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A STUDY ON THE EXTENT OF DIFFERENCES IN ICT USAGE BY ENTERPRISES IN EUROPEAN COUNTRIES DURING THE COVID-19 PANDEMIC

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Purpose: The aim of the study is to employ the proposed taxonomic methods to arrange - in the periods under study - Poland's provinces and European countries according to their similarity in ICT usage (including the use of computers and mobile devices, the internet, various internet services and IT systems) by enterprises.
Design/methodology/approach: The study applies the method devised by S. Chomątowski and A. Sokołowski, along with its later modifications proposed by A. Młodak. In the study, a taxonomic method was employed to analyse the level of variation of objects described by selected statistical characteristics and identify clusters of objects sharing a similar level of development of the phenomenon under consideration. The study covered the years 2021-2019 and 2012, including the time of the Covid-19 pandemic. First, Poland was analysed and the groups of voivodeships featuring a homogeneous level of development were identified. In the next step, the analysis was performed for the European countries to see how Poland compares to them.
Findings: The study analyzes internet and ICT usage by enterprises in the selected country in the years 2021, 2020, 2019 and 2012, with special focus on the COVID-19 pandemic period. To sum up, comparative analysis performed by means of taxonomic methods can be an effective tool to study the elements of a complex process, can provide a broad picture of this process.
Research limitations/implications: The main limitation is that it is not possible to collect a comparable data set over a long period of years.. The results of the proposed taxonomic method depend on the choice of value α.
Originality/value: The concept of comparative analysis of the phenomenon under consideration presented and implemented in this study can be applied to compare other countries, using relevant measures, or to perform comparative analysis of other aspects of the issue, and the findings of these studies will contribute to further research in this area. The results of the proposed research methodology applied to explore the selected research problem and the set of data the study was based on can be used in the analyses of economic and socio-economic policies.

Keywords: taxonomic methods, internet and ICT usage, COVID-19.

Category of the paper: Research paper.

1. Introduction

For several years now, we have witnessed significant and accelerated development of digitization processes and increased use of information and communication technologies by society, enterprises, public institutions, non-governmental organizations, etc. We have become reliant on the internet and ICTs (Bliźniuk, Nowak, 2005). The changes, taking place both in our daily lives and at work, have turned us into an information society. They have also had a considerable impact on our patterns of production and consumption, market organization, etc.

In order to survive, today's organizations need to respond to the changing environment promptly and implement relevant effective solutions. Thus, the processes related to the advancement in ICTs have brought about changes in the economy, which has led to the emergence of the digital economy. The literature offers multiple definitions of the digital economy; one of them describes it as "a worldwide network of economic activities which is enabled by the existence of information and communication technologies (ICTs). It can also be defined in simple words as the economy based on digital technologies". The transformation taking place in the economy translates into changes in the market, goods, services, the financial sector, enterprises, consumption, manufacturing, work, governments, etc. (Śledziewska, Włoch, 2020). On the one hand it allows development, but on the other, it gives rise to a number of threats. Advanced technologies destroy a lot of jobs and accelerate the creation of digital representations of the real world. Digitization is embraced not only by selected sectors of institutions, companies or administration, but permeates entire organizations, which necessitates the introduction of new solutions for manufacturing, employment, consumption, etc.

Western European countries have undergone a more profound digital transformation than Poland. In the 1980s, first companies providing internet services came into being, which enabled, among others, the use of electronic mail. It was also the time when enterprises and institutions started to provide their employees with access to local computer networks and thus embarked on digitalization. In the beginning, the technologies that digitalization is based on included the use of the computer, laptop and smartphone and later extended to cloud-based technologies, robotization and artificial intelligence (Goban-Klas, Sienkiewicz, 1999). The changes related to digitization have led to digitalization and datification, which have exerted a major impact on society as a whole. Man has access to an ever increasing amount of data and information and through online activities leaves behind digital footprints that are used by enterprises, organizations and public institutions, which changes the way the economy and business function (Śledziewska, Włoch, 2020; Gajewski et al., 2016).

Recent years have brought a lot of uncertainty and anxiety due to the COVID-19 pandemic. In addition, in the last few months, our attention has been focused on the war taking place in Ukraine. These events have had an impact on all of us and forced us to take measures to adjust to the existing and rapidly changing circumstances. The seriousness of their consequences depends on a business sector and a geographic location. During the pandemic, people and companies unable to work remotely suffered the greatest losses. The tourism industry was one of those most severely affected. People who worked online had to learn to combine work and family commitments in the same environment and arrange a virtual workplace at home. One of the serious problems was a decline in the number of customers resulting from the stay-at-home and social-distancing restrictions. Companies had to increase or introduce online services and thus contributed to the development of e-commerce. They had to deal with higher costs of conducting business activity, which have gone up further because of the war in Ukraine.

To sum up, the COVID-19 pandemic threatened the global economy, including the economy of the European Union. The measures taken by the EU countries in response to the pandemic such as restrictions on social contact, quarantine, travel restrictions or bans for certain countries, shutdown of commercial and cultural facilities, restrictions imposed on tourism, transport, etc., had a significant impact on the functioning of public administration, as well as large, small and medium-sized enterprises in the European Union.

