Advancement of Circular Economy Supported by Intelligent Communication System

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Abstract. However, the linear economy and its current model will not be able to ensure long-term sustainability. It is not appropriate, and above all possible, to increase production from primary sources indefinitely. In some areas, it directly affects the population's life. It brings negative elements, such as climate change, increasing differences between poor and rich regions, and natural disasters with more serious consequences. Emerging problems such as the deterioration of air, soil and water quality directly impact declining human well-being. But there is an economic model in which such non-ecological behaviour and waste of resources do not occur. This model is called a circular economy. The manuscript is focused on applying the circular economy within the enterprises of the Slovak Republic and individual EU states. An important task will be to use the information system and the method for obtaining data and subsequent processing. A properly set up circular economy can minimize the waste of resources, improve the efficiency of their use, reduce g reenhouse gas emissions and contribute to the preservation of biodiversity.

Keywords: Monitoring · Communication · Circular Economy · Sustainability

1 Introduction

Circular economy (CE), also called circular economy, is an economic model whose main goal is to reuse resources [1]. It is about changing the point of view of consumed goods. We no longer consider them as waste. We consider them as possible inputs. An important role is played by adopting sophisticated solutions that can bring new value to consumed goods and thus re-enter the economic process [2]. The circular economy changes the concept of "take-throw-away", which is characteristic of the linear economy, to the idea of cyclicity in (circulation), from which the name "circular (circular) economy" comes. [3, 4] Regarding energy, the circular economy prefers renewable resources naturally present in our biospheres, such as solar energy, water or wind current. It aims to minimize

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or even eliminate the use of toxic chemicals that harm the environment and represent a barrier to their reprocessing. [5, 6] The main task of the corporate information system is processing data that is created in the organization. Therefore, data processing can only be considered one of the subsystems of the information system. The information system consists of people, and technical and program resources to ensure the collection, transmission, processing, distribution, storage, selection and presentation of information for the needs of managers so that they can perform their management functions in all management system components (Fig. 1).

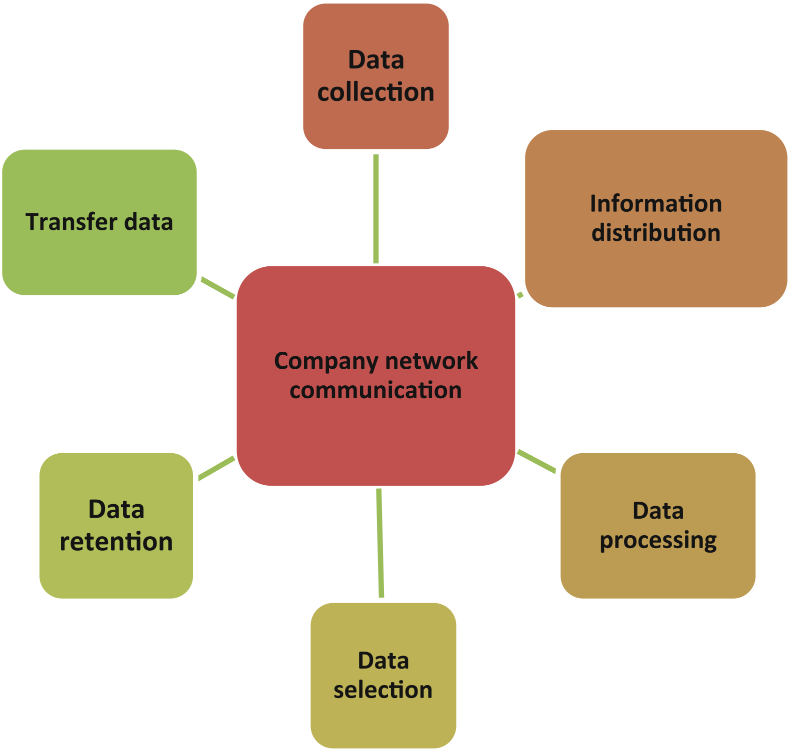

Fig. 1. Company network communication process [Authors own processing]

A very important part of the information system is the automated information system, which is ensured through computer technology. When applying the circular economy in the company, collecting, gathering and processing data is an important task [7, 8]. The main goal of the information system is also to achieve the highest possible quality in the shortest possible time and at the lowest possible cost [4, 18]. Currently, the information system significantly affects real human knowledge in various spheres. An individual needs new information for his management method and decision-making, which must be provided to him constantly, in the necessary quantity and quality. A comparison of the basic factors of the linear and circular economy is in Tab. 1. Today's society is characterized by high consumption [3, 13]. That is, we have been living for a long time in a way where we extract many natural resources, which we then transport to the opposite end of the world. There, it is processed using expensive technologies, the products are manufactured, and then they have transported again to other countries of the world, where consumers can purchase and consume them [5, 23]. After consumption, consumers throw away used, consumed products or just their remains, which creates waste that ends up many times thrown in the wild or the best case, ends up in incinerators or landfills. We can rightly consider this method of consumption as devastating and unsustainable socially, economically and environmentally [4, 9].

