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Role of digitalization to increase resource productivity (Balkan cluster case study)

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Abstract

Purpose: In today's dynamic conditions an important determinant of economic growth and well-being in each country is increasing resource productivity, which is a prerequisite for the transition to sustainable production and consumption. The aim of the study is: 1) Analysis of resource productivity in selected nine countries in the Balkan region, 2) Assessment of the role of digitalization (and four key characteristics) as a factor for increasing the productivity of resources in the Balkan cluster.

Method: The survey uses a method based on statistical analysis of Eurostat data and data collected in an open and standardized way, using a correlation coefficient.

Results: The results of the empirical study should demonstrate the link between the digitization process in the Balkan cluster and increasing resource productivity. The survey was conducted among 25 working clusters in Bulgaria and all of them have active cooperation with partners from the Balkan countries.

Conclusions: The study and conclusions demonstrate the significant opportunities for increasing resource productivity in the Balkan region by digitizing processes, resulting in optimizing consumption and separation of economic activity from material consumption. This process requires a new development strategy, strategic and flexible cooperation between the private and public sectors, between different companies, educational and research institutes, between companies from different countries in a region, which can be most effectively implemented in the cluster union.

Keywords: Resource Productivity; Digitization; Balkan Cluster; Sustainable Product; Learning; Knowledge Transfer

1. Introduction

Economic activity depends on a continuous flow of natural resources. As economies grow, more and more material resources (biomass, minerals, metals and fossil energy materials) are being extracted, and the increase in material consumption is intensifying competition for resources. Based on projected global population growth (up to over 9 billion people) and economic growth that will triple the wealth per capita compared to the current level, the International Energy Agency predicts that demand for materials will double by 2050 [1]. OECD report projects a doubling of global primary materials use between today and 2060 [2].

In this context, the study offers a vision to accelerate the transition of companies in the Balkan region to digitalization of processes as a factor in increasing resource productivity and creating additional opportunities to strengthen the competitiveness of businesses and economies. The aim of the study is: 1) Analysis of resource productivity in selected

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nine countries in the Balkan region, 2) Assessment of the role of digitalization (and four key characteristics) as a factor for increasing the productivity of resources in the Balkan cluster.

The models of resource use and their productivity in nine countries of the Balkan region are outlined, namely Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, North Macedonia, Romania, Serbia and Slovenia. A comparative characterization of the challenges related to increasing resource efficiency and the digital transition in the economies under consideration has been made.

Resource productivity in this study is defined as gross domestic product (GDP) per unit of domestic material consumption (DMC). Eurostat databases are a source of data and indicators on economic performance, resource consumption and resource productivity.

2. Theoretical analysis and research hypotheses

Achieving higher resource productivity is a particular focus of a European Green Deal - the EU's ambitious economic growth strategy that works through a framework of new regulation and legislation setting targets [3]. In the context of the Strategy, an essential challenge for Member States, in addition to decoupling economic growth from resource consumption, is to increase material efficiency and competitiveness. The circular economy (CE) model, and in particular waste management, recycling, sustainable production and resource efficiency, are among the main pillars for implementing the Green Agenda for the Western Balkans based on the digitalization of processes [4].

Economic growth and improving living standards, population growth, international trade, investment in construction and infrastructure increase demand and consumption of material resources and raw materials, which in turn is driven by the growth of developing economies and the emergence of new technologies [5]. During the period 2009 - 2019, except for Greece (real GDP contracted by 2.1%), the surveyed economies recorded positive real GDP growth rates - between 1% (Croatia) and 3.1% (Romania). More dynamic are the economies of Albania, North Macedonia, Bulgaria, Bosnia and Herzegovina, with an annual growth rate between 2% and 3%. During the same period, the real GDP growth rate is somewhat weaker in Serbia (1.9%) and Slovenia (1.8%).

