

The Realization of a Circular Economy in the Construction Industry and Its Adaptation to EU Standards in Hungary

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Transforming the linear economy into a circular one in the construction sector is not an easy task. Such a radical change entails a major transformation of the current production and consumption patterns, which in turn will have a significant impact on the economy, the environment, and society. The European Commission sees great potential in the recycling and reuse of construction and demolition waste (CDW) and has also emphasised the importance of this waste stream in its directives on the circular economy. This paper first presents the concept of CDW and its regulatory characteristics. It then introduces the types and sources of CDW. Third, based on an analysis of the literature, the paper identifies the possible links between the CDW and the circular economy and current trends and practices of recovery, reuse, and recovery. Finally, through the examples presented, it gives an overview of the current situation and trends in Hungary and makes recommendations for future development opportunities for the practitioners to help them adapt to recent changes. The options for doing this are important, but the problems that may hinder this process also need to be examined. In this article, the author seeks to find answers to this question.

1. Introduction

Chapter 2 The European Union pays special attention to the regulation of waste management. The reason for this is that the role and importance of waste in economic life has greatly increased. Nowadays, one of the defining issues within the field of environmental protection is the generation, reduction, and management of waste. Most of the waste can become a significant source of energy and raw materials, the processing, reuse and/or utilisation of which can reduce countries' dependence on raw material imports in the long term.

Chapter 3 The construction industry is extremely energy-intensive and generates a significant amount of waste. At the international level, many research studies deal with the methods by which the dismantled raw material can be placed economically and which raw materials can be incorporated with which processing method. Researchers also investigate how it is possible to organise the used raw materials into a database during planning and/or construction, which can help their subsequent recyclability (Boros et al., 2022).

Chapter 4 The objective of the present research topic is to point out to otherwise well-defined and consistent legal and strategic provisions, requirements, and standards since these are not effectively implemented into practical applications. The aim of the research is to answer the following research questions: what tendency can be observed in the development of construction and demolition waste in Hungary in the current waste management system - based on the waste statistics under investigation, and what problems can be identified in the transmission of the practical achievement of strategic objectives.

2. Materials and Methods

Several valuable national and international studies, strategic documents and laws were identified, which focus on construction and demolition waste (CDW) flow on country-level. The aim of this article is to provide a comprehensive summary of the current understanding of the topic of the CDW. A further objective is to help the interoperability between theory and practical application because, in many cases, the expectations regarding the green economy are not reflected effectively on the practical and implementation side. The data used for the research comes from secondary sources (information database of the Central Statistical Office). Data on the

amount of construction and demolition waste was collected from aggregated waste data according to the Hungarian waste groups.

3. Literature Review

Recently, researchers found it important to address the issue of the circular economy in the construction sector and propose sustainable solutions where waste is reused to generate a by-product. Teran Mejica et al. (2023) presented an idea for bricks made from glass residues as a sustainable alternative for construction and architecture. The production of artisan bricks from recycled glass proved favourable and can be a complete substitute for the coarse aggregate (gravel) used for the production of conventional bricks.

In another research, Bautista et al. (2023) presented an alternative of using two solid plastic wastes, determining the use of polymeric synthesis made from recycled polypropylene (PP) and expanded polystyrene (EPS). The research developed a new material using these two recycled raw materials and evaluated its physical-mechanical properties.

3.1 EU Regulation

Based on information from the European Commission, in Europe, approximately 2.5×10^9 t/y of waste is generated, of which at least 600 Mt of reusable and recyclable raw materials end up in landfills (European Parliament, 2023). In the European Union, however, the utilisation level differs significantly from country to country. All this shows that there is an opportunity for lower-performing member states to learn about and implement the best practices used by those with the highest recycling rates.

Among the production wastes generated in Hungary, CDW accounts for one of the largest masses and, at the same time, the largest volume. CDW contains many valuable materials, which can be collected and treated separately to obtain important raw materials in a cost-effective manner, as well as to be used as a secondary material source. The necessary possibilities for this are only solved to a very small extent in Hungary. The Ministry of Innovation and Technology (2021) already draws attention to the fact that the preparation, reprocessing, and utilisation of construction waste for road and other construction is not yet a widespread solution in the country, and its current utilisation is estimated around 30-40 %. The Strategy describes that the future use of bulk materials, secondary raw materials (such as inert materials) and waste in a greater proportion may, in some cases, be a solution in the event of supply difficulties, naturally keeping in mind the appropriate quality aspects.