The method of consumption of natural resources, in which waste is created after consumption, is called the linear economy. Human, material and economic resources are not inexhaustible. Despite this, the amount of waste produced is constantly increasing. As an example, we can cite plastic waste, of which a third of the total world volume is not collected or treated in any way.

Table 1. Linear vs. circular economy [10].

	Linear Economy	**Circular Economy**
Business model	Product	Services
Focused on	Environmental efficiency	Eco-efficiency
Step plan	Take-make-dispose	Reduce-reuse-recycle
Re-use **Border system**	Downcycling Short-term, from purchase to sale	Upcycling, cascading and high-quality recycling Long-term, multiple life cycles

As part of the application of communication and information systems in companies, they have at their disposal corporate communication networks that have been built for decades according to traditional and proven design concepts [16, 19]. However, based on the principle of functionality and operational possibilities, these communication networks can no longer flexibly absorb the demands for changes and keep up with the markets that the current dynamic competitive environment places uncompromisingly on companies. But today, they have a choice [10]. Either they will continue the current trend and manage the IT infrastructure in a traditional "manual" way, where almost every change in communication parameters means implementing a larger or smaller IT project [11]. However, such a time-consuming activity can also threaten the company to gradually retreat from its position in today's dynamic competitive environment. Or they fundamentally change the design of the IT infrastructure and, with it, their idea of how to operate it, and implement technical solutions based on so-called software-defined networks, which are based on the total automation of activities connected with the operation of corporate communication networks [12, 18].

1.1 Circular Economy Supported by Company Network Communication System

After defining its long-term and short-term goals and their subsequent achievement, the company implements many activities. In the mutual interaction of business activities, the inputs necessary for realizing business performance turn into outputs - this process is called the transformation process. We can define it as a set of business activities to change business inputs into results. This process cannot be perceived in isolation, only in close ties to other systems [13]. The transformation process (Fig. 1) is one of the basic features of the company's functioning when inputs are transformed into outputs (products, goods, and services) through the transformation process. The goal is to maximize profit, and its hallmark is economy. In connection with the complex transformation system, inputs are provided by the supplier system and outputs by the customer (user) system [13, 15] (Fig. 2).

Fig. 2. Transformation and communication process of circular economy [Authors own processing].

2 Work Methodology

For the circular economy to enter the thinking and behavior of producers and consumers, as it is a new innovative and in many cases, unknown approach, it is necessary to understand it. The main principles of the circular economy form the basis of this theory [14, 19]:

- For a customer, a consumer, his status as a consumer changes to the status of a user. With CE, companies will want back materials from products when the product has lost its value from the customer's point of view. This approach by manufacturers could intensive customers to return items at the end of their useful life [14, 17, 31].
- CE aims to produce zero waste. A minimum of waste is thrown away because the waste can be further used in various ways. For example, by re-using what should not have been used in the linear economy. Or by fixing what is broken and remaking what can no longer be improved. This principle works based on not adding any primary raw materials to the process but working with those raw materials that have already been used at least once [15, 18].
- For this industrial production cycle to be truly sustainable, the energy that enters it and drives it should also be almost completely renewable. The use of renewable energy would also lead to a reduction in the risk of resource depletion for businesses or fluctuations in energy supply. In the absolute sense, this would also reduce part of the costs for the actual production of the products [17, 27]

- According to the fourth principle, there are two types of industrial additives to products. They can be disposable (they can biodegrade in nature, for example, paper or fabric) or durable ("technical", for example, metal, glass or plastic, which can be reused relatively easily). The products should belong to one or the other group so that everything can then be reused or returned to nature, where the ingredients used in the product will naturally decompose. The design of more complex objects should be designed in such a way that the objects can be disassembled and subsequently so that they can be classified into these two categories at the end of the life of a certain product and further used properly according to this division [16, 18].

The main goal of the circular economy is to change the current popular system of producing one product in one country and then distributing this product around the world to a system where there will be smaller local producers, which would bring more jobs and prosperity to areas that may not have had it before [17, 23].

2.1 Circular Map in the Slovak Republic

Slovakia produces more than 2 million tons of municipal waste every year. More than half of it ends up in landfills. We use natural resources, often non-renewable, to create new products while our consumption grows exponentially [17, 19]. We throw away thousands of products every day, wasting the resources that were used to make them. The Slovak Republic is set to the so-called linear economy in which we take natural resources - create a product - depreciate through use - and throw them away. Even from this simplified view, it is obvious that such a principle cannot work in the long term. Reuse and sharing, repairability, upcycling, and, in the final phase, striving for zero waste are the basic pillars of the circular economy [18, 19]. The transition to an efficient circular economy at the level of individuals, producers, and municipalities is facilitated by several tools resulting from experts from various organizations (Fig. 3).