Maintaining the modern standard of living from economic activity leads to the consumption of more and more natural materials. Compared to other economies, Slovenia achieves a living standard that is closest to the EU-27 average. In 2019, Slovenia had the highest GDP per capita among all countries included in this comparison (at 11% below the EU average) In Serbia, North Macedonia, Albania and Bosnia and Herzegovina, GDP per capita is between 50% and 68% lower than the EU average. Romania, Greece and Croatia reach GDP levels between 30% and 35% lower than the EU average. In Bulgaria, GDP per head reaches 47% of the EU average. In all the countries surveyed, the expected growth in income per capita and approaching the level of income in the EU is a prerequisite for increasing resource consumption. In order to maintain and further increase well-being, improving resource productivity have to be an important priority in the Balkans region.

Simultaneously, as well-being increases, new approaches to resource management and an increase in demand for environmentally friendly goods and services that protect the environment and materials arise. The transformation of linear material flows into circular ones is a prerequisite for improving well-being through higher resource productivity. In CE, products' value and utility are expanded, and production and consumption wastes are utilized as secondary resources, promising solutions and co-benefits to a range of economic and environmental issues [6].

Population changes are also key factors for material consumption, especially of industrial materials and metals. The decline of the population in most of the selected countries affects the value of the indicator DMC per capita. Natural resources use is unevenly distributed among the countries analyzed in this study (Table 1). In 2019, except for Greece, the populous countries had the largest absolute amount of materials consumed. In 2019, absolute material consumption was the highest in Romania - 476 million tonnes, or 7.2% of total EU consumption. Bulgaria's economic activity also uses a large amount of materials, as measured by domestic material consumption - nearly 145 million tonnes, or 2.3% of material consumption in the EU. Resource consumption is lowest in Northern Macedonia - 17.7 million tonnes or 0.28% of the EU average.

Table 1 Domestic material consumption, thousand tonnes

	2017	2018	2019
EU-27_2020	6 254 485	6 355 076	6 325 358
Bulgaria	139 220	142 911	144 655
Greece	120 112	118 263	104 554
Croatia	41 226	42 585	45 851
Romania	417 639	449 786	475 536
Slovenia	27 081	29 889	30 804
North Macedonia	17 747	17 756	:
Albania	21 750	:	:
Serbia	113 890	118 850	:
Bosnia and Herzegovina	36 256	:	:

Source: Eurostat

The total DMC per capita of the EU economy is higher than global DMC per capita, reaching 14.2 tonnes in 2019. The average per capita consumption in the EU is relatively stable, falling from its highest of 15.2 tonnes per capita in 2011 to 14.2 tonnes per capita in 2019. In 2019 DMC varies significantly across countries (Table 2), ranging from 24.5 tonnes per capita (Romania) and 7.6 tonnes per capita (Albania). In Bulgaria, 20.7 tonnes per capita of materials are consumed, and 17 tonnes per capita in Serbia. Material consumption is lower than the EU average in Croatia (11.2 tonnes per capita), and in Bosnia and Herzegovina (10.3 tonnes per capita). In Greece and North Macedonia, DMC per capita is far below the EU average consumption - of 9.7 and 8.6 tonnes per capita, respectively. Eurostat data show that, with the exception of Romania, Bulgaria, Serbia and Slovenia, all other countries of the surveyed region reach DMC per capita lower than the EU average (Table 2).

The closest to the EU average is material consumption in Slovenia - 14.8 tonnes per capita. In 2019, the resource consumption per capita in Romania and Bulgaria was 10.3 and 6.5 tonnes higher than that of the average European. The downward trend in material consumption per capita (by 38.9%) throughout the study period was clearly expressed in Greece. The country is experiencing both a population decline and a prolonged downturn in GDP. With already high consumption per person in 2009 of 17.4 tonnes, Romania's economy increased its consumption to 24.5 tonnes per capita in 2019.

