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Breaking Down the Concept of Circular Economy: Qualitative Content Analysis

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Abstract

With acceleration of such emerging global problems as climate change, overpopulation, loss of biodiversity, deforestation, soil erosion, air, water and soil pollution modern economy is seeking for new and sustainable paradigm on how to operate. A promising concept which can have a positive impact on mitigation of global issues is circular economy. Concept is wide and seems to be philosophical in its essence. Therefore, the paper breaks down the concept of circular economy. The objective of the study is to identify characteristic elements of circular economy. Qualitative content analysis of 35 articles published from 2016 to 2019 and indexed in SCOPUS was used to identify the key elements of circular economy. The results show that key elements of circular economy are '4R+7R' (24,6%), waste (11,8%), closed-loops (10,8%), design (10,6%), business models (9,3%), systems thinking (6,0%), life cycle thinking (6,0%), resource efficiency (5,8%), consumption (4,8%), value preservation (3,0%), sharing (2,5%), renewable energy (2,0%), behaviour (1,5%) and industrial symbiosis (1,3%). This research indicating specific elements of circular economy reflect the concept as wide tool with various specific strategies which has a great potential in contributing to global issue solving.

Keywords: Circular Economy, Climate Change, Economy, Environment, Qualitative Content Analysis.
JEL codes: R11, Q01, Q53

1. Introduction

Up to this point society has lived according to the linear '*take-make-use-dispose*' consumption model. Global population is consuming like we have 1.75 planets Earth and the Earth Overshoot Day is coming earlier year by year. Earth Overshoot Day has moved from January 1st in 1970 to July 29th in 2019, which has been the earliest ever (Global Footprint Network, 2019). It means that by this specific date humanity has used nature`s resource budget for the entire year. After that date humanity lives 'on debt' and discourages sustainable development. Even worse – 'unsustainable development' based on linear consumption accelerates. Last 150 years of industrial development have been dominated by linear model of production and consumption in which products are produced from raw materials, sold, used and discarded as waste (Geipele I. and Others, 2018, p.66). This also has benefited to creation of 'consumption society' and created rather inflexible linear consumption patterns. From the perspective of energy a great harm has been done to environment, because linear economy is mostly driven by fossil fuels, which create great amount of CO_2 emissions contributing to climate change, which, however, has accelerated such global disastrous events as Amazon rainforest wildfires in 2019 and Australian bushfires in 2019-2020. Such extreme events increase the urgency of the situation and accelerate the need for research and development (R&D) activities to identify, develop and optimize tools to mitigate these global issues. Scientific environment has identified the concept of circular economy already from 1960s, when American economist Kenneth Ewart Boulding drew an analogy regarding rather circular than linear flow of resources transforming the paradigm from 'cowboy economy', which characterises with endless resources and ability to abandon problems, to 'spaceship economy', where limited resources had to be reused and recycled as precondition to sustainable life-support systems (Geipele I. and Others, 2018, p.66). The concept of the circular

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economy is opposite to the traditional 'linear economy' which turns raw materials into waste in the production process and which is seen to lead to ecological pollution and removal of natural capital (Zvirgzdins, Plotka and Geipele S., 2019, p.704). Circular economy is linked to such global initiatives as climate change mitigation and adaption in urban and rural areas, reduction of fossil fuel use and development of renewable energy sources, provisioning of food, and reuse of space and recovery of brownfields (Zvirgzdins, Plotka and Geipele S., 2018, p.94). The concept has been discussed for years among scientists and the most holistic definition of circular economy is given by Kirchherr, Reike and Hekkert (2017, p.p.224-225) and is following: *'A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations.'* However, there is still research gap which needs to be filled as the concept is wide and lacks measurability. Identifying the characteristic elements of circular economy is the first step towards creating methodology on how to make the concept of circular economy measurable. Therefore, authors have carried out qualitative content analysis in order to identify the main elements of circular economy.

2. Methodology

Qualitative content analysis of 35 articles published from 2016 to 2019 and indexed in Scopus was used to identify the key elements of circular economy.

Qualitative content analysis is a widely used qualitative research technique. This scientific approach is used to interpret meaning from the content of text data. In content analysis, coding categories are derived directly from the text data (Hsieh and Shannonc, 2005, p.1277).

