

DIGITAL CIRCULAR ECONOMY: REVIEW AND RECOMMENDATIONS

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ABSTRACT. This paper investigates and questions the liaison between circular economy and digital economy. To do so, review of definition of the circular economy and digital economy are combined with models and barriers to understand this emerging new concept – digital circular economy. On this basis, the models and recommendation were included in this paper. One of the main findings of this paper is that a country's economy must be analysed in the light of the digitisation of the circular economy. But for this to be possible, the two economies must be analysed together, holistically, as a whole – the Digital Circular Economy. The recommendations from the study of digital involvement in the circular economy would be: holistic thinking, establish framework for actions, use economic, strong partnerships between stakeholders, data standards.

KEYWORDS. *Digital circular economy, digital economy, circular economy, digitalisation, data, analytics*

Introduction

The world we live in is changing fast. One of the causes of course is population growth. Every week, the global population grows by 1.5 million people, 3 million people enter the middle class, 3 million people move from village to city.

This, of course, leads to an increase in the consumption of products - consumption of water, paper, automobiles, fuel, electrical and electronic equipment (mobile phones, refrigerators, air conditioners, network equipment), Internet traffic, etc.

Thus, consumerism characterizes modern society - especially the linear consumption of products, i.e. products are created, consumed - after which discarded (the model "take, make, dispose"). But there is growing talk of circular business models - the reintroduction into the economic cycle of waste that becomes resources.

Another cause of accelerated consumerism, of course, is digitalisation. Thus, we have access to more and more products, cheaper and more affordable as well as digital products, which we use daily – equipment (phones, computers, smart TVs, smart watches, smart homes, etc.) and services (Internet access, mobile phone, GPS).

All taken together bring an enormous burden on the environment, on the earth – if of course they are not used sustainably.

Circular Economy

The concept of circular economy is not a new term, it is over 50 years old and is influenced by Boulding's work [1] – which argues that for the economy and the environment to coexist in balance, the Earth must be seen as a closed loop system (or the closed economy of the spacecraft).

Although it has received special attention from academia, now there are more than 100 definitions of the Circular Economy, the most current and comprehensive is the following:

Circular economy - as an economic system in which resource input and waste, emission, and energy leakages are minimised by cycling, extending, intensifying, and dematerialising material and energy loops. This can be achieved through digitalisation,

servitisation, sharing solutions, long-lasting product design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. [2]

