figure 1. The four-layer model of telecommunications

Source: own study based on *Europe and the Global Information Society, Recommendations to the European Council: Conference G7 - Raport BANGEMANN*. Brussels 26 May 1994. Office for Official Publications of the European Communities, accessed on 10 January 2023, https://op.europa.eu/en/publication-detail/-/publication/44dad16a-937d-4cb3-be07-0022197d9459.

The dynamism of the development of telecommunications infrastructure is the result of the impact of many factors and processes. Among them, the basic role is attributed to technical and technological progress.[3]

Technical and technological progress[4] observed in the area of telecommunications services is manifested primarily in the progressive digitisation and development of fibre optic technology and software.[5]

3 Andrzej Małachowski, "Konwergencja rynku telekomunikacyjnego. Rozwój wybranych internetowych mediów komunikacji," Zeszyty Naukowe Uniwersytetu Szczecińskiego 544, *Rynki przesyłu i przetwarzania informacji - stan obecny i perspektywy* rozwoj 35 (2009), 2: 597.

4 Kenneth Joseph Arrow, "The Economic Implications of Learning by Doing," *Review of Economic Studies* 29 (1962): 155–173; Yanrui Wu, "Productivity Growth, Technological Progress, and Technical Efficiency Change in China: A Three-Sector Analysis," *Journal of Comparative Economics* 21 (1995), 2: 208–212, DOI: 10.1006/jcec.1995.9997; Khuong Vu and Kris Hartley, "Effects of digital transformation on electricity sector growth and productivity: A study of thirteen industrialized economies," *Utilities Policy* 74 (Feb. 2022), DOI: 10.1016/j.jup.2021.101326.

5 Jörg Rockenhäuser, *Digitale Konvergenz und Kompetenzen-management* (Wiesbaden: Deutscher Universitätsverlag, 1999), 20; Larry Downes and Chunka Mui, *Auf der Suche nach der Killer-Applikation. Mit digitalen Strategien neue Märkte erobern* (Framkfurt a.M.: Campus Fachbuch, 1999); James Martin, *Telecommunications and computer* (Englewood Cliffs: Prentice Hall, 1969); James Martin, *The wired society* (Englewood Cliffs: Prentice Hall, 1978).

The Internet and the creation and combination of three standards played a key role in further transforming the information and communication infrastructure:[6]
– Computer platform – based on the IBM PC computer,
– Graphical user interface enabling the use of spreadsheets and text editors – Windows,
– Communication tool – based on modem and global telephone network.

Some of the authors analysing the qualitative leap in network information and communication technologies associate this process with the development of the Internet services offer and the rapid increase in demand for these services and refer to them as the "internetisation" of telecommunications.[7]

Proposed basic criteria for evaluating modern information and communication infrastructure

The growing interest of societies and economies in the Internet and Internet services prompted the entities on the supply side of the telecommunications services market to develop networks ensuring efficient access to this medium and services provided through it. Among fixed networks, such access is provided by broadband networks. An important criterion for assessing the modern information and communication infrastructure is, therefore, the degree of coverage of individual countries with fixed broadband networks.

As part of fixed broadband networks, particularly efficient in terms of throughput and data transfer speed are the so-called new generation networks (NGA), which include VDSL, FTTx and DOCSIS 3.0 cable networks. Therefore, an important criterion for evaluating the modern information and communication infrastructure is also the degree of coverage of individual countries with NGA-type networks and the share of FTTx and DSL networks in the internal structure of fixed broadband networks.

Mobile networks are playing an increasingly important role in ensuring efficient access to the Internet. This is primarily due to the technical progress taking place in this area, which led to the creation of the LTE standard in 2010, allowing for "data download" at a speed of up to 100 Mbit/s. The presented information indicates that the basic criteria for evaluating the modern information and communication infrastructure include:
– The degree of coverage of countries with fixed broadband networks,
– The degree of coverage of countries with fixed broadband networks of the new generation NGA,
– Data download speed in fixed networks,
– Speed of downloading data in mobile networks.

