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THE CONCEPT, PRINCIPLES AND INNOVATIONS IN CIRCULAR ECONOMY

Abstract

Circular economy (CE) is a relatively new model of production that focuses at achieving savings in energy consumption, raw materials, and other resources in order to optimize the social, environmental, technical and economic effects of used materials and circular products in a given society. As a relatively new framework for waste and resource management, the CE concept takes the place of the traditional linear model of production (the take-make-discard model), emphasizing systemic, planned and rational thinking and action. Today, examples of circular solutions in the contemporary world are numerous and present in many industries such as manufacturing, computing, construction, furniture industry, food industry, design and others. The article discusses in detail the difference between a linear and a circular model of economy, as well as the underlying principles on which this innovative concept is based. The paper also provides an overview of various innovations in the circular economy, pointing out their features and benefits. The article specifically examines product innovations, process innovations, eco-innovations, as well as incremental and radical innovations in this area. Finally, the article analyses the latest trends in the circular economy, with special emphasis on the business sector, the food industry, as well as on textile, pharmaceutical, automotive, construction industry and service sector.

Key words: circular economy, linear production, innovation, reuse, recycling, refurbishment, waste minimization.

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1. Introduction

Circular economy (CE) is relatively new and very popular business concept, especially in the European Union (EU) and in the Nordic countries, that focuses at future sustainable development. More precisely, today, the EU countries, in cooperation with several governments of developed and developing countries (such as China, Japan, United Kingdom, France, Canada, the Netherlands, Germany and the Scandinavian states) mostly encourage and implement it in the practice. In addition, many contemporary countries around the world have adopted the principles of CE, with the aim of reducing energy consumption, as well as saving basic raw materials and non-renewable natural resources. The circular economy is considered a sustainable economic system, in which the decoupling of growth from the use of resources takes place through recirculation, reduction of resources` use [2, pp. 1-15] and prevention of waste generation, with the aim to preserve, advance and regenerate the environment. Moreover, this idea contributes to sustainable growth by optimizing the social, economic, environmental, health and economic values of materials and circular products in a given society [20, pp. 1437-1457]. Although CE still represents a set of rather hazy and insufficiently clear ideas from several technological fields, we can define this term as an economic system of closed loops, i.e. structures, series or processes in which raw materials, production components and products lose their value to the least extent possible and which emphasizes the use of renewable energy sources [4]. The literature especially highlights that this business philosophy still not bases on clear scientific postulates [19, p. 2], while the accent is on systematic, planned and rational thinking and acting. In essence, this notion still relies on an insufficiently coherent set of ideas originating from different scientific areas, as well as incomplete and vague scientific models. CE combines many approaches and concepts, such as industrial ecosystems, ecological innovations, industrial symbioses, ecological efficiency, cleaner and greener production, the concept of products in the role of services, cradle-to-cradle concept, biomimicry, as well as resilience and sustainability of socio-ecological systems. These pathways also include performance economics, closed loops economy, natural resources` capitalism, the concept of zero greenhouse gas (GHG) emissions, etc.

Today, two basic conceptual aspects can be found in contemporary literature on CE issues [8, p. 88]: a) definitions that bases on the most important academic knowledge, theories and conceptual frameworks, and b) definitions that mostly bases on a practical business approach. The business and political circles, as well as wider academic and social communities

support the latter. In this sense, Kersty Hobson defines this term as an industrial system whose design and purpose can be renewed or regenerated. This author emphasizes that the CE aims to eliminate waste by using superbly designed materials, products, systems, and business models [8, p. 88]. Based on the analogy with biological ecosystems, CE is designed as an industrial ecosystem that is characterised by highly optimised consumption of energy and raw materials, as well as the use of possible by-products in the form of raw materials for subsequent production cycles. Finally, a key component of an ideal industrial ecosystem is to increase resource efficiency through the free flow of materials. In that regard, Haupt et al. define this term as a production and consumption system that takes place with minimal loses of materials and energy, through their extensive reuse, recycling and refurbishment [6, p. 615]. On the other hand, one of the most practical definitions of the circular economy could be the one that defines it as a new framework for waste and resources management that aims to offer an alternative approach to the prevailing linear production practice that bases on traditional take-make-dispose model. Strategies such as reuse, recycling and the recovery of products and raw materials contribute to the operationalization of this concept [1, p. 603]. In this sense, the CE concept grows into a general term that encompasses all activities aimed at reducing, reusing, refurbishing and recycling materials and products in the processes of their production, distribution and consumption.

