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ANALYSIS OF THE DIGITAL ECONOMY AND SOCIETY INDEX (DESI) THROUGH A CLUSTER ANALYSIS

DİJİTAL EKONOMİ VE TOPLUM ENDEKSİNİN (DESI) KÜMELEME ALGORİTMASİ İLE ANALİZİ

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ABSTRACT: OBJECTIVE: This study has two main goals. The first one aims to determine how the European Union countries are clustered according to The Digital Economy and Society Index (DESI) 2020 data. The second one aims to determine whether there is a similarity between the DESI cluster of the European Union countries and the social welfare regime classification. METHODS: In the research, the cluster method was used in accordance with DESI 2020 data. RESULTS: Technological and digital investments and initiatives of countries have clustered the European Union countries in 4 different groups. The countries clustered according to DESI data are shaped for investments and spending for digitalization within the scope of sub-dimensions of DESI. In this context, the welfare regimes applied by the countries affect the spending for digitalization. CONCLUSIONS: According to The Digital Economy and Society Index (DESI) 2020 data has proved that there is a similarity between the classification of the European Union countries according to their welfare regimes and digitalization.

Keywords: Digital economy, Welfare regimes, DESI, European Union

ÖZ: AMAÇ: Bu çalışmanın iki temel amacı bulunmaktadır. İlki, Avrupa Birliği ülkelerinin Dijital Ekonomi ve Toplum Endeksi (DESI) 2020 verilerine göre nasıl kümelendiğini belirlemek. İkincisi, Avrupa Birliği ülkelerinin DESI kümelenmesi ile refah rejimi sınıflandırması arasında bir ilişki olup olmadığını tespit etmek. YÖNTEM: Araştırmada DESI 2020 verilerine göre kümeleme yöntemi kullanılmıştır. BULGULAR: Ülkelerin teknolojik ve dijital yatırım ve girişimleri, Avrupa Birliği ülkelerini 4 farklı grupta toplamıştır. DESI verilerine göre kümelenen ülkeler, DESI'nin alt boyutları kapsamında dijitalleşme için yatırım ve harcamalara göre şekillenmektedir. Bu bağlamda ülkelerin uyguladığı refah rejimleri dijitalleşme harcamalarını etkilemektedir. SONUÇLAR: Dijital Ekonomi ve Toplum Endeksi (DESI) 2020 verilerine göre Avrupa Birliği ülkelerinin refah rejimlerine göre sınıflandırılması ile dijitalleşme arasında benzerlik olduğu kanıtlanmıştır.

Anahtar Kelimeler: Dijital Ekonomi, DESI, Refah Rejimleri, Avrupa Birliği

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1. INTRODUCTION

The rapid advances in information and communication technologies have transformed countries both economically and socially. Today, the digitalization of the economy and society unavoidably affects the future of all countries. Strong socio-economic structures are directly linked to digitalization attempts of countries. In this context, technological transformation and digitalization on the socioeconomic level are realized slowly in some countries, whereas they are more rapid in others. The most important factor that affects the speed of digitalization is the policies and investments that countries apply in this sphere.

One of the most important steps of digitalization is the ability to keep up with the digital economy. The digital economy (also referred to as the Internet Economy, New Economy, Web Economy), is defined as doing business via web-based markets based on internet and computer technology. The digital economy has become an important factor that globally creates value with the spread of the Internet, increased use of smart mobile devices, and the popularization of social media. The digital economy is increasingly intertwined with the traditional economy. That is why it is hard to identify the notion. The digital economy is based on the online connection between billions of people using the internet daily, enterprises, devices, data, and processes. It is also based on the strong connection between the internet, mobile device technologies, and the Internet of Things (IoT) (Ertz & Boily, 2019: 87).

The prominent features of the digital economy vary from countries and economic structures. Although there is no single digital economy model applicable for all businesses, the digital economy has six prominent features according to OECD. 1) *Mobility*; Due to the reduced need for local personnel to perform certain functions and flexibility, the digital economy is heavily dependent on users and business functions. 2) *Reliance on data*; In the digital economy, companies usually collect data about their customers, suppliers, and operations. Especially including the use of so-called "big data." 3) *Network effects*; It refers to the fact that a user's decision may directly affect the benefits obtained by other users. 4) *Use a multilateral business model;* it is based on a market in which multiple different groups of people interact through intermediaries or platforms, and each group's decision-making will affect the results of other groups through positive or negative externalities. 5) *Tendency toward monopoly or oligopoly;* In some markets, network effects and lower incremental costs can enable companies to dominate in a short period of time. 6) *Volatility*; Technological advances have led to advances in miniaturization, and the cost of computing power has shown a downward trend (OECD, 2014: 84-96).