The study analyzes internet and ICT usage by enterprises in the selected country in the years 2021 – 2019 and 2012 with special focus on the COVID-19 pandemic period.

The aim of the study is to employ the proposed taxonomic methods to arrange - in the periods under study - Poland's provinces and European countries according to their similarity in ICT usage (including the use of computers and mobile devices, the internet, various internet services and IT systems) by enterprises.

2. The set of diagnostic characteristics of the problems under study

The study attempts to employ the selected taxonomic methods to order Poland's voivodeships (provinces), and next - European countries, according to the level of their development and to analyse their impact on the overall development in the periods under study as well as to use a taxonomic method to identify homogeneous periods of dynamics variations in the analysed phenomenon in selected countries. The study examines the use of the internet and information and communication technologies by enterprises of the selected country, with special emphasis placed on the Covid-19 pandemic period. In addition, the map add-on Excel was integrated for the selected dataset to compare the years 2012, 2019, 2020 and 2021 and to identify possible similarities or differences. The diagrams are shown below.

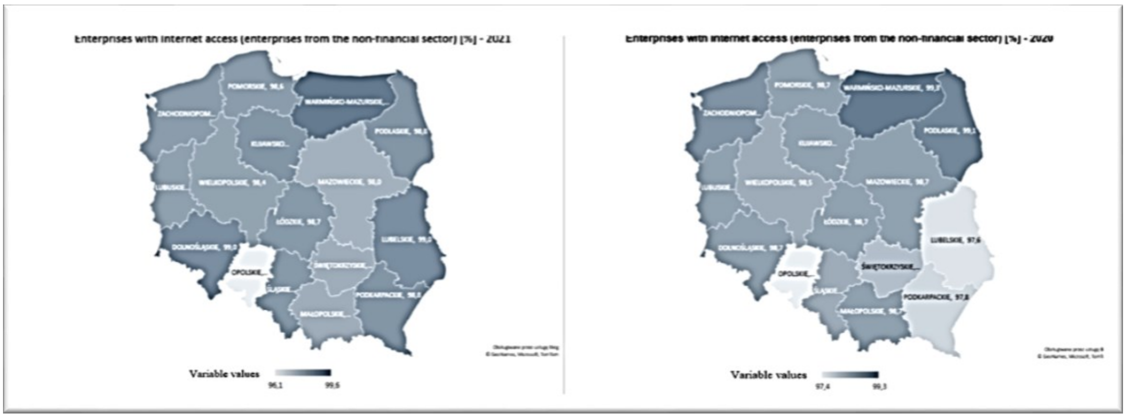

Figure 1. Enterprises with Internet access (enterprises from the non-financial sector) [%] – 2021 and 2020 (the Excel Map).

Source: based on own research.

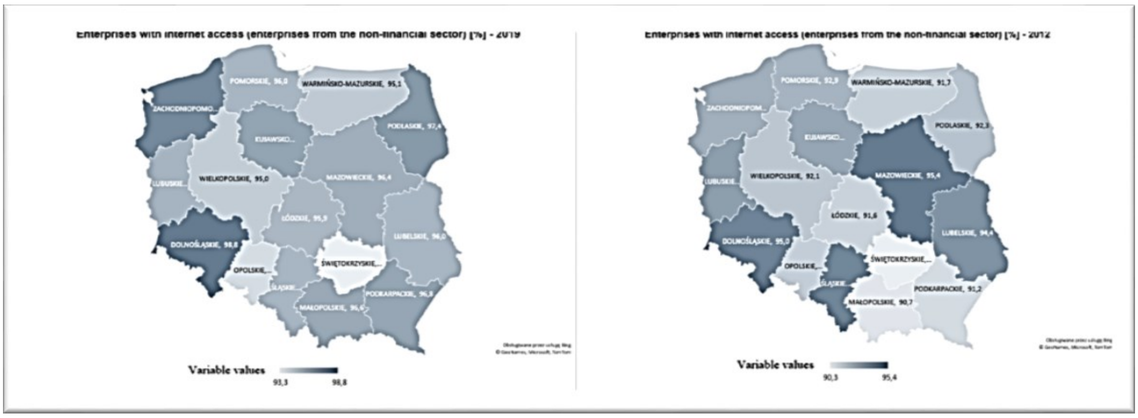

Figure 2. Enterprises with Internet access (enterprises from the non-financial sector) [%] – 2019 and 2012 (the Excel Map).

Source: based on own research.

The second variable was then taken into account - Enterprises with their own website (enterprises from the non-financial sector) [%].

