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Safety Engineering & Management
Science - Industry - Education

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FACULTY OF OCCUPATIONAL SAFETY

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SCIENCE, INDUSTRY, EDUCATION
(SEMSIE 2025)

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ADVANCING THE CIRCULAR ECONOMY: THE ROLE OF KEY SECTORS IN DEVELOPING COUNTRIES

Abstract: *The implementation of the circular economy in industry is essential for reducing waste, optimizing resource use, minimizing environmental impact, and fostering sustainable economic growth through recycling, reuse, and innovative production and consumption models. This paper examines the potential for adopting circular economy principles in key sectors of developing economies, with a particular focus on the Republic of Serbia. The analysis explores four critical sectors: construction, textiles, agriculture and food, and plastic packaging by evaluating their current practices, opportunities for circular transition, and the challenges involved. By assessing these sectors, the paper provides valuable insights into how Serbia can move toward a more sustainable and resource-efficient economy, aligning with broader global objectives of sustainability and circularity.*

Keywords: circular economy in Serbia, key sectors for circular transition, circular transition in developing countries

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INTRODUCTION

At a global level, the issue of sustainable development and efficient use of resources is gaining increasing importance, especially in the context of climate change, resource depletion and the increasing amount of waste generated. The traditional linear economic model of "take, make, dispose" has shown numerous weaknesses that lead to significant negative environmental impacts. In a linear economy, the production process operates by extracting resources from the environment and converting them into finished products, which are then distributed on the market and consumed. At the end of their life cycle, the products created in this way become waste, which often ends up in landfills or incinerators without further use. The linear economic model ignores the potential for material reuse, increases the demand for continuous extraction of raw materials, and contributes to the escalation of air, water, and soil pollution, as well as the degradation of ecosystems.

In response to these challenges, the concept of the circular economy has been developed, which aims to achieve a closed-loop material cycle. The circular economy is based on three key principles: elimination of waste and pollution, circulation of products and materials (at their highest value), and regeneration of natural systems (Ellen MacArthur Foundation, 2013). The circular economy represents an environmental imperative and at the same time offers significant economic potential, stimulating new jobs, diverse innovations, and sustainable economic growth. In developing countries, this concept is increasingly integrated into strategic plans and legislative frameworks. However, in developing countries, such as the Republic of Serbia, the transition to circular practices is still in an early stage of development.

This research aims to explore the potential for implementing circular economy principles in four key sectors of the Serbian economy: the textile industry, the agriculture and food sector, the plastic packaging sector, and the construction industry. By examining existing practices, potential for transformation, and barriers to implementation, this research seeks to provide insight into how Serbia can improve the sustainability of its economy and contribute to the achievement of the global sustainable development goals.

CONCEPTUALIZING THE CIRCULAR ECONOMY

The circular economy poses a significant challenge for every national economy, primarily due to the lack of a generally accepted definition (Kirchherr et al., 2017; Popović & Radivojević, 2022). An additional challenge lies in the fact that the circular economy is a holistic and multidimensional concept, and its definition often depends on the perspective of the entity defining it. As a result, the literature contains a wide range of different definitions.

The first steps towards the conceptualization and institutionalization of the circular economy within the European Union were taken with the adoption of the Circular Economy Action Plan in 2015, entitled "Closing the Loop – An EU Action Plan for the Circular Economy" (European Commission, 2015). Although the document is explicitly focused on

promoting the principles of the circular economy, it primarily presents legislative proposals and action plans related to raw materials management and waste management, without providing a concise and universally accepted definition of the circular economy model.

Other official European documents offer more practical definitions, including one of the most used, which describes the circular economy as a model of production and consumption that involves the reuse, repair, refurbishing, and recycling of existing materials and products in order to extend their life cycle as long as possible within the economy. In such a system, waste is converted into a resource, thereby reducing the total volume of waste destined for disposal and at the same time reducing the need to extract new resources.

