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THE CHALLENGES OF TRANSFORMING THE CONSTRUCTION SECTOR FROM A LINEAR TO A CIRCULAR ECONOMY

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Abstract: *One of the EU's priorities under the Green Deal to combat climate change is to transform the EU economy into a circular economy, as the extraction and processing of raw materials generates large amounts of greenhouse gas emissions. Unlike the linear economy, which essentially consists of the production, use and subsequent disposal of goods, the circular economy is a holistic approach aimed at conserving resources. The construction sector is known to consume many resources and produce large amounts of waste. The much-needed implementation of the circular economy in the construction sector requires a lot of effort, long-term planning, and a holistic approach. In essence, it is about designing a modern building that is both sustainable and circular. The measures needed to implement the circular economy concept are waste, resource efficiency, reuse of soil, circular design principles, non-destructive dismantling, a renovation wave and so on. We have long known that business as usual, i.e. economic activity in a linear pattern, is no longer possible in the face of climate change, resource scarcity and increasingly critical geopolitical dependencies. The fact is that the sooner the construction industry recognises the challenges, the more successful it will be in managing change.*
Keywords: *Circular economy, urban mining, secondary raw materials, material flows, resource consumption*

INTRODUCTION

Climate change and the loss of biodiversity and the ecosystem services associated with it are the most complex challenges humanity has ever faced. It can only be overcome through collective action. Linked to this is the problem of increasing global competition for scarce resources such as fresh water, land, and raw materials, and the closely related worldwide environmental problems of species extinction, deforestation, soil degradation, and the availability of landfill space. With resource extraction and processing accounting for 50% of total greenhouse gas emissions and more than 90% of biodiversity loss, the European Green Deal has launched a concerted strategy for a climate-neutral, resource-efficient, and competitive economy. (European Commission, 2020). It includes a series of measures to combat climate change and promote sustainable development, with a focus on the circular economy. The conservation of natural resources through a comprehensive circular economy – CE has become a key issue. As part of the Green Deal, the EU published a new Circular Economy Action Plan in March 2020. This plan outlines measures to transform the EU economy into a circular economy, focusing on sectors with high circular potential such as electronics, batteries and vehicles, packaging, plastics, textiles, and construction and demolition materials. The development of a circular economy should make a decisive contribution to achieving climate neutrality by 2050, decoupling economic growth from resource use while ensuring the EU's long-term competitiveness and leaving no one behind. To achieve this ambitious goal, the EU must accelerate the transition to a regenerative model that gives back more to Mother Earth than it takes and ensure that its consumption of resources remains within the limits of our shared planet.

RESEARCH METHODOLOGY

The research methodology aims firstly to demonstrate the urgent need to transform the current linear economic system into a circular one. It analyses the negative environmental impacts of the construction sector. It then identifies and explains a wide range of measures that can be taken to transform the linear economic system in the construction sector into a circular economy.

RESULTS

1. Linear economic system versus circular economy

The concept of the circular economy is first and foremost a critique of the dominant linear production system of 19th century industrialization. The problems associated with our linear economic system will become even more acute in the coming years unless radical changes are made as the world's population and economies continue to grow and prosper. A fundamental rethink is therefore urgently needed. The circular economy offers a way forward. Unlike the linear economy, which essentially consists of the production, use and disposal of goods, the circular economy is a holistic approach to conserving resources. It safeguards the livelihoods of future generations, reduces greenhouse gases and pollutants, and minimizes anthropogenic pressure on intact habitats. Waste is a recent invention. Until well into the 19th century, there was little waste. At that time, raw materials were highly valued. In this respect, there was a functioning circular economy in pre-industrial times. This changed with industrialization. Factories produced mass goods and people accumulated possessions. Waste became fuel for incineration and an integral part of the thriving economy. The growth of markets for new products depended on the continued short-term disposal of used goods. As the saying goes, "You can only grow if you throw away". In other words. Waste is the price of prosperity. Switching to a functioning recycling economy is the order of the day. (Strasser, 2000).