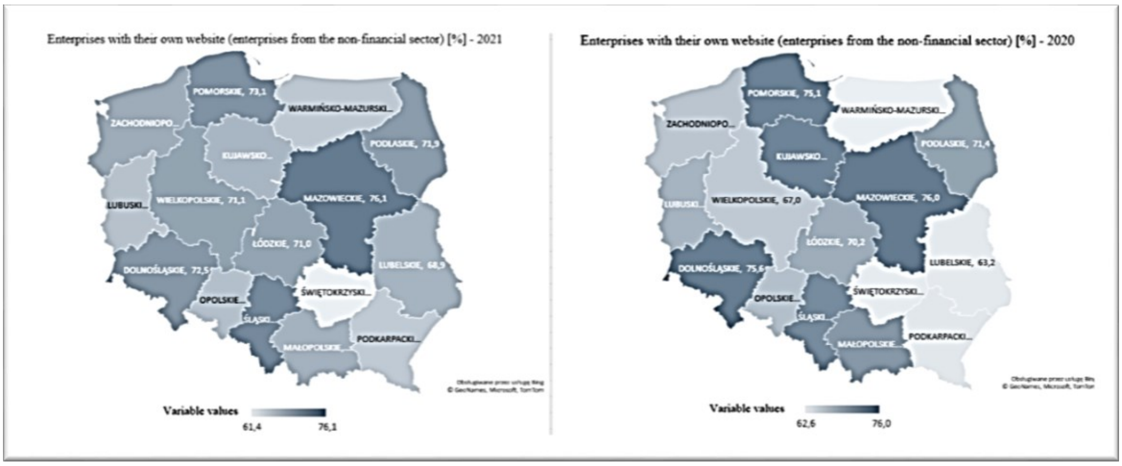

Figure 3. Enterprises with their own website (enterprises from the non-financial sector) [%] – 2021 and 2020 (the Excel Map).

Source: based on own research.

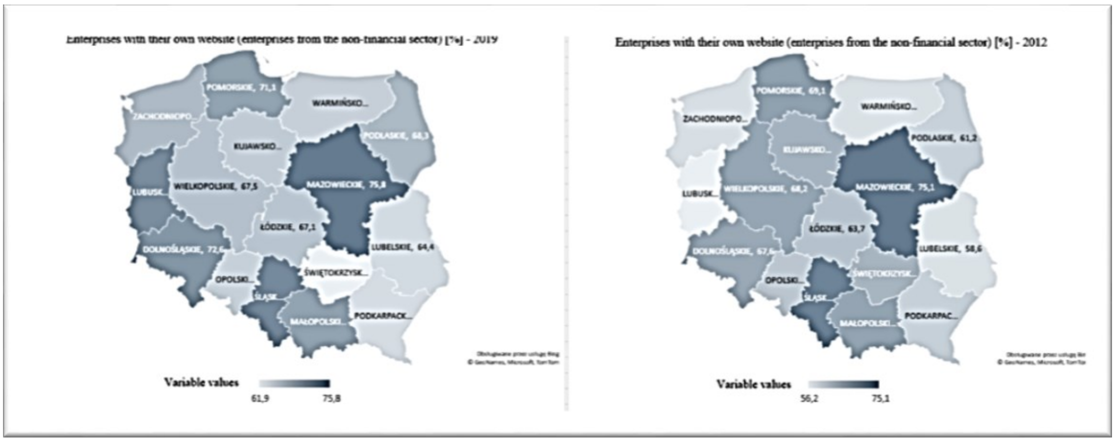

Figure 4. Enterprises with their own website (enterprises from the non-financial sector) [%] – 2019 and 2012 (the Excel Map).

Source: based on own research.

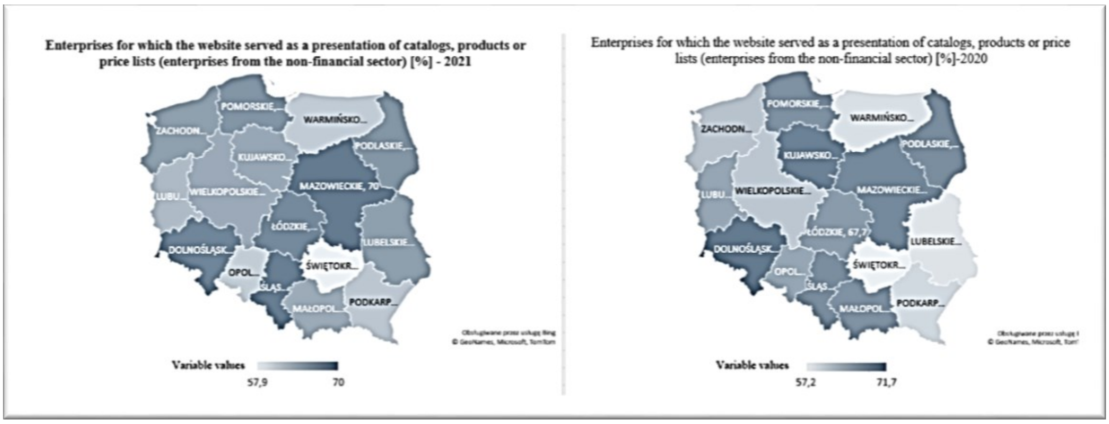

Figure 5. Enterprises for which the website served as a presentation of catalogs, products or price lists (enterprises from the non-financial sector) [%] – 2021 and 2020 (the Excel Map).

Source: based on own research.

