

Editorial

Theoretical and Practical Approaches of Circular Economy for Business Models and Technological Solutions

Csaba Fogarassy ^{1,*}  and David Finger ² 

¹ Climate Change Economics Research Centre, Faculty of Economics and Social Sciences, Szent Istvan University, Pater Karoly 1, 2100 Gödöllő, Hungary

² School of Science and Engineering, Reykjavik University, 101 Reykjavik, Iceland; davidf@ru.is

* Correspondence: fogarassy.csaba@gtk.szie.hu

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Abstract: Circular solutions are essential to tackle the imminent challenges of depleting resources and emerging environmental problems. The complex nature of material and energy systems and the changing economic and technological conditions depend on regional settings and accordingly result differently in developed and rapidly developing countries of the world. A wide variety of theoretical approaches can be used to facilitate a shift from the linear use of resources to circular systems, e.g., circular product planning, zero waste management, service-based repairing, refurbishing, and remanufacturing, to name just a few. The introduction and examination of circular solutions can be based on theoretical models in order to guarantee and ensure a successful application. The successful application of innovative technology approaches, business solutions, and organizational development can be facilitated through theoretical models and new scientific results that support innovation processes. The presented article focuses on sustainable and innovative methods that help and enable the proper use and recovery of resources.

Keywords: circular solution; environmental assessment; product lifecycle; sharing economy; short supply chain; biomass utilisation

1. Introduction

The concept of the circular economy has become well known and researched through the European Union's Action Programs in recent years, but its scientific foundations and other system solutions have long been known. The context of the application of circular economic systems, i.e., the economic and technological environment of the introduction of new solutions, allows the development of very novel solutions [1]. The use of digital tools has opened up new opportunities and wide gates for businesses to follow consumer needs accurately, discover new market opportunities, explore new ways to connect with customers, and build fast and low-cost profiles in their sourcing and sales channels [2]. The change also means that it is not product development or organizational development that becomes the most important factor in corporate competitive processes, but the improvement of product marketing and sales mechanisms [3]. The basis of the circular economic concept is therefore not classical, Schumpeterian typology, product, technological, marketing or organizational innovation, but the re-dimensioning of business processes and models, i.e., business model innovation. Irrespective of the EU Circular Action Programs, the application of circular transformation and feedback system models has already started in business, the phenomenon can also be traced during the development of business models in different sectors (biotechnology, informatics, transport).

In circular economic theory, the primary goal is not to create cycles of material and energy flows (these are largely known), but to transform business processes into sustainable, closed-loop resource

systems. As long as the basic mechanisms of business models and business innovation planning do not support circular operating principles, material and energy flows cannot be operated in closed cycles [4]. EU circular action programs can therefore provide good direction and financial resources for the introduction of sustainable business models, but unfortunately the scientific basis, the appropriate research background, the necessary and credible databases, and their thorough and scientific analysis, are not yet an active part of the current linear circular transformation processes [5]. Typically, in circular economic models, economic actors and members of the supply chain integrate their resources with each other, so that business ecosystems can constantly redesign themselves, i.e., operate dynamically and potentially in self-regulatory systems [6]. While in traditional supply chains, i.e., according to the linear business model, permanent roles are assigned, in the cyclical model we can talk about developing, dynamic and potentially independent actors who together create circular value flows in interaction with each other. The phenomenon can be visualized in a similar way to the form of the Archimedean spiral, in which the individual circles always remain circles but move to an ever-higher level on the scale of values.

Thus, according to the new business models, in the circular economy, we no longer talk about value chains, but circular value circle, because these value ranges contain the full spectrum of activities performed by different actors: a product or a service is not only delivered to the user, but its remnants (material and energy) are also transported back into the system. The different values and innovative elements are shared by the actors of each value group, so the existence of a wide-ranging system of relations and cooperation becomes especially important [7,8]. Such a degree of cooperation requires the use of digital decision support or data analysis technology systems, where the use of BigData systems, Internet of Things (IoT) or Artificial Intelligence (AI) systems becomes a basic criterion. Despite the fact that circular business model innovation is one of the development priorities of the European Union, currently interpreting the concept of circular economy and managing it in the right place is also a challenge, and market transformation research related to the field is an absolute novelty in the field. The key scientific challenge is to answer the following questions: how can business models of circular economic systems be successfully designed? What are the specific frameworks that can underpin sustainable business solutions in each sector? What sectoral and other specificities can be explored in the design and modeling of circular systems?

