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COMPETITIVENESS AND SUSTAINABILITY IN SMALL AND OPEN ECONOMIES IN THE AGE OF INDUSTRY 5.0

Konkurentnost i održivost u malim otvorenim ekonomijama u doba industrije 5.0

Abstract

We are living in the times of the fourth industrial revolution, which is quickly accelerating towards the fifth, which assumes that our civilization, in addition to exponential technological development, is already transforming itself through a green and human-oriented transition. In such uncertain and challenging times, the circular economy model is emerging as one of the leading economic concepts which both nations and economic blocks will focus on because it encompasses all contemporary trends of humanity, namely the care for the environment and the planet earth, the proliferation of the state-of-the-art technologies and human-centric development approach. In such global economic tendencies, the question arises as to how small and open economies should strategically position themselves in order to strengthen the competitive edge of their firms on the one hand and at the same time strengthen their own national competitiveness. This paper explores the possibilities of using the latest technologies, foremost Industry 5.0, to develop new innovative business models within the circular economy, with a special emphasis on the energy sector. The authors conclude that the use of Industry 5.0 technology is not only preferable as one of the competitiveness boosters for firms, but represents one of the must-have key success factors, especially when competing in niche segments.

Keywords: *company competitiveness, industry 5.0, circular economy, small open economies, Internet of Energy*

Sažetak

Živimo u vremenima četvrte industrijske revolucije, koja se brzo ubrzava ka petoj, koja pretpostavlja da se naša civilizacija, pored eksponencijalnog tehnološkog razvoja, već transformiše kroz zelenu i ljudski orijentisanu tranziciju. U ovako neizvesnim i izazovnim vremenima, model cirkularne ekonomije se pojavljuje kao jedan od vodećih ekonomskih koncepata na koji će se fokusirati i nacije i ekonomski blokovi jer obuhvata sve savremene trendove čovečanstva, a to je briga za okruženje i planetu zemlju, proliferaciju state-of-the art tehnologija i humancentrični pristup.U takvim globalnim ekonomskim tendencijama postavlja se pitanje kako male i otvorene ekonomije treba strateški da se pozicioniraju kako bi ojačale konkurentnu prednost svojih firmi sa jedne strane i istovremeno ojačale sopstvenu nacionalnu konkurentnost. Ovaj rad istražuje mogućnosti korišćenja najnovijih tehnologija, pre svega Industrije 5.0, za razvoj novih inovativnih poslovnih modela unutar cirkularne ekonomije, sa posebnim naglaskom na energetski sektor. Autori zaključuju da upotreba Tehnologije Industrije 5.0 ne samo da je poželjna kao jedan od podsticaja konkurentnosti firmi, već predstavlja jedan od ključnih faktora uspeha, posebno kada se takmiče u nišnim segmentima.

Ključne reči: *konkurentnost kompanija, industrija 5.0, cirkularna ekonomija, male otvorene ekonomije, Internet of Energy*

Introduction

Two processes in the 21st century have a dominant effect on the well-being of the individual and the future of humanity, as well as on the way companies operate and define their value propositions in new circumstances. On the one hand, the continuity of crises caused by various economic and geopolitical motives opened the issues of the price of ensuring long-term stability in supply chains, energy supply (from energy transition and decentralization to the issue of energy efficiency), but also sent a warning to the human population that at the top of the agenda they raise the issue of health, the effect of climate change and the issue of the green transition. On the other hand, the exponential development of new technologies that have opened up new opportunities for the development of humanity and which, thanks to the enormous growth in the amount of data in all areas of this hyperconnected world, are pushing the limits of production possibilities and opening up a new innovation space for both individuals and organizations. The key generator of change has become the individual, the consumer, who demands that the resultant of these two processes be a step towards the circular economy and the dynamic implementation of ESG (environment, sustainability, governance) principles both at the state level and in the business of companies. The key success factors will be the integration of the entire value chain into this process, the quality integration of a large amount of data and thus the effective implementation of new technologies, additional education, and the strengthening of the position of consumers in their demands for sustainability to be an important segment of companies' investment and business plans, all of which essentially affects redefinition of business strategies, innovating business models, while agility in using new opportunities will significantly determine the competitive advantages and required resilience of companies in the world of VUCA (volatility, uncertainty, complexity, ambiguity).

Industry 4.0 (I4.0), which marked a new industrial revolution based on new technologies, has already evolved into the concept of Industry 5.0 (I5.0), which places future development on human-centric values that promote the fifth element – environment and society, with the aim of achieving sustainable development. It is precisely the intention of this paper to investigate how organizations can strengthen their competitive position, taking into account new value propositions catalyzed by Industry 5.0 technologies. Therefore, the leading research question of the paper is how emerging state-of-the-art technologies (SOA) can promote the development of companies in the appropriate national ecosystem in order to achieve a synergistic double effect, developing the competitiveness of organizations that are able to actively implement technologies on the one hand, and raise the competitiveness of nations that can then implement such developed products/services or business models in their economy.

