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Grouping Countries of the European Region by Their Sustainability and Digitalization Performance

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ABSTRACT
Statement that digitalisation and innovation processes can affect sustainable development is widely accepted among scholars. The global digitalisation provide the necessary tools to ensure the development of economic, social and environmental issues and accelerate sustainable level. On the other hand, digitalisation may negatively enhance some sustainability aspects. The aim of the research is to define interaction between digitalisation and sustainability in the context of 39 countries of the European Region through data gathering and grouping countries by applying clustering analysis. The research is based on the performance scores in the fields of digitalisation (Global Innovation Index) and sustainability (Sustainable Development Goals Index.). Intragroup homogeneity of the profiles of four clusters was found. The results of this study indicate the concept of digitalisation act together with the goals of sustainability.

Keywords: *Sustainable Development Goals, Global Innovation Index, Clustering Analysis, European countries.*

1. INTRODUCTION

The topic has received particular attention since the formal adoption of Transforming Our World: the 2030 Agenda for Sustainable Development by world leaders at the UN Summit [1] The sustainability framework includes the 17 Sustainable Development Goals (SDGs), which cover a wide range of issues and aim to find effective solutions to the complex problems of modern society that require an interdisciplinary approach [1,2]. Thus, stakeholders of sustainable development are looking for unconventional ways to achieve the SDGs and are exploring the positive and negative factors that affect sustainable progress. Digitalisation is seen as one of the factors influencing sustainable development [3, 4]. Studying the positive and negative effects of digitalisation, it is worth noting there are different drivers and consequences in different countries [5]. Digitalisation is not only a process of accelerating change, but also a civilisational shift requiring institutional novation and public readiness [4, 5, 6].

In this study, the authors analyse countries of the European region for several reasons. The European region leads the world in terms of the SDGs results. Nevertheless, countries within the region can achieve only limited progress towards sustainable development by 2030 [7]. Moreover, the global sustainability map shows the strong fragmentation of the level of sustainable development in countries of the European region [8]. Based on this, European countries are an interesting sample for considering the transformation of the processes taking place within these states, affecting the economic, social, environmental, innovation, and political spheres.

The purpose of this paper is to reveal the picture of the interdependence between digitalisation and sustainable development in the context of 37 countries of the European region by clustering countries according to two criteria - digitalisation and sustainability.

[1] UN Sustainable Development Summit, New Yourk, 2015. (2015). Retrieved from https://sustainabledevelopment.un.org/post2015/summit

2. THEORETICAL BACKGROUND

There are three research outcomes based on literature analysis that explain the linkage between digital and sustainable development and the relevance of the research topic. First, governance and policy in sustainable development and digitalisation areas. The UN sustainable development framework is global by nature. Nowadays, countries are at completely different stages of implementing the SDGs. The adaptation of the global SDGs to national context requires taking into account existing national policies and governance systems, which in turn need to be dynamic and flexible enough to respond to unpredictable changes [9, 10]. Lanshina et al. (2019) distinguished three key schemes for localising the SDGs at the country level - deep localisation, implementation of the SDGs without formal localisation and complete lack of localisation [9]. According to Glass and Newig (2019), who analysed sample of EU and OECD countries with high- and upper-middle-income, strengthening democratic institutions can lead to greater progress in the implementation of the SDGs, providing an enabling environment for achieving the SDGs, accountability, transparency in policymaking, and political flexibility. Moreover, there is a need for adequate funding for the delivery of public services in order to achieve and support the principles of the 2030 Agenda. [11]. The same situation with digitalisation process because countries are implementing different models of the digital economy due to the difference in priorities, specifics of national innovation systems and policy methods [12].

Second path of the discussion is linkage between sustainability and digitalisation. A large body of research has explored the impacts of digitalisation on sustainable development progress. The deep interconnections between various sustainable topics and digital tools are becoming clearer, highlighting the need to address the digital revolution in a systemic manner [3, 13]. Industry 4.0 provides new solutions and flexible models to address environmental, social and economic issues. The linkage between digitalisation and sustainability uncovers opportunities for a more resilient economy and society, paving a unique way for achieving the SDGs [13, 14, 15, 16]. On the other hand, there are some challenges associated with the rise of digitalisation. Moreover, there are different approaches and controversies, as well as political reservations. Thus, the current research remains at an early stage and a gap in knowledge about the mutual nexus between digitalisation and the SDGs exists [14, 15]. The results of the study of Del Río Castro et al. (2021) prove the growing expectations for the added value that digitalisation brings to the achievement of the SDGs. Digitalisation can fill research gaps on sustainability. The authors emphasise the importance of research of policy implications and rethinking the agenda for unification of sustainable development and digitalisation policies seems appropriate to ensure holistic sustainability [14]. Some authors attempt to address the gaps by analysing impacts of different digitalisation tools and creating new participatory research approaches, for example, Gupta et al. (2020) propose the Digitalization–Sustainability Matrix that connects technologies with concrete indicators of the SDGs to find positive, negative or unknown impacts and relevance for the different stakeholders [15]. Most studies indicate that digitalisation should be used in responsible way and rebound effects of digitalisation must be identified and mitigated to any potential negative impacts [3, 13, 14, 15, 16]. Schulz et al. (2020) analysed the governance of sustainable development initiatives through blockchain technology and showed that governance policy and process must be adapted to technological acceleration in order to avoid creating risks [16]. Moreover, different drivers and consequences of digitalisation can be identified in different groups of countries. In the research paper of Zvereva et al. (2019), digitalisation has a positive impact on well-being in developed countries, while in the group of developing countries no impact was found [5]. Therefore, innovation shifts require major regulatory changes and clear institutional policies [4, 9, 11, 12].