2. Theoretical and Practical Approaches

The popularity of the concept of the circular economy is different from any of the policies of the European Union, so it is worth treating it as a special phenomenon. The circular economic model presented in the action program is essentially an industrial service system that replaces the classic, one-way life cycle concept by offering to redesign material flows by helping to use renewable energy sources. Its main goal is to get rid of waste through the circular design of material use, product use and system applications, and this is achieved through the introduction of efficient business models [9,10].

An important detail in describing the models of the circular concept is that it further develops the usable indicators of the previous two ideas—the bioeconomy and the low-carbon economy—to describe biological and technological cycles. In all of his documents, he emphasizes the importance of developing the scientific basis and systemic relationships. Currently, the Ellen MacArthur Foundation's research community publishes the most professional publications on the topic in Europe. However, the majority of European university research teams and scientific research institutes are also interested in the scientific background for the development of the circular economy. The circular concept is the result of a shift from a simple mitigation model to an absolute value creation model that is socially, economically and environmentally positive.

Central to this is the decoupling of economic growth from increasing resource use and reducing adverse environmental impacts. A very important benefit of the decoupling economic approach is that business "sustainability" has become a comprehensive, social and economic necessity among governments, international organizations and businesses alike. Leaders in different sectors now

understand that moving towards a more sustainable economy requires a global reduction in resource use, while human well-being requires an increase in economic activity and a local reduction in environmental impacts. The dilemma of expanding economic activities can be solved with this concept by reducing the rate of resource use while also reducing the environmental impacts of resource use [11].

In circular economic theory, unbundling means that we have to use fewer resources per economic emission unit on the input side, and from the resources used, the environmental impacts on the emission side also decrease exponentially [12,13]. The decoupling logic illustrates the two key aspects of decoupling sustainable development well, namely the separation of resources and environmental impacts. According to the resource-impact separation model, changes brought about on the input side result in a more efficient use of existing resources and technological assets and avoid the accumulation of means of production. On the output side of the production process, by recovering energy stored in secondary raw materials, we can reduce pollutant emissions and avoid external effect (harmful external, usually environmental, social costs).

Based on the professional concept established by the Ellen MacArthur Foundation in 2012, three important principles have been identified for the optimal design of circular economic systems [14].

2.1. Principle of Inputs

The first principle of the circular economic concept is to keep resource resources under control and to balance the material flow of renewable energy sources, to preserve and increase natural resource systems. In the case of inputs, the system is basically used to maintain the flow of renewable energy sources, so-called “flow or flow management”, and aims to continuously circulate stocks instead of accumulating them, i.e., to stockpile them, while serving technological processes. Therefore, in terms of economic processes, they also focus on ensuring that renewable materials, resources and non-renewable raw materials are always available. In terms of systems that implement cycles (such as soil regeneration or the provision of secondary raw materials), this is achieved primarily by maintaining the flow of materials, most notably by continuously increasing the proportion of services. Therefore, the operation of the input side of circular economic systems requires, where possible, the provision of energy sources free from political and economic risks (production of renewable energy with local supply) and safe access to secondary raw materials by keeping material flow subsystems [15].

2.2. The Principle of Sustainable Cycles

The previously mentioned biological and technological cycles or cycle processes close the processes of the subsystems through loops of different lengths. As the functioning of the economy, but especially its growth, depends on the amount of resources available, these cyclical processes are able to ensure that production systems continue to function properly. In linear systems, if the resources (raw materials) essential for production cannot be obtained, the economy will be unable to grow or develop. Circular economic solutions offer directions for development that can ensure that these resources are always available at the highest possible level of material cycles (biological raw materials and raw materials) [14]. Its aim is to release the raw materials of the biological cycle processes into the environment through the shortest possible cycles, so-called cascades (e.g., circulation of soil nutrients, water cycle). The new product cycles of circular economic models are mainly generated in technological cycles, by re-acquiring resources or by modernizing and improving technological systems. It incorporates the requirement for circular design into the early stages of product design in order to reduce energy consumption throughout the product life cycle. Waste-free design principles that can be applied at this level therefore include reuse and recycling planning, remanufacturing, refurbishment, energy efficiency and flexibility of use. The essence of circular operation in sustainable cycles thus lies in the design of the product or service [15].