Literature review

Two processes marked the 21st century. On the one hand, numerous challenges embodied in multiple crises (economic, health, environmental, geopolitical), and on the other hand, new opportunities created by the exponential growth of new technologies in a hyperconnected world, which have changed the way we live, how we communicate, how we innovate, how we create new value. The fusion of the technical, physical, and biological world has pushed the limits of production possibilities and there is a lot of literature dealing with the topics of Industry 4.0 and the impact of new technologies on many aspects of economic and social life. The pressures of all interested stakeholders (consumers - B2C, customers - B2B, employees, regulatory institutions, NGOs, banks, and investors) initiated a review of the linear take-make-waste model, which on a global scale does not return over 90% of materials to the production cycle. For businesses to understand that the circular economy, by transforming the value chain into a value circle, means not only sustainable business but also increases efficiency, innovation, and competitive advantage, new fields of research in the literature have been opened (BCG estimates that the transition to a circular economy has the potential to increase GDP for an additional $4.5 trillion by 2030, [31]). The application of the circular economy concept is important because it contributes to the realization of the triple bottom line 3P goals, Paris climate goals, European Green Deal, as well

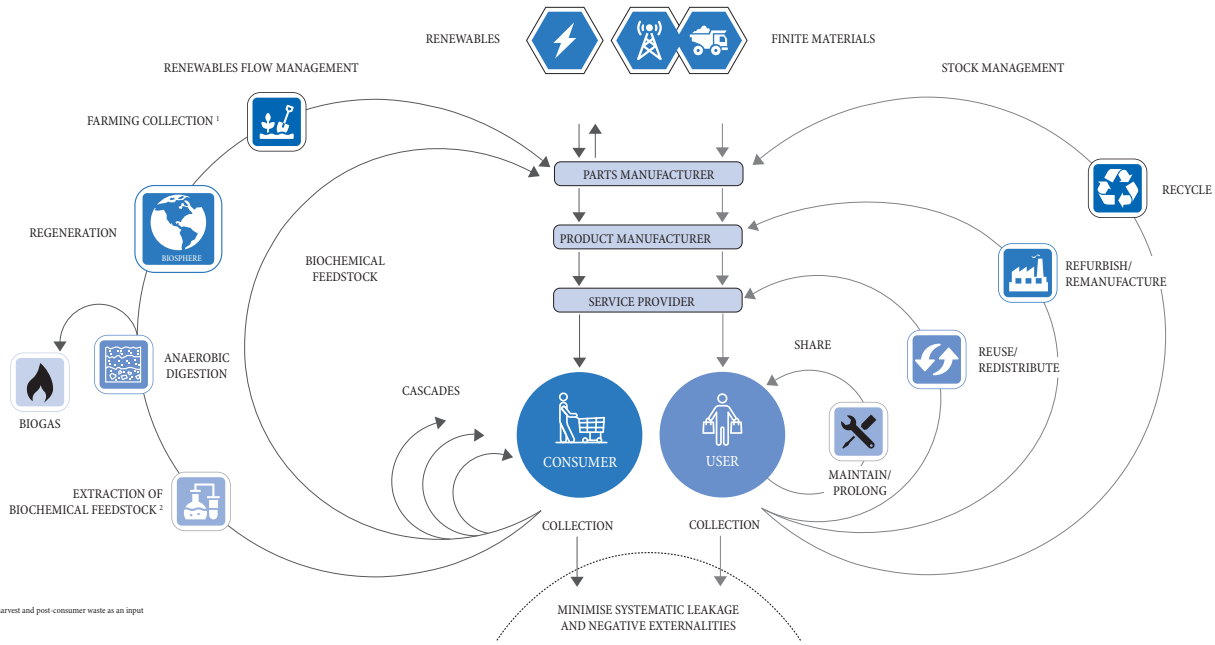
as energy and resource efficiency. A new step forward in literature was launching the concept of Industry 5.0 and shifting the focus from economic to social values, that is, from welfare to wellbeing [26]. For the purposes of this paper, we will review the literature that investigates the role of new technologies in promoting sustainable business in the context of the concept of circular economy and Industry 5.0.

The conceptual basis in our paper that served as a methodological tool in understanding the convergence of digital technologies and the circular economy is the circular economy model known as the butterfly concept (Figure 1, [13]). The biological cycle, by returning food and biological materials to the system, regenerates living systems, thus providing renewable resources for the economy. The technological cycle through the 4R concept (reuse, repair, remanufacture, recycle) returns products and components to the system instead of waste.

This diagram provides a basis for understanding business strategies, as it not only indicates the necessary adjustments to reduce the negative effects of the linear economy but also possible steps forward in innovating business models based on the principles of sustainability, resilience, and agility. For the successful implementation of this concept, cooperation in the entire value chain is needed. The main factor in the implementation of the circular economy is technological innovation, and the convergence of these two processes, aimed at increasing the efficiency of the use of resources, basically contains environmental sustainability, making digitization more useful [17]. There is an evident agreement among numerous authors on the importance of digitization in the application of the circular economy concept, using a large amount of data and their processing in order to monitor the entire flow of the product life cycle [23, 9, 49, 45]. The development of the circular economy, in the conditions of the rapid growth of new technologies, opens up space for numerous innovations, from new product designs, through the optimization of supply chains, to new circular business models (transition from classic ownership-based to result-oriented models), with possible benefits of lower costs, risk optimization, strengthening resilience in complex business circumstances, better financial performance, and increasing consumer satisfaction, as one of the most important stakeholders in this process [49, 37, 7].