Third block of a literature stream is pandemic influence on sustainable development and digital transformation. Notwithstanding the fact that over the past 5 years, some progress has been made in terms of achieving the SDGs, according to some experts, the Covid-19 will have a negative impact on the dynamics of achieving sustainability due to resetting of priorities and allocation of resources to the immediate priority sectors [17]. Nevertheless, the coronavirus pandemic presents new opportunities to turn this crisis into an incentive to achieve the SDGs despite of significant damages. In addition, Pan and Zhang (2020) urged to pay more attention to research on the achievement of the SDGs through the development of the concept and practice of digital sustainability [18]. Expert's opinions about pandemic impact on the digital economy are mixed [19]. The pandemic has forced governments and different types of organisations to rethink processes, reassess the use of digital tools, implement transformations and use technology to support operations. The digital gap is most evident in developing countries [20], furthermore COVID-19 is exacerbating the digital divide dramatically [21].

Thus, the digitalisation is an essential condition of achieving sustainable development. The aim is to re-investigate the impact of digitalisation on sustainable development focusing on European countries grouping on common grounds.

3. RESEARCH METHODOLOGY AND ANALYSIS APPLICATION

Segmentation is the most widely used multivariate descriptive method for analysing data. Clustering methods are divided into two main groups: hierarchical and non-hierarchical [13]. Hierarchical clustering techniques are a series of successive merges or a series of split processes [22]. Ward method, as a hierarchical clustering method, was used to create groups due to small samples selects clusters of small size. The data set consists of the *Global Innovation Index (GII)* and *Sustainable Development Goals Index (SDGI)* of 39 countries of the European region for the period 2018-2020 years [23, 24, 25, 26, 27, 28, 29]. The *SDGI* Report is the annually worldwide study by Bertelsmann Stiftung and the Sustainable Development Solutions Network to measures the overall progress of countries towards the SDGs and to identifies countries' current positions and priorities in terms of the sustainability targets [3, 13, 26]. The *GII* published annually by Cornell University, INSEAD and the World Intellectual Property Organization. The GII aims to provide detailed metrics about the innovation performance of countries around the world and to provide tools that can help in adopting multi-dimensional innovation aspects [3, 13]. The clustering algorithm was implemented in Stata environment.

Firstly, it was necessary to analyse the distribution of the original features. The variables do not contain outliers and have a good symmetric distribution (figure 1).

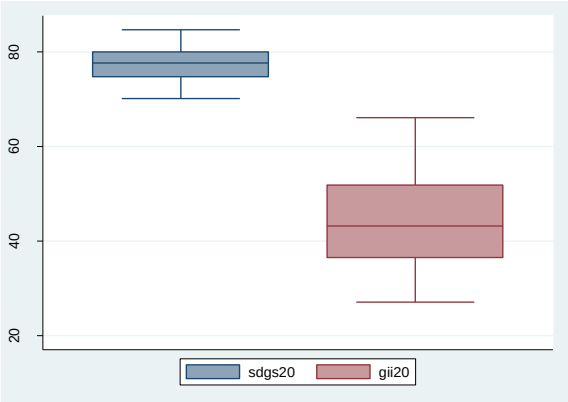

Figure 1 Box plot (2020)

In the cluster analysis stage, according to the dendrogram result obtained by the Ward method, the country groups was interpreted as 2, 3 and 4 clusters. Four clustered result was preferred with the highest conceptual detailed meaning (figure 2).

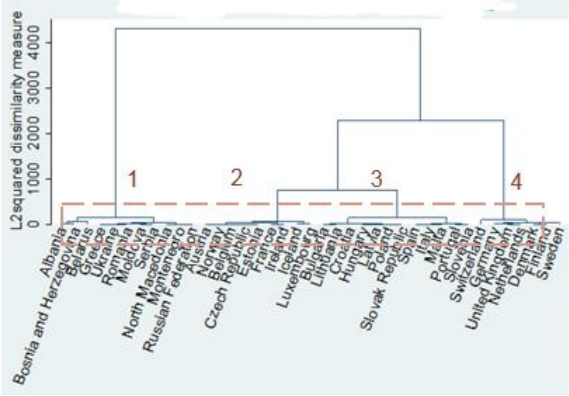

Figure 2 Dendrogram for clustering analysis (2020)

The same separate tests was carried out for the 2018-2019 data. The data showed no outliers and were classified according to the dendrograms into four groups of countries.