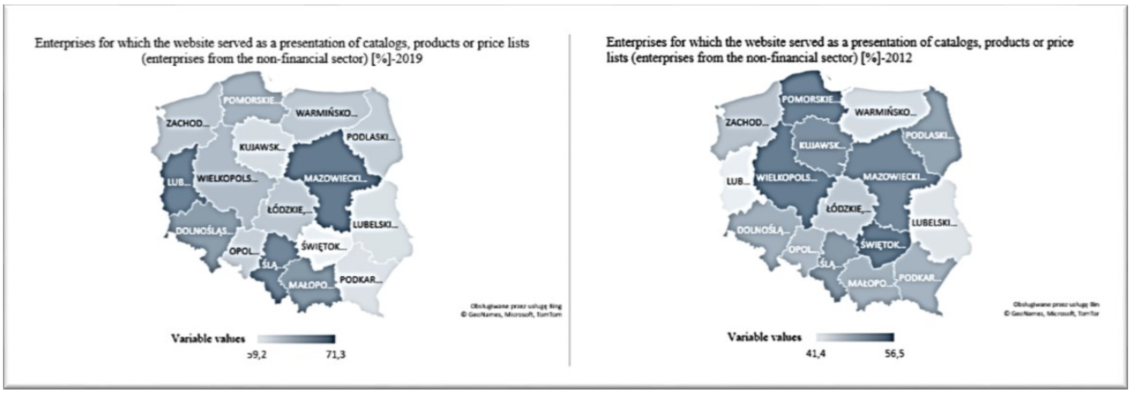

Figure 6. Enterprises for which the website served as a presentation of catalogs, products or price lists (enterprises from the non-financial sector) [%] – 2019 and 2012 (the Excel Map).

Source: based on own research.

Last of the selected statistical variables - Enterprises providing their employees with mobile devices (e.g. laptops, smartphones) allowing for mobile access to the Internet (enterprises from the non-financial sector) [%].

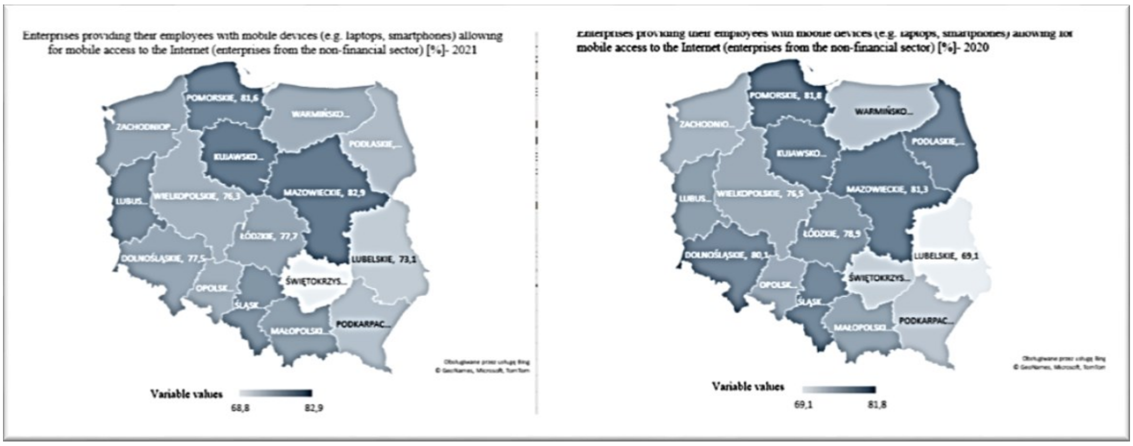

Figure 7. Enterprises providing their employees with mobile devices (e.g. laptops, smartphones) allowing for mobile access to the Internet (enterprises from the non-financial sector) [%] – 2021 and 2020 (the Excel Map).

Source: based on own research.

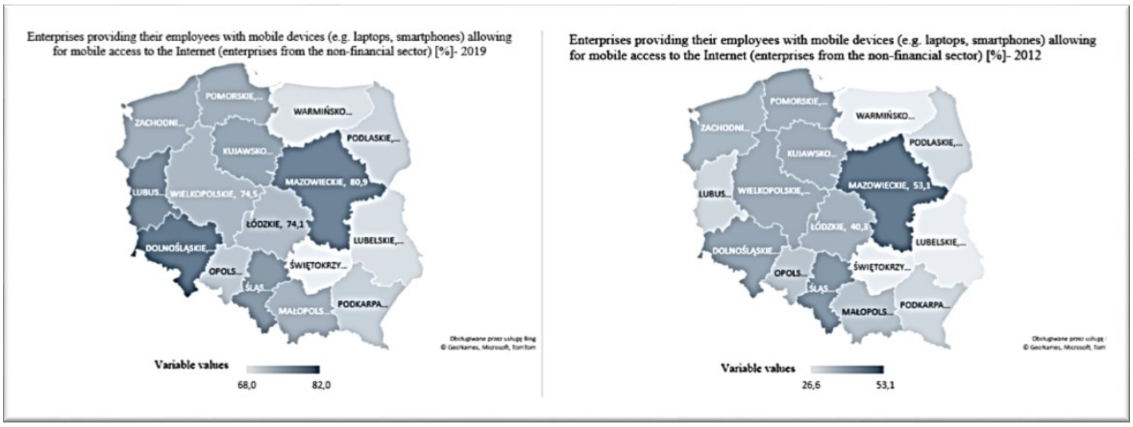

Figure 8. Enterprises providing their employees with mobile devices (e.g. laptops, smartphones) allowing for mobile access to the Internet (enterprises from the non-financial sector) [%] – 2019 and 2012 (the Excel Map).