Table 2 Domestic material consumption, tonnes per capita

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
EU-27	14.9	14.4	15.2	14.1	13.7	13.8	13.7	13.7	14.0	14.2	14.2
Bulgaria	16.4	16.3	18.2	17.6	17.1	18.8	21.3	18.9	19.7	20.3	20.7
Greece	17.8	15.9	14.3	13.2	12.4	12.7	12.3	11.6	11.2	11.0	9.7
Croatia	12.3	10.4	10.4	9.5	10.0	9.2	9.8	10.1	10.0	10.4	11.2
Romania	17.4	13.7	19.0	18.0	18.0	18.8	22.5	22.9	21.3	23.1	24.5
Slovenia	17.0	16.0	14.4	12.5	12.2	13.1	13.3	12.8	13.1	14.4	14.8
North Macedonia	:	9.0	9.9	9.5	9.2	9.3	9.3	9.1	8.6	8.6	:
Albania	:	7.0	7.1	7.2	8.0	7.9	9.1	9.9	7.6	:	:
Serbia	14.3	15.2	15.4	14.0	15.3	14.5	15.5	16.9	16.2	17.0	:
Bosnia and Herzegovina	:	:	:	:	:	:	9.7	11.8	10.3	:	:

Source: Eurostat

Resource productivity refers to the efficiency of using natural resources within economic system. Resource productivity increases are gaining importance in the context of resource scarcity and future economic growth, especially in the economies of the Western Balkans. Resource productivity in the EU is EUR 2.2 per kilogram (using current price data for GDP) in 2019. In 2019, resource productivity in Greece reached 1.9 EUR/kg, in Slovenia 1.6 EUR/kg, in Croatia 1.2 EUR/kg (Table 3).

Table 3 Resource productivity 2009-2019, Euro per kilogram

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
EU-27	1.6	1.7	1.7	1.8	1.9	1.9	2.0	2.1	2.1	2.1	2.2
Bulgaria	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4
Greece	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.5	1.6	1.9
Croatia	0.9	1.0	1.0	1.1	1.0	1.1	1.1	1.1	1.2	1.2	1.2
Romania	0.4	0.5	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5
Slovenia	1.0	1.1	1.3	1.4	1.5	1.4	1.4	1.5	1.6	1.5	1.6
North Macedonia	:	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	:
Albania	:	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.5	:	:
Serbia	0.3	0.4	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.4	:
Bosnia and Herzegovina	:	:	:	:	:	:	0.4	0.4	0.4	:	:

Source: Eurostat

North Macedonia's economy has generated 0.6 euros of GDP. Romania and Albania have resource productivity of 0.5 euros worth of GDP created per kilogram of material used. For every kilogram of material consumed, EUR 0.4 of gross domestic product are generated in Bosnia and Herzegovina, Bulgaria, and Serbia.

Expressed in purchasing power standards per kilogram, (using current price data for GDP converted into purchasing power standards), resource productivity varies among different countries. The difference between the countries with the lowest productivity (Serbia and Bulgaria) and the EU average is significant. Resource productivity is highest in the four countries with the highest living standard (measured in GDP per capita, Table 4).

Table 4 Resource productivity, GDP and DMC, by country, 2019

	GDPPPS per capita (PPS per capita)	DMC per capita (tonnes per capita)	Resource Productivity (PPS per kilogram)	GDPPPS/DMC (index EU-27=100)
EU-27_2020	31 105	14.2	2.2	100.0
Bulgaria	16 414	20.7	0.8	36.0
Greece	21 040	9.7	2.2	97.9
Croatia	20 183	11.2	1.8	80.9
Romania	21 568	24.5	0.9	40.0
Slovenia	27 220	14.8	1.8	83.8
North Macedonia (*)	11 306	8.6	1.3	60.0
Albania (**)	8 944	7.6	1.2	53.7
Serbia (*)	11 983	17.0	0.7	32.0
Bosnia and Herzegovina (**)	9 046	10.3	0.9	39.7

(*) 2018 instead of 2019, (**) 2017 instead of 2019 Source: Eurostat

In 2019, the EU average productivity is 2.2 purchasing power standards (PPS) per kilogram (Table 4). The indicator varies widely between individual countries. Resource productivity in the same year is highest in Greece, where it reaches the average European levels. Taking into account price differences, the comparison between countries shows that second highest resource productivity values were recorded in Slovenia and Croatia (1.8 PPS/kg) or over 80% of the EU average.