Considering these six primary features of the digital economy, social media seems to have transformed into an important part of the digital economy. Users are now at the centre of the digital economy with Web 2.0 and User Created Contents (UCC). Mostly stable until Web 2.0, digital content production and consumption processes have rapidly increased with the influence of social media. Especially with social media, users have transformed into prosumers (producer+consumer) as individuals who both produce and consume content (Ritzer & Jurgenson, 2010: 17). This transformation overlaps with the dynamism that the digital economy needs. When six prominent features of the digital economy underlined by OECD are regarded within the scope of the prosumer, social media becomes an important part of the digital economy.

The basic dynamic of the transformation of countries into the digital economy is enabling digital transformation. Digital transformation is not only a factor that affects the market, but it also contains social and cultural content. From this aspect, digital transformation has the potential to trigger the activity in the digital economy and social dynamics. The pressure created by globalization and global competition compels digital transformation in markets. This pressure manifests itself not only in capital markets but also in labour markets. Workers try to be prepared for the digital economy, to adapt to changing jobs and working conditions. This eventually triggers a social transformation, and the digital economy transforms societies (Carlsson, 2004: 254); (EIB, 2020: 1-3).

In this context, this study aims to determine how the European Union countries are clustered according to The Digital Economy and Society Index (DESI) 2020 data. And whether European Union countries show similar features in their digitalization processes will be discussed. In addition to this main objective, the study also aims to determine whether there is a similarity between the DESI cluster of the European Union countries and the social welfare regime classification. For the classification of European Union countries according to their welfare regimes, the Liberal, the Conservative, and the Social Democratic Welfare Regimes classification in *The Three Worlds of Welfare Capitalism* (1990) of Esping-Andersen and Southern, Central Europe and Eastern Europe Welfare Regimes will be taken as the basis. And whether there is a relation between the clustering among the European Union countries in the digitalization process and clustering according to welfare regimes will be discussed.

2. THE DIGITAL ECONOMY AND SOCIETY INDEX (DESI)

The Digital Economy and Society Index (DESI), is an integrated index created to measure the digital competitiveness of European Union countries and monitor their general digital performance. The main goal of DESI is to help determine the areas in each European Union country that need investment in the economic and social

digitalization process. For this reason, DESI measures the digital performances of countries in a 3-layer structure. This 3-layer structure consists of 5 main dimensions. These dimensions are connectivity, human capital (digital skills), use of the Internet by citizens, integration of technology, and digital public services. These 5 dimensions are not isolated from each other; on the contrary, they are directly connected. 5 main dimensions consist of more than one sub-dimension and indicator (DESI, 2020: 10-11); (DESI, 2020b); (Başol & Cumhur, 2020: 3-4).

2.1. Connectivity

The connectivity dimension is directly related to the speed and coverage of internet connection in countries. The higher is the speed of the internet connection and the wider the coverage of the web, the easier is the digitalization process of countries. In this sense, this dimension regards at the supply and demand side of fixed and mobile internet network. Under fixed internet, it evaluates the utilization of basic, fast (next generation access – NGA provides 30 Mbps or more) and ultra-fast internet (100 Mbps or more), as well as retail prices (DESI, 2020a).

The connectivity dimension consists of sub-dimensions such as fixed internet take-up, fixed internet coverage, mobile internet, and internet price index. An increase in the connectivity value refers to easier access to the Internet. A decrease in this value refers to harder access to the Internet. According to the 2020 data, Denmark has the best score, after Denmark, Luxembourg, the Netherlands, Sweden and Finland has great scores on this dimension.

2.2. Human Capital - Digital Inclusion and Skills

This dimension includes 2 sub dimensions: first one is Internet user skills, the other one is advanced skills and development. The previous draws on Digital Skills Index, which is determined dependent on the number and intricacy of exercises including the utilization of computerized gadgets and additionally the Internet. The last incorporates markers of work of ICT experts and ICT graduates. This sub-dimension of DESI measures socio-economically to what extent individuals in the EU countries adapt to the new technologies. Basic digital skills, higher than basic skills, basic software skills, advanced skills and development capabilities, ICT, experts, and ICT graduate indicators can be used to measure personal readiness for the digital world (DESI, 2020c).