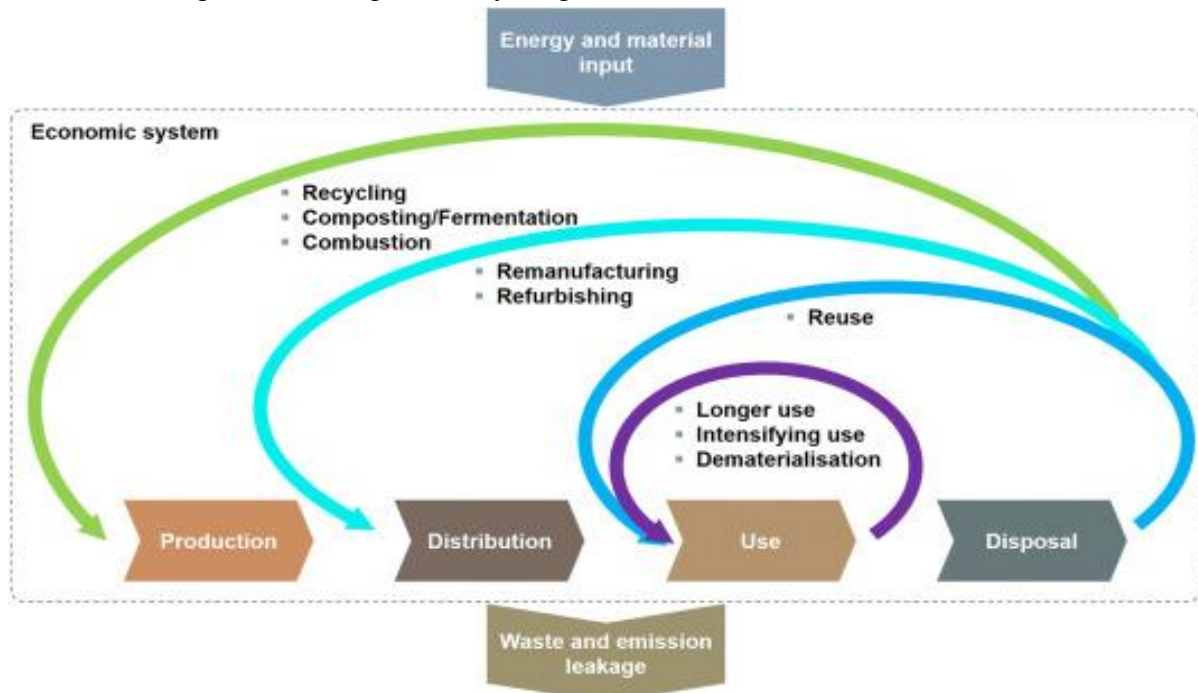


Figure 1. **Circular economy – actions to take** [2]

When we study the Circular Economy - the waste hierarchy is important - thus, at every level - concrete actions are implemented – reduction, reuse, recycling.



Figure 2. **Waste hierarchy** [3]

It is also necessary to know the life cycle of the product (and the constituent elements) – which must be extended to the maximum. Lifecycle assessment provides the most recognized method of quantifying the environmental impact of products, processes and/or systems. It highlights the environmental effects of a particular product throughout its life cycle, including the extraction of raw materials, the manufacture of materials and products, construction, use and end-of-life. And the Environmental Product Declaration (EPD) provides a standard way of communicating the results obtained from such a lifecycle assessment and allows the user to assess the environmental impact of the product used and make comparisons with alternative products. The EPD are based on the ISO standard on type III ecological declarations (ISO 14025), European standard EN 15804 (Sustainable development of

construction works – Environmental declarations for products – Basic rules for the category of construction products) and EN 15942 (communication format). The underlying LCAs comply with the principles of ISO 14040 and 14044 standards.

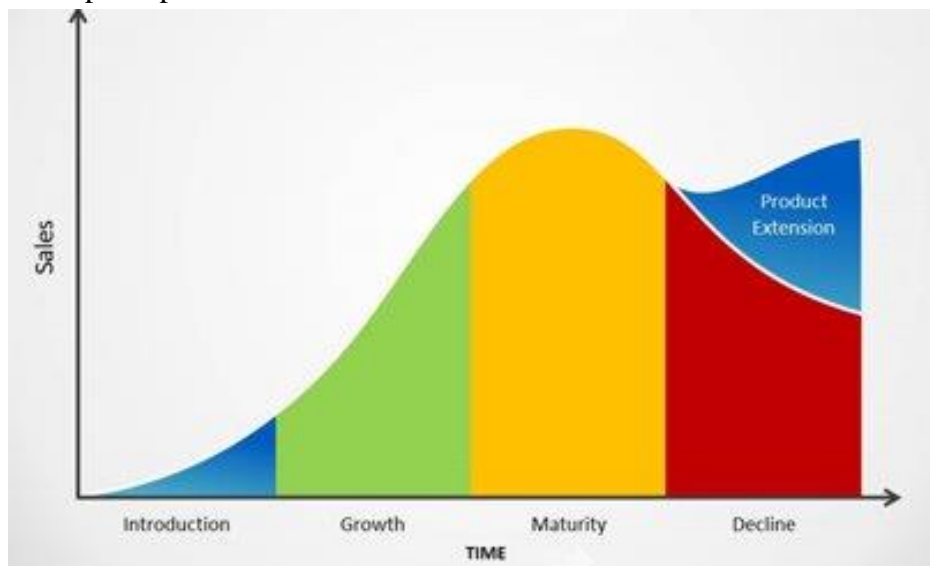


Figure 3. Life Cycle of the products

Of course, two simple concepts are presented above, but the reality is much more complex. Below is a model of the functioning of the Circular Economy presented by the European Environment Agency. It is therefore very complicated to implement actions on the Circular Economy – bearing in mind – that a systemic approach and long-term research is needed. A lot of DATA is needed.