Resource productivity stood at 1.3 PPS/kg in North Macedonia and at 1.2 PPS/kg in Albania, respectively 60% and 54% of the EU average. The resource productivity of the Romanian economy remains among the lowest in the countries surveyed, as well as that in Bosnia and Herzegovina - 40% of the EU average. Bulgaria had resource productivity of 0.8 PPS/kg in 2019, second lowest in the region, according to Eurostat data. Serbia had a lower resource productivity of 0.7 PPS/kg. In Serbia and Bulgaria, resource productivity is 64% and 68% lower than in the EU, with purchasing power-adjusted GDP. There are large differences between individual countries, both in absolute terms and in trends over time.

The change of resource productivity in the period under review varies between countries. Almost all EU Member States improved the productivity of their resources between 2000-2019 by best performing Slovenia, where resource productivity increased by 74.7%, followed by Greece (50.1%). Since 2000, resource productivity in Bulgaria's economy has increased by around 35% and Croatia's by 4.6%. Productivity decrease was observed in Romania (22.3%). In the period 2001-2018 Serbia achieved an increase of 39.4%. Between 2010 and 2018 in North Macedonia, resource productivity increased by 25.3%, in Albania, resource productivity increased by 35.8%, and in Bosnia and Herzegovina 4% (between 2015 and 2018).

The study outlines differences between countries, with some of them achieving resource efficiency improvements by changing economies to generate more product from the same resources. Increasing resource efficiency is key to reducing resource consumption in economies that are catching up with higher living standards. The distinct heterogeneity in the models is related to a number of factors, including the available natural resources, the structure of the economy, economic development models, integration into the world economy, etc. The countries with lower well-being and consumption in Western Balkans, as well as more dynamic economies, need to benefit from technology transfer and innovation, as well as external support for their development. One possible way to achieve these goals and increasing resource productivity is the construction of a Balkan cluster.

The cluster is a geographically concentrated voluntary association that includes interconnected companies, specialized suppliers of components, equipment and services, as well as specialized infrastructure, intermediaries, government and other institutions (universities, think tanks, agencies, trade associations), which provide specialized training, education, information, research, technical support and whose activity is based on competition and cooperation [7]. The geographical scope of the cluster varies from one region, country, or even one city, and may cover neighboring cities, regions, countries, as borders are constantly evolving (new companies and markets are emerging, and others are shrinking or dying out). For the purposes of the study, the Balkan Cluster is defined as a union (horizontal, vertical, sectoral and intersectoral) of companies, public and scientific institutions from different countries in the region, or the creation of a cluster network that brings together clusters from different Balkan countries, as well as active cooperation and partnership between national clusters in the region. The main factor ensuring the effective functioning of the cluster is the presence of a core, leading company (often called an anchor), well-developed infrastructure, access to markets, raw materials, social services and financial resources (Figure 1).

A key factor in increasing resource productivity and realization of the principles of the circular economy, including the Balkan cluster is digitization. The process of digitization (seen as combinations of information, calculations, communications and connection technologies) leads to significant changes in company capabilities, which allow the creation of new interconnections between products, processes and services, new business networks and inter-company relations, regardless of time and distance [8].

The use of digital resources and information exchange through digital platforms inside and outside the cluster optimize intra-company operations, which reduces costs (transaction and operational) and increases resource productivity. This determines the first hypothesis in the study - *H1: The digitization of the processes in the Balkan cluster is a factor in increasing resource productivity.*

The study identifies four key characteristics of digitalization (creating a sustainable product and a circular model, knowledge transfer and training and communication with public institutions), which have a strong influence on the achievement of goals in the cluster.