3.2 New Directions

One of the possible political tools could be the introduction/application of 'green public procurement' in a larger proportion. A procedure which 'when applied, tenderers give preference to the procurement of those goods, services and construction projects that have a lesser impact on the environment compared to other goods, services and works of the same purpose' (Public Procurement Authority – Sustainable Hungary Program, 2021). The 'Green Code' is voluntary. It defines specific guidelines so that the aspects of environmental and economic sustainability are applied as much as possible in public procurement and investments. In this way, those who join voluntarily set a good example through their public procurement and can influence the attitude and behaviour of other economic actors and society. The 'Green Code' designates the environmental protection goals and areas to which special attention must be paid, including the circular economy approach. In addition to the fact that the 'Green Code' provides assistance to economic companies, it also supports the creation of new opportunities for the authorities in terms of eco-innovation, resource efficiency and green growth, mainly by applying new public procurement criteria in calls and tenders. As it appeared in the Information note (5/2022), a parliamentary report on the Office of the Hungarian Parliament (2022), 10 % of public procurements under the national procedure were considered Office of the Hungarian Parliament (2022); investments were included in the highest proportion, with 15 % in the construction sector.

Finally, it is worth mentioning the EU taxonomy regulation. The decree defines the range of economic activities that can be said to be sustainable from an environmental protection point of view. One of the six environmental goals set out in the decree, the transition to a circular economy as a criterion, is also of particular importance for the CDW. The long-term goal of the decree is that in the future, the flow of capital will go towards sustainable activities, thereby creating the possibility of long-term 'green' investments (Boros et al., 2022).

3.3 General Rules

The central element of the currently effective regulation is Directive 2008/98/EC on waste and the repeal of certain directives, which defines the general rules for waste management. Article 11 of the directive states that the preparation for reuse, reprocessing and other material utilisation of non-hazardous CDW must be increased to a minimum of 70 % by mass. Despite the existence of regulators, the achievement of the target value was

not achieved at the expected pace. The reason for this is seen primarily in the mistrust experienced in terms of quality and health risks towards materials produced by the CDW (Kozma, 2022). In many cases, there is no technological possibility and/or available interface that would help the feasibility of selective collection. Furthermore, the dense location of municipal landfills makes it easier to transport the waste generated in the construction-demolition area to a landfill close to the area, thereby achieving significant cost savings. The Official Journal of the European Union (2018) states that the member states take measures to support selective demolition and establish the sorting systems of the CDW, at least for wood, mineral materials, metal, glass, plastic and plaster. From the directive and the target values, it is clearly visible at the central level that the effort is aimed at the integration of the CDW into the circular economic model, and it is expected that it will soon be put into practice. The basis of future waste management is determined by this approach, which prioritises sustainability and the cooperation of industrial players through the construction of a more material and energy-efficient economic model.

3.4 National Documents

The strategic directions designated by the EU must be adapted at the domestic level, one of which is the National Waste Management Plan (2021-2027). The goal of the strategy is to make waste appear as a resource, to reduce the level of landfilling, and in the future, only that waste that cannot be utilised in any form will end up in landfills. The National Prevention Program (NPP) contains the objectives related to the prevention of waste generation and the measures to be implemented in order to achieve them, in accordance with the National Environmental Protection Program (2021-2027) adopted by the National Legal Repository (2021). One of its main goals is to eliminate the connection between reasonable economic growth and the environmental effects caused by waste generation.

Another extremely important strategic document is the Government of Hungary (2023). It can be clearly read from the strategy that the mandatory use of secondary raw materials must become a fundamental element of industrial material management and logistics, as well as generate a demand market for secondary raw materials. In the current package of circular economy directives, the responsibilities also clearly fall on the manufacturers/producers, which is expected to be further increased by other emission restrictions appearing in the next 30 years, as well as by the voluntary commitments and measures of individual industries.

3.5 Quantities of CDW

Construction demolition waste (CDW) is a special form of generated waste. The available statistics clearly show that this type of waste is generated annually in outstanding quantities in Hungary and in other member states of the European Union. The CDW accounted for 35 % of all waste generated in the EU in 2021, while it accounted for 40 % in Hungary (Figure 1). In order to deal with the situation, more and more good solutions are being created, and more and more regulatory systems are being modified, the joint goal of which is to validate and implement the aspects of the circular economy within waste management (Kozma, 2022).

Construction and demolition projects are responsible for around a third of all waste generated in the EU. At current population growth rates, the middle class is projected to grow from 2 billion to more than 4 billion people by 2030, requiring more urban buildings than have been built in the last 4,000 y. Another important issue is the increase in the price of raw materials, which encourages the construction industry to use resource-efficient and alternative materials, such as reuse and recycling. The rate of change for construction and demolition waste is based on the National Environmental Protection Information System database.