Source: based on own research.

The graphical representation made it possible to compare a particular phenomenon over time. The richest voivodeship in Poland is the Mazowieckie voivodship due to the capital of Poland. Second place in the ranking of the richest voivodeships is the Dolnośląskie voivodship with the developing city of Wrocław. The third place belongs to the Wielkopolskie voivodeship. The poorest polish voivodships are: Lubelskie (agricultural region), Podkarpackie and Warmińsko-mazurskie.

Data were drawn from Eurostat and Statistics Poland, taking into account the thematic scope of the study and data availability. The diagnostic variables selected for the study had to be measurable and best describe the level of development of the examined phenomenon. Based on the calculated values of the coefficients of variation and the results of verifying correlation analysis conducted by means of an inverted correlation matrix, the final set of diagnostic characteristics which describes the phenomenon for a given country was adopted.

The first stage of the analysis was to examine the voivodeships of Poland in the years 2021, 2020, 2019 in terms of three thematic scopes:

a. Enterprises and those working with internet access and using mobile devices (for entities from outside the financial sector) - The set of diagnostic features used:
   x_1 - Number of enterprises operating (S),
   x_2 - Number of enterprises equipping their employees in mobile devices allowing mobile access to the Internet (S),
   x_3 - Number of employees equipped with mobile devices enabling mobile access to the Internet (e.g. notebooks, netbooks, tablets, smartphones) (S),
   x_4 - Number of employees with Internet access (S).
b. Enterprises with Internet access and e-commerce (for entities outside the financial sector) - The set of diagnostic features used:
   y_1 - Number of enterprises with Internet access (S),
   y_2 - Number of enterprises with a website presenting products, goods or services and a price list (S),
   y_3 - Number of enterprises with a website with the option - online ordering or booking (S),
   y_4 - Number of enterprises with a website with the option - ordering products according to your own specification (S),
   y_5 - Number of enterprises with a website with the option - information about job vacancies or the ability to send application documents online (S),
   y_6 - Number of enterprises with a website with the option - personalization of the website content for frequent/regular users (S).
c. Outlays on information and telecommunications technologies incurred by enterprises (for entities from outside the financial sector) - The set of diagnostic features used:
   z_1 - Number of enterprises (S),
   z_2 - Number of enterprises that incurred expenditure on IT equipment (S),
   z_3 - Number of enterprises that incurred expenditure on telecommunications equipment (S),
   z_4 - Number of enterprises that incurred expenditure on financial leasing of ICT devices (S),
   z_5 - Gross value of expenditure on IT equipment (S),
   z_6 - Gross value of outlays on telecommunications equipment (S).

In describing the variables, the determination S – stimulant was introduced (Mika, 1995).

3. The set of diagnostic characteristics of the problems under study

The study uses the taxonomic method of direct clustering, which allows obtaining the final classification without prior transfer of objects between subgroups at consecutive stages of the procedure (Ward, 1963; Wishart, 1969). The method was first presented in the works of S. Chomątowski and A. Sokołowski. (Chomątowski, Sokołowski, 1978). In this analysis, some modifications of the method, the proposals of which can be found in the work of A. Młodak, were introduced (Młodak, 2006). The method consists in comparing pairs of objects with the aim of identifying objects of similar structure (Pociecha et al., 1988). A pair of objects is considered similar if their structure distance measure is smaller than the calculated threshold value α. The analysis consisted of two stages. The first stage involved using measure (Młodak, 2006; Panek, 2009):

$$CS_{ik} = 1 - \sum_{j=1}^{m} \min(x_{ij,} x_{kj}) \tag{1}$$

used in the direct clustering method and calculating the threshold value α in accordance with formula (Młodak, 2006):

$$\alpha = \mu\alpha_{min} + (1 - \mu)\alpha_{max} \tag{2}$$

where:

$$\alpha_{min} = \min_{\substack{i,k=1,2,\dots,n \\ i \neq k}} p_{ik}$$

$$\alpha_{max} = \underset{i,k=1,2,\dots,n}{max}\, p_{ik} \tag{3}$$

In the second one, measure (1) was replaced with measure (the median "Canberra" measure) (Młodak, 2006):

$$MC_{ik} = \underset{j=1,\dots,m}{med} \left(\frac{|x_{ij} - x_{kj}|}{x_{ij} + x_{kj}} \right) \tag{4}$$

while α was determined according to formula:

$$\alpha = \underset{i=1,\dots,n}{min}\ \underset{k=1,\dots,n}{max}\, p_{ik} \tag{5}.$$

In the next step, we carry out the following procedure: distance matrix D is converted into similarity matrix P', and afterwards into a dissimilarity matrix P, P = $[p_{ik}], i, k = 1,2, \dots, n$. A detailed discussion of the method can be found in the works of A. Młodak , S. Chomątowski and A. Sokołowski. In the last step of the analysis, the groups obtained through the applied modifications have to be compared by means of cluster accuracy measures, which requires determining the degree of homogeneity and heterogeneity (Strahl, 1998).