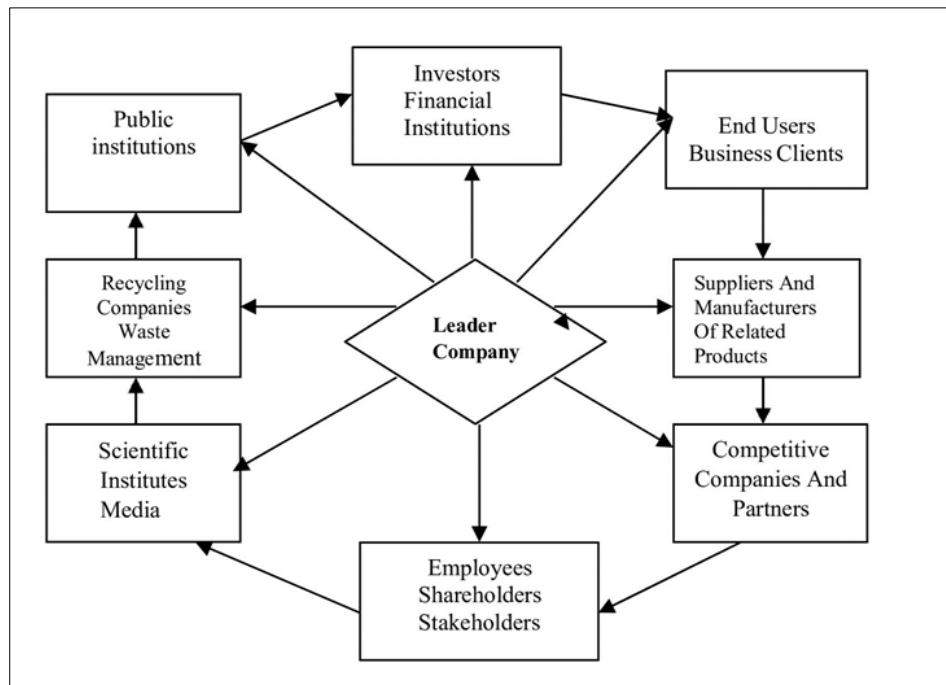


Figure 1 Structure and Organization of the Balkan Cluster - a factor for increasing resource productivity

An important starting point in the cluster is the eco-projecting of manufacturing processes, products and services. The leader company defines the social and environmental requirements and norms for the product created at each stage of total production, which must be followed by other participating companies. Information modeling of the product has central in this process. It integrates data related to cost estimate, production and design time so that the product to endure longer, be easier to reuse, repair and recycling, and include as many recycled materials as possible [9]. The second hypothesis in the study is - *H2: Digitization of the processes in the Balkan cluster is a factor in creating a sustainable product and increase resource productivity.*

The process of digitization increases sources of information and knowledge about cluster participating companies (clients, stakeholders, institutions, alliances, social networks, etc.). Cluster union creates formal and/or informal arrangements between participants, strategic relationships and exchange mechanisms, dissemination of information, experience, ideas for innovation, and ultimately transfer of knowledge, which carries mutual benefit [10] and determines the third hypothesis - *H3: Digitization of processes in the Balkan cluster is a factor for learning, knowledge transfer and increase resource productivity.*

The digitization of intercompany relations creates conditions for developing a new strategy based on the use of digital resources, technologies, learning, knowledge transfer. A digital business strategy changes, reconfigures operational capabilities and different functional areas of company activity, expands scope (territorial and product) and facilitates connections with other interconnected and/or complementary companies from the external environment. That's a factor in creating a multi-faceted sustainable business model, through which resources are allocated and company actions and decisions are coordinated in the process of creating, offering and realizing value for all stakeholders, by reconciling, synchronizing public and private interests and considering natural and social/societal constraints [11]. The new challenges require a radical change in strategic behavior, organization and management of companies included in the cluster (and cluster as a whole) and change in corporate culture and employee support. This determines the fourth hypothesis in the study - *H4: Digitization of the processes in the Balkan cluster is a factor in creating a sustainable circular model, which increases resource productivity.*

The cluster combines efforts, potential, funds of the private and public sector for working together. Especially important for the success of the cluster is the availability of an educated and skilled workforce, proximity to scientific and research activities, higher education, development of entrepreneurial spirit and culture that values education and knowledge. These services must be provided by public institutions, which determines the fifth hypothesis - *H5: Digitization of processes in the Balkan cluster facilitates links, communication with public institutions, which increases resource productivity* (Figure 2).