2.3. Principle of Outputs

Increasing the efficiency of the system must be achieved by accurately identifying the processes, adhering to the principles of the original circular design and providing the possibility of redesign, through which we can avoid negative and positive externalities with great certainty. This may include planned land use, avoid water and noise pollution, maintain good health, avoid the use and generation of toxic substances, avoid improper business solutions, and perform all of the interventions listed above using local resource utilization systems. In recent years, the principles of circular design have evolved the most in the direction of sustainability. In business innovation, environmental or economic problems are not solved through the development of technological systems or organizational innovation, but through a more efficient allocation and use of existing resources and means of production. As a result, far fewer new devices and equipment are introduced into production, and thus less pollution appears at the system level in connection with the production of these devices [15]. In business innovation, the process of value creation only supports systems that are viable on their own (also financially sustainable) [16]. With this, you can safely avoid harmful government interventions, negative externalities, and most of the external phenomena that were previously indispensable in business solutions referred to as sustainable. The development of closed-loop material flows, which may primarily be the responsibility of the circular service sector in the future, will significantly change the potential outputs of the consumption system. Zero waste systems can become an essential structure for economic systems thanks to proper regulation and the rapid development of a closed-loop material flow service system. This is illustrated, for example, by the announcement by British Prime Minister Boris Johnson in February 2020 of the UK's first post-Brexit climate action [17]: "Like several European countries, the UK has pledged to phase out petrol and diesel sales by 2040. However, the new plan is to bring this date forward five years and to add hybrids to the ban list".

This means that from 2035, only electric vehicles and electric vans will be available on the UK car markets.

3. Business Model Innovation

Irrespective of the EU Circular Action Programs, the application of linear-circular transformation, transition management, and system models based on feedback from cycles has already started in business [18]. There are economic sectors where this phenomenon is very spectacular (biotechnology, informatics, transport), the linear-circular transformations observed in these areas are actually the result of the natural development of business models. The resizing of business processes and models—that is, circular business model innovation—is therefore, if not necessarily conscious, an integral part of current business processes. In traditional value chains, these innovation processes can diverge, consumer chains break, economic and social change processes run side by side, changes actually evolve side by side (in each sector separately) and there is no relationship between the resources used. In this case, innovation in the traditional sense is not necessarily a useful element of system processes either (disruptive innovation effect). Nevertheless, development does not stop, but without the different levels of development (or values) building on each other, the loss of resources in the transformation process can be very significant, and the development/transformation phases lengthen. That is why it has a key role to play in consciously building the values that we want to see as an integral part of economic life for a long time to come. Sustainable business models are thus well-embedded systems, use resources efficiently and operate with less risk (mainly affecting risk factors stemming from global systems), permanently changing people's lives and the ways companies or society operate in a given circle. This position is in line with [5], who viewed environmental solutions as market expectations rather than complementary functions. The authors argued that the current benefits of business as usual (BAU) processes will soon pose a threat to companies in many ways. These include deficiencies in primary resources, including resource price volatility, declining supply chain efficiency, increasing bans on waste trading, declining costs of renewable energy sources, etc., and these unfavorable patterns can also be termed "linear risks". Recent studies [6,19] supported the above when they argued

that the profitability of “mainstream” economic systems lies in outsourced external factors, i.e., it is cheaper to waste resources than to monitor and eventually regain them. However, this situation seems to be changing soon, as key global players (e.g., China, Kenya, Bangladesh) have exited from the waste markets.