The Ellen MacArthur Foundation has conceptualised the circular economy as a system based on the idea of dividing material flows into two cycles: the technical resource cycle and the biological resource cycle. In the circular economy, products and industrial processes are designed so that materials are left behind to be used in either the biological or the technical cycle. The traditional linear economy, which dominates most sectors, including the construction industry, is based on the 'extract – produce – dispose' model. In this model, resources are extracted, processed into products, and often disposed of very quickly after use. The construction sector is known for its high consumption of resources and large quantities of waste. In addition, many building materials are suspected of containing harmful substances that can endanger the environment. These challenges to the linear economic model have far-reaching environmental and economic consequences. Given the planet's limited resources and the need to minimise environmental impact, a new approach is required. Contrary to what the name suggests, the concept of the circular economy is not limited to simply returning waste to the production cycle through recycling. It is about optimising the use of resources throughout the value chain.

2. THE MAIN CHARACTERISTICS OF THE LINEAR OR CIRCULAR ECONOMIC SYS TEMS ARE:

- **Resource consumption:**

In a linear economic system, resources are often used only once before they become waste. This take-make-waste model leads to high consumption of raw materials and energy. In contrast, the circular economy aims to preserve the value of resources for as long as possible by reusing, repairing, upgrading and recycling products and materials.

- **Waste production:**

A linear economic system generates large amounts of waste because products are often disposed of after use. In the circular economy, waste is seen as a resource. The aim is to minimise waste and return it to the production process wherever possible.

- **Life cycle of products:**

In a linear economy, the life cycle of a product is often short – It is made, used and then disposed of. The circular economy tries to extend the life cycle of products, for example through durable design, repair options and upcycling.

- **Sustainability:**

A linear economic system cannot be sustainable in the long term because it is based on the consumption of limited natural resources. The circular economy aims to create a sustainable economy that works within the ecological limits of our planet.

- **Business model:**

In a linear system, economic success often depends on constant growth and increasing consumption. In contrast, the circular economy promotes business models based on services and sharing resources rather than selling more and more products. The circular economy decouples economic growth from resource consumption.

These differences make it clear that the transition from a linear to a circular economy requires fundamental changes in the way we make, use, and dispose of products.

3. TOWARDS A CIRCULAR ECONOMY IN THE BUILDING SECTOR

The built environment has a significant impact on many sectors of the economy, local employment and quality of life. The construction sector is one of the most resource intensive in the world. It accounts for around 50% of total raw material extraction and more than 35% of total waste generation in the EU. Greenhouse gas emissions from the extraction of raw materials, the manufacture of construction products and the construction and renovation of buildings are estimated to account for 5-12% of total national greenhouse gas emissions. Improving materials efficiency could save 80% of these emissions. (European Commission, 2020).

Since the 1980s, the term 'circular economy' has been used to describe models that extend the useful life of products, minimise waste and conserve resources. The idea is to organise construction in cycles. Building projects that use recycled materials such as old tyres, cork, newspapers or seaweed to insulate climate-friendly social housing show how this can work. These are valuable resources that would otherwise be landfilled or incinerated. By recycling or reusing them, they are put back into the economic cycle. Implementing the circular economy in the construction sector has some unique features. Buildings and built infrastructure often have a long lifespan of decades or even centuries. This requires long-term planning and a holistic view of materials and resources to ensure sustainable use throughout the life cycle.

In recent years, the EU has made considerable efforts to promote the circular economy in various sectors, including construction. Essentially, it is a matter of designing a modern building which is both sustainable and circular. The measures needed to implement the circular economy concept are listed below:

-**Waste reduction:**

One of the main areas in which the EU expresses its ambitions for a circular economy in construction is through waste reduction. The construction sector is one of the largest producers of waste in the EU, and much of this waste ends up in landfills. The EU therefore aims to reduce construction waste while promoting its reuse and recycling.

- **Resource efficiency:**

Another important aspect of the EU's circular economy objectives for construction is to improve resource efficiency. This means using fewer resources to construct buildings and infrastructure and using materials for as long as possible. This can be achieved through a number of measures, such as the use of sustainable construction materials, innovative construction methods or designing buildings to last longer and to be easily dismantled and reused at the end of their useful life.