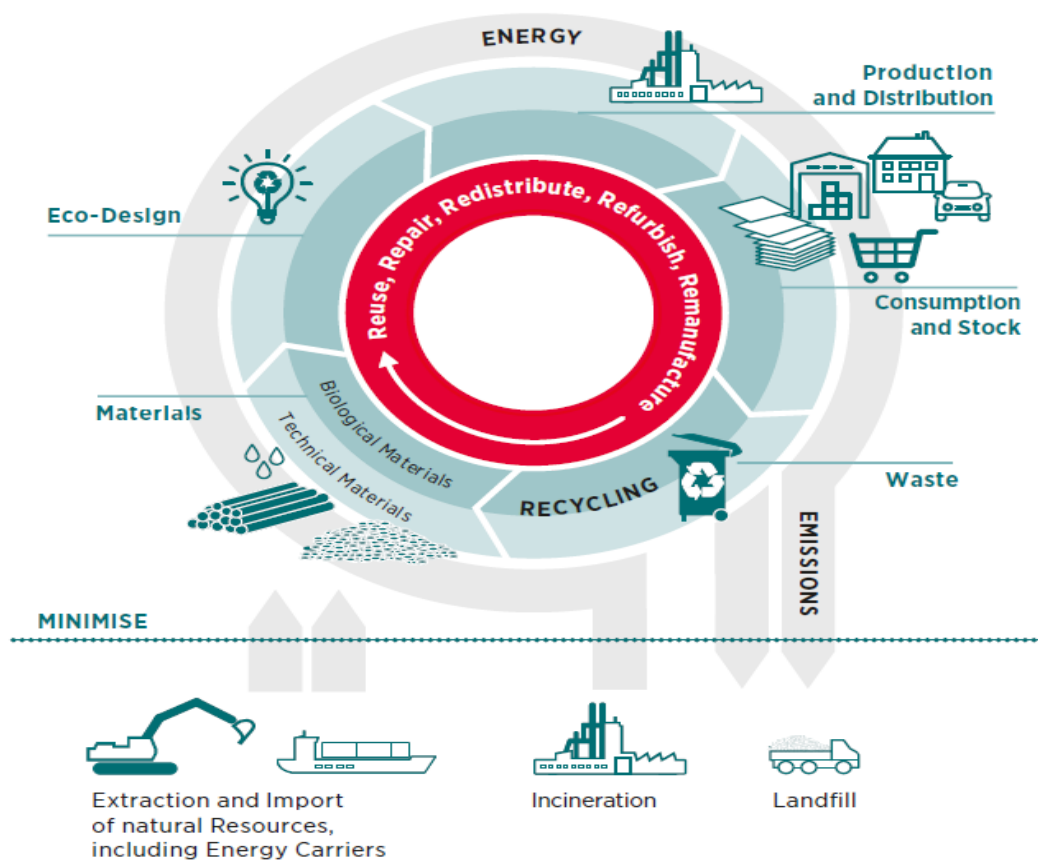


Figure 4. The concept of the Circular Economy

Source: European Environment Agency

Digital Economy

The Internet, broadband networks, mobile applications, ICT services and equipment are the foundation of the digital economy. And mobility, cloud technologies, social networks, sensor networks and Big-data analytics, AI are some of the most important trends in the digital economy today.

In common, these trends make possible a future where "everything is intelligent" (e.g. houses, phones, televisions, society, business processes, transport, government, energy) by empowering and empowering the business environment, consumers and society entirely

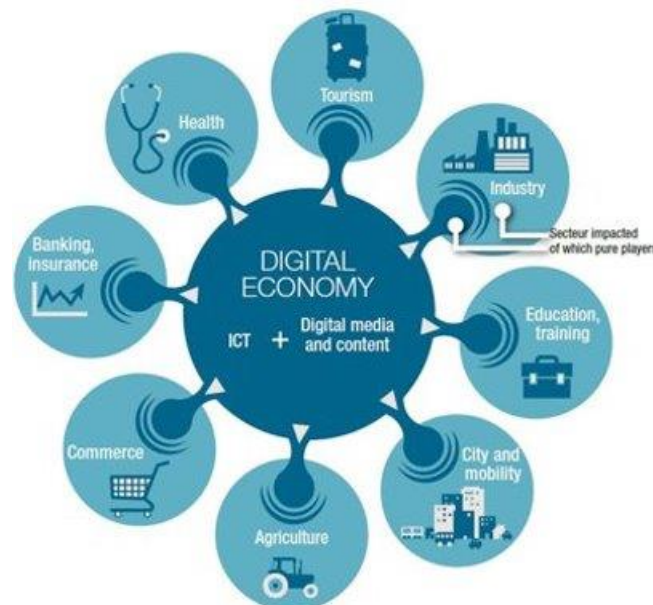


Figura 5: The digital economy and other sectors of the economy

Source: <https://www.osce.org/files/f/documents/4/f/392669.pdf>

The concept of the digital economy has evolved over time thanks to dynamism and the development of digital technologies. According to the Oxford dictionary – the digital economy is the economy that operates primarily on digital technologies, especially the digital economy is called the Internet Economy, the New Economy or the Web Economy. It is often perceived as doing business on Internet-based markets.