According to 2020 data, in terms of Internet user skills, Luxembourg, the Netherlands and Sweden are the best performing countries, while Finland, Sweden and Estonia score the highest in DESI.

2.3. Use of Internet by Citizens

This DESI dimension consists of 3 sub-dimensions: use of the Internet, online activities, transactions. The use of the Internet by citizens will measure how many individuals use the Internet and what operations they conduct online. Such operations require the consumption of content online (for example, activities such as listen music, watch movies or play online games, social media etc.), the use of digital communication operations (for example, participating in web meeting) and other activities such as online banking or online investing (DESI, 2020d).

Balanced digitalization among European Union countries is important for the future digital harmony of the union. Therefore, the absence of a big difference between Internet usage habits of individuals will positively affect the digital performance of the European Union in the future. However, according to DESI 2020 data, there are still huge differences in the use of Internet services among EU member states. People in the European Union are engaged in a series of online events. They effectively utilize the Web to reach online networks such as online shopping, online games, social media platforms etc.

2.4. Integration of Technology

According to European Commission: "*Digital technology enables companies to gain a competitive advantage, improve their services and products, and expand their markets. The digital transformation of enterprises has brought new opportunities and promoted the development of new and reliable technologies.*" This dimension measures the degree of digitization of enterprises and e-commerce. There is also The Digital Intensity Index (DII) under this dimension of DESI. At the enterprise stage, it tests the use of various digital technologies (DESI, 2020e).

It contains the subjects of integration of technology, cybersecurity, and emerging technologies. Cybersecurity measures the internet security of the European Union citizens and ICT security of companies operating in the European Union. Emerging technologies are related to the status quo of the four emerging technologies: "Blockchain, High Performance Computing (HPC), quantum technology, and data and edge computing" (DESI, 2020f; DESI, 2020g).

2.5 Digital Public Services

This aspect of DESI focuses on the use of digital technologies for government organizations. Efficient e-government may have multiple advantages, including greater productivity and savings for government and business. It can also increase transparency and openness. The demand and supply side of digital public services and open data tests this dimension. There are 5 indicators for this dimension: "e-Government users, pre-

filled forms, online service completion, digital public services for businesses" (DESI, 2020h). Digitalization of state institutions has the potential to pave the way for the digitalization of economy and society. For this reason, the digitalization of public services is important for the digital performance of the European Union.

3. SHAPING EUROPE'S DIGITAL FUTURE

With the increasing importance of the digital economy, the Commission put forward the vision of digital transformation in the social and economic life "Shaping Europe's Digital Future" to realize the inclusive use of technologies that are useful to mankind and respect the basic values of the European Union. Digital communications, e-commerce, social media, and digital enterprises are steadily changing our world. Digital transformation represents a European society driven by digital solutions. The solutions are people-oriented, bring new opportunities for enterprises, and promote the development of trustworthy technologies, thereby promoting an open and democratic society and a vibrant and dynamic society. Sustainable economy. The Commission focuses on the three main targets to enable the required transformation for the digital economy of the European Union member countries: Technology for the people, fair competition economy and open, democratic and sustainable society (EC, 2020).

According to the European Commission: *"Technology for people*, the development, deployment and adoption of technology have had a real impact on people's daily lives. A strong and competitive economy, mastering and shaping technology in a way that respects European values. *A fair and competitive economy*, in a frictionless single market, companies of all sizes and in any sector can compete on an equal footing, and can develop, market and use digital technologies, products and services on a scale that improves productivity and global competitiveness, and consumers can be confident of their Rights are respected. *An open, democratic, and sustainable society*, a trustworthy environment in which citizens can act and interact, and have the right to provide data online and offline." The way of digital transformation in Europe can strengthen our democratic values and respect our fundamental rights (EC, 2020a).