4. The use of taxonomic analysis in a study on the phenomenon under consideration

First, based on the selected set of the diagnostic characteristics, homogeneous groups of Polish voivodeships for the year 2021 were identified. It was done by following the procedure presented in the previous chapter: a distance matrix and next, a matrix of distance structure indicators were built, which provided a basis for the construction of a similarity and dissimilarity matrix ($\alpha = 0.1591$ - for the first stage), (Due to the large number of matrices, their presentation has been omitted). As a result, the following development homogeneous groups of voivodeships formed.

a. The groups of homogeneous development of the phenomenon - voivodeships of Poland - 2021 (Enterprises and those working with Internet access and using mobile devices (without financial sector)):
   Method I:
   Group 1 = {Dolnośląskie, Łódzkie, Pomorskie}
   Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie}
   Group 3 = {Małopolskie, Wielkopolskie, Śląskie}
   Group 4 = {Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
   Group 5 = {Mazowieckie}
   Method II:
   Group 1 = {Dolnoślaskie, Łódzkie, Pomorskie, Małopolskie, Śląskie, Wielkopolskie}
   Group 2 = {Opolskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie}
   Group 3 ={Kujawsko-pomorskie, Lubelskie Podkarpackie, Zachodniopomorskie, Lubuskie}
   Group 4 = {Mazowieckie}
b. Enterprises with Internet access and e-commerce (without financial sector):
   Method I:
   Group 1 = {Dolnoślaskie, Łódzkie, Pomorskie}
   Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie}
   Group 3 = {Małopolskie, Wielkopolskie, Śląskie, Mazowieckie}
   Group 4 = {Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
   Method II:
   Group 1 = {Dolnośląskie, Łódzkie, Pomorskie}
   Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie}
   Group 3 = {Wielkopolskie, Śląskie}
   Group 4 = {Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
   Group 5 = {Małopolskie}
   Group 6 = {Mazowieckie}

c. Outlays on information and telecommunications technologies incurred by enterprises (without financial sector):
   Method I:
   Group 1 = {Dolnoślaskie, Łódzkie, Pomorskie}
   Group 2 = {Kujawsko-pomorskie, Podkarpackie}
   Group 3 = {Lubelskie, Zachodniopomorskie}
   Group 4 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie}
   Group 5 = {Małopolskie, Mazowieckie, Wielkopolskie, Śląskie}
   Method II:
   Group 1 = {Dolnoślaskie, Łódzkie, Pomorskie, Małopolskie}
   Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie, Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
   Group 3 = {Mazowieckie, Śląskie, Wielkopolskie }
d. The groups of homogeneous development of the phenomenon - voivodeships of Poland - 2020 (Enterprises and those working with Internet access and using mobile devices (without financial sector)):
   Method I:
   Group 1 = {Dolnośląskie, Łódzkie, Pomorskie}
   Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie}
   Group 3 = {Wielkopolskie, Śląskie}
   Group 4 = {Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
   Group 5 = {Mazowieckie}
   Group 6 = {Małopolskie}
   Method II:
   Group 1 = {Dolnośląskie, Łódzkie, Pomorskie, Małopolskie, Śląskie, Wielkopolskie}
   Group 2 = {Świętokrzyskie, Warmińsko-mazurskie Opolskie }
   Group 3= {Kujawsko-pomorskie, Lubelskie Podkarpackie, Zachodniopomorskie, Lubuskie, Podlaskie}
   Group 4 = {Mazowieckie}
e. Enterprises with Internet access and e-commerce (without financial sector):
   Method I:
   Group 1 = {Dolnośląskie, Łódzkie, Pomorskie}
   Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie}
   Group 3 = {Małopolskie, Wielkopolskie, Śląskie, Mazowieckie}
   Group 4 = {Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
   Method II:
   Group 1 = {Dolnośląskie, Łódzkie, Pomorskie}
   Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie}
   Group 3 = {Wielkopolskie, Śląskie}

Group 4 = { Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
Group 5 = {Małopolskie}
Group 6 = {Mazowieckie}

f. Outlays on information and telecommunications technologies incurred by enterprises (without financial sector):
Method I:
Group1 = {Dolnośląskie, Łódzkie, Pomorskie}
Group 2 = {Małopolskie Wielkopolskie Śląskie}
Group 3= {Lubelskie, Zachodniopomorskie, Podkarpackie, Kujawsko-pomorskie}
Group 4 = {Warmińsko-mazurskie, Lubuskie, Świętokrzyskie, Podlaskie, Opolskie}
Group 5 = {Mazowieckie}
Method II:
Group 1 = {Łódzkie, Pomorskie, Małopolskie, Wielkopolskie, Śląskie}
Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie, Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
Group 3 = {Mazowieckie}

g. The groups of homogeneous development of the phenomenon - voivodeships of Poland - 2019 (Enterprises and those working with Internet access and using mobile devices (without financial sector)):
Method I:
Group 1 = {Dolnośląskie, Małopolskie}
Group 2 = {Łódzkie, Pomorskie}
Group 3 = {Mazowieckie, Śląskie, Wielkopolskie}
Group 4 = {Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
Group 5 = {Lubuskie, Warmińsko-mazurskie}
Group 6 = {Świętokrzyskie, Podlaskie, Opolskie}
Method II:
Group 1 = {Dolnośląskie, Małopolskie, Śląskie, Mazowieckie Wielkopolskie}
Group 2 = {Świętokrzyskie, Opolskie Podlaskie Warmińsko-mazurskie}
Group 3 = {Kujawsko-pomorskie, Lubelskie Podkarpackie, Zachodniopomorskie, Lubuskie, Łódzkie, Pomorskie},

h. Enterprises with Internet access and e-commerce (without financial sector):
Method I:
Group 1 = {Dolnośląskie, Łódzkie, Pomorskie}
Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie}
Group 3 = {Wielkopolskie, Śląskie}
Group 4 = {Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}
Group 5 = {Małopolskie}
Group 6 = {Mazowieckie}