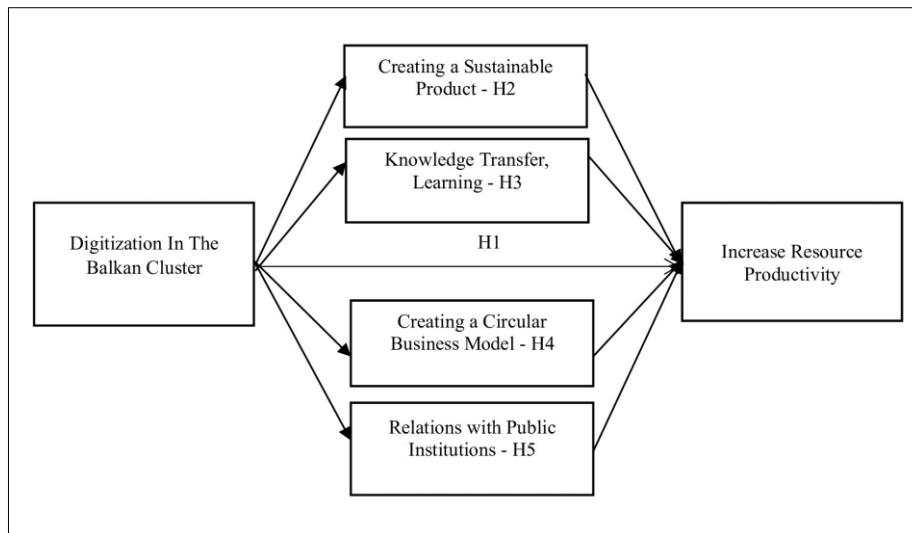


Figure 2 Conceptual Model and Research Hypotheses

3. Research methods

The study of the role of digitalization (and four key characteristics) in increasing resource productivity in the Balkan cluster is part of a large-scale study that includes issues related to the impact of an integrated vertical management chain, open innovation, organizational and managerial change and public institutions. on the circular process in the cluster. The testing of the formulated hypotheses was carried out through an empirical study, which includes 25 working clusters in Bulgaria, selected at random. The surveyed clusters include over 200 companies (in the largest cluster 64 companies work, and in the smallest – 7). They work in different sectors/markets of the economy - textile, construction, automotive, pharmaceutical industry, electric mobility, renewable energy sources, waste collection and recycling, information and communication technologies, health, wellness & SPA tourism, ecology and environmental protection, etc. Depending on the nature of the links between the participating companies, the studied clusters are both horizontal and single-sector, as well as vertical and intersectoral, which expands the research base. What unites the studied clusters is, that they all have partners from the Balkan countries - Greece, Serbia, Romania, Croatia, Montenegro, North Macedonia. Partnerships are developed both between the cluster and individual companies, and between individual clusters by creating a cluster network.

The information was collected through an online survey among managers at the cluster level (25) and managers of individual companies (85) participating in the cluster, or a total of 110 respondents (in the period September - December 2020) and was largely provoked by the new challenges for the development of the region. The study also uses information and analyzes made in the Balkan Cluster Project [12].

The survey included a total of 30 questions, constructed as wordings, to which the respondents referred, noting their answers from 1 to 5 on the Likert scale (where 1 stands for “I fully disagree” and 5 stands for “I fully agree”).

