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Circular economy: business models, design strategies and its indicators

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KEYWORDS

- circular economy
- circular business models
- circular design
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- Circularity assessment

ABSTRACT

Over the last years, the concept of Circular Economy has received a lot of attention from major global companies, with the intent of giving a better alternative to the prevailing economic development model, known as "take, make, and dispose". Moving from one business model to another requires a mutual effort from companies, government and consumers as well as a better understanding is needed to promote and stimulate this new model. However, there is not a comprehensive framework available to assist all businesses in developing a circular business model. This paper addresses this gap and develops a theoretical framework of strategies to provide a clear vision for designers and business strategists in the transition from a linear to a circular economy.

JEL-codes: Q56, Q01

KULCSSZAVAK

- körforgásos gazdaság
- körforgásos üzleti modellek
- körforgásosság kialakítása
- fenntarthatóság
- körforgásosság mérése

ABSZTRAKT

Körforgásos gazdaság: üzleti modellek, tervezési stratégiák és indikátoraik | Az elmúlt években a világ nagyvállalatai nagy figyelmet szenteltek a körforgásos gazdaság koncepciójának, azzal a szándékkal, hogy jobb alternatívát nyújtson az uralkodó gazdasági modellhez, az úgynevezett „vedd, használd, dobd ki" lineáris logikájához képest. Az egyik üzleti modellről a másikra való áttérés kölcsönös erőfeszítést igényel a vállalatoktól, a kormányzattól és a fogyasztóktól, valamint jobb megértés szükséges az új modell előmozdításához és ösztönzéséhez. Nem áll azonban rendelkezésre olyan átfogó keretrendszer, amely minden vállalkozást segítene a körforgásos üzleti modell kialakításában. Ez a tanulmány ezt a hiányosságot orvosolja, és a stratégiák elméleti keretét dolgozza ki, hogy világos jövőképet nyújtson a tervezők és az üzleti stratégák számára a lineáris gazdaságról a körforgásos gazdaságra való átmenet során.

JEL-kód: Q56, Q01

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Introduction

The industrial revolution of the last two centuries has led to a high consumption of renewable and non-renewable natural resources. This industrial revolution is characterized by mechanized factories, the rapid invention of new technologies, the "increasingly large number of works, workers, factories, markets, businesses, products", the quadrupling of agricultural yields achieved by the mass use of chemicals (Barreiro-Gen & Lozano, 2020). This industrialization based on a linear process has developed without the concern that one day these extracted resources would come to an end. It is an economy characterized by a mode of consumption, production and abusive management of natural resources called "cradle to grave": "from cradle to grave" (Morseletto, 2020). It is a business logic that takes resources from the planet (agricultural, mining, energy, soil, air, water...), transforms them to make new products, which are in turn used and then thrown away without any concern for the environment and available resources. For Aurez & Georgeault (2016), the linear economy optimizes flows (resources of the biosphere) by increasing yields at the expense of optimizing the remaining stocks (capacities of the biosphere), thus, it wrongly represents nature as inexhaustible and indestructible, while giving importance to monetary economic relations, to the detriment of non-monetary economic relations and dimensions of being.

The circular economy tends to decouple economic growth and resource use, which means that economic wealth production continues to grow independently of resource consumption, however, successful Circular Economy (CE) implementation often requires collaboration among a wide range of economic and societal stakeholders in terms of facilitating the circular flow of resources (Moktadir et al., 2020).

Although the concept of CE is widely used by businesses, the transition to CE is still in its very early stages. In fact, there is a significant gap between the CE business model as it is implemented and the CE theory (Ogunmakinde, 2019). In addition, there are not many studies that cover a circular business model framework in depth. Thus, the comprehensive knowledge on CE business model is needed to provide insight and support businesses in their transition to the new business model. Therefore, this study aims to provide an overview of the CE concept as it is represented in the literature in a deeper and more precise manner as well as to give tools for CE integration. This paper is structured as follows: Section 2 presents the theoretical background of the study, offering a review of the literature

in the field of Circular Economy. Section 3 provides an overview about CE design strategies and key performance indicators for assessing CE business model.

Theoretical Background

This section provides a concise summary of the literature on circular business models, pertinent implementation level and impetus of the implementation.

Circular Economy

Through the process of recycling the waste products of its model, the CE is an economy system that is defined by the concept of sustainable growth and needs less on resource depletion than traditional economies. The circular economy is a new way of thinking about how the economy and the environment interact. Since the material economy is dependent on the natural world, this perspective holds that the economy must operate with biological processes rather than against them, following natural circular structures (Urbinati et al., 2017).

Indeed, the 3R principles are part of the CE model: The reduce principle means the reduction of inputs and the use of the raw materials, energy and waste generated (Parthiban Manickam). The Reuse principle refers to the use of the products or components in another stage of production rather than disposal of them, this principle leads to the utilization of fewer resources, energy, and labour than is required to manufacture new products from virgin material. The recycling principle aims to convert waste objects into reusable materials to prevent waste of potentially useful materials, minimize the consumption of virgin raw materials (Araujo-Morera et al., 2021).

The adoption of more sustainable and cleaner manufacturing systems necessitates changes in how businesses operate. Improvements in product design, as well as equipment and production processes, introduction of new technologies, product changes, and internal and external waste management, are examples of such changes. The shift to a circular economy within society may entail new infrastructures, consumption models, and service access based on the collaborative and sharing

economies (Geisendorf & Pietrulla, 2018). Changes in consumer behaviour are also a result of the emergence of new sustainable products and business strategies.

Moving toward CE is relatively challenging and requires fundamental changes in several subsystems (Hussain & Malik, 2020). In fact, there is a huge gap between the theory of CE and its implementation process, in other words, the CE business model is not fully implemented. Several companies have intended to adopt the CE business model but unsuccessful as there are different barriers and challenges that hamper or slow down during their transition. The exploration of the current barriers is required to give insight and support companies to shift towards the new business model.