Method II:

Group 1 = {Dolnośląskie, Łódzkie, Pomorskie Małopolskie}

Group 2 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie, Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}

Group 3 = {Mazowieckie Wielkopolskie, Śląskie}

i. Outlays on information and telecommunications technologies incurred by enterprises (without financial sector):

Method I:

Group 1 = {Dolnośląskie, Łódzkie, Pomorskie}

Group 2 = {Wielkopolskie, Śląskie }

Group 3 = {Lubelskie, Zachodniopomorskie, Podkarpackie, Kujawsko-pomorskie}

Group 4 = {Warmińsko-mazurskie, Lubuskie, Świętokrzyskie, Podlaskie, Opolskie}

Group 5 = {Mazowieckie}

Group 6 = {Małopolskie}

Method II:

Group 1 = {Łódzkie, Dolnośląskie, Małopolskie}

Group 2 = {Pomorskie, Śląskie, Wielkopolskie}

Group 3 = {Lubuskie, Świętokrzyskie, Warmińsko-mazurskie, Podlaskie, Opolskie, Kujawsko-pomorskie, Lubelskie, Podkarpackie, Zachodniopomorskie}

Group 4 = {Mazowieckie}

The analysis was repeated for European countries. For selected countries, the following data was taken into account:

w1 - Type of connections to the internet, Enterprises use DSL or other fixed broadband connection, All enterprises, without financial sector (10 or more employees and self-employed persons). Percentage of enterprises (S).

w2 - Use of computers and the Internet by employees (S),

w3 - Value of e-commerce sales (Percentage of turnover) (S),

w4 - Number of enterprises with e-commerce sales (S).

The following homogeneous groups were identified – 2021.

Method I:

Group 1 = {Bulgaria, Romania, Greece, Portugal}

Group 2 = {Latvia, Poland, Slovakia, Hungary}

Group 3 = {Czechia, Malta, Serbia, Spain, Croatia, Slovenia}

Group 4 = {Ireland Lithuania Germany France Estonnia Italy Cyprus}

Group 5 = {Denmark, Sweden, Netherlands}

Group 6 = {Finland, Norway}

Method II:

Group 1 = {Bulgaria, Romania}

Group 2 = {Czechia, Greece, Portugal, Italy, Cyprus}

Group 3 ={Latvia, Poland, Slovakia, Hungary}
Group 4 = {Germany, France, Estonnia, Spain, Croatia, Slovenia, Malta, Serbia, Lithuania}
Group 5 = {Denmark, Sweden, Netherlands, Ireland}
Group 6 = {Finland, Norway}
Groups of homogeneous development of the phenomenon for countries in 2020:
Method I:
Group 1 = {Bulgaria, Romania}
Group 2 = {Estonnia, Italy, Cyprus, Portugal}
Group 3 = {Greece, Latvia, Hungary, Slovakia, Poland}
Group 4 = {Czechia, Malta, Lithuania Serbia, Spain, Croatia, Slovenia, Ireland}
Group 5 = {Denmark, Sweden}
Group 6 = {Germany, France}
Group 7 = {Netherlands, Finland}
Group 8 = {Norway}
Method II:
Group 1 = {Bulgaria, Romania}
Group 2 = {Greece, Cyprus, Portugal, Latvia, Hungary, Poland, Slovakia, Czechia}
Group 3 = {Croatia, Serbia, Spain, Lithuania, Slovenia, Malta}
Group 4 = {Germany, France, Estonnia, Italy, Ireland}
Group 5 = {Denmark, Sweden}
Group 6 = {Finland, Norway, Netherlands}
Groups of homogeneous development of the phenomenon for countries in 2019:
Method I:
Group 1 = {Bulgaria, Romania}
Group 2 = {Greece, Latvia, Hungary}
Group 3 = {Italy, Poland, Slovakia, Cyprus, Portugal}
Group 4 = {Czechia, Lithuania, Serbia}
Group 5 = {Estonnia, Croatia, Spain, Malta, Slovenia, Ireland}
Group 6 = {Denmark, Finland, Netherlands, Norway, Sweden}
Group 7 = {Germany, France}
Method II:
Group 1 = {Bulgaria, Romania}
Group 2 = {Greece, Latvia, Hungary}
Group 3 = {Italy, Poland, Slovakia, Czechia, Portugal, Serbia, Lithuania}
Group 4 = {Estonnia, Croatia, Malta, Spain, Slovenia}
Group 5 = {Ireland, Germany, France}
Group 6 = {Finland, Norway, Netherlands}
Group 7 = {Denmark, Sweden}

In the last step of the analysis, the groups obtained thanks to the applied modifications were compared by means of cluster accuracy measures.