Scopus is the largest abstract and citation database of peer-reviewed literature: books, scientific journals and conference proceedings. Database delivers a comprehensive overview of the world`s research output in the fields of science, technology, medicine, social sciences, and arts and humanities (Scopus: Access and use Support Center, 2019).

Research objective: to identify characteristic elements of circular economy.

Research object: the concept of circular economy.

Research subject: characteristic elements of circular economy.

Research question: What are the characteristic elements of circular economy?

Initial search for the scientific literature, which could provide authors with comprehensive answer to the research question, was carried out based on key words. Following key words were used for initial search: 'circular economy' and 'literature review'. First keyword 'circular economy' is directly related to research object, but the second key word 'literature review' is aimed at narrowing the total amount of literature sources to theoretical studies, which have greater potential in discovering the essentials of the concept of circular economy. Entering both key words, the search resulted with 1074 search results. Authors limited publishing time-scale of literature sources to articles published from 2016 to 2019 and the number of literature sources was narrowed down to 916 results. Subject area was limited to 'Social sciences' narrowing the number of literature sources down to 213.

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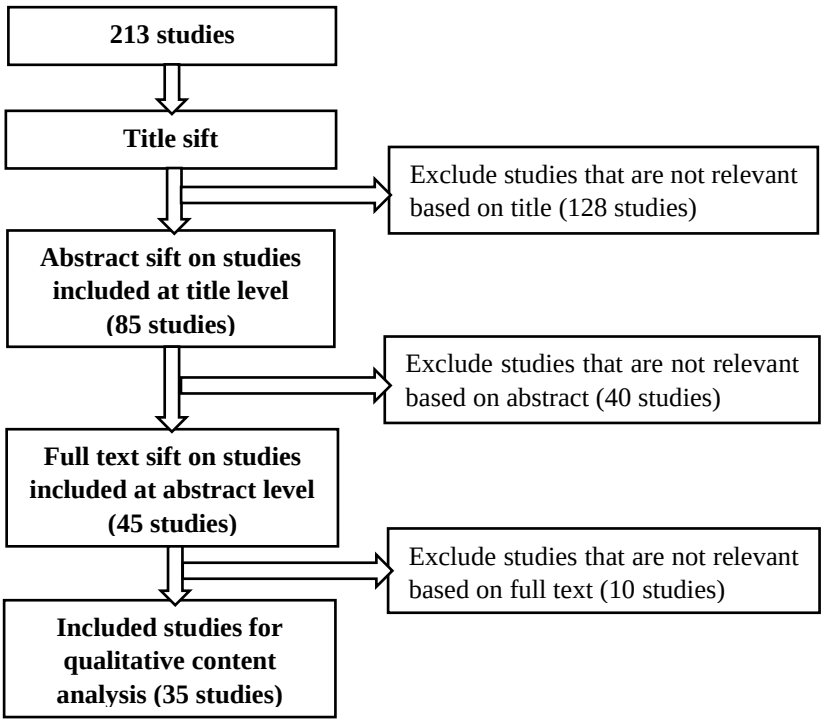
Further selection process of scientific literature sources was carried out based on process of selecting studies reflected in Figure 1. After title sift 128 studies were excluded leaving 85 studies for abstract sift, during which 40 studies were excluded from further selection process. Full text sift were executed on remaining 45 studies, which resulted in selection of 35 studies which were included in qualitative content analysis.

Figure 1. Process of selecting studies for qualitative content analysis (adapted from (Booth, Sutton and Papaioannou, 2016, p.99))