The internet economy can be identified as a broad set of the digital economy. The term Internet economy has been defined by the OECD as "the value of all economic activities that are undertaken with/and using the Internet". Technically, the digital economy is expanding a little further by including non-internet digital technologies.

Research methodology

Considering the development of the fields, the method was used from general to private. Method of analysis was based on data available in reports of institutions of profile, method of observation.

The previous sections have highlighted the definitions of the circular economy and digital economy; little attention has been devoted to the liaison between both definitions. The research objective it is to investigate both topics in literature.

Outcomes of the research

No other market benefits more from digitalisation such as the green services branch – it can become a decisive tool for disseminating and accelerating the field of green services and for new opportunities, through the prism of new business models. Digitalisation increases the incentives of companies to participate and can become a determinant enabler, by adoption of new technologies [4].

Today, more than ever, we are hearing more and more of the Digital Economy and the Circular Economy. But we need to look at them together – the Digital Circular Economy. Because the Digital Economy promotes inclusion, innovation, efficiency and automation, it can be used as a support, facilitator for the implementation of the Circular Economy, through digital technologies and data. This is because – as we know digitalisation is everywhere, in all sectors of the economy. And the two economies must work together and complement each other, they have to work hand-in-hand.

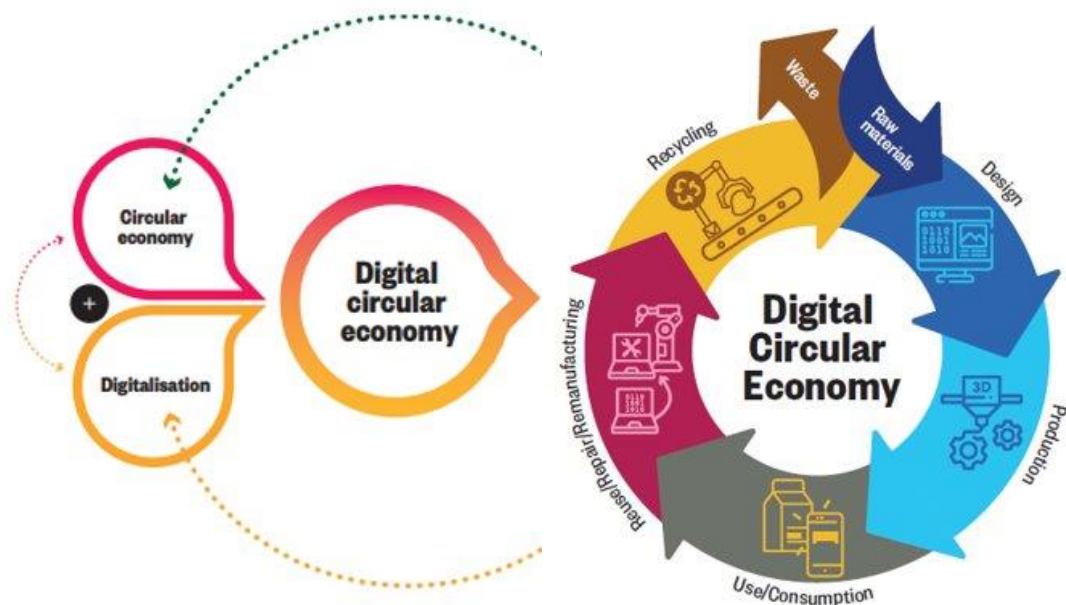


Figure 6. The concept of Digital Circular Economy [5]

However, the relationship between these terms is not an area of research explored widely due to the complexity of the circular economy and the novelty of research on digital technologies, and the literature still overlooks how digital technologies allow the transition to the Circular Economy [5].

The above statement is even more relevant to the investigation today in the context of digital business transformation. Indeed, a lot of digital technologies proliferate to support companies in managing the growing amount of knowledge and information flows captured and transferred within and beyond the company's borders, as well as improving process performance, redesigning the organizational structure and innovating business models. In particular, Business Intelligence and massive data analytics, the Internet of Things, Blockchain etc. and so-called "key facilitating technologies", such as micro- and nano-electronics, nano-technology, advanced materials, industrial biotechnology and advanced manufacturing technologies are nowadays causing radical innovations in industry and society. These technologies are characterized by trans-industrial application profiles, causing ubiquity

and rapid innovation cycles, new business models, the creation of new industrial areas and the structural re-foundation of existing ones, the continuous updating of competences at both individual and organisational levels. Therefore, these technologies are promising levers for promoting circularity in start-ups, SMEs, as well as for supporting digital processes by transforming and transitioning the business model to the Circular Economy paradigm [6].