5. Conclusion

In the present study, the taxonomic method discussed in the works of S. Chomątowski and A. Sokołowski (Chomątowski, Sokołowski, 1978; Młodak, 2006), which estimates the level of variation of objects described by selected statistical characteristics and groups the objects according to the similarity of development of the examined phenomenon, to conduct an analysis of the internet and ICT use in the years: 2021, 2020, 2019, 2012 with special focus on the time of the Covid-19 pandemic. In this analysis, some modifications of the method, the proposals of which can be found in the work of A. Młodak, were introduced (Młodak, 2006). In the first stage of the analysis, Polish voivodeships were examined with regard to the phenomenon in question.

The groups of homogeneous development were identified for the years 2021, 2020 and 2019.

Both methods determined groups of voivodships with a similar level of the phenomenon, differed in the number of designated groups.

In 2021 (theme a), five homogeneous groups were identified for method I and four homogeneous groups for method II. Both methods designated one-element groups with the same voivodeships, i.e. Mazowieckie. The third group (method I) included voivodeships: Małopolskie, Wielkopolskie, Śląskie. The first group (method II) included voivodeships: Dolnoślaskie, Łódzkie, Pomorskie, Małopolskie, Śląskie, Wielkopolskie. The group 3 (method I) and group 1 (method II) represent voivodeships with the similar level of the phenomenon. In 2021 (theme b, method II) one-element groups with the same voivodeships, i.e. Mazowieckie and Małopolskie were determined. In 2021 (theme c), five homogeneous groups for method I and three homogeneous groups for method II were identified.

In 2020 (theme a) one-element groups with the same voivodeships, i.e. Mazowieckie and Małopolskie were determined. In 2020 (theme a) method I, two one-element groups of voivodeships were identified: Mazowieckie and Małopolskie. And for method II only a one-element group was obtained (Mazowieckie voivodeship). Method I - Śląskie and Wielkopolskie voivodeships were classified into one group, and for Method II - with the following voivodships: Dolnośląskie, Łódzkie, Pomorskie, Małopolskie, Wielkopolskie. For method II (theme b), the Małopolskie and Mazowieckie voivodeships were classified as one-element groups. And for method I and method II (theme c) only a one-element group was obtained (Mazowieckie voivodeship).

In 2019 (theme a), six homogeneous groups were identified for method I and three homogeneous groups for method II (no one-element groups). In 2019 (theme b) - for method I, two one-element groups were obtained (the Małopolskie and Mazowieckie voivodeships). In 2019 (theme c) for method I, the Mazowieckie and Małopolskie voivodeships formed a one-element groups. For method II, a one-element group (Mazowieckie Voivodeship) was obtained.

In the next step, the method was used again to compare Poland and the European countries, which involved determining groups of homogeneous development among the latter. In 2021 six homogeneous groups were identified for method I and six homogeneous groups for method II. The second group included Latvia, Poland, Slovakia, Hungary in both methods (low level of development of the phenomenon). The eighth group (method I) was a single-element group in 2020, including only Norway, and was enlarged with Denmark, Finland, Netherlands and Sweden in 2019. In 2020, the third group (method I) included Greece, Latvia, Hungary, Slovakia, Poland and was enlarged with Cyprus, Portugal and Czechia for method II (group 2). In 2019, the third group included Italy, Poland, Slovakia, Cyprus, Portugal, but for method II the group comprised also Czechia, Serbia and Lithuania (without Cyprus).

In the years covered by the study, the Nordic countries always formed a separate group. They display a high level of the internet and ICT use. The groups include the time of the pandemic, which triggered an increase in the internet and ICT use. This is the time when remote work and online education entered our lives on a massive scale and a lot of people had to buy PCs or computer hardware, etc.

To sum up, the results of the analysis show that the homogeneous groups of Polish voivodeships with the highest level of the internet and ICT use form around the capital and big cities, which offer ample employment and educational opportunities. The lowest level can be observed in the groups comprising mainly rural areas. The analysis of the countries reveals that another factor affecting the level of internet and ICT use is economic development. Rich countries and states can afford to invest in new technologies, ensuring their citizens access to such solutions while companies and investors provide them with job opportunities.

This leads to a society's improved standard of living, extended life span and successful fight against poverty and hunger.

In sum, it can be said that the enterprises, public administrations, society and the national economy are implementing the digital transformation.

In recent years, automation and robotization have covered more and more new areas of life.

Digitalization has a significant impact on consumer behaviour, changes the rules of competition in the market and creates new economic models. We should know that digitization is not just a technological innovation, but an important response to changes in the environment.

We should solve problems that are related to the rapid development of digital technologies (transformation of economic activity, organizational changes of the enterprise, changes in public administration, etc.).

Automation is a threat to many professions. In the literature we find the term "technological unemployment". Technological unemployment will increasingly affect people in the tourism, construction, food and transport sectors.

To sum up, in order to survive, today's organizations, enterprises, society and economy need to respond to the changing environment promptly and implement relevant effective solutions. In the future, the effects of digitization will be a major problem, but we cannot foresee them all.

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