6 Thomas Friedman, *Świat jest płaski* (Poznań: Dom Wydawniczy REBIS, 2006), 65.

7 Matthias Pohler, Berndt Beckert, and Michael Schefczyk, *Technologische und ökonomische Langfristperspektiven der Telekommunikation. SAP-Stiftungslehrstuhl für Entrepreneurship und Innovation* (Dresden: Technische Universität Dresden, 2006).

Evaluation of the existing information and communication networks of the Three Seas countries

One of the main objectives of the Three Seas Initiative is to improve the region's infrastructure and digital connectivity in order to support economic growth and development.

In terms of digital connectivity, the Three Seas Initiative aims to achieve reliable, sustainable, and inclusive connectivity. This includes expanding and modernising the region's telecommunications networks, increasing broadband coverage, and improving access to digital services. The goal is to ensure that all citizens and businesses in the region have access to high-quality and affordable digital infrastructure, which would help to reduce the digital divide and promote social inclusion. It is recognised that sustainable and reliable connectivity requires significant investments in information and communication networks.

In order to make a comparative assessment of the information and communication networks of the Three Seas Initiative countries, it is necessary to use statistical data on these networks. The research conducted by the authors in this chapter is based on available secondary data showing the transformation of telecommunication markets as a result of the development of the Internet. In particular, the information presented by national statistical offices, international statistical offices, international telecommunications organisations, national telecommunication market regulators and international organisations of telecommunications regulators, as well as by telecommunications operators, especially the so-called incumbents, i.e., former monopolistic operators, who currently, as a rule, still play a dominant role on national telecommunication markets.

Considering the availability of data, the years 2013, 2017 and 2021 were considered. According to the authors, the time series adopted in this way should ensure a good reflection of the impact of the Internet on changes in the telecommunication market area, allowing to present changes in the structure of telecommunications networks, often resulting from long-term investments.

Taking into account the topic of the work in geographical terms, the research covered 12 countries that are part of the Three Seas Initiative.

The growing interest of societies and economies in the Internet and Internet services prompted telecommunication markets supply entities to develop networks ensuring efficient access to this medium and services provided through it. Among fixed networks, such access is provided by broadband networks. The degree of coverage of individual countries with fixed broadband networks began to grow rapidly. Information on this subject for the surveyed countries in 2013, 2017 and 2021 is shown in Figure 2.

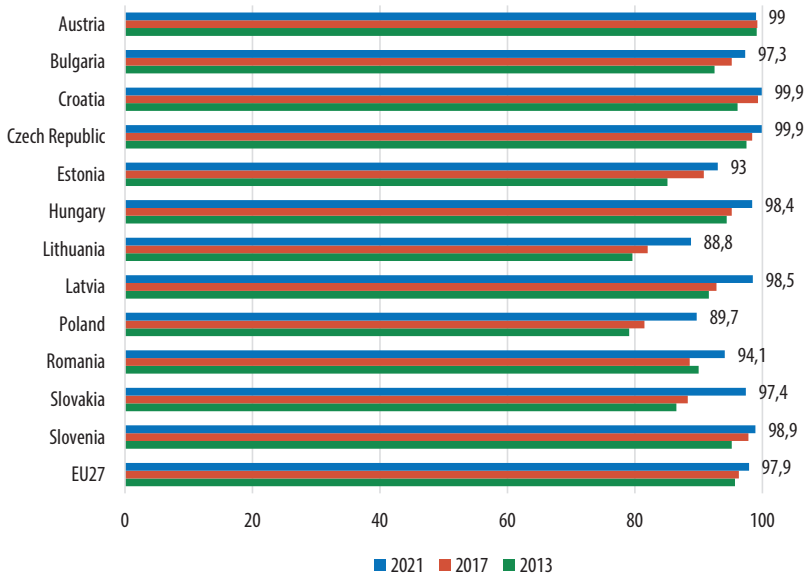

Figure 2. Coverage of the surveyed countries with fixed broadband networks (DSL, VDSL, FTTx, DOCSIS 1.0/2.0 and 3.0 cable access and WiMax) in 2013, 2017 and 2021 (in %)

Source: own study based on *Broadband Coverage in Europe 2013 Final Report*, accessed on 7 October 2022, http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=8238; *Broadband Coverage in Europe 2017 Final Report*, accessed on 7 October 2022, https://ec.europa.eu/digital-single-market/en/news/study-broadband-coverage-europe-2017; *Broadband Coverage in Europe 2021 Final Report*, accessed on 7 October 2022, https://digital-strategy.ec.europa.eu/en/library/broadband-coverage-europe-2021; *Households with broadband access*, OECD Statistics, accessed on 7 October 2022, https://data.oecd.org/broadband/households-with-broadband-access.html.