In his paper, Trevisan systematizes the research into the impact of digital technologies on the circular economy in three directions [43]. The first refers to the role and importance of the influence of Industry 4.0 for the transition to a circular economy (we find a positive correlation in numerous other works, on the challenges of implementation [9, 27, 7, 28]. The second direction refers

Figure 1. Butterfly diagram



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

to the transition from linear to smart circular business models. The third one includes topics from the domain of sustainability, especially variations on the theme of waste management and industrial symbiosis. Antikainen sees the importance of digitization in obtaining reliable information about the location, availability, and conditions of products (smart connected products), as well as in the development of innovative circular business models aimed at creating value based on the concept of competitiveness and sustainability, increasing the efficiency of resource use, as well as closing the material loops [5, 40]. Exploring the potential of the Internet of Things (IoT), big data, and analytics in strengthening the circular economy, Bressanelli et al. identified eight possible processes: attracting target customers, monitoring and tracking products, improving product design, providing maintenance, providing technical support, optimizing the product usage, upgrading the product, enhancing renovation and end-of-life activities [8]. Liu et al. categorizing circular economy strategies, define a slightly different circular economy digital framework of seven mechanisms – empowering the reverse supply chain, fostering industrial symbiosis, supporting remanufacturing activities, enabling predictive and prescriptive maintenance, supporting reselling and sharing used products, improving energy and resource efficiency, supporting circular product design, manufacturing and use [28].

Using case studies, Ucar et al. identified two ways in which digital technologies (IoT, big data analytics, artificial intelligence – AI) correlate with the circular economy [45]. The first is when they act as an "enabler" of circular economy development and when they promote cooperation at all levels. The other is when they act as a "trigger" of innovative processes.

Numerous authors indicate the importance of integrated databases as the basis of monitoring, optimization, and innovation functions [27, 28]. Data availability is further enhanced by the data-sharing function, which initiates new forms of connection and cooperation. The importance of digital technologies is particularly indicated in the optimization of decision-making related to the principles of circular economy, based on data analysis, possible monitoring (IoT is of great importance), and the track and trace function that monitors the status of the product during its life cycle [27].

IoT is a key integrator in promoting circularity for other digital technologies. Ingersmadotter claims that circular strategies based on IoT solutions extend the useful life of products, and enable data-based decision-making that helps to fulfill the 4R principles, as well as the integration of smart products into the business ecosystem (the case study in this paper analyzes the opportunities that IoT provides in the energy sector as part of decentralization and increasing energy efficiency in the context of the circular economy, [23]). With IoT technologies, companies have better monitoring of the supply chain and greater opportunities for control and innovation in the reconfiguration of the supply chain in accordance with circularity goals. There is a wide range of industries today in which companies form their competitive advantages on the principles of the circular economy by regenerating nature, eliminating waste, and using materials in the circular chain.

By ensuring digital identity and security in transactions between different actors, blockchain technology enables the development of new resource trading systems and commodity flows in the supply chain, reducing transaction costs and thus increasing efficiency and transparency and facilitating the design of mechanisms to encourage consumer actions in the direction of the green transition [9].

Artificial intelligence has tremendous potential to support the transition to a circular economy throughout the value chain. By analyzing a large amount of data, determining patterns in supply chains and the entire value chain, automating decision-making based on established algorithms, and predicting demand, it is possible to increase the efficiency of resource consumption on the one hand, smart inventory management, predictive maintenance, as well as speeding up the development of new products, components, materials, based on the principles of the circular economy. AI can help improve optimal reverse logistic operations by improving the process of remanufacturing components, and the reuse of materials [9]. Also, AI is very useful in innovating and creating new circular business models (product-as-a-

service or leasing) that give agile companies the chance to respond to the pressures of all stakeholders and at the same time strengthen their competitive position on sustainable principles.

The literature is very extensive when it comes to the need for circular economy development, as well as the positive role of digital technologies/Industry 4.0 in that process. However, it is evident that there are also costs for the implementation of this development, as well as certain obstacles. The material footprint of digital equipment quadrupled between 1995 and 2015, generating a lot of waste in both the technological and biological parts of the circular diagram [13]. The world annually produces over 50 million tons of e-waste and estimates are that further technological progress will additionally escalate this problem [7]. Powerful data centers and digital infrastructure are large consumers of energy (energy-intensive technologies, e.g. blockchain, which imposes urgency on the topic of energy transition and increasing energy efficiency) and various materials. Ingersmadotter emphasizes the lack of a structured approach to data management, the increase in transaction costs, the lack of adequate knowledge, but also the necessary regulations [23]. Pellegrini points to the problems of asymmetric information, lack of cooperation between companies and the inertia of business routines, inadequate institutional frameworks [36].

Industry 5.0 has recently appeared in the literature as a concept that does not represent a chronological continuation of Industry 4.0, but a symbiosis of technological, social, and environmental aspects, with the goal of realizing business and social visions. The basic values of I5.0 are marked as economic resilience, environmental sustainability, and human-centricity within the framework of the sustainable development agenda [3]. The difference is that I5.0 includes in its concept the perspectives of all stakeholders and shifts the focus from technology-driven productivity and profit as the basic functions of the company's operations to solving socio-environmental challenges that have been observed for a long time - climate change and environmental destruction, global challenges, increase in regional and other forms of inequality. New technologies certainly play an important role in this concept, but combined with functional principles with the aim of strengthening corporate responsibility in the entire value chain [20].