Fig. 3. The circular map of the Slovak Republic [21].

The circular economy tries to create services and places that help us prevent waste: reuse centers, repair shops, libraries, community composting sites, rental shops, packaging-free shops. And precisely, circular maps contain lists of these places important for the circular economy (circular economy), the goal of which is not to create waste, but on the contrary, to use it as a source of material or energy [20, 24]. This map is a guide on how to handle waste more responsibly. The map is intended to help all state residents and visitors to individual cities find ways to prevent waste and use the services of the sharing economy [21]. Municipalities and towns thus always have an up-to-date overview of data available 24/7.

3 Results and Discussion

Recycled waste represents processed waste that has been sent to other forms of recovery than energy recovery. Wastewater data are adjusted for waste collected in one state and recycled in another [20, 23]. The waste-recycling indicator expresses the ratio of recycled waste to the total processed waste, multiplied by 100, as this indicator is expressed in %. Both of these indicators are measured in tons. This indicator applies to hazardous and non-hazardous waste from all economic sectors and households, including waste from waste processing (secondary waste), except for mineral waste. [21, 23]. Mineral waste is excluded in order to avoid situations where trends in the production of ordinary waste can be "drowned" due to massive fluctuations in the production of waste in the mining and mineral transformation industry. It also allows for a more meaningful comparison between countries, as mineral waste represents significant amounts in countries characterized mainly by the mining and construction sectors. [20] The change in the rate of wastewater recycling in the period from 2010 to 2018 is shown graphically in Fig. 3. The higher the value - the percentage of the waste recycling rate, the more waste is secondary processed, and the less waste ends up in landfills, incinerators or just thrown away, often in the wild [21, 22].

Based on the analysis, we can conclude that in 2010 there were only nine states within the European Union (out of a total of 28 countries) whose waste recycling rate was higher than the European average (53%). In 2014 it was already in 11 countries (which had a higher percentage of recycling than the European average of 55%), and in 2018 it was also in 11 countries, but this year the European average was 56% [22] (Fig. 4).

One of the indicators of the application of the circular economy to the economy of a given country is the rate of use of circular material (CM) [22]. This indicator measures the share of recycled material and its reuse in the economy, which leads to a reduction in the amount of extracted primary raw materials in the overall use of the material. Circulating material usage, also known as circulation rate, is defined as the ratio of circulating material used to total material used [23, 27]. The total use of the material is equal to the sum of the total domestic consumption of material and the use of circulating material. Using recycled material approaches the amount of waste recycled in domestic waste recovery facilities minus imported manure intended for recovery plus exported waste intended for recovery abroad [24]. Waste recycled in domestic waste recovery facilities includes recovery activities, defined in the Waste framework directive

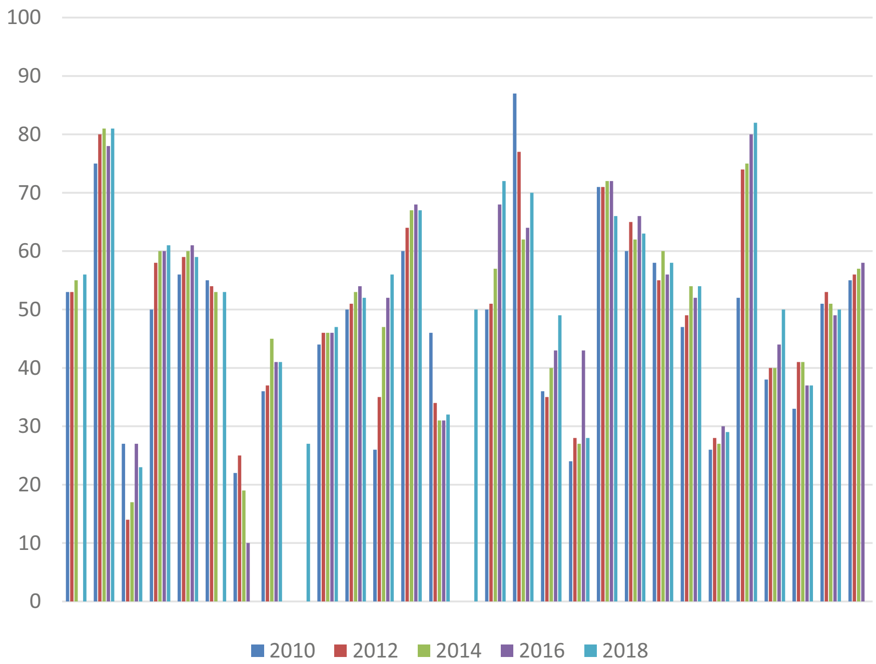

Fig. 4. Recycling rate in EU countries in the period 2010–2018 [22].

