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CIRCULAR ECONOMY AND ITS BARRIERS TO IMPLEMENTATION IN THE CONSTRUCTION SECTOR

Abstract

The concept of circular economy has become an important topic during the last decade, because it offers a systems solution framework that creates a closed-loop system to minimize waste and maximize resource efficiency in order to achieve a better balance and harmony between economy, environment and society. The construction industry has significant potential to apply a circular economy model since this industry is responsible for considerable global natural resource extraction and solid waste production. Worldwide, more than 10 billion tons of construction and demolition waste are produced annually, while the demolition alone is responsible for 50% of all waste produced by the building sector. In Serbia, the sectors of agriculture, forestry and fishing, mining, manufacturing, electricity, gas and steam supply, water supply and wastewater management, construction and service activities generated 56.3 million tons of waste just during 2020. Although 80% of construction waste can be recycled according to the Agency for Environmental Protection reports the waste recycling has not yet been established in Serbia. On the other hand, Serbia adopted the Roadmap for Circular Economy in Serbia, the Law of Waste Management, the Regulation on the Manner and Procedure of Waste Management from Construction and Demolition, and accepted the conditions of the European Union for linking the European Green Deal with the strategic development of the region by signing the Green Agenda for the Western Balkans. This paper provides a brief literature review that introduces the circular economy by presenting its origin, definition and principles as well as the barriers (five categories: technological, economic, socio-cultural, institutional and regulatory) to its wider adoption in the construction sector.

Keywords

Circular economy, barriers, principles, 10R model, construction and demolition waste, construction industry.

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1. INTRODUCTION

During the last decade, increasing attention has been paid to the circular economy (CE) worldwide, as a new concept and model of development that goes beyond the current production and consumption model based on continuous growth and increasing resource throughput. CE offers a systems solution framework that creates a closed-loop system to minimize waste and maximize resource efficiency in order to achieve a better balance and harmony between economy, environment and society [1].

In general, waste is generated throughout the lifecycle of an asset. Demolition alone is responsible for 50% of all waste produced by the building sector around the world. Furthermore, the end-of-life phase of assets represents the least sustainable phase, given the amount of waste generated by the demolition process [2]. Potential end-of-life scenarios for three common construction materials are presented in Figure 1. Globally, more than 10 billion tons of construction and demolition waste (C&DW) are produced every year [3]. With approximately 2.36 billion tons, China represents the largest producer of solid waste in the world [4] followed by the European Union with approximately 820 million tons [5] and the United States with approximately 700 million tons per year [6].

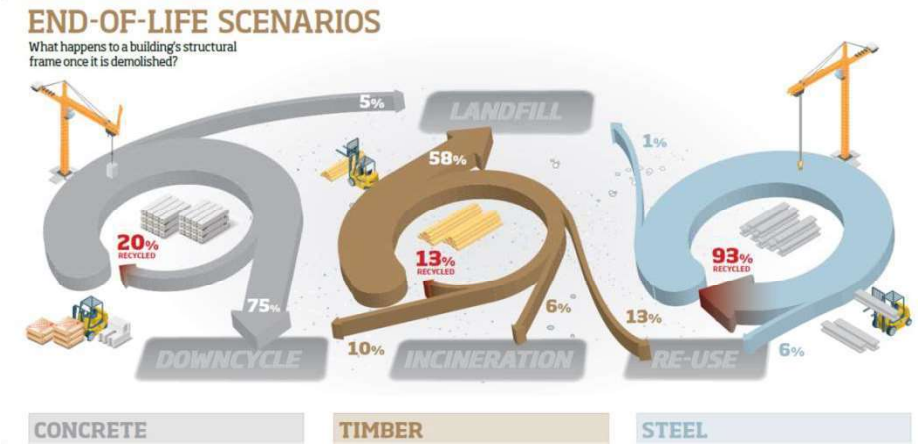


Figure 1. Possible end-of-life scenarios for three common construction materials [7]

During 2020 in Serbia, the sectors of agriculture, forestry and fishing, mining, manufacturing, electricity, gas and steam supply, water supply and wastewater management, construction and service activities generated 56.3 million tons of waste [8]. From the total amount, even 20.1% was hazardous waste, while the rest was non-hazardous [8]. Waste recycling has not yet been established in Serbia, although 80% of construction waste can be recycled according to the Agency for Environmental Protection reports [9]. Furthermore, Serbia adopted the Law of Waste Management [10], but the Regulation on the Manner and Procedure of Waste Management from Construction and Demolition [11] was adopted only a few months ago, in October 2023.