One of the key challenges will be the speed of knowledge absorption and the creation of innovations that will enable companies to use I5.0 or other SOA technologies to create new value and strengthen their competitive position in the circular economy environment [47].

Small, open economies (SOEs), in order to strengthen their own robustness and resilience, have no other options but to choose directions of strategic guidance that go towards industries with more and high added value that can ideally be complemented and/or servitized with their existing service industry [35, 38]. In their work Geerken et al are evaluating the potential for a circular economy in SOE and conclude that there are development opportunities, specifically connected to public policy objectives in the following segments: reduction of dependency on materials, resource efficiency, creation of domestic jobs, competitiveness, reduced Greenhouse Gas (GHG) emissions [18].

Methodology

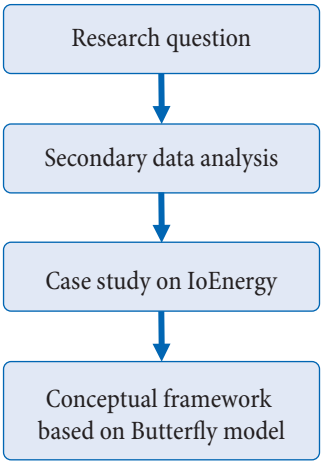
In the context of the elaborated theoretical background and research interest, the authors are hereby setting a leading research question. As also presented in the introductory part of this paper, the leading research question is how emerging state-of-the-art technologies, especially those that make up the concept of Industry 5.0, can catalyze firms' competitiveness of the companies in the appropriate national SOE ecosystem in order to achieve a synergistic double effect. First of all, developing their own competitive advantage by being able to agilely implement SOA technologies on the one hand, and raising the competitiveness of SOE nations that can implement such developed innovative products/services or business models in their economy.

In order to answer the leading research question on the one hand, and on the other hand offer answers on how to strengthen the competitiveness of companies that compete in SOEs and thereby strengthen national competitiveness, it was necessary to develop an adequate methodology that would correspond to the goals of this paper.

For the purpose of answering the leading research question, a cascading methodology was designed and

constructed, which combines two predominantly qualitative scientific research methods, as shown in Figure 2. The methodological approach consists of a combination of quantitative and qualitative research as follows. As a first step, an analysis of available secondary data sources was performed with a specific emphasis on the management perspective related to the introduction of SOA in firms in order to increase their competitiveness in the contexts of the circular economy, i.e. green transition and global trends.

Figure 2. Cascading combinatory methodology



The second methodological step represents the validation of previous research results through the presentation of a specific case presentation on the Internet of Energy (IoE) topic, which includes a typology of companies that currently disrupt the energy sector with their innovative business models.

When it comes to the conceptual model, the authors of this paper have chosen the previously presented framework of the circular economy represented by the Butterfly diagram (Figure 1) as the leading model. The results of this research will be validated and interpreted along with identified possibilities and recommendations and sketched on the diagram.

Interpretation

Secondary data analysis

Our secondary data research includes relevant sources issued as the most recent reports by relevant opinion makers in the field. KPMG Annual survey of 1,325 CEOs from 11 different markets has provided an in-depth look at three years giving insight into their views on the business and economic environment [25]. Despite the immense challenges posed by the pandemic, inflation, and geopolitical tensions, CEOs surveyed in the 2022 CEO Outlook remain confident in their companies' resilience and optimistic about their own growth prospects. Furthermore, according to McKinsey, technology "holds the key to unlocking decarbonization" since it can be used to help businesses reach their net-zero emissions goals [30]. Technology can be used to identify problem emission areas, prioritize investments, and use analytics to make green decisions.

UNIDO is recognizing that digitalization can be beneficial in achieving a green transition, for example, by allowing firms to become more resource efficient, also underlying that green and digital production is likely to turn into a competitive advantage in the future [46]. Global value chains will depend on green suppliers and be able to trace and verify their production methods, which usually require the use of digital technologies. Therefore, to be a part of the global economy, suppliers must meet green and digital standards. In its recent survey, Deloitte discovered that 98% of customers believe that brands have the responsibility to make the world better [11]. As the ESG agenda continues to shape the business landscape, CIOs have the chance and obligation to lead the transformation to achieve net-zero climate sustainability. To do this, they must ensure that technology tied to environmental sustainability is utilized efficiently, while also reducing the environmental effects of existing and new infrastructure and technology. There are three main areas where CIOs can become important leaders in sustainability: creating a unified data and insights program to monitor and promote environmental sustainability, using a sustainability-based tech strategy, and increasing transparency and accountability in the value chain. However, technology can be a blessing and a curse when it comes to environmental issues. Technology such as IoT sensors, AI, and blockchain can be used to aggregate real-time data and optimize processes to reduce environmental impact. On the other hand, some of these technologies have been known to increase the demand on the power grid, and CIOs must weigh the benefits against the costs of these technologies.

While the post-pandemic fatigue and economic issues, such as the increase in interest rates and inflation, are the most pressing worries for CEOs today, in the following three years they have identified emerging and disruptive technology as the number one risk and the greatest danger to growth with environmental and climate change issues included in top five risks. When looked at in combination with other identified matters of concern, such as regulatory pressures, supply chain issues, operational difficulties, and potential reputational damage, it appears that risks are more intertwined than ever. As the possibility of a recession looms, many are already prepared with a focus on planning and agility, and some are even seeing potential opportunities in the midst of uncertainty, such as those presented by technology and environmental/social/governance principle (ESG).