- **Reusing soil**

Until now, urban mining has been understood as a strategy related to anthropogenic materials and deposits. In addition to construction waste, soils can also be used and reused as part of the circular economy. A large proportion of construction-related waste streams are generated during the excavation of building pits. While excavated soil is usually transported away and disposed of, gravel and sand from construction pits can be processed into concrete on site using mobile plants. A mobile batching plant on site reduces transport distances by 40%, protects quarries and landfills and saves money by eliminating disposal. Not all excavated soil is suitable for construction purposes such as concrete production. But even soil that is not suitable for construction can be incorporated into the design in the form of mass levelling.

Natural soil is a non-renewable resource. All terrestrial production processes, such as food production, are directly dependent on healthy, intact soil. It is therefore necessary to use soil as a resource not only sparingly but also in a circular way: To integrate soil protection into the construction process, strategies for reusing soil are summarised in the concept of "circular soil". Soil from the excavation phase is stored and can be used as an organic component in the mixing and preparation of vegetation substrates and for construction purposes.

- **Circular design principles**

Circular design must become an integral part of planning in architecture and engineering. The principles of circularity must be taken into account in the design phase and the objectives and criteria for achieving them must be defined. The definition of measurement and performance indicators is particularly important in order to be able to check the implementation of circular objectives in the subsequent project steps. The transition from a linear to a circular economy does not necessarily mean a return to pre-industrial production methods. If sustainability can be successfully integrated into the design process, products can be used for much longer.

- **Non-destructive dismantling:**

Deconstruction plays an important role in the circular economy. It is understood as "reverse construction", i.e. the possibility of dismantling a building piece by piece in a non-destructive way and preserving its value by reusing it in different contexts. It is the alternative to traditional demolition, which tends to be a haphazard and destructive process. Compared to conventional demolition, deconstruction allows for a much higher degree of reuse and recycling of materials. After demolition, building components can be reused in a new context and life cycle. Before being reused, they must reach a qualified and certified level of quality to ensure construction and use safety.

- **Renovation wave:**

The circular economy in the construction sector is often associated with new buildings. However, there are many buildings that need to be renovated as part of a 'renovation wave'. This means that we will need to focus even more on renovation in the future in order to meet ambitious climate targets.

- **Energy efficiency:**

The EU also aims to improve the energy efficiency of buildings, which is an important aspect of the circular economy as buildings account for a large proportion of total energy consumption in the EU. Improving the energy efficiency of buildings can reduce energy consumption while reducing dependence on fossil fuels.

- **Renewable and local raw materials:**

An important lever for improving the environmental performance of buildings is the substitution of materials such as steel and concrete, i.e. the replacement of materials with poor environmental performance with climate-friendly building materials, preferably made from regional and renewable resources. Great progress is being made in materials science. However, the use of such materials must not lead to competition or land conflicts with food production. Transport routes should be kept short, and energy consumption during production and recyclability at the end of use should be taken into account. In the future, buildings will be constructed mainly from renewable or locally available raw materials. Architects are rediscovering clay and wood as sustainable building materials. Wood is renewable, generally requires less energy to manufacture building products and can be easily reused or recycled if treated without chemicals or pesticides and the structure can be dismantled. The wood used should be native species from certified sustainable forests with less than 60 per cent deforestation. Native hardwoods should be preferred to softwoods.

- **Collaboration between stakeholders:**

There are a variety of building materials such as concrete, steel, glass, wood and plastic. Each material has its own recycling and reuse characteristics, making it difficult to implement circular approaches. Construction projects are often very complex and involve many actors from architecture, engineering, construction and supply industries. A successful transition to a circular economy therefore requires close cooperation and coordination between all parties involved.

- **Life cycle assessment:**

A circular economy in construction must consider the entire life cycle of a building, from design and construction to use and eventual disposal or reuse. This means identifying opportunities to maximise resource efficiency throughout a building's life cycle.