4. Results and Discussions

The impact of the built environment on society and nature is unavoidable when sustainability and a circular economy are discussed. For this reason, it is extremely important to exploit the circular connection points found in the construction industry. The impact on the environment does not end with the completion of construction either, as our buildings also burden the environment during their useful life: more than 40 % of primary energy consumption can be attributed to it, and the emissions of harmful substances are also considerable. At the end of the life cycle, the impact of the CDW on the environment is also significant.

The built environment includes the man-made elements of our environment, buildings, and infrastructure, including transport, telecommunications, energy, water and waste management systems. Design and construction contribute to the quality of the built environment, which has a significant impact on human health, well-being and productivity (Buruzs, 2022).

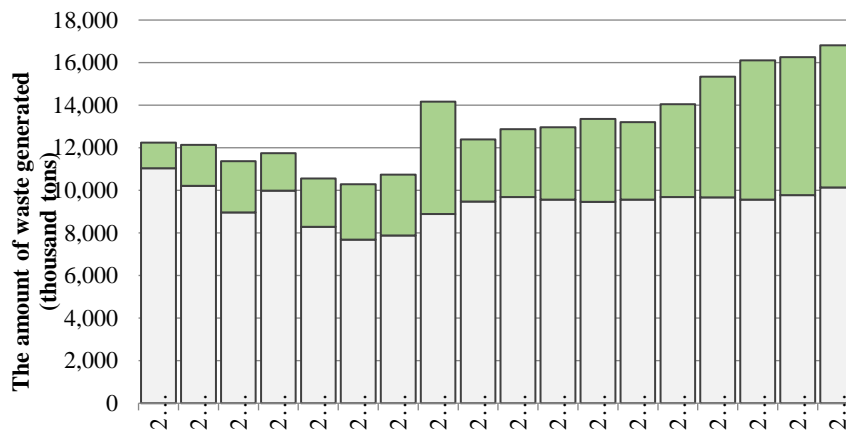


Figure 1: The share of the amount of construction and demolition waste generated from the annual waste balances between 2004 and 2021 in Hungary. Source: Based on the National Environmental Protection Information System (OKIR) database, own editing. *Note: marked in green is the percentage of the amount of construction and demolition waste generated

4.1 Strategies, practices and principles

Given the scale of raw material demand in the construction industry, many best practices in this sector focus on reduced resource consumption, and eco-design is key to achieving the strategy's goals. Eco-friendly design has many other tools, such as favouring wood over steel and concrete and developing concrete with less CO₂ emissions through innovative solutions.

Extending the life of products and components is another strategy. Buildings can be designed specifically with maintenance, repair and renovation in mind. In Scotland, for example, ARUP designed a fully integrated structural health monitoring system that placed a thousand sensors in a building to provide alerts in the event of structural failure. Henk Jonkers (TU Delft) has developed self-healing concrete that contains bacteria that fill cracks when the concrete comes into contact with water (Background Materials for Circular Economy, 2021).

Designing buildings to be decomposable is an effective practice, as it allows for easy reuse of individual building components when buildings are demolished as an alternative to landfilling.

There are many other ways to give new life to resources in the construction industry. The European Commission (2018) has developed a structured plan for the management of construction waste to ensure maximum reuse and recycling. By using recycled materials, the construction industry can turn waste from other industries into useful building materials. Developments have also been made in the field of 'green insulation', where the insulation material was produced from cork, cellulose from recycled paper, and used textiles (e.g. cotton, denim). Recycling is particularly important for the construction industry, given the huge amount of waste generated during demolition. Construction waste can also be turned into an energy source, thereby enabling the utilisation of energy. For example, the Lafarge cement plant in Richmond, British Columbia, uses construction waste to operate instead of burning fossil fuels (Background Materials for Circular Economy, 2021).

The introduction of the circular economy principle in the construction industry promotes the use of sustainable materials, maximises material utilisation and avoids unnecessary waste generation. By applying the principles of the circular economy in the European built environment, it is expected that 350 billion EUR can be saved by resource and energy minimisation by 2030 (Ellen MacArthur Foundation, 2015). However, this sector is characterised by a strong project-based institutionalised practice and market mechanisms, aspects which, in many cases, do not facilitate the incorporation of circular economy principles. In the case of construction projects, their implementation requires the cooperation of a large number of interested parties within a complex supply chain, where each link contributes to the environmental impacts and costs of building production. In this context, it is clear that European governments have a key role to play in developing appropriate guidelines and policy interventions for the construction industry to support the transition to a circular economy (Norouzi et al., 2021).