The Serbian Ministry of Environmental Protection and the Circular Economy United Nations Development Program participated in the drafting of the document Roadmap for Circular Economy in Serbia [9] that was adopted back in April 2020, and it represents the first document that initiated a dialogue between decisionmakers, industry representatives, academia and civil society in order to

define the goals, future steps and time frame for the transition from a traditional linear model to the circular economy [8]. In November 2020 [8], Serbia accepted the conditions of the European Union for linking the European Green Deal with the strategic development of the region by signing the Green Agenda for the Western Balkans [12]. Serbia also has a Digital Platform for the CE [13] that provides support to companies through business models, examples of good practice and tools, in order to more easily apply the circular business model, reduce the carbon footprint in production processes and products.

Worldwide, the construction industry has significant potential to adopt CE practices, although it faces several barriers that hinder its implementation. In this paper is given a brief literature review that introduces CE by presenting its origin, definition and principles as well as the barriers to the wider adoption of CE in the construction sector.

2. CIRCULAR ECONOMY DEFINITION AND PRINCIPLES

Over the last 150 years [14], the worldwide industrial economies have been dominated by a traditional linear economy model so called "take, make, use and dispose" (Figure 2). The need for an alternative to the dominant linear economy that would reduce the consumption of raw materials [15], and therefore, put greenhouse gas emissions and use of natural resources under control within the specific territory, led to the creation and development of CE, which concept has been discussed since the late 1970s [16]. The environmental economists, Pearce and Turner [17], primarily introduced the concept of circular economic system which is based on the Boulding's idea [18].

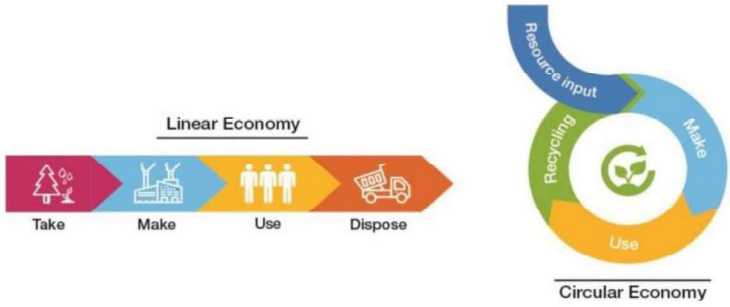


Figure 2. The model of linear and circular economy [19]

There is not just one, but many definitions that are used in parallel for CE, although there is still no clear and accepted definition in the construction industry [20]. Kirchherr et al. [21] gathered and analysed 114 CE definitions and their findings indicated that CE is most frequently depicted as a combination of reduce, reuse, and recycle activities, whereas it is oftentimes not highlighted that CE necessitates a systemic shift. Also, the definitions showed few explicit linkages of the CE concept to sustainable development, and that the main aim of the CE is economic prosperity, followed by environmental quality, while its impact on social equity and future generations is barely mentioned. One of the most recognized definitions of the circular economy was proved by the Ellen MacArthur Foundation and that is: "A circular economy is one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles." [22].

CE principles are largely derived from several intertwined schools of thoughts. Currently, there are a number of CE models that have been implemented with a simple approach such as the

3R model [19] or the 5R+ models. CE, which is based on 3R principles, includes Reduce, Reuse, and Recycle [23], while 5R principles are encouraged by adding Recovery and Reclamation/Repair to the 3R principles [24]. Nowadays, a 10R approach is suggested [21,25,26] with five more additional principles including Refuse, Refurbish, Remanufacture, Repurpose, and Re-mine/Rethink (Figure 3).