In a circular economy, the design of products, materials, and infrastructure is oriented towards reuse and long-term resource efficiency from the outset. Rather than allowing waste to be generated and managed after consumption, a more efficient approach emphasizes waste prevention at source. Extending the life of a product through repair, remanufacturing, and reuse reduces the need for primary raw materials. When a product can no longer be used, its components can be reintegrated into new production processes. Biodegradable materials can be composted, returning nutrients to the soil. This approach supports resource conservation and mitigates negative environmental impacts. Unlike systems based on the depletion of natural resources, a circular economy emphasizes the regeneration of ecosystems. Nature does not create waste – waste is exclusively a human invention.

Circular economy strategies are aligned with R-frameworks, which serve as practical guidelines for implementing circular practices. These R-frameworks bridge the gap between theoretical concepts and real-world applications. The circular economy can be represented through the 15R framework (Fröhlich et al., 2024) – a comprehensive range of strategies for closing material loops and achieving sustainability goals.

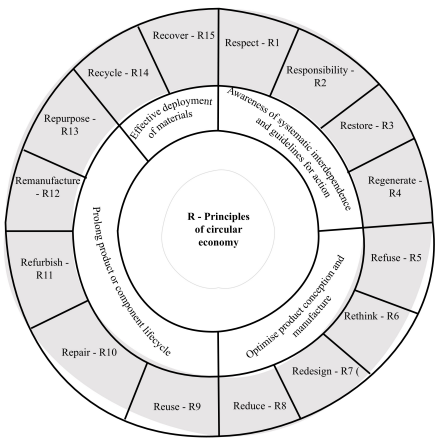

Figure 1. *R principles of circular economy*

The presented diagram offers a comprehensive visualization of the basic circular principles, structured to illustrate their interrelationships and their joint contribution to strengthening circularity within economic systems.

The true meaning of the circular economy becomes more evident when examining the business models that enable its practical application. Circular economy business models are concrete strategies that companies adopt to extend the life cycle of products, optimize resource use, and minimize generated waste – thereby creating economic, environmental, and social benefits. The five basic circular business models can be applied individually or in combination (Lacy et al., 2014):

- Circular supply chain – reforming use of renewable, recyclable, or biodegradable resources;
- Recovery and recycling – extracting value from waste through reuse or material recovery;
- Product life extension – prolonging the use phase of products through maintenance, repair, or refurbishment;
- Sharing platforms – optimising capacity use and maximizing asset utilization through shared access;
- Product as a service – delivering performance or outcomes instead of transferring product ownership.

These business models play a crucial role in translating the principles of the circular economy into strategies that are easily achievable and can be implemented.

THE ROLE OF KEY SECTORS IN CIRCULAR ECONOMY IMPLEMENTATION

The implementation of the circular economy in industrial sectors is an important step towards achieving sustainable economic development. For developing countries, such as the Republic of Serbia, directing resources and policies towards the application of circular principles and models can significantly contribute to the development of circularity at the national level. At the European Union level, seven priority sectors have been identified as key for the implementation of the circular economy: plastics, textiles, electrical and electronic waste, food, water and nutrients, packaging, batteries and vehicles, and construction (European Commission, 2020). On the other hand, during the negotiations on accession to the European Union, the Republic of Serbia adopted legal frameworks in the field of waste management, circular economy, and environmental protection, committing to transpose the regulations in these areas into its national legislation.

Accordingly, the Roadmap for Circular Economy in Serbia directly addresses sectors that have significant potential for implementing circular economy practices (Ministry of Environmental Protection, 2020):

- manufacturing industry with a focus on the textile sector;
- agriculture and food – surpluses and food waste;
- plastics and packaging;
- construction sector.

The four sectors mentioned above are of particular importance in the transition to a circular economic

model in the Republic of Serbia. The identified key sectors are responsible for significant use of natural resources, generation of large amounts of waste, and emission of harmful gases. By applying circular principles, it is possible to reduce resource consumption and mitigate environmental impact. The application of circular economy practices in these sectors contributes to the reduction of waste and pollution, but also creates new economic opportunities, improves the efficiency of production and consumption, and supports long-term sustainability. Given their significant role in the overall use of resources and the generation of waste, these sectors are essential for achieving the goals of the circular economy and sustainable development in the Republic of Serbia.