Information on the coverage of the surveyed countries with the most efficient fixed broadband networks, the so-called next generation networks (NGA) are shown in Figure 3.

In addition to the growing availability of fixed broadband, mobile networks are starting to play an increasingly important role in ensuring efficient access to the Internet. This is primarily due to the technical progress taking place in this area, which led to the creation of the LTE standard in 2010, allowing for "data download" at a speed of up to 100 Mbit/s. Very good transmission parameters offered by this technology, previously unattainable for mobile networks, in connection with the convenience of mobile Internet use, translated into its rapid implementation and rapid spread on a global scale. This is shown in Figure 4.

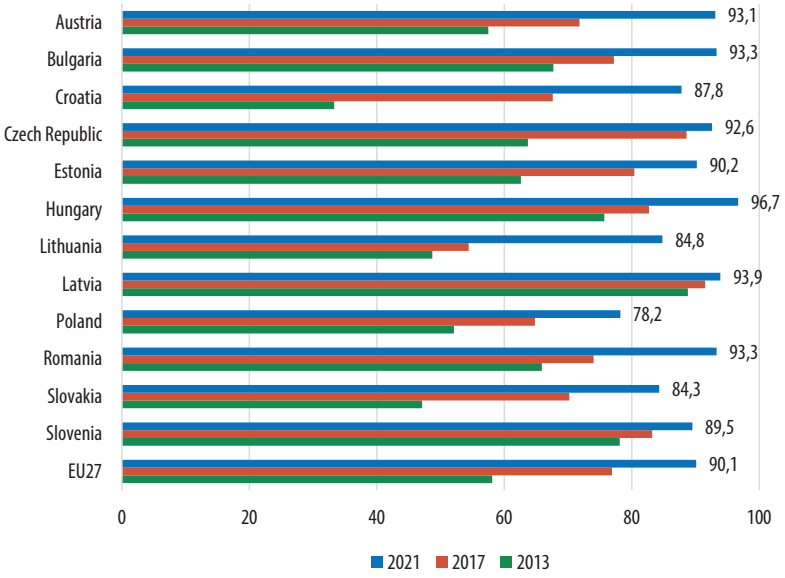

Figure 3. Coverage of the surveyed countries with NGA networks (VDSL, FTTx and DOCSIS 3.0 cable access) in 2013, 2017 and 2021 (in %)

Source: own study based on *Broadband Coverage in Europe 2013 Final Report*, accessed on 7 October 2022, http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=8238; *Broadband Coverage in Europe 2017 Final Report*, accessed on 7 October 2022, https://ec.europa.eu/digital-single-market/en/news/study-broadband-coverage-europe-2017; *Broadband Coverage in Europe 2021 Final Report,* accessed on 7 October 2022.,https://digital-strategy.ec.europa.eu/en/library/broadband-coverage-europe-2021; *Households with broadband access*, OECD Statistics, accessed on 7 October 2022, https://data.oecd.org/broadband/households-with-broadband-access.html.

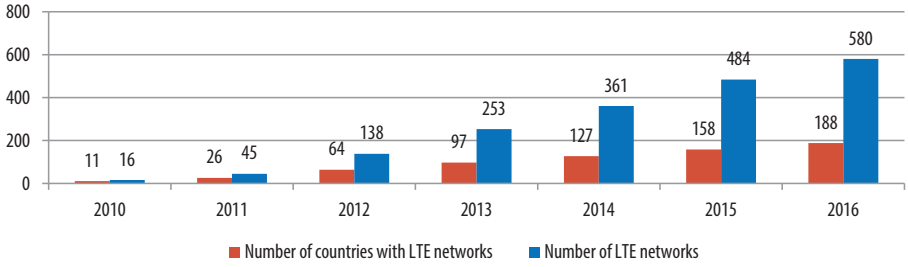

Figure 4. Increase in the number of LTE networks in use and the number of countries in which these networks were operated in 2010–2016

Source: *The Mobile Economy 2017,* GSMA Intelligence (2017), accessed on 10 April 2018, https://www.gsmaintelligence.com/research/?file=9e927fd6896724e7b26f33f61db5b9d5&download.