Qualitative content analysis was based on 35 studies indexed in Scopus (Lewandowski, 2016; Moreno and Others, 2016; Barrie, Zawdie and Joao, 2017; Kopnina, 2017; Murray, Skene and Haynes, 2017; Nobre and Tavares, 2017; den Hollander, Bakker and Hultink, 2017; Masi, Day and Godsell, 2017; Nußholz, 2017; Barragán-Escandón, Terrados-Cepeda and Zalamea-León, 2017; Kirchherr, Reike and Hekkert, 2017; Camilleri, 2018; Schroeder, Anggraeni and Weber, 2018; De Mattos and De Albuquerque, 2018; Shih and Others, 2018; Marin and De Meulder, 2018; Wastling, Charnley and Moreno, 2018; Cui and Zhang, 2018; Camacho-Otero, Boks and Pettersen, 2018; Lahti, Wincent and Parida, 2018; Geisendorf and Pietrulla, 2018; Stewart and Niero, 2018; Gregorio, Pié and Terceño, 2018; Laumann and Tambo, 2018; Esposito, Tse and Soufani, 2018; Lüdeke-Freund, Gold and Bocken, 2019; Vanhamaki and Others, 2019; de Carvalho Araújo and Others, 2019; Trica, Banacu and Busu, 2019; Prieto-Sandoval and Others, 2019; Bruel and Others, 2019; Mayer and Others, 2019; Kjaer and Others, 2019; Tate and Others, 2019; Nosratabadi and Others, 2019).

Qualitative content analysis was carried out collecting parts of the selected studies which were answering the research question. 23 codes were developed from the text fragments. From 23 codes 14 categories were developed, defined and analysed.

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3. Results and Discussion

Results of qualitative content analysis is shown in Table 1 reflecting the characteristic elements of circular economy. There are reflected 14 categories as answers to the research question: 'What are the characteristic elements of circular economy?' Categories are ranked in descending order based on their frequencies. The most characteristic elements of circular economy based on results of qualitative content analysis (see Table 1) are '4R+7R' activities, waste, closed-loops, design and business models, which should be considered as priorities when discussing the concept of circular economy. Percentage of Table 1 reflects the share of respective category being answer to the research question.

Table 1. Summary of categories and frequencies of qualitative content analysis

Rank	Category	Frequency	%
1	4R+7R	98	24,6%
2	Waste	47	11,8%
3	Closed loops	43	10,8%
4	Design	42	10,6%
5	Business models	37	9,3%
6	Systems thinking	24	6,0%
7	Life cycle thinking	24	6,0%
8	Resource efficiency	23	5,8%
9	Consumption	19	4,8%
10	Value preservation	12	3,0%
11	Sharing	10	2,5%
12	Renewable energy	8	2,0%
13	Behaviour	6	1,5%
14	Industrial symbiosis	5	1,3%
	Total	398	100%

Source: Developed by authors

Data of Table 1 is illustrated in Figure 2 which emphasizes '4R+7R' activities (reduce, reuse, recycle, remanufacture; refuse, refill, repeat, repair, remediate, reclaim, return) as main element of circular economy. Category 'Waste' is with second greatest frequency (47), which is followed by 'Closed loops' (43), 'Design' (42) and 'Business models' (37) categories. It can be seen that there is a significant drop between category 'Business models' and 'Systems thinking' (24) regarding the frequencies of categories of qualitative content analysis, emphasizing the previously mentioned categories. A smaller emphasis is given to such categories (characteristic elements of circular economy) as 'Systems thinking', 'Life cycle thinking' (24), 'Resource efficiency' (23), 'Consumption' (19), 'Value preservation' (12), 'Sharing' (10), 'Renewable energy' (8), 'Behaviour' (6) and 'Industrial symbiosis' (5).