It can therefore be assumed that the transformation from the “take-make-waste” approach and the creation of closed resource loops will be a basic requirement for companies and economic actors in general. This is one of the reasons why the European Commission has issued the Closing the Loop (An EU Action Plan for the Circular Economy) action plan, also mentioned in the introduction, which urges the transition to a circular economy [18]. The Circular Economy Action Plan is a concept that rejects the traditional features of economic growth (e.g., mass production, use of non-renewable resources, production of preserved goods, etc.) but offers innovative solutions to preserve natural capital and enhance social well-being. Achieving the best possible circular flow of materials and energy through economic processes and avoiding resource leaks is a top priority [20]. Contrary to previous sustainability efforts, these circular initiatives are receiving increased attention from the business sector. According to a recent study by the World Business Council for Sustainable Development (WBCSD), 80% of companies surveyed say that accelerating growth and increasing competitiveness depend on the use of circular strategies. The remaining 20% identified risk reduction as the main motivation for developing business models [21]. These results suggest that the application of circular strategies has reached the realm of business model research. In interpreting the concept of circular business models, Scott (2013) [22] argued that circular initiatives should use recyclable biological materials or use their technical raw materials continuously. Both activities are expected to be harmless to ecosystems and can be operated without waste. According to Mentink (2014) [23], circular businesses need to create value and capture material flows in a closed material cycle. However, he pointed out that a business model alone cannot be a circular system. Previous studies have not examined the business-level changes in circular progress, i.e., what circular elements and solutions the currently used business models use, and what phase of the linear-circular transformation they are in. Therefore, the main goal of our research in the future should be to evaluate the current business models and to analyze their fit with circular solutions. In characterizing business models, Segers (2015) [24] highlighted that each model variant is most often used in a consolidated manner by market participants, so a firm integrates the mechanisms of multiple models into one application when looking for the right solution for itself. In order for a small business to develop a proper business model, it must consider important design considerations [25]. One of the most popular types of sustainable business model design methods is the canvas design matrix, developed by Osterwalder and Pigneur (2010) [26] under the name “Business Model Canvas” (BMC), which has gained incredible popularity over the past decade. Lewandowski (2016) [27], who proposed the ReSOLVE criteria system for the circular evaluation of business models, considered BMC itself to be the best tool for developing and customizing business models. In a visual matrix, BMC demonstrates to the stakeholder how their business can create, deliver and capitalize on the value it offers. Of course, designed business models cannot consist of just circular attributes, as the operation of a business requires several additional activities that do not directly affect energy and material flows.

4. Technological Solutions

The sustainable engineering approach has represented the foundation that can be learned in environmental education, the importance of the three core competencies (reading, writing, arithmetic). Over time, environmentalists—symbolizing the priorities they represent—also created their own 3R trend by the second half of the twentieth century; it refers to the reduction in rapidly increasing amounts of waste (reduce), recycling (recycle), or prevention of their formation at all by reusing products (reuse). Thus, the theory of the circular economy [15], which is gaining more and more ground today, relies on these 200-year-old pillars. The concept was born in response to the linear economic approach that prevailed until the beginning of the 20th century, which favors production based on the use of new

resources and then the disposal of products after their useful lives (end of life). In the cycle of natural ecosystems, the end product created by one life form always serves as a nutrient for another life form. It is inconceivable that any living thing in nature would create an 'output' that would not constitute an 'input' for another organization [28]. Another important aspect of natural life, in addition to the absence of waste generation, is that the phenomenon of overconsumption is also unknown. In the early stages of history, humanity, like animals, had to hunt, collect, and later produce for itself in order to obtain the food it needed. Today, however, these processes have been replaced by artificial care systems. Foods, which are thus becoming cheaper and more readily available, have induced the development of consumption, which is sometimes immoderate today [29]. In the last half century, however, our economy has begun to push for the overuse of people in other areas of life. The camp of representatives of alternative economic trends sees the foundations of today's consumer society in three main pillars. The first of these is the previously planned obsolescence.

The second such aspect is the issue of the use of credit. Although this tool has always been used to stimulate the economy, it was initially used with the aim of having its user invest the money earned in this way for later income. Later, however, it became common to use it to satisfy a constant consumption compulsion. Finally, marketing has emerged as another cornerstone of consumer society as one of the most effective ways of influencing consciousness to stimulate growing consumption. It is important to emphasize the processes that take place in nature, as this also contributes to the correct interpretation of the circular economic concept. This is because, in the light of experience to date, the name 'cycle' often gives rise to misinterpretations. This can be fatal in the sense that the scientific and practical foundations of the concept are still being laid. Based on what has been seen so far, the circular designation has repeatedly diverted researchers' attention towards increasing recycling. That is, most experts started from the question of how to recycle all the waste that humanity produces into production systems. This certainly proves to be a misinterpretation. Circularity actually refers to the environmental cycle as explained above. The idea is that the economy should replicate the functioning of natural ecosystems, where the functioning of systems in symbiosis with each other precludes the appearance of waste from the outset [30].