The developed fixed broadband networks and innovative mobile networks in the LTE standard contribute both to the increase in the role of the Internet and to the acceleration of the convergence process of these networks, thanks to their ability to transmit voice, data and images, and the resulting possibilities of offering more and more extensive package services.

The growing availability of particular types of fixed broadband networks and modern mobile networks in the LTE standard translates into increasing speeds of the so-called downloading data from the Internet, which encourages the increasing use of Internet services. Information on the average speeds of the so-called data download in fixed and mobile networks measured in Mbit/s in November 2022 is presented in Figure 5.

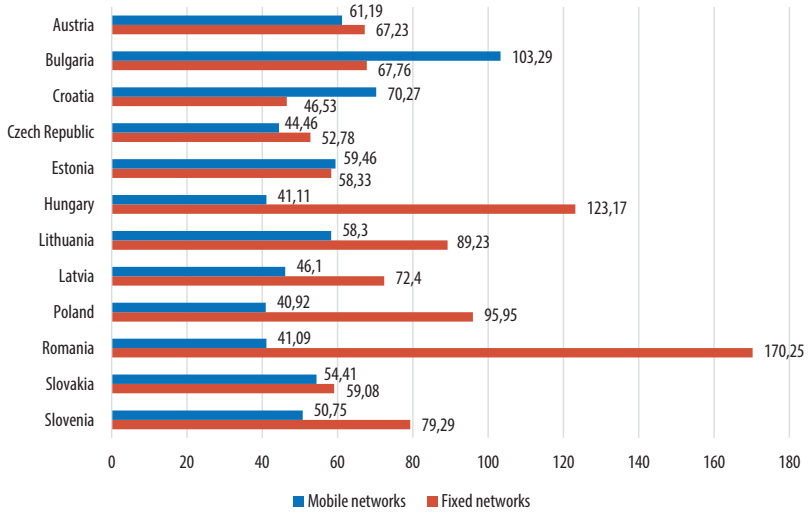

Figure 5. Data download speed in telecommunications networks in selected, surveyed countries in November-2022 in Mbit/s, broken down into fixed and mobile networks

Source: *Speedtest Global Index,* accessed on 30 December 2022, https://www.speedtest.net/global-index.

An attempt to assess the condition of the information and communication infrastructure of the Three Seas countries

Based on a general comparative assessment of the coverage of the Three Seas countries with fixed broadband networks, the most efficient fixed broadband networks (NGA), the use of LTE mobile networks by these countries, and the offered data download speeds in fixed and mobile networks, the following can be stated:

- In terms of coverage with fixed broadband networks, Croatia and the Czech Republic (99.9% coverage) and Austria (99% coverage) are leading countries among the Three Seas Initiative. The situation of Lithuania (88.8% coverage) and Poland (89.7% coverage) is the least favourable.
- In terms of coverage with the most efficient fixed broadband networks (NGA), the highest position among the Three Seas countries is occupied by Hungary (96.7%), and the lowest position by Poland (78.2%).
- In terms of data download speed in fixed-line networks, the best result is achieved by Romania (170.25 Mbit/s) and the weakest by Croatia (46.53 Mbit/s).
- While in terms of download speed in mobile networks, Bulgaria is the leader among the countries of the Three Seas Initiative (103.29 Mbit/s), and the weakest results are shown by Poland (40.92 Mbit/s) and Romania (41.09 Mbit/s).

In general, it can be concluded that among the Three Seas Initiative countries, Austria, the Czech Republic, Hungary, Slovenia, Romania, and Lithuania have a relatively strong position in terms of their information and communication infrastructure, which:

- Have a relatively high share of fixed broadband networks, including a large share of the most efficient next-generation (NGA) networks.
- They can also boast relatively good results in terms of data download speed in fixed and mobile networks.

However, these results are less impressive compared to the average results for the entire EU.