Our research has unveiled that ESG, similar to digital, has the potential to revolutionize how successful organizations strategize, execute, and function. However, ESG is a broad subject, making it difficult for organizations to know where to start. When it comes to digital, this hesitancy at the start has caused many organizations to take a gradual approach, testing out various projects and learning as they go, but also running the risk of being outpaced by more daring competitors who were quicker to recognize the chance to reinvent their business digitally. Now, most management teams understand that to truly take advantage of digital, they need to take an all-in approach, with digital impacting every aspect of the company. Digital is not just about doing the same things faster; it is about changing what you do.

According to S&P Global, another aspect proving how closely ESG and technology are interconnected and how there is a positive influence of both on one another is the impact of ESG on IT and technology [42]. We are in an early stage of assessment and trying to understand the implications of ESG and what it means for how technology is used. According to the report, ESG is expected also to become a growing part of the information technology industry narrative over the coming months and years since, like in other industries, the impacts and implications of ESG on technology are both wide-ranging and material. Most interesting given current hot topics are biased in AI, consumer data privacy, and dependence on smart technology which gives rise to growing environmental, social, and governance risks across almost all aspects of human existence. So, ultimately, it seems not only technology can be a catalyst for the green transition, but also ESG will bring environmental awareness and ethical perspective to IT and digital.

Case study on IoE (Internet of Energy)

In order to support the leading research question, the following case study was conceived and produced, referring to a conceptual example of the use of technologies in the environment of the circular economy, specifically the energy transition according to the Internet of Energy model.

The existing model of centralized production and linear electricity supply chain is unsustainable for a long period of time for several reasons. First, the existing capacities cannot meet the growing needs. The expected growth in electricity consumption at the global level, 30% by 2040 compared to the consumption in 2017, requires a significant increase in production, which cannot be achieved only by using traditional energy sources (fossil fuels, nuclear power plants), but it is necessary to increase the share of electricity produced from renewable sources [43]. Also, in March 2020, the European Commission adopted the European Green Deal, a set of measures and recommendations, which include the energy sector, and foresee a reduction in the net emissions of gases that cause the greenhouse effect, primarily carbon dioxide and methane, by 55% by 2030 (decarbonization). In addition to a significant increase in the share of electrical energy obtained from renewable sources, these measures encourage the development of regenerative circular economic models in order to achieve sustainable growth in electricity consumption, while reducing negative environmental effects.

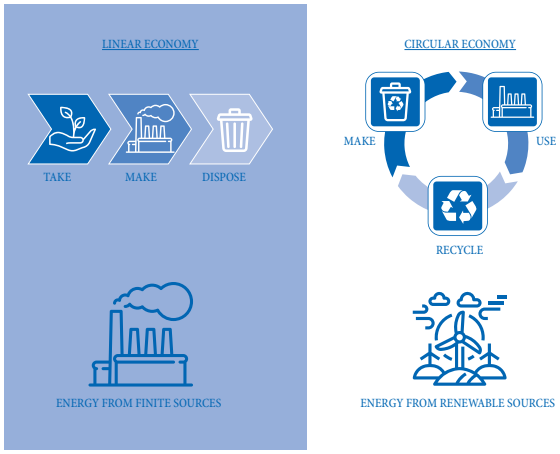
Secondly, the production of electricity from renewable sources, primarily wind energy, and solar radiation, water power, is characterized by instability and unpredictability of production, which depends on weather conditions. This requires additional costs of maintaining the central energy transmission network, i.e. its balancing, and supply and demand balancing. HROTE, the Croatian electricity

market operator, had balancing costs of EUR 25 million in 2022 [14].

In the existing energy infrastructure, by integrating advanced digital technologies of Industry 5.0, it is possible to include a large number of energy producers from renewable sources - DRS (distributed renewable energy system), which are connected by the smart grid. In addition to using the produced electricity for its own needs, DRS takes over (buys) the missing amounts, and hands over (sells) any surpluses back to the central energy system, thus achieving a two-way, circular flow of energy. This decentralization of production from renewable sources allows energy to be used at the place where it is generated, thereby increasing the efficiency of the transmission network. This is in accordance with the circular economic model, which, in addition to decentralized and sustainable production, foresees the use of resources from renewable sources, with minimal energy losses, pollution, and waste.

This new concept of distributed production and two-way energy flows, in which DRS, i.e. households and virtual groups of clients connected in an independent microgrid, create, exchange, and sell energy (*prosumers*), will lead to increasing digitization of the energy sector, as well as its decarbonization. This is how Deloitte US talks about 3D's, the three basic drivers of the development of smart energy systems – IoE [12]. Finally, the existing centralized energy infrastructure, designed for one-way transmission of electricity (producer → consumer), by including a large number of DRS, becomes inefficient.

Figure 3. Implementation of IoE in the context of the Circular Economy [47]



By applying IoT technology, Internet-connected devices, equipped with appropriate sensors and software, distributed energy systems can increase efficiency, and reduce consumption, as well as energy transmission losses. These devices, connected to smart meters, monitor in real time the production and consumption of each DRS connected to the central transmission network. By applying predictive machine learning algorithms to internal data (generated by sensors), as well as external data generated outside the energy network (e.g. weather data), consumption patterns can be identified. Thus, it is possible to predict the required amounts of electricity, as well as the amounts that can be produced. Based on these data, it is possible to balance the central transmission network more efficiently, even in the case of a two-way flow of electricity, which is the basic feature of the IoE platform.