- **Innovative business models and services:**

Another important lever for conserving resources in a circular economy is the intensification of use through innovative business models. These include rental and service models such as car sharing, but also the development of new business areas through the use of previously unused waste streams (e.g. innovative materials made from feathers from the poultry industry). So-called operator models (also known as XaaS models) are increasingly finding their way into the building sector, from the building envelope to building services and interiors.

- **Digitalization:**

Developments in the construction industry and the circular economy are very dynamic. New regulations and organisations are constantly emerging to address the issue. In addition, the rapid development of Building Information Modelling (BIM) and building simulation (digital twin) is rapidly changing project management. The same applies to the field of building automation (BA), with a focus on artificial intelligence (AI) in buildings and cybersecurity. Transparency in construction projects is an important basis for the circular economy in buildings. If you know what has been used where and how, you can plan for conservation and reuse. Digitalization already makes this possible. Information transparency is happening on several levels. Building Information Modelling (BIM), for example, stores a digital twin or passport of the building. The technology enables more efficient planning and networking of data throughout the entire lifecycle of buildings, right up to demolition. This information can be stored in digital cadasters and would then form the basis for long-term urban mining in the EU. At the product level, material and product passports can be used to compile information on the material composition, origin, manufacturing method, service life, repairability and recycling options of building materials. This would provide designers and clients with an overview of the overall impact of building products at an early stage of the project, enabling them to make informed decisions. Transparency at product and building level can also make the grey energy and grey emissions of buildings visible.

- **Urban Mining:**

Urban mining refers to the concept that buildings are “mines” containing valuable secondary resources. The aim is to avoid the extraction of primary resources and to optimise the use of secondary resources. The materials should be able to be recovered, reused, or recycled in at least the same quality, e.g. during renovation or demolition, instead of being disposed of or landfilled. The concept is that they can be dismantled and reused at the end of the building's life. The building becomes part of the urban mine. At the end of its life, instead of becoming rubble for landfill, it becomes a valuable source of raw materials or a supplier of raw materials for new construction projects. Maximising value retention is a prerequisite. Waste generation, landfill, air and water pollution should be avoided and fossil fuel consumption reduced. Urban mining offers the opportunity not only to reduce CO2 emissions in the construction sector through recycling in the sense of a circular economy, but also to make the construction industry somewhat less dependent on raw material shortages. It should be noted that urban mining is not limited to cities or buildings, but also fundamentally affects durable goods such as electrical appliances or cars.

- **Material Building Passport:**

A Material Building Passport (MBP) is a documentation of the material composition of a building. It provides quantitative and qualitative information on the relevant raw materials in a building. The MBP serves as a planning and optimisation tool for the efficient use of materials and subsequent demolition. It documents the material information required for the recycling of buildings at the end of their life cycle and serves as the basis for an urban resource register at the city level. New planning tools such as Building Information Modelling (BIM) offer great potential for the creation of a MGP. The basic concept is similar to that of the Energy Performance Certificate. It aims to show the resource consumption, climate impact and recyclability of each individual building. The first step is to collect general information about the building, such as its location, year of construction and construction method. The total mass of the building is also recorded. The main focus is on the materials used and which recyclable materials were used. In the case of construction and demolition waste, the proportion of renewable raw materials and reused or recycled materials is also recorded. This creates transparency and opens up new possibilities for assessing the recyclability of a building. In practice, the Building Resource Passport creates an information base for

all phases of a building's life cycle and thus makes an important contribution to transparency regarding the materials used, the greenhouse gas emissions of buildings and their recyclability. All information about the building will be made available in order to promote the refurbishment and new construction of buildings in a circular manner. In the long term, the digital building passport will enable a consistent circular economy in the construction sector by linking all life cycle phases from planning to recycling