The presented results regarding the fixed and mobile information and communication network of the Three Seas Initiative countries indicate the need for its further improvement. This improvement should primarily focus on the following directions:

- Further expansion of modern broadband networks enabling the offering of the so-called triple service providing voice, image and data transmission,
- Developing the possibility of offering by fixed-line and mobile operators the so-called a quadruple service providing access to voice, video and data using fixed and mobile technology,
- Further migration of the networks of fixed-line operators and mobile operators towards the IP standard, allowing for the standardisation of the existing set of telecommunications networks, enabling rationalisation of the costs of maintaining and developing these networks.

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English version: Mark Atkinson

SUMMARY

In the scientific literature in the field of regional economy and economic policy, the subject of the so-called Three Seas is often taken up. It is most often indicated that this area covers 12 countries located between three seas: the Adriatic, the Baltic, and the Black Sea. The need to accelerate the development of this structure is often indicated by expanding the Three Seas

Infrastructure, especially energy, transport and information and communication infrastructure. The present article focuses on the latter one.
The considerations based on literature analysis allow us to assume that for the assessment of modern information and communication infrastructure a special role is played by the following criteria: the degree of country coverage with fixed broadband networks, the availability of modern mobile networks in the LTE standard, and the speed of data download in fixed and mobile networks.

To carry out a comparative assessment of the information and communication infrastructure of the Three Seas countries according to these criteria, the authors used the data presented by the statistical offices of these countries and the data of international telecommunications organisations. The assessment of the information and communication infrastructure of the Three Seas countries based on these criteria indicates qualitative discrepancies of these infrastructures, which is not supporting a suitable socio-economic development rate of this structure.

Therefore, an important task is to reduce the discrepancies observed in the studied area. According to the authors, this will primarily require:
– Further expansion of modern telecommunications fixed broadband networks,
– Further migration of fixed-line operators' networks of mobile operators' networks towards the IP standard.

Infrastruktura informacyjno-komunikacyjna jako ważne narzędzie rozwijania Trójmorza

Słowa kluczowe: Trójmorze, telekomunikacja, infrastruktura informacyjno-komunikacyjna

STRESZCZENIE

W literaturze naukowej z zakresu gospodarki regionalnej i polityki gospodarczej w ostatnim czasie często podejmowana jest tematyka tzw. Trójmorza. Najczęściej wskazuje się, że obszar ten obejmuje 12 państw zlokalizowanych między trzema morzami: Adriatykiem, Bałtykiem i Morzem Czarnym. Często wskazuje się na potrzebę zdynamizowania rozwoju tej struktury poprzez rozbudowę infrastruktury Trójmorza, w tym zwłaszcza infrastruktury energetycznej, transportowej i informacyjno-komunikacyjnej. W prezentowanym artykule skoncentrowano uwagę na tej ostatniej.

Przeprowadzone rozważania oparte na analizie literatury pozwalają przyjąć, że dla oceny współczesnej infrastruktury informacyjno-komunikacyjnej szczególna rola przypada takim kryteriom jak: stopień pokrycia państw stacjonarnymi sieciami szerokopasmowymi, dysponowanie nowoczesnymi sieciami mobilnymi w standardzie LTE, prędkość ściągania danych w sieciach stacjonarnych i mobilnych.

Dla przeprowadzenia, według tych kryteriów, oceny porównawczej infrastruktury informacyjno-komunikacyjnej państw Trójmorza wykorzystano dane prezentowane przez urzędy statystyczne tych państw oraz dane międzynarodowych organizacji telekomunikacyjnych.

Dokonana na podstawie tych kryteriów ocena infrastruktury informacyjno-komunikacyjnej państw Trójmorza wskazuje na rozbieżności jakościowe tych infrastruktur, co nie sprzyja dynamizowaniu rozwoju społeczno-gospodarczego tej struktury.

Istotnym zadaniem jest więc doprowadzenie do ograniczenia obserwowanych w badanym obszarze rozbieżności. Zdaniem autorów będzie to przede wszystkim wymagało:

– dalszej rozbudowy nowoczesnych telekomunikacyjnych stacjonarnych sieci szerokopasmowych,
– dalszego migrowania sieci operatorów telefonii stacjonarnej sieci operatorów telefonii mobilnej w kierunku standardu IP.

Citation

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