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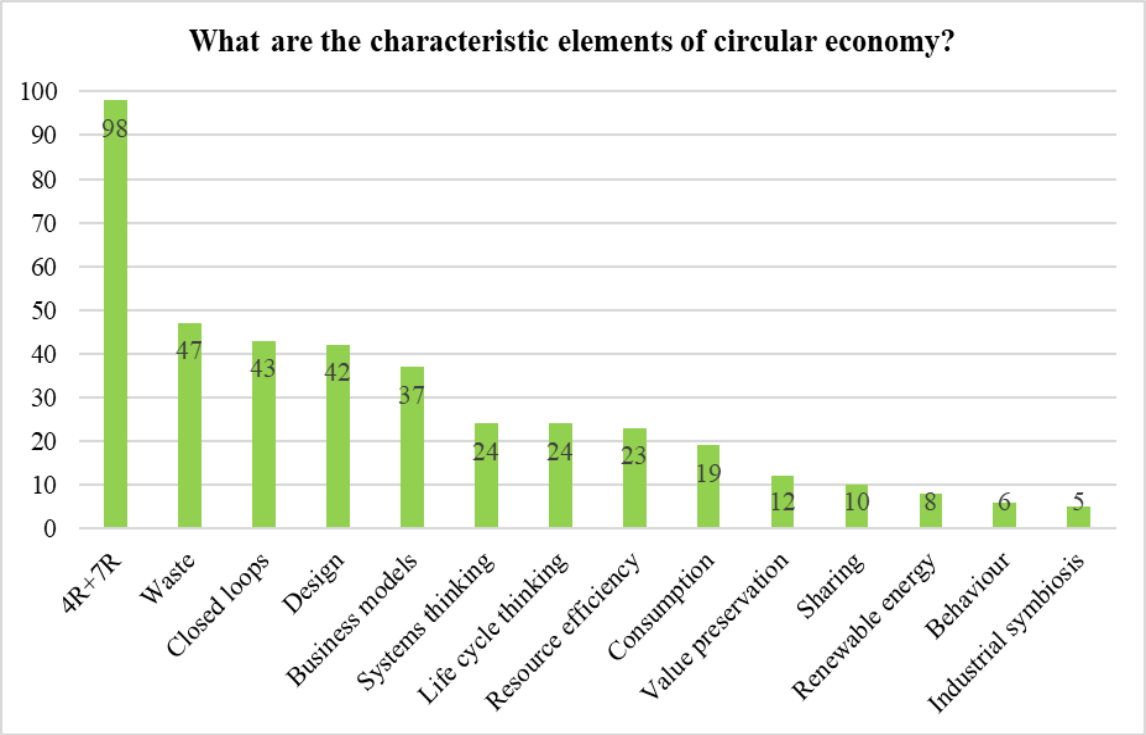
Figure 2. Frequencies of categories of qualitative content analysis (developed by authors)



In order to understand how many articles have addressed the specific element of circular economy, authors developed summary in Table 2. The difference from the data in Table 1 is that at this case each element of circular economy was counted only once per study. The results of Table 2 reflect similar situation as the Table 1 emphasizing '4R+7R', 'Waste', 'Closed loops', 'Design' and 'Business models' categories. It can be seen that categories 'Systems thinking' and 'Life cycle thinking' are also crucial as they are mentioned as characteristic elements of circular economy in the same amount of studies as category 'Business models' (18 studies).

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Table 2. Summary of amount of category mentions per study out of 35 studies included in qualitative content analysis

Rank	Category	Frequency	%
1	4R+7R	31	88,6%
2	Waste	27	77,1%
3	Closed loops	24	68,6%
4	Design	19	54,3%
5	Business models	18	51,4%
6	Systems thinking	18	51,4%
7	Life cycle thinking	18	51,4%
8	Consumption	15	42,9%
9	Resource efficiency	12	34,3%
10	Value preservation	12	34,3%
11	Sharing	8	22,9%
12	Renewable energy	7	20,0%
13	Industrial symbiosis	5	14,3%
14	Behaviour	2	5,7%

Source: Developed by authors

In order to understand, what is meant by each category, authors developed the definitions of each category and reflected them in Table 3.

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Table 3. Definitions of categories derived from qualitative content analysis

Category	Definition
4R+7R	Principle of multiple use and recovery (reduce, reuse, recycle, remanufacture (4R); refuse, refill, repeat, repair, remediate, reclaim, return (7R) …). In scientific publications this principle is also referred to as 3R principle - reduce, reuse, recycle. However, the amount of Rs and variations is flexible as there are more than 11 'R' activities in totality.
Waste	Reduction of waste generation and waste management.
Closed loops	Flow of materials and resources in a closed system to reduce the volume and speed of resource flow.
Design	Product and service design that includes such elements as long-lasting, regenerative, reuse, recyclability, durability, maintenance and circularity.
Business models	Models describing and visualizing the basic principles of monetization. In the context of the circular economy, the most common are: 1) repair and maintenance; 2) reuse and redistribution; 3) refurbishment and remanufacturing; 4) recycling; 5) cascading and repurposing; 6) organic feedstock business model.
Systems thinking	A system or system approach that points to the necessity for general paradigm shifts to successfully implement the concept of circular economy.
Life cycle thinking	A life-cycle approach to products and resources from the extraction of primary resources to the management or disposal of waste considering ecological, economic and social aspects.
Resource efficiency	Efficient and smart use of raw materials and energy with minimal harm to the environment.
Consumption	Society`s consumption of materials, resources and products, which in the framework of circular economy should aim for minimum volumes.
Value preservation	Preserving the value of a product or material with the aim of preserving the quality of the material or product for as long as possible.
Sharing	Derivative of the 'sharing economy' concept based on a change of ownership model from private goods (washing machines, cars, etc.) to shared products used by more than one household, thus reducing overall demand for the relevant products.
Renewable energy	The use of renewable energy (solar, wind, water, geothermal, bioenergy, wave energy) in the energy sector within the framework of circular economy and the use of renewable resources.
Behaviour	Consumer behaviour related to consumption trends, flexibility to change and paradigm shift in resource use and management.
Industrial symbiosis	Intercompany clusters at the supply chain level where waste from one company serves as a resource for another.