2. Philosophy and Basic Principles of Circular Economy

As already mentioned, the CE concept can be perceived as a kind of alternative to the classical linear production model that bases on the principles of extraction, reuse and disposal of waste. Unlike the traditional economic model, in the CE framework resources are kept in use as long as possible, the maximal possible value is extracted from them during their use, so that the efforts of circular companies are further focused on renewal and regeneration of products and materials at the end of lifetime of given product or service [17].

On the other hand, unlike the contemporary model of CE, the classical model of linear economy is burdened by its prevailing limitations. Namely, during the accelerated industrial development a linear model of production and consumption dominated. In this model, goods were primarily produced from available raw materials, while they were sold, used and after that disposed in landfills or incinerated as waste. However, along with technological advances, the new industrial revolution has led to an increase in the economic productivity, bringing unprecedented prosperity to global society. In order to further develop and grow, such economic systems

provided incentives to increase sales and stimulated economies of scale, which further led to increasing consumption of goods and services, as well as the emergence of consumer society. As shown in Figure 1, the linear model identifies itself with take-make-discard pattern, based on two strong assumptions [22, p. 18]: a) limitlessness and ease of availability of resources (primarily energy and raw materials), and b) unlimited regenerative potential of the Earth. In accordance with that, along with the growth of the economy, the need for increasing volume of raw materials and products occurred, which naturally led to the creation of larger amounts of waste.

Figure 1 Model of linear economy – take, make and discard approach

Source: [22, p. 18]

The circular economy model is extremely important because it creates new opportunities for economic growth by reducing industrial waste, increasing resource productivity and the competitiveness of the observed economy and enterprises, enabling better solutions to the problem of resource scarcity, as well as by reducing harmful production and consumption impacts on the environment [17]. In this regard, the production process in the CE framework can be presented in the following way (Figure 2).

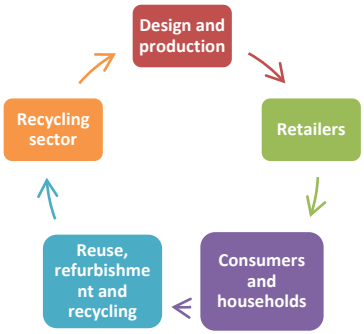

Figure 2 Production process in circular economy
Source: [17]

The CE approach basis on several important principles [15, pp. 7-8 and 24]:

- Optimization of resource yields – this production model consists of biological and technological cycles. While technological cycles focus on managing the stocks of final materials, biological cycles manage renewable materials. Resource yield optimization requires effective circulation of products and materials, both in technological and biological cycles. In the circular economy, there is actually a frequent flow of materials in tight loops, before they will pass into external loops, which is way the reuse of certain products has a higher value than their recycling. In addition, the more times a certain material continues to circulate within each cycle, the greater is its usefulness, as well as its value in the production process,
- Treatment of energy and resources as priceless inputs – since the CE model bases on the design and minimization of waste, circular products rely on the use of quality materials. In this way, they become optimized for the disassembly cycle and for reuse, with the aim of facilitating their handling, recovery and transformation. This feature distinguishes the CE concept from waste disposal and classical recycling paradigm,
- Fostering an effective system and design with the absence of negative externalities – this idea involves minimizing the damage done to existing systems, as well as to the impact of negative externalities. Negative externalities usually occur in the form of land use, soil pollution, deforestation, water and air pollution, emissions of toxic substances and GHG gasses, climate change, etc. Since they cause market failures, their management may involve designing systems that will minimize the occurrence of these unwanted externalities or controlling them by applying certain fiscal instruments, such as prudent taxation, tax exemptions and other fiscal incentives,
- Following natural cycles – since consumption takes place only in biological cycles, in which bio based materials are designed to return in the ecosystem, the CE model is considered to regenerate living systems, such as soil, oceans, seas or rivers, providing renewable sources. On the other hand, in technical cycles the reuse, renewal, repair, reproduction, refurbishment and recycling of these resources take place,
- Conservation and strengthening of natural capital – in a CE framework, resources are carefully selected according to the needs and provided through renewable and resource efficient processes and technologies. The CE concept provides growth in the natural capital value, by creating good conditions for the regenerative flows` realization, and
- Insisting on the use of renewable energy sources – the CE model relies entirely on renewable energy sources in order to reduce resource

dependence and increase the resilience of the economic system. In this regard, this principle refers to the development of efficient systems by minimizing and phasing out negative externalities.