4. CLUSTERING WELFARE REGIMES

Welfare regimes have been tried to be classified by various writers. Many scientists tried to classify the welfare regimes of the countries in the scope of certain constraints. For example, Wilensky and Lebeaux classify welfare states in two groups as residual and institutional (Powell & Barrientos, 2011). Richard Titmuss divides the welfare states into three with a different approach: "Residual welfare, industrial achievement–performance, institutional redistributive" (Titmuss, 1958). Furniss and Tilton have also three types of welfare regimes: "Positive state, the social security state,

and the social welfare state" (Furniss & Tilton, 1977). Jane Lewis developed a gender-based aspect to welfare regimes and has an alternative welfare state classification. Lewis classifies welfare regimes in the framework of the male-breadwinner model under three titles: "strong", "moderate" and "weak" male-breadwinner model (Lewis, 1992).

The most referenced source in the welfare regime classification studies is "*The Three Worlds of Welfare Capitalism* (1990)" by Esping-Andersen. Esping-Andersen differentiates 3 types of welfare regimes: "Liberal Welfare Model (primarily in Anglo-Saxon countries)", "Conservative Welfare Model (particularly in Germany, Austria, and France)", and "the Social Democratic Welfare model (Scandinavian countries)". Esping-Andersen has done a new conceptualization study for welfare states, consisting of very large program series, and referred to it as the welfare regimes notion. Using Esping-Andersen's model, A fourth type was introduced to the typology by Leibfried (1991), which they called "Latin" or "Southern" because it was found primarily in countries of Southern Europe.

The biggest impact of further research on the welfare state is the Esping-Andersen classification, which is based on decommodification and stratification criteria. Decommodification here reflects the extent to which individuals can maintain a socially acceptable standard of living without market intervention. Esping-Andersen distinguishes these three systems by the degree of decommodification and the type of stratification they produce in society. Returns "occur when the provision of services is a matter of rights and one can make ends meet without relying on the market" (Esping-Andersen, 1990: 21-22); (Saint-Arnaud & Bernard, 2003: 503).

5. CLUSTER ANALYSIS

5.1. The Aim and Importance of The Research

This research has two aims. Firstly, it aims to examine The Digital Economy and Society Index (DESI) 2020 data with cluster analysis and determine how the European Union countries are classified. The structure of classification will be discussed in terms of digital competitiveness and performance of the European Union countries. The second aim of the research is to reveal similarities and differences between the classification arisen from DESI 2020 data and the welfare regime classification among the European Union countries. The classification obtained from DESI, welfare regime classification of Esping-Andersen, and additionally, Southern, Central Europe, and Eastern Europe Welfare Regimes will be taken as the basis. The research showed that the subject of the research, The Digital Economy and Society Index (DESI) cluster analysis, and comparison of this analysis with welfare regimes were not reviewed. Therefore, the research is significant, filling an important gap.

5.2. Method

In research, the cluster method was used in accordance with DESI 2020 data. The cluster method is an analysis that enables distinguishing the ungrouped observations or variables into homogeneous subgroups according to specific features. Since there is no prior information on how many clusters a country should consist of, first the dendrogram was obtained using the Ward method and Euclidean distance with hierarchical cluster analysis, and the number of clusters was determined (Tokatlıoğlu and Yalçın, 2019: 9-10). Countries were seen to be in 4 clusters. In fact, the recommended number of clusters after the analysis based on the observation number was again 4. In cluster analysis, what needs to be considered is not the normal distribution of variables but the normal distribution of distance values (Tatlıdil, 1992: 252). Accordingly, values were standardized according to the Z value. After the obtained results, the k means method in the non-hierarchical clustering analysis was applied.

5.3. Research Findings

Table 1 shows the final cluster centres obtained after the analysis.

Table 1: Final Cluster Centres

	Cluster			
	1	**2**	**3**	**4**
Connectivity	15.01077	11.92860	14.11017	11.13915
Human Capital	16.83425	13.75822	11.56741	9.32363
Use of Internet	10.84924	9.14174	8.35430	7.05137
Integration of Digital Technology	11.87087	11.38196	7.68676	5.92442
Digital Public Services	12.54723	10.99034	11.23747	8.94145

Table 2 shows the ANOVA Results. The aim of this analysis is to determine whether groups obtained after the clustering analysis are collected in different clusters statistically.