By applying IoT, it is possible to automatically manage large consumers of electrical energy (heating, cooling, lighting, etc.), in such a way that, based on movement, occupancy of space, sound volume, and previous data (habits of space users), their operation can be optimized, i.e. adapted to real needs. In cases where DRS needs additional energy from the central energy network, it is possible to limit the takeover to periods when the demand, and thus the price of electricity is lower (*off pick time*). This reduces large fluctuations in the network, which is often the cause of outages and supply interruptions. The UK National Grid estimates that 30-50% of fluctuations in the network can be avoided by intelligently connecting consumers to the network, especially in *off-peak* times.

IoT devices and smart meters are the basic elements of a smart transmission network. Energy, which is gradually transforming into a decentralized system, is currently the largest user of IoT with 1.37 billion devices in 2020, while the number of smart meters at the end of 2021 in Europe reached 163 million, which is 53% of all installed meters [6, 39].

By applying blockchain technology as a component of I5.0 and *smart contracting*, IoE provides a high level of security and transparency, through the decentralized verification of every P2P (*peer-to-peer*) sales transaction (between producers, buyers, and *prosumers*), which is recorded in distributed registers, which guarantees high

availability of all data (transactions). The generation of transaction contracts, according to predefined conditions (which are part of the code of the *smart contract* application) is automatic.

In order to use SOA technologies as an accelerator of the energy transition, the importance of energy smart routers, as one of the key technologies applied in the IoE platform, is emphasized. Their basic role is to direct, control and coordinate the energy flow in the direction of the least load on the network. The intelligent *smart grid* can automatically recognize each new so-called *plug-in* device (consumer and/or producer of electricity).

The development of IoE has led to the disruption of the traditional, centralized energy business model. New digital technologies have made possible the integration of a large number of distributed producers and users of energy from renewable sources (DRS). Thus, traditionally vertically integrated large producers and distributors, who enjoyed the position of a natural monopoly, began to face competition, which was almost unimaginable until recently due to the necessity for large capital investments required to enter this industry. In addition to the decrease in sales, as a consequence of lower demand, due to the fact that DRS through the central transmission network, takes only the missing electricity, there was also an increase in the cost of maintaining the transmission network. The slow transformation (digitalization) of traditional companies, which would lead to increased efficiency and competitiveness, through the offer of new services (such as financing, planning, development, management of energy plants of the economy and housing), opened space for the entry of new agile companies into the energy sector.

Aggregators represent companies that connect and unify the supply of distributed electricity producers. In case of additional energy needs, such requests are consolidated and brought to the market. By aggregating common energy needs or offering surpluses, better prices are achieved, and aggregators create new value for their clients (DRS), while reducing costs and balancing complexity for network operators [24]. Table 1 shows the new business models that disrupt the energy sector.

Energy as a service (*EaaS*) represents a new business model in which clients, without the need for capital investment in energy capacities, rent them with the aim of reducing consumption or generating additional amounts of electricity. In the energy sector, this business model most often occurs in the form of energy service agreements - ESA, according to which the customer pays the service company for the service, as well as the cost for the consumed electricity or gas, which in total should be less than the amount the client previously paid. The model of managed energy service agreement (MESA) is also very widespread, according to which the service company takes over the management of the existing energy capacities, for which it is paid from the savings realized by the client (industrial, commercial facilities, business parks, etc.) achieved as a result of lower consumption (pay for performance).

Serbia has many opportunities to improve energy efficiency and independence right away. These initiatives involve both public and private sectors, and include waste

Table 1. Disruption models and disruptive companies

Business model	Company disruptor	Country	Description
Agregators	*Eneco CrowdNett*	Holland	a company founded in 2016, is a Dutch aggregator of batteries, used by households to store excess electricity. Households are offered the purchase of batteries at a significant discount, with an additional amount that the company pays monthly, in exchange for 30% of their capacity, which should be available throughout the day. *Eneco* offers these combined capacities to distribution network operators for balancing purposes.
Agregators	*Next Kraftwerke*	Germany	the largest virtual power plant (capacity 11,182 MW, Q3 2022), which brings together the electricity supply and needs of a large number of DRS of different sizes across Europe. Using digital technologies, they offer clients electricity trading services, power scheduling), as well as balancing.
EaaS	*Metrus*	USA	one of the largest USA companies, which, based on the ESA model, offers financing and project implementation services, as well as analytics and reporting on consumption.
EaaS	*Petrol*	Slovenia (SOA)	offers energy solutions based on the principle of ESA and MESA models for industry, legal entities and individuals.

management, waste-to-energy solutions, taking advantage of waste heat from sources such as data centers, utilizing biomass, and utilizing solar energy. These solutions are currently available. Additionally, modern technological and smart solutions can be applied to the outdated distribution network. Data and analytics can also be used to optimize energy consumption in factories. The responsibility lies partly with the state to provide incentives to the economy since not all EU funds that could be used for such purposes are currently available.