3. Innovations in Circular Economy

The fourth edition of the innovation data collection and interpretation manual, also known as the Oslo Manual defines innovation quite widely as a new or significantly improved product or process (or a combination thereof) that differs significantly from previous products or processes of the observed institutional unit [12, p. 20]. The European Commission (EC) defines innovation as the use of new ideas, methods or products that has not been applied before. More precisely, the EC defines it as a new or significantly improved good or service that has been introduced to the market, or as the introduction of new or notably improved process in certain company [21, p. 161]. In the context of this analysis, we should make a clear distinction between process and product innovation. While in the case of goods the difference between products and processes is entirely clear, when it comes to services this difference is less pronounced as the process of their production, distribution and consumption coincide in time. The 2005 Oslo Manual defines process innovation as the application and/or introduction of new or significantly improved methods, equipment or skills used to deliver a service. On the other hand, this source defines product innovation as all those activities that involve new or significantly improved product or service features offered to customers [11, p. 53].

Innovations in circular economy are innovative ventures that lead to significantly positive environmental impacts in any of the following areas: energy and material savings, replacement of fossil energy sources with renewables, replacement and disposal of hazardous substances, waste recycling, wastewater treatment, production processes based on less energy consumption, improving the recyclability of products and increasing their lifespan [9, p. 9]. The most important factors that contribute to the introduction of innovations in CE approach primarily include rising costs of energy, water and materials; existing environmental regulations; improving the business reputation of companies; voluntary activities or standards of good practice in environmental protection; environmental regulations, as well as existing and expecting environmental taxes, costs or fees. Other factors encompass current or expected demand for environmental innovations; government or public donations; subsidies for the introduction of environmental innovations, etc. Eco-innovation, as a special form of CE innovation, includes the creation or the improvement of green products and

environmentally efficient production processes that lead to improved environmental performance. Research indicates that the contemporary market recognizes and values the importance of production-driven environmental innovations, as well as the role and value of good environmental performance and practice [16, p. iii].

Furthermore, in the context of this discussion, it is also necessary to make a clear distinction between circular-economic process innovations (example of energy or material savings in the production process) and circular-economic product innovations (example of greater recyclability of products or their longer lifetime), both of which will likely to have different impacts on business performance and employment. Process-oriented CE innovations could have negative effects on employment because the realization of such innovations could result in higher labour productivity. On the other hand, their application can cause direct favourable impacts on the employment if they require additional investments, greater specialization or better qualifications of employees. When it comes to the impacts of CE production innovations on employment, they have also remained insufficiently clear from a theoretical point of view. These completely novel innovative actions can stimulate new demand for the CE products of the observed company, whereby net employment can grow only if the newly introduced product does not replace the old labour-intensive product. On the other hand, an increase in product lifespan may reduce employment due to lower demand for observed product, although this loss could be offset by higher consumer demand for such products [9, p. 5]. Today, there are already many innovative products, processes and contracts designed in accordance with the CE concept, which are available in their various forms – from innovative design of materials and products in everyday use (example of biodegradable food packaging and easily disassembled printers), all the way to payment agreements for the purpose of use (for instance, payment for the use of tires) [5, p. 17].

The transition from a linear to circular economy is usually accompanied by the introduction and development of technological, production design, process, business and organizational innovations, as well as the implementation of socio-institutional changes. Perhaps innovations in the circular economy can best be perceived as incremental and radical innovations. Unlike incremental CE innovations that imply gradual changes and small, slight improvements, radical CE innovations imply the emergence of specific and radically new technologies that play a key role in shaping this process. Radical CE innovations usually include the

implementation of the necessary socio-institutional changes to enable new technology to take its deserved place in a given society [13, pp. 5-6].

4. Current Trends in the Circular Economy

The CE concept itself is an innovative form of production, trade, distribution, use and reuse of products and their components, as well as of collecting and recycling products and the waste, all in the form of final loop in its cycle. In addition to actively encouraging industrial innovation and innovative business solutions, this is a business model that leads to new employment, additional economic value creation, economic growth and its long-term resilience to shocks, as well as direct benefits for the environment and society [5, p. 7]. Ellen Mc Arthur Foundation, as one of the proponents of this idea, states other values of CE model application, such as changes in logistic networks, introduction of more advanced and better innovations, higher rates of technological development, improving the quality of materials and labour, energy efficiency, as well as greater opportunities for making profits for resource-profitable companies [5, p. 22]. Today, examples of circular solutions in the contemporary world, and especially in the Nordic countries, are numerous and present in many industries, ranging from the production of suitcases, cameras, eyewear parts, toys, mobile phones, computers, clothing, footwear and furniture, through small household appliances, and cars, all the way to mattress production. These examples also include construction and office furniture industry, bicycles, scooters, wood products, plastic bags, batteries, light bulbs, glass packaging, etc.