Table 2: ANOVA Results

ANOVA						
	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df		
Connectivity	22.892	3	2.199	24	10.411	.000
Human Capital	69.697	3	2.736	24	25.473	.000
Use of Internet	17.153	3	.893	24	19.208	.000
Integration of Digital Technology	55.706	3	3.306	24	16.850	.000
Digital Public Services	15.948	3	1.383	24	11.536	.000

Connectivity (F: 10,411; p: 0,000), Human Capital (F: 25,473; p: 0,000), Use of Internet (F: 19,208; p: 0,000), Integration of Digital Technology (F: 16,850; p: 0,000) and Digital Public Services (F: 11,536; p: 0,000) variables are substantially different according to groups. Countries have been clustered in 4 groups after the analysis according to DESI 2020 data.

Table 3: Clusters by K Means Method

Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 4**
6 countries	**5 countries**	**9 countries**	**8 countries**
Finland	Ireland	Luxembourg	Cyprus
Sweden	United Kingdom	Spain	Italy
Denmark	Belgium	Germany	Romania
Netherlands	Austria	Lithuania	Greece
Malta	Czechia	France	Bulgaria
Estonia		Slovenia	Croatia
		Latvia	Slovakia
		Portugal	Poland

Accordingly, the 1st cluster consists of Finland, Sweden, Denmark, Netherlands, Malta, Estonia; the 2nd cluster consists of Ireland, the United Kingdom, Belgium, Austria, Czechia; the 3rd cluster consists of Luxembourg, Spain, Germany, Lithuania, France, Slovenia, Latvia, Portugal, Hungary; and the 4th cluster consists of Cyprus, Italy, Romania, Greece, Bulgaria, Croatia, Slovakia, and Poland.

6. DISCUSSION AND RESULT

Technological and digital investments and initiatives of countries have clustered the European Union countries in 4 different groups. Similar technological investments have led to similar results and grouped countries together. The research showed that there was a slight difference between clusters in terms of the number of countries. The biggest cluster was the 3rd with 9 countries and the 2nd cluster was the smallest one with 5 countries. According to DESI data, European Union countries can be said to have different investments and strategies in digitalization and developing digital competitiveness. The prominent result in this regard is that the 1st cluster has the highest averages for all sub-dimensions. Accordingly, the cluster consisting of Finland, Sweden, Denmark, Netherlands, and Norway consists of the best results according to DESI data. On the other hand, even though the connectivity value in the 3rd cluster is higher than in the 2nd cluster, it has a lower value than the 2nd cluster in the human capital dimension. Accordingly, we can say that the 3rd cluster countries turn towards investments and strategies for internet connection and coverage but remains weak in studies necessary for the digitalization of human capital.

While the integration of digital technology, a sub-dimension of DESI, is low in all dimensions, it shows a close value in the 1st and 2nd clusters and the lowest value in the 4th cluster. This dimension aims to measure e-trade and the digital transformation of companies, one of the most important steps of the digitalization process. Therefore, it is hard to say that the countries in the 4th cluster have enough infrastructure for e-commerce required for digital transformation. The countries in the 1st and 2nd cluster performed requirements of the integration of digital technology dimension at close levels.

The human capital dimension among all dimensions has the highest value with its value in the 1st cluster. Accordingly, it is possible to say that the countries in the 1st cluster focus on education investments involving human capital in the digitalization process. The lowest value of the human capital dimension is in the 4th cluster. Accordingly, the countries in the 4th cluster are the countries where the digital transformation of human capital, which has an important place in the digital transformation of countries, is realized the slowest. Digital public service dimension, measuring the digital transformation of public institutions, which is one of the important steps of Europe's digital transformation, has the highest value in the 1st cluster, and the lowest in the 4th cluster. This dimension is the highest 3rd value in all clusters except for the 2nd cluster. In this context, it is possible to say that there is a positive effort to digitalize public services and prepare for the digital future in the European Union countries.

The countries clustered according to DESI data are shaped for investments and spending for digitalization within the scope of sub-dimensions of DESI. In this context, the welfare regimes applied by the countries affect the spending for digitalization. Consequently, whether there is a similarity between the classification of the European Union countries according to their welfare and DESI is important. According to Esping-Andersen, there are three classic welfare state models: the Liberal, the Conservative, and the Social Democratic. However, as the number of countries increases, intermediate or hybrid models can appear. For example, Saint-Arnaud and Bernard added a "*Latin*" group into the 3-layer welfare regime classification in their clustering on the European Union countries (Saint-Arnaud & Bernard, 2003: 513). Maître, Nolan, and Whelan added a "*Southern*" group in their cluster analysis (Maître, Nolan & Whelan, 2005: 164). Similarly, Kammer, Niehues, and Peichl identified a "Southern" group among the welfare regimes of the European Union countries (Kammer, Niehues & Peichl 2012: 467). As the number of the European Union member countries increases, the welfare regime classifications expand as well. Lauzadyte-Tutliene, Balezentis, and Goculenko