75/442/EEC. [21] The rate of use of circulating material has changed over the years in individual countries of the European Union (Fig. 5) It declares the change in the rate of use of circulating material in the period 2010–2020 and a graphic representation of the map of Europe in the period 2010–2020 [22, 25].

The higher the value of the recycling material utilization rate, the more secondary materials replace primary raw materials, which reduces the environmental impact of primary material extraction [26, 29]. Unlike the linear one, the circular economy works in closed circles: biological and technical. Within those circles, materials move, and there is no waste, because the circular economy perceives waste as a resource [27, 29]. Because he is: textiles as a source for building material, food waste as a source for the paper industry, bio-waste as a source for agriculture. This systemic change is not a choice for people, but an obligation. It requires the cooperation of all areas of society, from consumers, designers and material experts, developers, companies, and investors, to the third sector, academics and politicians [28].

However, unless countries around the world implement the "polluter pays" rule and economically favour ecological business (for example, by taxing carbon dioxide production), the transition of companies and their customers to green mode will be more or less only a matter of personal conviction [19, 28].

Although the current economic system knows the concept of renting, long-term borrowing is perceived as economically disadvantageous. In the circular economy, renting is the basis for completely new business models in all sectors of life, which fundamentally

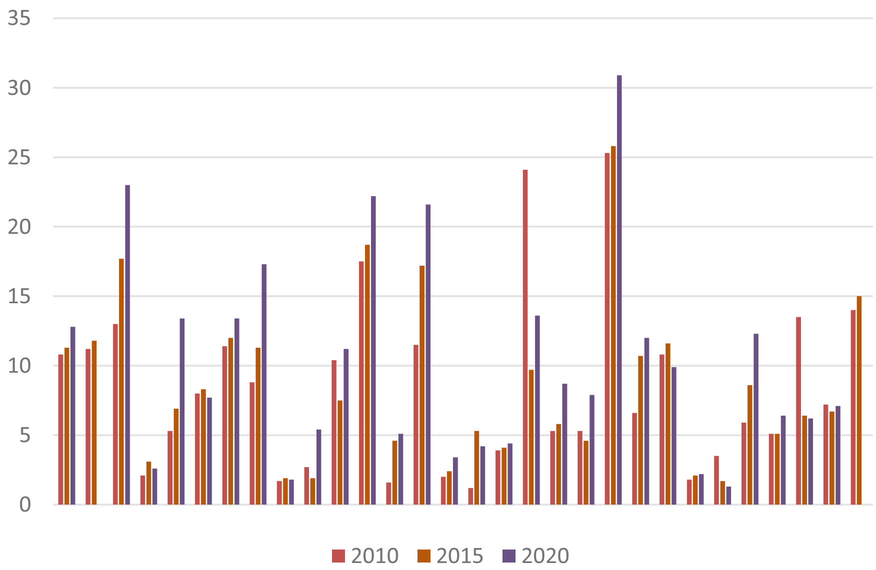

Fig. 5. Transformation and communication process of circular economy [22].

change how products are owned [29, 31]. Consumers become users who buy the service, that is, the flawless functioning and performance of the products, not the product itself.

Companies are the owners of the products and are also responsible for their maintenance, repairs, energy efficiency and recovery. Such a system is a win-win for everyone. Users do not have to worry about repairs or high one-time purchase costs, allowing many to have a better standard of living and use first-class products [30].

Companies are motivated to produce quality products and design them so they can be evaluated as best as possible. Waste, dependence on raw materials and negative impacts on the environment or human health are eliminated. A fundamental part of this effort is a change in the approach to product design.

Another key element in building a circular economy is creating new business models and reforming existing supply chains [31]. By moving from transactional models to contractual models (i.e. models where products are seen as a service), companies can work more closely with their customers and contribute to a strategy that keeps products out of the landfill [32].

4 Conclusion

Innovations in the field of production and processing of mineral raw materials through the transformation process always bring with them new possibilities, which on the one hand, are positive. There is a faster, more efficient, more variable transformation of inputs into outputs. Still, on the other hand, such rapid and uncontrolled consumption greatly burdens nature and the environment. It is, therefore, necessary to stop, or at least slowdown, this fast consumer lifestyle and think about your actions.

Circular economy - a modern strategy of thinking and acting which aims to teach this planet's inhabitants to minimise waste production. It is becoming more common among people, especially state representatives who are adopting a large number of measures, regulations, and directives to reduce and prevent waste generation in a certain time horizon. The level of implementation of the circular economy in individual countries is different, due to the maturity of the countries and the standard of living.

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