Circular economy indicates the way in which circular business models function in practice. In contemporary world, there are many examples of circular companies in various industrial branches, from start-up companies and micro, small and medium enterprises (MSMEs), through multinational (MNCs) and transnational companies (TNCs), all the way to semi-public companies that provide us with good examples of circular entrepreneurship. Circular entrepreneurship is mainly present in the Scandinavian states today, while slowly spreading to the Netherlands, Germany, as well as other EU countries. The following seven are just some of the most interesting examples of the CE solutions in global practice, bearing in mind the limitations of the scope of this article.

Business sector – in taking CE measures, the business sector is certainly in the lead, taking various initiatives for the products` and their components` retrieval. Namely, lately, it has become more common for business companies to overcome traditional recycling mechanisms by

encouraging circular solutions in order to achieve the return the value of products and their components to manufacturers or resellers. These items can occur simultaneously in the form of recovered products, production components and raw materials, as well as in the form of waste collected and generated from their production, as is the case with the gathering of different types of industrial packaging, reusable wrapping material, the replacement of plastic packaging with paper, etc. In any way, these trends are in growing phase in parallel with the growth of e-commerce [23].

Food production and delivery services – another example of practical application of the CE concept is the case of food delivery companies that operate as an online shops. These companies are usually teamed up with numerous online stores with the aim of more efficient returns of packaging and raw materials. More precisely, these systems make the return process more easier for sellers and customers, making it less attractive to keep those products that consumers are not satisfied with. Today, many companies successfully apply these business models in their practice [15, p. 19].

Textile industry – the current system of production, distribution and use of textile products, as one of the most important sectors of the world economy, began slowly to shift from the linear model. The old and obsolete textile economy based on the use of huge amounts of non-renewable resources for the production of clothing, which were most likely to be used in a limited time period. Over time, it turned out that this system became unsustainable, because it did not use all available economic opportunities, thus causing many negative effects. In that sense, the circular textile industry has started to shift to the use of renewable materials, as well as to the optimization of resources by enabling the circulation of cloths and materials. Unlike the old linear business model that has led to declining clothing prices and quality, excessive clothing supply, environmental pollution and waste generation, the new model is turning to innovative trends such as digitization, sustainability, resource efficiency, reuse of materials, waste minimization, as well as new models of production and consumption. Circular textile production systems are regenerative and restorative in nature, providing multiple benefits to businesses, consumers, the environment and society as a whole [3].

The pharmaceutical industry – the growing problems of the pharmaceutical industry related to its sustainability have triggered the need to adopt the concepts of green chemistry and the use of plants for health purposes. Green chemistry refers to the design, composition, evolving and production of chemical products by applying efficient production processes that reduce the required materials` and reagents` use, minimize waste

generation, use healthier resources, phasing out the use or creation of hazardous substances, while reducing ultimate disposal too. Green chemistry is a holistic approach that prevents pollution at the molecular level, applies innovative and environmentally friendly scientific solutions, eliminates the negative effects of chemical products and processes on human health and the environment and reduces hazardous side effects of existing products and processes. Therefore, the circular pharmaceutical industry today is innovative and resource efficient, focusing on increasing the sustainability as well as the intrinsic health and economic value of contemporary pharmaceutical products [18].

Automotive industry – the contemporary automotive industry today faces its many challenges such as the fight against global warming, huge GHG emissions, depletion of fossil sources, the need to reduce the negative impact on humanity and the environment, the preservation of natural resources and the environment, as well as the need to establishing a balance between environmental and economic considerations. Due to the production of cars that cause a huge amount of waste and pollution, the automotive industry has increasingly begun to focus on recycling as a proven cost-effective method, as well as on remanufacturing, closed-loop cycles and sustainability of its production processes. Remanufacturing includes the recovery and retreatment of products, applying repaired, reused and new components in order to reduce ultimate waste. On the other hand, closed-loop cycles represent a self-sufficient process that uses recyclable materials with the aim to maintain their quality and usability throughout the whole cycle. Therefore, this model, unlike the traditional linear model, is considered a sustainable solution that targets available resources as preconditions for ensuring growth and stability [14].