classified the welfare regimes of eastern and central European countries as "*Central Europe Welfare Model*" (Bulgaria, Estonia, Latvia, Lithuania) and "*Eastern Europe Welfare Model*" (Croatia, Poland, Slovakia, Slovenia, Hungary) in their cluster analysis (Lauzadyte-Tutliene, Balezentis and Goculenko, 2018: 110). Fenger differentiated between the welfare regimes of countries that joined the European Union later as "Former USSR type (Estonia, Latvia, Lithuania)" and "Post-communist European type (Croatia, Czech Republic, Hungary, Poland, Slovakia, Slovenia)" (Fenger, 2007). According to all these studies, welfare regimes applied in the European Union countries are clustered in a total of 6 groups as the 4 main groups (Liberal, Conservative, Social Democratic, Southern) and 2 additional groups (Central Europe and Eastern Europe).

Table 4: Welfare Regimes in the European Union

Social Democratic	**Conservative**	**Liberal**	**Southern**	**Central Europe**	**Eastern Europe**
Finland	Germany	UK	Italy	Croatia	Bulgaria
Sweden	Luxemburg	Ireland	Spain	Poland	Estonia
Denmark	Belgium		Greece	Slovakia	Latvia
Netherlands	Austria		Portugal	Slovenia	Lithuania
Norway	France				Romania

According to DESI data, countries clustered in 4 groups are divided into 6 groups in terms of their welfare regimes. As the welfare regime concerns wide socio-economic policies, it is a natural consequence that countries are divided into more than 4 groups. When the welfare regime clustering and DESI clustering of countries are compared, countries with the social democratic welfare regime are seen in the 1st cluster of the DESI classification. These countries all have the highest values in all the sub-dimensions of DESI. Therefore, we can say that countries applying the social democratic welfare regime are more prepared for the digitalization of the economy and future digital competition than other countries in the EU.

All countries in the Southern, Central Europe, and Eastern Europe in the welfare regime classification are in the 3rd and 4th groups of DESI clustering. The countries in these groups have lower values in all sub-dimensions of DESI. Countries that apply these welfare regimes are more likely to face problems in the future in terms of technological transformation and digital competition than other countries in the European Union.

Liberal Welfare Regime countries have the best values right after the social democratic welfare regime according to DESI data. For example, there is a little

difference between these two welfare regimes in the integration of digital technology sub-dimension. The difference is at the highest level in the connectivity and human capital sub-dimensions. In this context, it is likely that Liberal Welfare Regime countries will be at a level that they will be able to compete with Social Democratic Welfare Regime countries in terms of digitalization and technological transformation in the future. Belgium and Austria from conservative welfare regime countries also have similarities with Liberal Welfare Regime in point of DESI data by being in the 2nd Group. Germany, Luxembourg, and France from Conservative Welfare Regime countries are in the 3rd group according to DESI data. Therefore, the DESI data of these countries are lower in comparison with the countries in the 1st and 2nd groups.

DESI helps the policy development process by presenting the strong and weak points of the countries to balance digital transformation to be realized in the future among the European Union countries. The applied welfare regimes directly affect digital transformation policies as the policy development process cannot be independent of welfare regimes applied by the countries. In this context, while the countries applying Social Democratic Welfare Regime are getting prepared for digital transformation more decisively, it is thought that the countries applying Southern, Central Europe and Eastern Europe welfare regimes will confront a harder process in terms of digital transformation.

7. LIMITATIONS AND FUTURE RESEARCH

In this research, 2020 DESI data is used for EU countries. It should be noted that the results can change for different country groups and years. Additionally, cluster analysis is made according to the k means method. It should be considered that the results can change with different techniques.

The research can suggest two important topics for researchers in the future. The first is how the DESI clustering changes according to years. For instance, the question of how the clusters have changed from 2015 until now and what the countries have done to be in a different cluster can be an important research topic. Lastly, similar research for different country clusters like BRICS and OECD countries can be important for filling a considerable gap in the literature.

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