- **Commercial viability:**

In addition to the environmental urgency, there are also economic reasons for change in the construction sector. Circular and recyclable buildings make economic sense. In addition to the environmental benefits of protecting the climate, resources and biodiversity, they also offer advantages for building owners and the construction industry as a whole. It is true that recyclable buildings are currently more expensive to buy. This is because recyclable, durable materials are generally of higher quality and are more expensive due to lower volumes and availability. The scarcity of resources will tend to lead to rising raw material prices, i.e. the material value of the materials used will increase (rising residual values). The economic benefits will be realised in the renovation and maintenance of buildings that can be recycled and dismantled. Connections are easily removable, making it easier to replace parts. In addition, recyclable building materials are of higher quality and therefore tend to last longer. Replacements and repairs are less frequent. Cost savings during demolition are particularly high. Instead of costly disposal, recycled building materials can be more easily reused, recycled and even resold. Cost-saving processes such as prefabrication, modular construction, serial construction, etc. have a significant cost-reducing effect. When costs are considered from this life-cycle perspective, recyclable buildings are quite competitive in terms of price.

CONCLUSION

The recent EU Climate Change Adaptation Strategy sets out how the EU can adapt to the unavoidable impacts of climate change and become climate neutral and resilient by 2050. This strategy has implications for the buildings sector and requires a transformation. The transformation of the buildings sector towards a circular economy is inevitable from both a climate and resource perspective. The first regulatory frameworks that take into account the need to transform the sector are now in place. The decarbonisation of the buildings sector is one of the major challenges that policymakers, businesses and society need to address urgently in the coming years. At the European level, the European Green Deal is also ensuring that policymakers take a closer look at measures in the construction and building sector. The Circular Economy Action Plan foresees a wave of renovation and a revised Construction Products Regulation, with increased use of recycled materials, digital building logbooks, life cycle analysis, recycling targets for construction and demolition waste, and less soil sealing. The concept of the circular economy is a promising one. By valorising, reusing, and recycling resources, it aims to ensure their availability and quality for future generations. The circular economy is therefore a fundamental building block of sustainability and applies this to the economic system and its individual sectors. We have long known that “business as usual”, i.e. economic activity in a linear pattern, is no longer possible in the face of climate change, resource scarcity and increasingly critical geopolitical dependencies. Change and the abandonment of established and traditional ways of doing things automatically trigger resistance. A lack of life cycle thinking leads to a focus on supposedly 'low-cost building'. There is currently a strong sense of optimism among stakeholders. EU projects such as the New European Bauhaus are proving fruitful. The fact is that the sooner the construction industry recognises the challenges, the more successful it will be in managing chang.

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ПРЕДИЗВИКАТЕЛСТВАТА ПРЕД ТРАНСФОРМИРАНЕТО НА СТРОИТЕЛНИЯ СЕКТОР ОТ ЛИНЕЙНА КЪМ КРЪГОВА ИКОНОМИКА

Резюме: *Един от приоритетите на ЕС в рамките на „Зелената сделка“ за борба с изменението на климата е превръщането на икономиката на ЕС в кръгова икономика, тъй като добивът и преработката на суровини генерират големи количества емисии на парникови газове. За разлика от линейната икономика, която по същество се състои от производство, използване и* последващо *изхвърляне на стоки, кръговата икономика е цялостен подход, насочен към опазване на ресурсите. Известно е, че строителният сектор консумира много ресурси и произвежда големи количества отпадъци. Така необходимото прилагане на кръговата икономика в строителния сектор изисква много усилия, дългосрочно планиране и цялостен подход. По същество става въпрос за проектиране на съвременна сграда, която е едновременно устойчива и кръгова. Необходимите мерки за прилагане на концепцията за кръгова икономика са отпадъците, ефективното използване на ресурсите, повторното използване на почвата, принципите на кръговото проектиране, неразрушителното разглобяване, вълната на обновяване и т.н. Отдавна знаем, че обичайната стопанска дейност, т.е. икономическа дейност в линеен модел, вече не е възможна в условията на изменение на климата, недостиг на ресурси и все по-критични геополитически зависимости. Факт е, че колкото по-рано строителният бранш признае предизвикателствата, толкова по-успешно ще се справи с промяната.*

Ключови думи: *кръгова икономика, градски добив, вторични суровини, материални потоци, потребление на ресурси*

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