The climate crisis, environmental challenges, lack of competitiveness and competition in terms of resources - the world faces multiple challenges that it will have to address in order to ensure long-term sustainable prosperity. At the same time, there are two ongoing trends in the economy - the creation of a circular economy and a digital transformation - that could provide the means to address these challenges if managed well. And digitalisation is a determining factor for the circular economy and the SDGs, in particular for The Sustainable Development Goal 12 – Responsible Consumption and Production, where the national policy framework can be further adjusted to the principles of a circular economy, sustainable consumption through understanding by Government, the business environment and the population [7].

The implementation of the circular economy is primarily an information problem or rather lack of data. The transition to a circular economy will be improved by coordinating material flows and information flows is essential for addressing the problems described.

The data must also be kept together with the materials in the cycle so that waste can become a processable resource. A key challenge in this process is to generate, collect, efficiently process and make available the volume of information about the composition of each individual product, its usage patterns, its location within the waste system, etc. All this is necessary to establish functional markets and cycles at the next stage. This will make effective, market-based solutions possible rather than just regulatory. Until now, it has not been possible to overcome much of this information deficit. However, the application of the elements of the digital economy could now offer exactly this solution - after all, in many ways it is primarily an information revolution. Therefore, the information can be considered as the "missing link" towards the implementation of the circular economy. [8]

Therefore, the Circular Economy – cannot rid itself of the Linear economy, and digitalisation will allow it to impose itself as the only solution for the new global economy. Starting with the birth of the product – until its death, everything must be conceived in the context of the digital and circular framework.

National and international institutions, as well as all stakeholders, must use governance tools and economic instruments to create the framework conditions for the transition to a modern economy – a circular digital economy that should be based on its strengths, including value-based, multidisciplinary approaches and technological knowledge. There should be a comprehensive scientific assessment and a clear set of indicators to monitor progress. One solution would be Digital Twin, which is to capture, structure and synchronize all product data from idea, design, manufacturing, launch, use, maintenance to decommissioning and recycling. Digital twins allow optimization of all phases of the product lifecycle [9].

Building on the single market and the potential of digital technologies, the circular economy can strengthen the EU's industrial base and stimulate business start-ups and entrepreneurship among SMEs. Innovative models based on a closer customer relationship, customisation of mass-produced products, participatory and collaborative economy, supported by digital technologies (such as the Internet of Things (IoT), high-data technologies (Big

Data), blockchain technology and artificial intelligence (AI)), will accelerate circularity and dematerialize our economy; as a result, Europe will be less dependent on raw materials [10].

CONCLUSIONS AND RECOMMENDATIONS

One of the main findings of this paper is that a country's economy must be analysed in the light of the digitisation of the circular economy. But for this to be possible, the two economies must be analysed together, holistically, as a whole – the Digital Circular Economy. Of course, in order to reach this goal, which is a modern concept, lobbied by the developed countries, it is important to research the Governance and capacity-building of both: people and institutions (state, private).

The recommendations from the study of digital involvement in the circular economy would be:

1. Holistic thinking – by defining a clear vision of the Digital Circular Economy
2. Establish framework for actions - using governance, policies and regulations
3. Use economic tools to stimulate and enable the transition to the type of economy you want.
4. Strong partnerships between government institutions, the private sector and citizens to achieve better results.
5. Data Standards – to analyse all this inputs data

Artificial intelligence and digitalisation have the potential to optimise the use of energy and resources and to provide information in support of circular business models and responsible consumer choices. However, a circular digital economy must have a net positive impact on resources and address substantial challenges, including the risk of fueling unsustainable consumer patterns, shortening the sustainability of smart products and compromising the security of sensitive business information [11].

Thus, the smart use of resources in the Circular Economy can be supported by the creation, processing and analysis of digitised data, and the digital transformation of processes will play a key and intensifying role in the transition to a circular economy that will bring more resilience and sustainable jobs, with the circular digital economy becoming a hallmark of a new economy after the COVID-19 pandemic period.

This study is the first step in trying to present information on the circular economy and the digital economy. However, further research is needed, especially with the government and private environment – in order to elucidate the best and most sustainable models of cooperation, so that synergy between the two stakeholders and the two economies is possible to achieve as efficiently as possible.

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