Discussion

The previously produced results of this research offer principled answers to the research question of this paper from two basic perspectives. The first is that companies are increasingly aware of the changes that are coming, that the challenges, as well as the opportunities offered by SOA and I5.0 technologies, are placed high on the list of priorities that they need to address. In particular, this refers to the growing awareness of company management when it comes to strengthening competitive advantage through innovating the organizational offer in the conditions of circular economy development. Secondly, the presented case study confirms the thesis that by applying SOA and I5.0 technologies, in this presentation in the field of energetics through the IoE model, new business models, products, and services, ideally of a niche type can be found and innovated and also validated in the environment/ecosystems provided by SOEs.

Our research demonstrates that SOA/I5.0 technologies can help green transition and meet corporate (ESG) goals in emerging markets or SOAs by providing sustainable and energy-efficient solutions. Such solutions include renewable energy sources, energy storage technologies, energy efficiency solutions, smart grids, green buildings, and transportation solutions. In particular, digital technologies can be used to monitor and measure the performance of these solutions to ensure they are meeting their ESG goals. For example, AI and machine learning can be used to analyze large amounts of data in order to identify trends and potential areas of improvement such as GHG emissions and aimed reductions. Finally, blockchain technology can be used to increase transparency and traceability for sustainability initiatives in order to ensure that ESG goals are met.

The growing importance of developing economies to the global economy cannot be overstated. In 2020, emerging markets contributed more than 50% of total global economic growth, and are home to more than 70% of the world's population. The well-being of people around the globe is inseparable from the economic and social progress of these countries, and ESG (environmental, social, governance) factors are increasingly influential in this development.

From a local point of view, companies operating in Serbia and other non-EU countries should not be complacent and should be proactively involved in the green transition, even though they may not currently be subject to the same pressures as those in the EU. In addition, Serbia's current energy profile, which is heavily reliant on coal for more than two-thirds of its electricity and has an energy intensity that is close to 50% higher than the European average, further emphasizes the need for an immediate increase in the proportion of renewable energy and an improvement in energy efficiency.

Funds to finance expensive green transition also seem to be more available than ever with investors rapidly incorporating ESG into their portfolios in emerging markets, recognizing the potential for greater positive impact and the shift towards ESG-based investing. The debate around the ethics of investing in emerging markets often centered around cost-related issues, is being addressed by an ESG-driven approach. This approach ensures that companies investing in these markets act responsibly and invest in the communities they serve.

The success of investing through ESG in emerging markets is in the numbers. Over the last decade, the MSCI Emerging Markets ESG Leaders Index, which tracks companies with high performance in ESG metrics relative to their peers, outshone the broader MSCI Emerging Markets Index according to the data from indexing firm [32].

By applying digital technologies, industry 5.0, which has become Europe's new development paradigm for sustainable, resistant, and ecological industrial development, and above all IoT, *Big Data, Blockchain,*

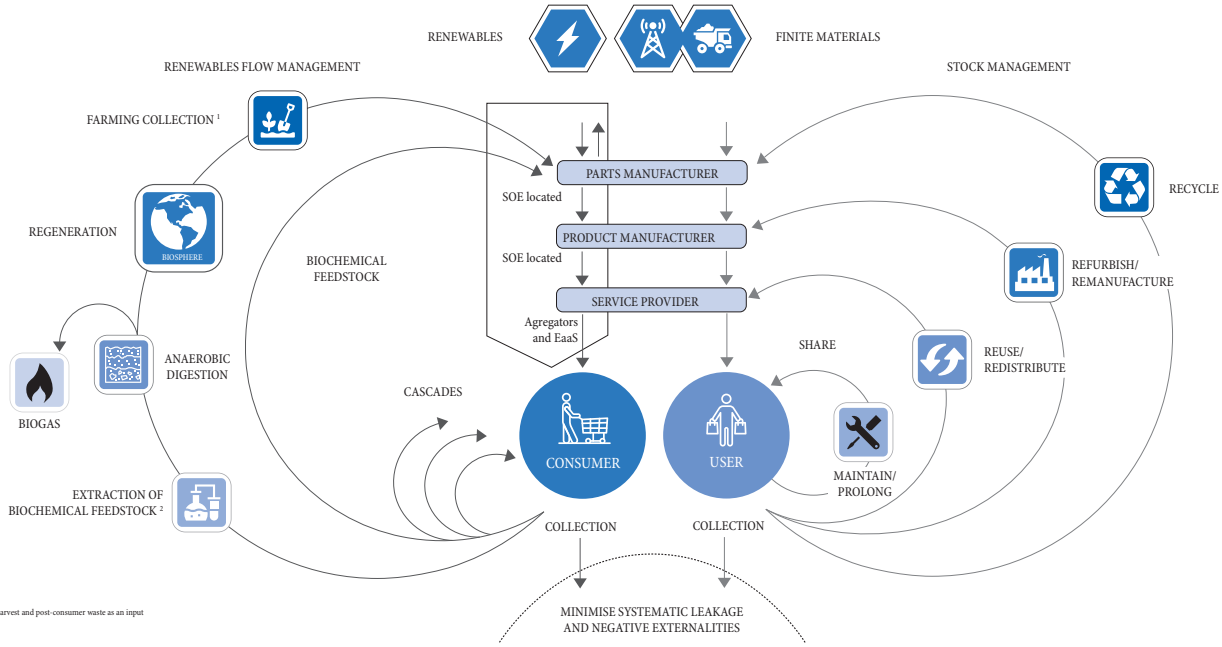
and artificial intelligence, the traditional energy system is transformed into a new energy platform IoE. The application of digital solutions per se is not enough, but it should lead to fundamental changes in work methods, organization, and company culture.