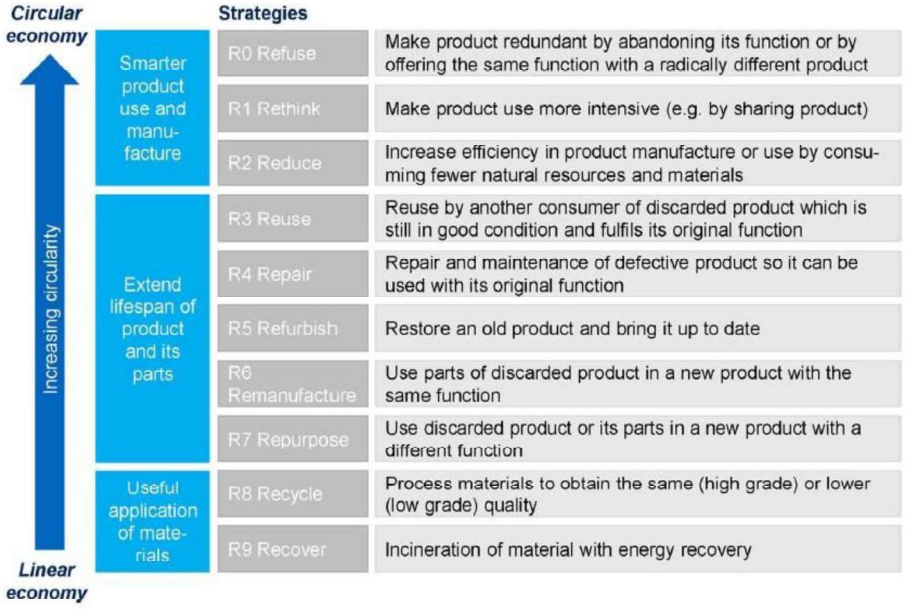


Figure 3. 10R model of the circular economy [21]

3. IMPLEMENTATION BARRIERS OF CIRCULAR ECONOMY IN CONSTRUCTION SECTOR

The adoption of the CE in the construction sector has its challenges due to complexity and faces several barriers. De Jesus and Mendonça [27] made a division into soft (institutional and social) and hard (technical and economic) barriers that hinder the implementation of CE. Further, Kirchherr et al. [28] classified the barriers into four categories (cultural, regulatory, market and technological). The classification into five categories was done by Ritzén and Sandström [29] (financial, structural, operational, attitudinal and technological barriers), Masi et al. [30] (financial, institutional, infrastructural, societal and technological barriers), and Munaro and Tavares [31] (regulatory/political, technological, economic/financial/market, socio-cultural/informational and institutional/organizational).

The technological barriers in the previous listed researches are recognized as: Generally lack of technologies and infrastructure; Lack of integrated C&DW processes, tools and practices; Lack of effective green building design development; Lack of quality and availability of data (privacy, trust, ownership, access); Lack of documentation of new and used building products; Lack of datasets and tools compliant with BIM, etc.

The economic barriers are: Low costs and high availability of virgin raw materials; High costs of deconstruction, separating, treating, transportation and storage of C&DW as well as high

prices of recycled/reused materials/products; Lack of market mechanisms for recovery/reuse of materials or it is underdeveloped; Extra costs of building insurance and/or professional indemnity when using recycled materials; Lack of reward and penalty schemes for C&DW management operations; High prices for green buildings; High investment costs of waste technologies; Cost of developing products certifications, Limited funding for circular business models, etc.

The socio-cultural barriers represent: Generally the lack of research, education and information; Lack of publicity and information campaigns; Social and behavioural aspects of modern consumerism; Negative public perception e.g. impaired quality perception of recycled materials in components and buildings; Limited environmental management programs at academic institutions, Operating in a linear system; Hesitant company culture; Limited willingness to collaborate in the value chain, etc.

The institutional barriers include: Generally the lack of knowledge, integration, and cooperation between stakeholders; Lack of strategic vision and collaborative platforms; Lack of guidance and tools for the implementation/assessment of circular buildings; Conservative, competitive and fragmented supply chains; Lack of knowledge about circular tools such as Material Passports, certifications, etc.

The regulatory barriers represent: Generally the lack of government policies, regulatory instruments, and fiscal actions; Lack of global consensus; Lack of flexibility in the building codes and regulations; Lack of a waste code to guide C&DW management and discourage landfilling; Lack of a tax system and standard quality for reclaimed materials; Lack of circular vision, etc.

3.1. BARRIERS TO CIRCULAR ECONOMY IN THE WESTERN BALKAN COUNTRIES

Serbia accepted the conditions of the European Union by signing the Green Agenda for the Western Balkans to link the European Green Deal with the strategic development of the region [12]. The main pillar of a modern economy development represents The Industrial Policy Strategy of the Republic of Serbia (2021-2030) driven by circular and high-value principles in Serbia, that emphasize the circular economy promotion, encourage investments in circular and low-carbon solutions as growth drivers as well as more efficient use of the material resources and energy efficiency in industrial processes [32].