Construction industry – the construction industry causes significant economic, social and environmental effects due to the recent more intensive urbanization, use of energy and various construction materials, as well as due to waste generation. Due to its negative environmental impacts, circular solutions in the construction industry target the development and use of alternative, renewable building materials, development and application of circular business practices, as well as various artificial intelligence techniques such as smart cities, smart apartments, various forms of virtualized industry, etc. The circular construction economy mainly relies on the growth of energy efficiency in buildings, recycling, waste management and the use of alternative, circular construction materials with the aim of achieving sustainable development. By reusing and recycling of construction materials, the construction industry is slowly shifting from the

current paradigm to a far more sustainable concept with the goal of realizing circular solutions. Today, it is based on the concept of zero GHG emissions, 3R principles (reduce, reuse and recycle), product-service systems, cradle-to-cradle innovations, environmental efficiency, energy efficiency, cleaner production, circulation of building materials, natural capitalism, etc. [10].

Service sector – finally, the services sector also has the potential to shift the economy towards circular activities, due to its intermediary position in the interactions between manufacturing and end consumers. By shifting their goal from production-oriented to consumer-oriented business models, service companies today are successfully implementing sustainable innovative business methods in the domain of the CE. Today, circular solutions are present in many service sectors such as business, information and communication technology (ICT), service contracting, tourism, retailing, hospitality, health, environmental management, service-oriented technology sector, financial sector, waste management, cosmetics, sustainable technologies, etc. All of these sectors have the potential to use recycled, recovered and reusable materials, substances and reagents in their efforts to improve resource efficiency, business performance and adaptation to climate change [7, pp. 621-622].

5. Concluding Remarks

Circular economy directly leads to the reducing of ecological pressures, fostering economic growth, boosting recyclability of raw materials, improving the security of the supply of raw materials, increasing competitiveness, creating new employment opportunities, reducing undesirable environmental impacts, increasing consumers` surplus and welfare, etc. It certainly pays off for contemporary enterprises to introduce innovations in the area of CE practices. First, they can lead to lower operating costs, at least in the long term. These benefits relate to the reducing of energy and raw materials` consumption, replacing fossil energy sources with renewables, as well as to water purification, recycling waste and other resources. These cost savings further allow them to reduce prices of their products, which can also cause the increased demand for their products. Then, new CE products (such as, energy-saving products, longer lifespan products, green goods or products with greater recyclability) can also affect the growth of the competitiveness of circular-innovative companies. All these effects can be achieved under the assumption that consumers are willing to pay more for the additional environmental value caused by the use of CE products. Finally, in those areas where there is a high social awareness of green issues, CE innovations can also positively

affect the growth of the companies' business reputation, which also leads to increased demand for their products, and thus to higher profits.

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KONCEPT, PRINCIPI I INOVACIJE U CIRKULARNOJ PRIVREDI

Apstrakt

Cirkularna privreda je relativno nov model proizvodnje koji je usmeren na ostavrivanje ušteda u potrošnji energije, sirovina, materijala i drugih resursa sa ciljem optimizacije društvenih, ekoloških, tehničkih i ekonomskih efekata korišćenih materijala i cirkularnih proizvoda u jednom društvu. Kao relativno novi okvir upravljanja otpadom i resursima, cirkularna ekonomija zauzima mesto tradicionalnom linearnom modelu proizvodnje (uzmi, napravi i odbaci modelu), naglašavajući sistemsko, plansko i racionalno razmišljanje i delovanje. Danas su primeri cirkularnih rešenja u savremenom svetu brojni i prisutni u mnogim industrijskim granama poput proizvodnje, računarstva, građevinarstva, industrije nameštaja, industrije hrane, diz ajnu i dr. U članku se detaljno razmatra razlika između linearnog i cirkularnog modela privrede, kao i osnovni principi na kojima počiva ovaj inovativni koncept. Rad daje i pregled raznih inovacija u cirkularnoj ekonomiji, ukazujući na njihove karakteristike i koristi. Članak posebno proučava inovacije proizvoda, procesne inovacije, ekološke inovacije, kao i inkrementalne i radikalne inovacije iz ovog područja. Na kraju članak analizira i najnovije trendove u cirkularnoj ekonomiji, sa posebnim naglaskom na poslovni sektor, industriju hrane i tekstila, farmaceutsku i automobilsku industriju, građevinarstvo i uslužni sektor.
Ključne reči: cirkularna ekonomija, linearna proizvodnja, inovacije, ponovna upotreba, recikliranje, obnavljanje, minimiziranje otpada..