Source: developed by authors

The principle of multiple use and recovery (4R + 7R) is mentioned as a characteristic element of the circular economy in 88.6% of the scientific studies included in qualitative content analysis. Category`s '4R+7R' frequency is 98 (Table 1), which is more than two times greater than the frequency of the category 'Waste', which is characteristic element of the circular economy with the second highest frequency. '4R + 7R' includes reducing product and resource consumption, reusing products and resources, recycling, refurbishing, repairing,

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repurposing and re-designing, for example, transforming redundant office buildings into living spaces. The concept of circular economy emphasises waste management, which is closely linked to the previously mentioned '4R + 7R' concept. The category 'Waste' is related to the reduction of waste generation and waste management, which is mainly based on recycling. In the ideal model of circular economy there is no waste - all resource inputs are used over and over again. Category 'Closed loops' is mentioned as a characteristic element of the circular economy in 68.6% of the selected scientific studies. It is based on the flow of materials and resources in a closed system with the aim of reducing the volume and speed of the flow. Closed loops is highly linked to '4R+7R' concept as within the loop materials are consistently reused. In the ideal closed loop no waste is being generated. Category 'Closed loops' is also linked to category 'Resource efficiency' which is mentioned as a characteristic element of the circular economy in 34.3% of the selected scientific studies. Reducing the speed and volume of resource and material flows while meeting the general demand for goods and services is achievable at the same time if resource efficiency is being increased. This aspect is being more crucial as the global population is growing exponentially and is expected to reach the 9.7 billion margin by 2050. Additionally, scientists say that it will require global revolution to feed the world in 2050 (Ehrlich, Harte, 2015, p.14743). Considering that there are only 30 years left authors suggest that 'revolution' and shift of paradigm needs to start now. The category with the fourth highest frequency (42) regarding the characteristic elements of circular economy is 'Design' which includes the design of products and services. It is closely linked to the '4R + 7R' category as within the circular economy the product is designed considering regeneration, reusability and recyclability as well as long-lasting feature, durability and maintenance. Considering current practices with non-consumption products designed to end their service life shortly after the warranty period for profit maximization, the circular economy concept aims to shift these patterns extending the life of any material and product by changing the resource consumption paradigm which applies to category 'Systems thinking', which is mentioned as a characteristic element of the circular economy in 51.4% of the selected scientific studies. The category is based on a systems approach, which points to the need for a general paradigm shift for the successful implementation of the circular economy. It could be argued that the other categories are subject to a systems approach that is comprehensive and helps to see synergies within the concept of circular economy. The fifth largest category is 'Business models', which is mentioned as a characteristic element of the circular economy in 51.4% of the selected scientific studies. Business models describe the fundamentals of revenue generation. In the context of the circular economy, the most common business models are: 1) repair and maintenance; 2) reuse and redistribution; 3) refurbishment and remanufacturing; 4) recycling; 5) cascading and repurposing; 6) organic feedstock business model. Given the characteristics of business models, their relation to the '4R + 7R' category should be emphasized. Category 'Life cycle thinking' is mentioned in 51.4% of the selected scientific studies. It is a life cycle approach to products and resources from the extraction of primary resources to the management or disposal of waste considering the ecological, economic and social aspects. The category is directly linked to 'Waste', 'Systems thinking and 'Resource efficiency' categories. Considering the pattern that global society is currently consuming resources in the amount which is analogue to 1.75 planets Earth, authors emphasize category 'Consumption' (which is mentioned in 42.9% of the selected studies) as crucial to promote transition to circular economy and sustainable development. 'Value preservation' is the category mentioned in 34.3% of the selected studies. It is a characteristic element of the circular economy that aims to preserve the quality of the material or product for as long as possible in order to reduce the demand for new goods and thus reduce the consumption of resources and products. Another characteristic element of the circular economy associated with demand reduction is the 'Sharing' category which is mentioned in 22.9% of the selected studies. The category is based on the concept of sharing economy. The main idea of concept is the change of ownership model - from private goods (washing machines, cars, etc.) to shared products used by more than one household. Sharing economy can create great positive impact on global issue solving. For example, passenger vehicle sharing strategy applied to passenger vehicles in European Union (excluding Bulgaria, Cyprus, and Malta) has a potential to cut emissions by 358.6 $MtCO_2$ eq. and save 7.64 billion EUR annually (Zvirgzdins, Plotka and Geipele I., 2020, p.870). Category 'Behaviour' is directly linked to category 'Consumption'. This element of circular economy is characterized by public consumption trends, flexibility towards the change and paradigm shift in resource use. Category 'Industrial Symbiosis' is mentioned as a characteristic element of the circular economy in 5 of 35 (14.3%) scientific studies included in qualitative content analysis. The essence of the