The role of digitization to increase resource productivity in the cluster (H1) is assessed on the basis of the degree, scope and efficiency of digitization integrated into the general philosophy of each company and the cluster as a whole.

The impact of digitalization on the design of production processes, products and services is studied on the basis of cost evaluation, time, eco-design, long-term customer relations, additional services (H2).

The role of digitization on the process of learning and knowledge transfer (H3) includes assessing the ability to develop effective procedures for assimilating, generating, integrating and creating new knowledge that has the potential to stimulate innovation (creation of new products and processes).

An important place is the assessment of the creation of a sustainable business model (H4) based on a broad and comprehensive digitization of all company processes, at all levels. This enables the collection, analysis and evaluation of information from all direct and indirect stakeholders, coordination and integration of knowledge, skills, competencies of all participants by creating a digital network model, which changes the corporate culture and behavior model as a whole.

Questions related to the role of public institutions (H5) include an assessment of the ability to develop strategic plans for the development and management of new initiatives, an effective structure of organization and management, stimulation and support, creation of specialized teams aimed at joint management of sustainable projects, and these indicators are separately assessed state and local institutions.

4. Results

The summarized results of the study are shown in Figure 3. The indicated values (Pearson's correlation coefficient - R, which is calculated for the whole sample based on the average of the answers received from the online survey) show the correlation rate between independent variables (digitization and four key characteristics) and the dependent variable (resource productivity in the Balkan cluster) (Figure 3).

According to the surveyed managers, the process of transforming information from physical to digital format and applying it to an increasingly large part of business processes ensures a faster pace and higher quality of design, implementation, production and communication with customers and stakeholders. The results obtained in the empirical study prove the existence of a significant positive relationship between the digitalization process in the Balkan cluster and the increase in resource productivity ($R = 0.725$), which fully confirms the first hypothesis (H1).