Furthermore, there is no overconsumption in this cycle. The theory itself cannot be said to be entirely new, as alternative trends (e.g., biomimicry, industrial ecology, natural capitalism, the cradle to cradle principle, the blue economy) have emerged continuously since the 1970s, placing production on systems with a natural basis. The circular economic theory sees all these theories as a breeding ground and its guiding principle is "The problem must be solved at the root!" view. This also emphasizes the need to work to avoid the appearance of waste instead of looking for waste management solutions [31]. The source of this can be seen in a much older context, the Jevons paradox, considered one of the foundations of environmental economics. In his 1865 book 'The Coal Question', William Stanley Jevons explained the long-term negative mechanism by which technological advances are aimed at increasing the efficiency of current systems. According to his example, although improving the efficiency of coal-based production has reduced industrial air pollution in the short term, more economical processes have ultimately led to the increased use of fossil fuel technology and higher CO₂ emissions [32]. Based on this, it is easy to imagine what would happen if circular solutions focused solely on recycling material flows back into production. The '3R' guideline presented at the outset is based on a similar logic, with only one of the three keywords focusing on recycling, the other two calling attention to curbing our consumption and maximizing the use of products we have already purchased. This is also based on Tom Szaky, director of the world-famous waste management company Terracycle. According to him, before declaring a product a waste, we need to focus on three things. The first is the function you loaded. If, in our opinion, it has not been used to such an extent that it is unable to fulfill its original purpose, we will continue to use it. In cases when it no longer meets our needs, we offer it to 'second hand' stores where others can still decide if they are willing to use it in its current form. The second important aspect is the shape of the product. In today's world, we have become accustomed to the fact that production systems assign different products to each function in order to increase consumption. As a result,

we often do not even think about how many different purposes an object could be utilized for if we used our creativity. For example, instead of buying new pots, we can put our plants in used sour cream boxes. The series of examples could continue for a long time, as so-called 'further use' is now being built on several business models. Returning to Szaky's line of thought, the material of the worn-out object also appears as the last aspect. If we judge that a product no longer serves its original function for itself or for others and cannot be utilized for other purposes, we can think about recycling [29]. In developing circular theories, researchers use the 'R' -labeled methods presented earlier and follow a philosophy similar to that of Tom Szaky. The repository of waste management and prevention practices has now been expanded to '10R', which have been considered as priority levels in the circularity (refuse/reduce/renew/reuse/repair/refurbish/remanufacture/recycling/re-purpose/recovery).

In the circular concept, two priority aspects can be identified, along which we reinterpreted the order of methods and technological solutions. The application of the 'function before substance' principle aims to maintain the original purpose of the product for as long as possible. This ensures that the product used in the preferred function uses the least amount of material. The second priority is to minimize the energy used. That is, after the end of the useful life, convert the products for later use to use as little energy as possible.

5. Outlook and Conclusions

Further research is needed to clarify the theoretical details of the circular economy. A complete overview of resource systems needs to be set as a goal in order to extend the potential business innovations to the use of free resource elements with the greatest efficiency. A key goal in the future is for circular business models to focus not only on energy or material transport processes in scientific research, but also on the use of human resources or the circular operation of financial resources as a part of research. In order to eliminate existing or ongoing externalities for the sustainable operation of business models, it is necessary to know exactly which elements can be considered as the interventions needed to implement the circular economy, which are the parts and which are not. Linear-circular transformation processes are micro-, meso- and macro-level processes, the coordination, management and acceleration of which require information and data that can only be collected coherently from public and private data collection systems. In linear systems or in the traditional value chain, sectoral development processes may deviate from each other, there are no values, the processes of economic and social change do not or rarely meet each other, innovation processes do not support each other in the use of resources, but compete for available resources. Then, innovation is not a useful element of system processes either. Nevertheless, development does not stop, but without the different levels of development (or values) building on each other, the loss of resources in the transformation process can be very significant, and the development/transformation phases lengthen.

In circular business innovation, environmental or resource problems are not solved through the development of technological systems or organizational innovation, but through a service-based, more efficient allocation of existing resources and means of production. The presence of circular business solutions in the environmental sector is currently not common, because the tax system following the polluter pays principle in Pigou cannot deprive the state of its prominent role in the operation of the processes. Modification of this system property is essential to motivate circular mechanisms.

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