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industrial symbiosis is that the waste of one company serves as a resource for another, theoretically closing and slowing the flow of resources and minimizing the waste. This clearly indicates links to 'Waste' and 'Closed loops' categories. The category 'Renewable energy' is mentioned as a characteristic element of the circular economy in 20% of the scientific studies. Within the circular economy all the energy should be generated by renewable energy sources - solar, wind, water, geothermal, bioenergy and wave energy. Additionally, production also should be based on such renewable and sustainable resources as timber. In the view of authors, the concept of circular economy focuses on '4R+7R' and waste management activities without paying much attention to energy aspect. Therefore, the category 'Renewable energy' has relatively low frequency in the qualitative content analysis even though the energy is one of the most important aspects in any concept.

4. Conclusion

As a result of qualitative content analysis which was carried out analysing 35 scientific studies published from 2016 to 2019 and indexed in Scopus, 14 categories as answers to research question revealing characteristic elements of circular economy have been developed and mentioned 398 times in total.

The results show that characteristic elements of circular economy are the principle of multiple use and recovery '4R+7R' (mentioned as answer to research question in 24,6% cases), waste (11,8%), closed-loops (10,8%), design (10,6%), business models (9,3%), systems thinking (6,0%), life cycle thinking (6,0%), resource efficiency (5,8%), consumption (4,8%), value preservation (3,0%), sharing (2,5%), renewable energy (2,0%), behaviour (1,5%) and industrial symbiosis (1,3%).

The principle of multiple use and recovery (4R + 7R) is considered to be the central element of the circular economy which is highly linked to other elements of circular economy. In the ideal model of circular economy there is no waste considering the flow of resources and products through closed loops. Therefore, minimization of waste generation and waste management are essential for the transition from the linear economy to circular economy.

The concept of the circular economy covers the whole life cycle of a product or material from the design phase considering reusability, recoverability, recyclability, durability, to waste management. Meanwhile, the concept strives to preserve the maximum value of products and materials.

Consumption and overall demand for goods can be reduced by designing long lasting products and implementing business models based on the features of '4R + 7R' principle. Additionally, great impact on solving global issues can be achieved using the concept of sharing economy (which is a part of circular economy) and changing the model of ownership from a private to shared.

All required energy throughout the product life cycle (design, production, logistics, use, waste management) within the circular economy concept must come from renewable energy sources.

The characteristic elements of the circular economy are greatly interconnected. Comprehensive element of the circular economy is systems thinking or systems approach. It encircles other elements of the circular economy and indicates synergies between them.

The future research direction is linked to more detailed exploration of characteristic elements of circular economy and their interconnectedness. In order to make the concept of circular economy measurable authors plan to develop methodology based on the identified characteristic elements of circular economy. Therefore, next steps are linked to identification and development of indicators which will provide the basis for measurable mathematical model of circular economy.

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