To comprehensively assess the role and potential of these sectors in the transition to a circular economy, it is necessary to apply a structured and methodologically appropriate research framework. In addition to identifying their theoretical relevance, systematic research is needed to assess the extent to which circular economy principles are currently being applied and to explore the specific opportunities and constraints that characterize each sector in Serbia. Accordingly, the research methodology outlined below provides a basis for examining these dimensions through qualitative and comparative analysis.

The methodological approach of this research is based on a qualitative analysis of secondary sources (desk research) and a comparative sectoral review, with the aim of identifying the current state, challenges, and potential for the implementation of the circular economy in selected economic sectors of the Republic of Serbia. Such an analysis allows for a holistic examination of the implementation of the circular economy in the context of a developing country, considering the economic, social, and environmental dimensions of sustainability.

Textile sector

The textile industry represents one of the most important sectors of the global economy, playing a key role in international trade, employment, and economic development – a trend that is similarly reflected in Serbia (Radić Milanović, 2024).

In recent years, there has been a significant increase in the production of textiles, clothing and fashion products, primarily due to the growth of the global population and the improvement in the standard of living of the world's population. It is estimated that the textile sector has doubled, mainly due to the expansion of the middle class and the increasing prevalence of rapid fashion cycles (i.e. fast fashion), the culture of instant gratification and the increase in consumption per capita. These trends have contributed significantly to the ecological imbalance at the global level (Denić et al., 2021).

The production, distribution, and consumption of textiles contribute to high levels of water, energy, and chemical use, as well as significant generation of waste, while textile recycling rates remain extremely low. In particular, the low rates of recycling of textiles into textiles are particularly pronounced. Current practices in this sector are predominantly based on a linear model, which is characterised by mass production of cheap clothing, minimal oversight of product life cycles, and the almost complete absence of systems for the collection and processing of textile products at the end of their life. While there are initiatives focused on upcycling and local sustainable fashion production, they remain marginal and lack institutional support.

In the Republic of Serbia, data on waste generation by origin (excluding municipal waste from households) show that the leather, fur, and textile industries generated a total of 13,062 tonnes of waste in 2023. Of this amount, only 1,508 tonnes of textile waste underwent R operations (SEPA, 2024a). Textile waste accounts for 2.8% of the total municipal waste. In Serbia, most textile waste ends up in landfills, while consumer awareness of reuse and recycling remains limited.

Establishing a textile industry in line with the principles of the circular economy requires continuous efforts and investments. A crucial step in this transition is a change in the design process that enables the reuse and recycling of products, thereby bringing environmental, social, and economic benefits while reducing the negative impacts of the textile sector. Circular design in textile products includes strategies that aim to extend the life cycle of textiles, clothing and fashion products, promote material recycling, and minimize waste generation in this sector. These strategies can be broadly categorized into two key areas: design for material circularity and design for durability (Circular fashion, 2021).

The new circular system for the textile industry is based on four key principles (Ellen MacArthur Foundation, 2017):

- eliminating harmful substances and microfiber release;
- increasing utilization of textile products,
- improving the recycling sector;
- efficient resource use and transition to renewable sources.

Based on the above principles, it can be concluded that the potential for a circular approach to this sector includes the development of systems for collecting, sorting, and recycling textiles, and the use of natural and biodegradable fibres, encouraging local high-value production and extending the life of clothing through repairs, replacements, and reuse.

In the Republic of Serbia, the main challenges for implementing a circular economy in this sector are:

- the lack of infrastructure for processing textile waste;
- the low level of awareness and environmental consciousness among producers and consumers;
- the dominance of foreign brands that do not follow circular principles in local supply chains;
- the lack of incentive mechanisms and policies, etc.

The textile industry in Serbia has the opportunity to contribute to local economic development and

environmental preservation through innovative business models, provided that appropriate institutional conditions and stronger cooperation between the design, production, and recycling sectors are created.