When it comes to the energy sector and the relevant companies, due to their monopolistic position, complexity, and size, they are slow to react to challenges from the environment, inertness representing the biggest threat to traditional companies. As a successful transformation of the energy sector can achieve immeasurable positive effects, it is necessary for managers not only to be sponsors of transformation projects but also their owners, because transformation changes their habits and work practice. In an industry that is in the phase of disruption, with the appearance of distributed energy producers and digital energy service companies, the path to the successful transformation of the company does not lead through sporadic big-bang projects but contains a series of agile transformation projects, by which digital solutions, ideally co-created with the employees, are quickly realized and implement.

The application of the principles of the circular economy in energetics represents the foundation for the development of the Internet of Energy (IoE) or intelligent transmission smart grid. Unlike traditional energy systems, based on a linear one-way flow of energy from centralized, geographically concentrated producers to consumers, IoE is based on circular distributed production.

This new IoE business model enables both small and large economies to develop their own ecosystem and economic entities in which they operate. A new value chain is created or an existing one is modified, in which part manufacturers, product manufacturers and service providers are involved, as shown in Figure 5. The proliferation, then the use of SOA and I5.0 technologies, enable, especially companies in small and open economies, to develop niche innovative products. This is especially true for innovative business models, which for the purposes of this paper is shown through the energy sector. High-tech products, services or business models developed in this way enable production to take place at the point of consumption (parts manufacturers and product manufacturers), but in the case of SOE companies, at the same time, they should be export-oriented, i.e. internationalized. When it comes to evaluating new business models, they represent the company's offer with the highest added value in de facto all industries. In the case of the IoE case study described here, new business models have been presented those turn companies into aggregators or EaaS providers (Figure 4.)

Figure 4. Presentation and interpretation of research results on the Butterfly diagram, the case of the energy IoE sector in the SOE environment, authors' presentation



States and appropriate regulatory bodies should define new energy policies with the goal of decarbonization, affordable, safe, and quality supply, which will also encourage the application of new technologies in the sector.

Conclusions and recommendations

SOA and I5.0 technologies *per se* are not fundamentally changing the world but they possess enormous transformational potential, foremost helping companies to maximize their internal potential, and create and develop innovative products/services, particularly in the area of developing new innovative disruptive business models. At the same time, the proliferation of SOA technologies, especially Industry 5.0, offers today more than ever business opportunities for SOEs in order to strengthen all components and improve processes within the framework of the circular economy. The results of this research are advocating that business leaders have had to learn to adjust to the ever-changing environment, making changes to their workforces, supply chains, and more. In small and open economies, Industry 5.0 can unquestionably serve as a competitiveness booster for firms by enabling them to increase their productivity and efficiency while reducing transaction costs, while competing in specific market niches. This will differentiate them and enable their agile internationalization to be able to compete better with larger, more established firms in the global marketplace. One way Industry 5.0 can improve competitiveness in small and open economies is through the use of advanced technologies such as AI, IoT, and robotics implementing these technologies in specific market niches and sectors.

These technologies can automate repetitive tasks, increase the speed and accuracy of data analysis, and allow for greater customization of products and services. This can lead to increased productivity, improved quality control, and faster time-to-market for products and services. Industry 5.0 can also help small and open economy firms better compete by improving their ability to respond to changing market conditions and customer demands. For example, Industry 5.0 technologies can provide real-time data on customer preferences, allowing companies to quickly adapt their products and services.

Another way Industry 5.0 can help small and open economy firms is through the use of digital platforms to connect with global customers and suppliers, regardless of geographical location. This can provide access to new markets, customers, and suppliers that would be difficult to reach through traditional means.

Overall, Industry 5.0 can help SOA firms to increase their competitiveness by providing them with the tools to improve efficiency, reduce costs, increase productivity, and respond quickly to changing market conditions and customer demands

When the national ecosystems are in question, in order to transit towards a circular economy the SOA government policies should play a key role in order to flexibly and agile adjust their policies and make resources available, especially in public infrastructure and governmentally managed segments, ideally through public procurement of innovation. Governments in SOEs should strongly encourage their companies to innovate and excel in niche segments, where they can relatively more easily strengthen their competitive advantage, which should be confirmed from the very beginning of developed offerings on global markets as well.

However, as much as SOA technologies might be available at an affordable price, SOE economies are on the other side confronted with a chronic lack of investment capital, chronic problems with skilled labor, as well as growing operating costs, especially in the energy segment. All these hampering issues should not be neglected when taking in consideration the use of SOA and their proliferation in SOE.

Due to the relatively wide scope, this paper covers, i.e. circular economy and a green transition, the limitations of the research are primarily linked to the single nevertheless robust case study presented on the IoE topic. Other areas and sectors most certainly eligible for the proliferation of SOA in SOE are smart agriculture, smart transport, and cities, quality of life and health, protection of critical infrastructures, and cyber security, all the way to a smart public sector. Further research should be focused in this direction, and it could be complemented with quantitative methods.

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