4. RESEARCH RESULTS

Based on cluster analysis using the Ward method, intragroup homogeneity of country profiles was revealed according to sustainable development and digitalisation. As a result, four groups of countries with special characteristics were introduced: the first cluster can be called «low-performance» in achieving the SDGs and innovation, the second cluster is «lower middle» (below average), cluster number 3 is «upper-middle» (above average), and the fourth cluster is «high-performance» (figure 3).

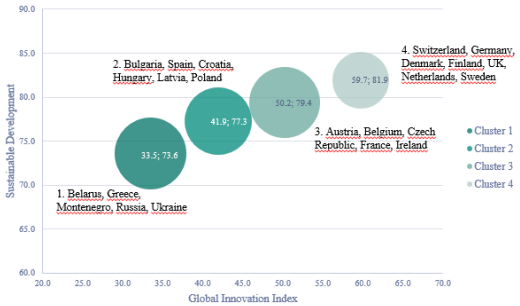

Figure 3 Grouping countries of the European region by their sustainability and digitalisation performance

These groups of countries of the European region indicate differences in key aspects. The first cluster represents the lowest efficiency of the global innovation and sustainable development and includes

Albania, Bosnia and Herzegovina, Belarus, Greece, Moldova, North Macedonia, Montenegro, Romania, Russian Federation, Serbia, and Ukraine. The second cluster has a low than average characteristic and includes the next countries: Bulgaria, Spain, Croatia, Hungary, Lithuania, Latvia, Malta, Poland, Slovak Republic, and Slovenia. Austria, Belgium, Czech Republic, Estonia, France, Ireland, Iceland, Italy, Luxembourg, Norway, Portugal represent 3th group that is upper-middle. The fourth cluster is characterised by high efficiency and the relationship between innovation potential and sustainable development. Countries of this cluster are in the top 15 in the overall sustainability ranking and top 10 in the global innovation ranking. Most countries of the fourth cluster stood at the origins of the formation of the concept of sustainable development. Many of these countries are leaders in providing support to developing countries, for example, Denmark, Switzerland, Sweden, Great Britain, Sweden form a narrow circle of countries that annually allocate about 1% of their gross national income to official development assistance [9]. The results demonstrate countries are at completely different stages of introducing the SDGs into strategic documents - from absence to full localisation of all the 17 SDGs. Moreover, in this way, the components and technologies of the digital ecosystem work together with the principles of sustainability.

Analysing data in the dynamic of 2018-2020 year (figure 4) the authors got the following results and come to several conclusions: 1) clusters 1 «low-performance» and 4 «high-performance» maintain the same set of countries for 3 years while there are some changes in clusters 2 and 3. Slovenia lowered its position in terms of innovative and sustainable development, moving to the second cluster. Italy and Portugal, on the contrary, strengthened their positions by climbing the classer higher. 2) Moreover, the results in table 1 demonstrate the increase in the SDGs achievement in clusters 1 and 2. At the same time, countries of all clusters have reduced the level of innovative development (on average). This results may mean that some new impact factors of sustainable development appear or/and the institutional agenda of sustainable development are becoming more significant (particularly in clusters 1 and 2). It should be noted the SDGs ranking methodology has undergone changes what may be indicated as the limitation of the study.

	2018	SDG (mean)	GII (mean)	2019	SDG (mean)	GII (mean)	2020	SDG (mean)	GII (mean)
Cluster 1	-	70.8	34.8	-	71.7	35.3	-	73.6	33.5
Cluster 2		74.5	44.4	Slovenia Italy, Portugal	76.6	43.6		77.3	41.9
Cluster 3	Slovenia	79.2	51.8		79.5	52.0	Italy, Portugal	79.4	50.2
Cluster 4	-	81.9	61.6	-	81.8	61.4	-	81.9	59.7

Figure 4 Comparing clusters 2018-2020

5. CONCLUSION

The global call for action on sustainable development is becoming more relevant. Countries are starting to implement sustainable policies and continue to embrace digitalisation despite the existing difference in socio-economic development. It is vital to investigate the effects of both phenomena and assess whether changes are desirable especially in the post-pandemic era. The literature review shown digitalisation is a prerequisite for long-term sustainability. The main objective of the study was to define interaction between digitalisation and sustainable development on the national level.

This paper presents the results of the study on the 39 countries of the European region where countries are grouped by hierarchical cluster analysis based on the GII and SDGI performance. Using the Ward method for group allocation, countries were categorised in homogeneous groups according to achievement of sustainable and innovation development. The positive correlation between technological development and socioeconomic development based on the four clusters was reviled. The finding demonstrates the more digital and innovative country is, the more developed it is in terms of achieving SDGs. Thus, the global digitalisation can provide the necessary tools to ensure the development of economic, social and environmental issues and accelerate sustainable level. At the same time, countries must anticipate the rebound effect and be institutionally prepared for the new reality This study contributes to the discussion on digital transformation and its influence on the attainment of the sustainable development.

AUTHORS' CONTRIBUTIONS

Yana Lopatkova and Zhanna Belyaeva conceived of the presented idea and designed the contextual framework. Yana Lopatkova analysed the data and performed the calculations. The authors discussed the results and contributed to the final manuscript.

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