Agriculture and food sector

In addition to the textile sector, agriculture and the food industry show significant potential for the implementation of circular economy principles in Serbia. The high consumption of resources such as water and land, together with significant waste generation, places this sector at the centre of the circular transition process. Globally, agriculture accounts for a significant share of greenhouse gas emissions, while the food industry is one of the largest producers of waste (including food waste), packaging, and production residues.

The agricultural sector of the Republic of Serbia contributes about 10% of the gross domestic product. Agricultural residues primarily originate from agriculture, forestry, the food industry, and the wood processing industry. These residues can be categorized into three main groups: residues from the cultivation of field crops, residues from fruit production, and residues from livestock farming (Ministry of Environmental Protection, 2022). On the other hand, the agriculture and food industry sector generated a total of 232,302 tonnes of non-hazardous waste and 2 tonnes of hazardous waste in 2023. It is estimated that around 247,000 tonnes of edible food are thrown away in Serbia annually – more than 40 kilograms per capita, while the estimated amount of food waste from 'farm to fork' reaches up to 900,000 tonnes (SEPA, 2024a).

Current practice in Serbia indicates that most agricultural and food products do not apply the principles of the circular economy. These sectors face significant food losses, especially at the farm level and during distribution, while waste is largely not recycled or reused. In addition, the use of chemicals and pesticides in agriculture is still widespread, which directly contributes to soil degradation and water pollution.

The principles of the circular economy in agriculture and the food industry are based on waste prevention and its reuse. A key step towards the proper management of this type of waste is its separation, which is a necessary condition without which the implementation of circular economy practices becomes extremely difficult.

The potential for a circular transition in these sectors is multifaceted (USDN, 2025):

- Food waste prevention – These strategies offer the highest economic value per ton of food and require minimal capital investment. The focus is on preventing food waste before it occurs, through measures such as improved logistics, optimized inventory management, and consumer education.
- Food rescue – These strategies have significant potential to reduce hunger and make better use of edible surplus food. Key initiatives include tax incentives for food donations and technological solutions, such as software platforms that connect food donors with organizations that distribute food to vulnerable populations.
- Food recycling and reuse – These strategies contribute to reducing greenhouse gas emissions but require higher capital investment and infrastructure support. Key approaches include composting, anaerobic digestion, water recovery plants, etc.

When analyzing the Serbian agricultural and food sector, several main challenges stand in the way of adopting circular practices:

- There is a clear lack of infrastructure for efficient food and agricultural waste treatment.
- Small and medium-sized farmers often struggle to put the circular principes into practice, due to limited resources as well as knowledge.
- The shift towards more sustainable models such as urban and vertical farming, organic farming, and aquaponics, is slowed by a lack of financial incentives and political support.

Nevertheless, the agriculture and food sector in Serbia holds significant potential for the application of circular practices.

Plastics and packaging sector

Plastic waste causes numerous environmental problems, which are the result of the accumulation of plastic products and plastic particles in the environment (WEF, 2022). The aforementioned environmental problems have a negative impact on the environment, but also on human health. The advantage of plastic products is their low production cost, durability, and functionality, while the disadvantages become apparent through their long-term use in disposable products and the significant amount of waste generated, which is not biodegradable. One of the most critical products in terms of implementing the principles of the circular economy is plastic packaging. Plastic packaging presents one of the biggest challenges in the context of the circular economy, both at the global and local levels.

In Serbia, as in many other countries, plastic packaging accounts for a significant portion of total waste, while the recycling rate of plastic materials remains very low. Plastic waste accounts for 12.1% of total municipal waste generated in the Republic of Serbia, while plastic packaging accounts for 25% of total packaging waste (SEPA, 2024b). It is important to note that in Serbia, the largest share of plastic packaging waste comes from the food and beverage sector. Current practices in Serbia regarding plastics and plastic packaging are characterized by a high level of single-use plastic products, especially in the food and retail sectors. Although there are some efforts to reduce the use of plastics (e.g. banning plastic bags in retail), the issue of plastic packaging has not yet been fully resolved. The collection and recycling of plastic materials is also at a low level, as recycling capacities are not sufficiently

developed, and consumers are often not fully informed about proper waste segregation.