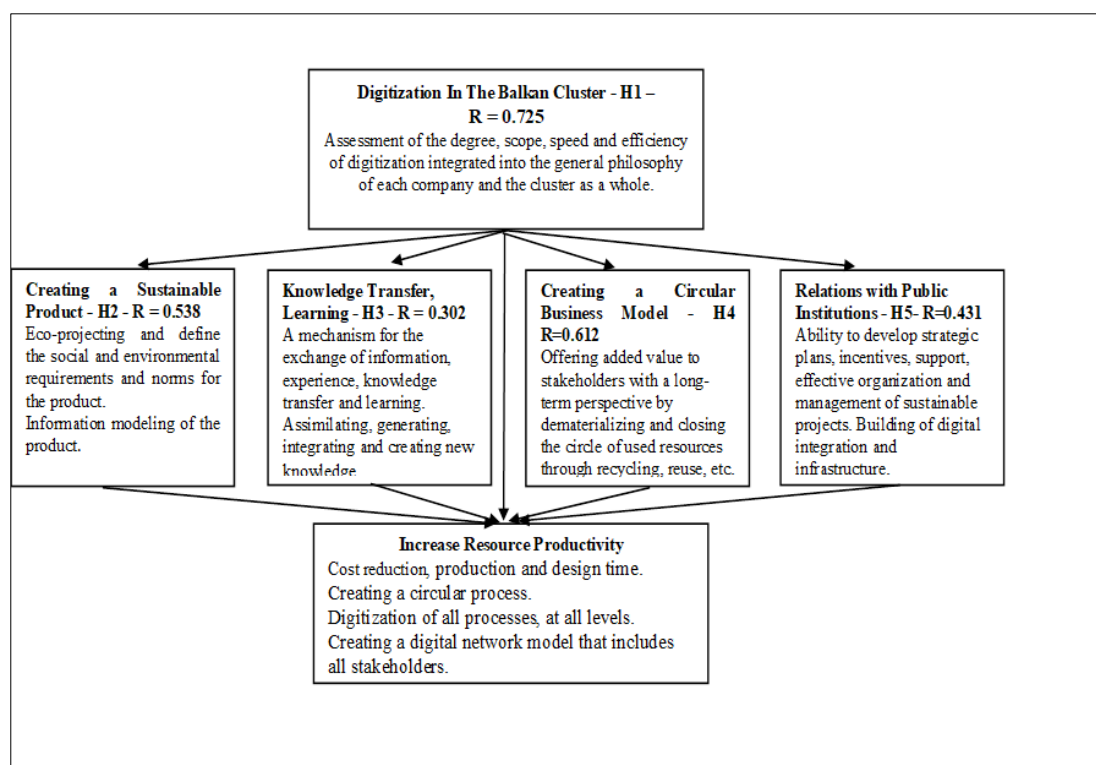


Figure 3 Correlation between digitalization (and four key characteristics) and increase resource productivity in the Balkan cluster

Respondents highly appreciate the opportunities of digitalization to create a sustainable product in the cluster, resulting from the application of integrated principles of eco-design and integrative approach to various activities that are interrelated and complementary, but also assess the difficulties in the process ($R = 0.538$). This allows the circular process to be implemented in practice, which is a strong factor in increasing resource productivity (H2).

A key feature for the success of the Balkan Cluster is the creation of network effects and multilateral platforms of interconnected companies based on knowledge transfer and training, which are broader than traditional supply chains (H3). According to the respondents, so far this sounds more like a wish, without real practical results (which determines the lower value - $R = 0.302$). However, the organization of each cluster creates incentives for new associations, cooperation, expansion of activities, which increases the opportunities of participating companies for training, transfer, generation of new knowledge and development of innovation.

The research also confirms a relatively strong correlation between the need to develop a new digital business strategy that facilitates strategic and operational decision-making, increases the efficiency of the integrated vertical chain, reveals new opportunities and distinctive competencies of the company and the cluster (H4 - $R=0.612$). These factors facilitate the creation of a circular business model that not only creates value for multiple stakeholders and has a long-term perspective, but also dematerializes, narrows, and closes the circle of used resources through recycling, reuse, etc.

Although with a proven correlation, the results of the studied fifth hypothesis are of lower value ($R=0.431$). Respondents share concerns about the relatively low interest of institutions, universities and research units in working together and the relatively difficult access to funding for various projects due to lack of experience or skills. The modernization of the activity of public institutions, improvement of the business climate and facilitation of cooperation and unification, through the development of digital integration and the construction of digital infrastructure in the region is still a good wish.

5. Conclusion

The presented research aims to analyze and compare the trends and results regarding important aspects of the countries' socio-economic development, internal material consumption and resource productivity in the period 2009-2019 (Eurostat data). The conclusions drawn show that, in addition to social and territorial cohesion, the sustainable development of the region requires/presupposes more efficient use of resources and orientation of business towards more innovative forms of production and consumption.

From such a point of view, the study evaluates the role of digitization as a factor in increasing the resource productivity in the Balkan cluster. Four key characteristics of digitization (creating a sustainable product, transfer of knowledge and learning, sustainable business model and communication with public institutions) have been identified, which have a strong impact on the achievement of the objectives in the cluster.

A conceptual model was developed and five hypotheses were defined, empirically tested through an online survey conducted among 110 managers from 25 clusters. A statistical and correlational analysis was applied when processing the results, which confirms the defined hypotheses and at the same time outlines the problems, the need for support (expert and financial) support at all levels and speeding up the digitalization process in the region.

The study proves the significant opportunities for increasing the resource productivity in the Balkan region by building a Balkan cluster based on digitalization of processes, which leads to optimization of consumption and separation of economic activity from the consumption of materials. At the same time, the difficulties in this process and the lag behind other countries and regions are clearly assessed. Digitalization transforms the structure of social relationships between customers, between companies and between customers and companies. The expected end result in the cluster is improved customer service, reduced inventory, optimized technology, closing the cycle, offering a better product, reducing harmful environmental impacts, improving social relations, and ultimately building competitive advantages in the region.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to disclosed.

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