In Montenegro, the CE concept is on the rise with a strong tendency to grow and develop in the upcoming period. The public system of this country makes efforts to enable the development of eco-sustainable business, especially after a realization of the Smart Specialization Strategy of Montenegro for the period of 2019-2023, and the adoption of the Roadmap Towards the Circular Economy in Montenegro in 2022 [33].

Although the CE concept in Bosnia and Herzegovina (B&H) is still in its early stages, there are positive developments in this direction. At first, the Roadmap Towards the Circular Economy in B&H has been drafted [34]. Other positive developments in this direction can be seen in the Implementation of the 2030 Agenda and the Sustainable Development Goals (SDGs) in B&H, published in April 2019, which emphasizes that the business sector has to adapt to the SDGs recommendations.

Despite the different policy situations, the main barriers to implementation the CE in the Western Balkan countries (Figure 4) are: lack of knowledge and skills, unawareness of perceivable benefits, lack of experience of where and how to start, and lack of multidisciplinary professions and skills [32]. The lack of knowledge and skills as well as the lack of multidisciplinary professions and

skills is in a strong relation with education and innovation, which are additionally under different barriers and most of them originate from society as it is.

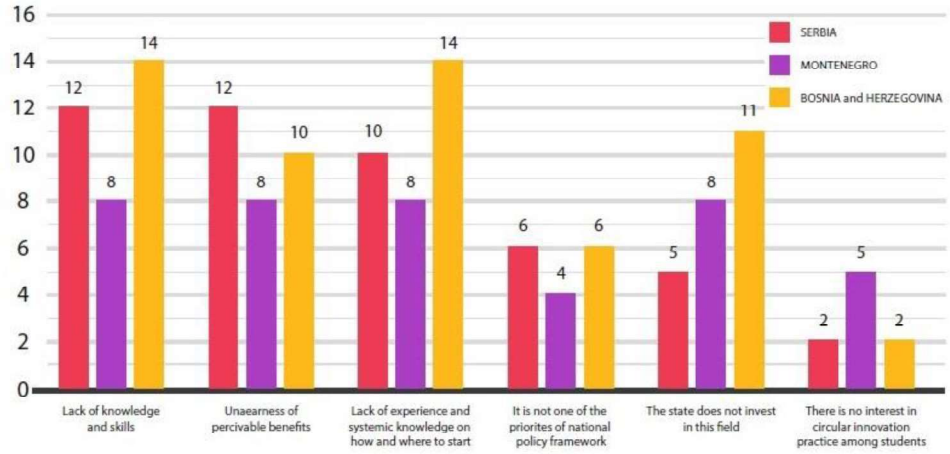


Figure 4. Implementation barriers to the circular economy in innovation sector and academia in Western Balkan countries [32]

4. CONCLUSION

Based on a brief review of the literature in terms of CE (its definition and principles), as well as its implementation barriers in the construction sector, the following conclusions can be drawn:

- In order to reduce the consumption of raw materials, to put greenhouse gas emissions and the use of natural resources under control within the specific territory, the dominant linear economy model needs to be replaced with the CE;
- One of the most recognized definitions of the CE was proved by the Ellen MacArthur Foundation;
- CE principles are largely derived from several intertwined schools of thoughts. The basic 3R model is based on the three principles, Reduce, Reuse, and Recycle, while nowadays, a 10R model is used with additional principles including Recovery, Reclamation/Repair, Refuse, Refurbish, Remanufacture, Repurpose, and Re-mine/Rethink, in comparison to the 3R model;
- The major issues related to the implementation of CE in construction sector are lack of government policies, regulatory instruments and fiscal actions, lack of strategic vision and collaborative platforms, lack of integrated C&DW processes, tools and practices, lack of an efficient C&DW management program, high costs of deconstruction, separating, treating, transportation and storage of C&DW as well as high prices of recycled/reused materials/products, low costs and high availability of virgin raw materials, lack of research, education and information, and impaired quality perception of recycled materials in components and buildings;
- The main barriers to implementation the CE in the Western Balkan countries are the lack of knowledge and skills, unawareness of perceivable benefits, lack of

experience of where and how to start, and lack of multidisciplinary professions and skills.

In general, the implementation of CE in construction sector depends on an effective communication about CE supported by a flexible and collaborative governance policy with the construction value chain.

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