4.2 The Symbiosis of the Construction Industry and the Circular Economy

CDW can be generated during the entire life cycle of buildings, but the most decisive phase is the end of their life cycle. This is due to the fact that a large amount of waste is generated during demolition activities, and most

of the building materials are not reused at the end of their useful life but are disposed of by landfilling or burning. The main reason for this is that the construction industry uses a linear economic model based on the 'take, make, dispose' principle. In this model, the first phase is to extract the raw materials, which are then transformed into building materials and used on the construction site. CDWs are disposed of after they are used up – and they become waste (Buruzs, 2022).

In contrast, another economic model emerging in recent decades is the circular economy, the basic principle of which is more efficient resource management. The Ellen MacArthur Foundation (2015) promotes the ideas and possibilities of the circular economy through a number of studies, defining the economy as a regenerative system that aims to keep materials at their highest value in a closed loop.

The concept of the circular economy developed from industrial ecology. It tries to gather existing methods and approaches from different scientific fields under one hat: for example, industrial ecosystems and industrial symbioses, the 3R principle, cleaner production, eco-efficiency, cradle-to-cradle design, and biomimicry. Approaches in this direction require closing material flow loops by reusing waste and resources and slowing them down by developing long-life, reusable products (Norouzi et al., 2021).

In a circular economy, the primary thing is not to achieve the actual material cycle but rather to break away from the use of materials or to minimise it. One of the ways to do this is to produce products with as long a lifespan as possible. During their use, these products act as a 'material bank', which we cannot and do not want to utilise during this time. In the circular economy model, worn-out building materials should be reused to act as material banks for new buildings, keeping building elements and materials in a closed loop, as the Ellen MacArthur Foundation proposes in the general circular economy concept.

However, in connection with this new type of approach, the development of the knowledge base and tools is still necessary in order for it to spread more widely in the industry. Especially in the construction industry, where the implementation of innovation typically takes more time. Building construction is often a one-off project with a large supply chain, which only adds to the complexity of the process.

The construction industry is responsible for significant environmental impacts due to its large demand for resources and energy, as well as its production of waste. The circular economy can significantly improve the sustainability of this sector, where the main focus areas are:

- energy efficiency of buildings;
- recycling, waste management and the use of alternative building materials.

Recently, it can be stated that the application of the EU directives in Hungary in practice is difficult and/or not always successful. The parameters required by policies and legislations need to be made more understandable to practitioners, underpinned with practical solutions, best available techniques, best practices and benchmarking.

These can, therefore, be considered as potential future research topics.

5. Conclusions

Based on the research, it can be concluded that the construction industry is under urgent pressure to transition from the current paradigm (linear economy) to a more sustainable paradigm (circular economy) as soon as possible, which approach provides an opportunity to address the challenges detailed above and to create a sustainable, green construction sector. In the future, it is expected that regulatory approaches at the national level will evolve in a way that will provide a strong incentive for the owner of the waste, i.e. the business entity in the construction sector, to use the generated construction and demolition waste for its original purpose in an environmentally sound way and/or to make it available as a secondary raw material for other economic sectors. The reason for the uncertainty of the adaptability is that the circular economy - in contrast to previous environment-based initiatives - does not represent just one ecological aspect (e.g. climate protection). Rather, it means a new development paradigm in which a holistic vision integrates the various subsystems of the pillars of sustainability in a versatile way, and it is difficult to interpret and/or implement for practitioners in Hungary. As a result, the circular economy appears not only in the production and use of building materials but also in operation and maintenance and, finally, in the rehabilitation and demolition of old buildings and the management of the generated waste.

Furthermore, the intention of the authors in this publication was to establish a connection between the theoretical, strategic, and legislative sides and the activities involving significant waste generation in practice. Based on experience, in many cases, the priorities included in the guidelines are not sufficiently effective in practice, so it would be necessary to create more attitude-shaping and knowledge-sharing networks that facilitate and support this process. This study tries to help in this situation.

In the course of further research, the authors' intention is to make the best practices available to the actors of the domestic construction industry by studying international practical examples and creating cooperation between the actors of the construction industry. This includes understanding where material flows shift from

push to pull triggers (disconnect points) and how these flows can achieve efficiency and sustainability. Furthermore, it would be important to expand the focus of the study to other supply-demand balance points and involve construction industry players.

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