To effectively integrate circular economy principles into the plastics and plastic packaging sector, systemic changes need to be implemented through several key strategies:

- improving the design of plastic products and plastic packaging;
- extending the lifespan of plastic products,
- effectively managing plastic waste;
- restoring natural systems and reducing negative environmental impacts (e.g. use of bioplastics);
- regulatory and economic mechanisms to promote circularity (e.g. extended producer responsibility).

In the plastics and packaging sector, numerous challenges hinder the implementation of a circular economy. One of the key issues is the lack of infrastructure for recycling plastic materials, which further complicates the process of separating different types of plastics. In addition, low public awareness and insufficient engagement regarding the proper disposal and recycling of plastics pose significant obstacles. The high costs of implementing advanced recycling technologies and the production of bioplastics are often obstacles for small and medium-sized enterprises. Moreover, the market for recycled plastics is still underdeveloped and insufficiently competitive compared to products made from virgin plastics, which further slows down the transition to more sustainable plastic waste management models.

Despite these challenges, the plastics and packaging sector offers significant opportunities for the transition to a circular economy, particularly through innovations in materials, legislative initiatives aimed at reducing waste, and the development of recycling infrastructure. By implementing green initiatives and systemic changes, this sector can become a key element in achieving sustainability in Serbia.

Construction sector

The construction sector in Serbia is one of the largest consumers of natural resources and producers of waste. According to available data, construction waste accounts for a significant share of total municipal and industrial waste, while only a small percentage of the materials used are recycled. The share of construction waste in total waste generated was 0.36% in 2022, or 630,134 tonnes. Therefore, the introduction of circular economy principles in the construction sector is becoming increasingly important in order to reduce resource consumption, extend the lifespan of buildings, and minimize the amount of construction waste. The possibilities for implementing circular economy measures in construction should be defined within the entire life cycle of buildings (EDA, 2022).

Current practice in the construction sector generally does not include systematic selection, recycling, and reuse of construction waste. Demolition of buildings is often carried out without a plan for material conservation, and the waste is mainly disposed of in landfills. There are isolated examples of recycled concrete and the use of secondary materials, but they are not yet part of standard practice.

The potential for a circular transition is significant. Applying the principles of the circular economy in the construction sector can contribute to:

- reuse and recycling of construction materials (concrete, metal, glass, wood);
- reduction of the consumption of primary raw materials;
- reduction of carbon dioxide emissions by using local and sustainable materials;
- application of modular and flexible architecture that allows for adaptation and deconstruction without destruction.

Challenges in the construction sector in Serbia include the lack of infrastructure for sorting and processing construction waste, weak implementation and monitoring of legal regulations related to construction waste management, low awareness among stakeholders (investors, designers, contractors) about the benefits of a circular approach, as well as the lack of financial incentives for green construction and sustainable reconstruction.

Despite these challenges, the construction sector has great potential to become a leader in the circular transition in Serbia, provided that the regulatory framework is improved, the market for recycled materials is stimulated, and educational initiatives are implemented within the construction industry.

CONCLUSION

The sectors analyzed, each at different stages of development and readiness for the application of the principles of the circular economy, will certainly face different challenges. Even though each of them shows potential, there are also obstacles that must be adequately addressed in order to ensure sustainability and resource efficiency. The circular economy offers enormous opportunities for reducing waste and using resources, while minimizing environmental impact, especially in developing countries such as Serbia. The application of circular principles in the four sectors examined can contribute to sustainable economic development, increased competitiveness, and a reduced ecological footprint at the national level.

Despite the significant challenges and obstacles outlined in the paper for each sector, the potential for a circular transition remains significant. It is necessary to establish appropriate institutional frameworks, provide incentives for innovation, and promote education among all stakeholders involved in the transition process – from producers to end consumers.

In the coming years, the circular economy is expected to become an environmental necessity, but also an economic imperative. As such, countries such as Serbia will need to align with global trends and integrate circular practices into their development strategies, especially in sectors that are presented as key in official

documents. This shift will enable the creation of a more sustainable and efficient economic model, fostering long-term prosperity.

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