Classification of Circular Business Model: ReSOLVE framework analysis

The CE concepts of natural capital preservation, resource optimization, and designing out negative externalities are translated into the ReSOLVE framework by the Ellen MacArthur Foundation, which stands for Regenerate, Share, Optimize, Loop, Virtualize, and Exchang (Smol et al., 2020) as it is shown on the *Table 1*.

- ***Regenerate:*** involves the set of actions that anticipate and regulate resource production, consumption, and disposal in such a way that the greater ecosystem's health is preserved and biological nutrients are returned to the biosphere (Jabbour et al., 2019).
- ***Share:*** Maintain the product's life cycle and contribute to making the most out of it. In other words, ensures that products are used to their full potential and that waste and duplication are avoided, this leads to decrease the use of raw materials and establish a strong reverse logistics flow.
- ***Optimize:*** by applying technologies like automation, big data, and remote sensing would improve product performance or effectiveness while eliminating waste from the production cycle and supply chain.
- ***Loop:*** A resource process is involved when goods or components are reused, remanufactured, or recycled. It is crucial to recover assets by collection and segregation in order to maintain the

materials in a closed loop, reducing premature waste and ensuring for sustainability. In either case, resources are processed, recirculated, and reintroduced into the economy rather than being discarded in waste. This stage creates several economic opportunities since the recovery of products, components and waste resources are guaranteed (Pizzi et al., 2021).

- ***Exchange:*** The last category covers the procedures of incorporating new technology or eco-friendly materials, improving, or replacing older methods of operation so as material efficiency, durability, zero waste, and low emissions are all ensured. Internal combustion engines, for example, will be replaced with electric motors. The importance of incentivizing and establishing norms for cleaner production methods, as well as supporting in research for more sustainable operation and manufacturing methods. Implementing green materials and processes is beneficial not only economically, but also socially and environmentally – and can be measured in terms of lower prices and lower carbon emissions (Williams, 2016).

Regenerate	All activities aimed at restoring, preserving and repairing the quality of ecosystems as well as returning recovered biological resources to the biosphere
Share	Sharing resources between different users through sharing private products with multiple co- owners or by publicly using a certain group of products; by reusing them during their entire technical lifetime and by extending their lifetime through maintaining, repairing and designing for durability
Optimize	Increasing the efficiency of a given product, eliminating waste in the production and supply chain at all stages of the cycle
Loop	Keeping components and materials in closed circulation loops and assigning priority to internal loops, which means reusing products or components in production and in material recycling
Virtualize	Dematerialization of resource use by providing a given feature in a virtual way: directly of indirectly
Exchange	Exchanging old non-renewable materials with advanced materials, using new technologies or new forms of services

Table 1. Circular business models according to ReSOLVE
Source: Brendzel-Skowera (2021)

Implementation level of CE

After careful examination, the researched articles were reviewed to find out the level of implementation of the CE efforts at different scale levels to achieve a holistic approach: macro, meso and micro levels are all required (Kristensen & Mosgaard, 2020).

The *macro level* referred to the initiatives undertaken at city and regional scale. Most of the CE initiatives have been at the macro-level and modelled by authorities at the national or regional level, assuming a comprehensive, long-term police strategy as well as citizen and local stakeholder (Kirchherr et al., 2017). These activities aim to develop a recycling-oriented culture, eliminate the heavy pollution and redesign the infrastructure and economical layout of the region based on its characteristics. Biwei Su, suggested the promotion of the typical practices of green consumption such as green restaurants and hotels (buildings), energy saving goods as well as green technologies (Su et al., 2013).

The transition to CE at *meso level* implies the shift towards an industrial network by the introduction of an *eco-industrial zones* applying the industrial symbiosis based on cooperative resource flow management between companies and *eco-agricultural system* attempting to make use of agriculture and livestock wastes and by-products. The eco-industrial zones could be defined as the collection of industrial and service companies working together to improve environmental and economic performance by cooperating on environmental and resource control (Barreiro-Gen & Lozano, 2020). To enhance industrial symbiosis, eco-friendly designs that maximize energy performance, life cycle planning, and product upgradability are promoted. Additionally, resource reuse and recycling throughout industrial zones and clustered companies is critical for the CE's execution, which enables effective resource circulation throughout the region (Saidani et al., 2019)

At the *micro level*, the core of CE adoption is cleaner production. This concerned the actions taken by industrial companies to adopt cleaner production through the reduction of energy use and minimizing of toxic materials as well as the emission of air and water pollution. As eco-design considers all of a product's environmental implications from the beginning, it has the capacity to boost the circular economy strategy by facilitating better material and resource use.

The latter defined as a systematic integration of environmental factors into the design of the manufacturing process and the finished product. It

promotes polluting manufacturing and processing enterprises to develop more integrated, efficient, and green production methods through creative production line design (Vural Gursel et al., 2023).

Impetus of the Implementation CE

Unarguably, the adoption of CE delivers a wide range of benefits and procures a better harmony and balance between three pillars economy, environment, and society (Ghisellini et al., 2016). The following are the main issues that have arisen as a result of the linear economy in recent decades: Increasing pollution of the atmosphere and soil, scarcity and pollution of water, huge amounts of communal and waste material, increasing consumption of energy, destabilization of ecosystems, rising CO^2 concentration in the atmosphere, rising prices as a result of natural resource depletion, fluctuating on the markets. These strong constraints challenge the traditional linear economy model and lead to the emergence of new approaches that converge in a system around the concept of circularity: the circular economy commits organizations to rethink their boundaries, to evaluate growth differently, and even to redefine their business model.

The concept of the CE evolves in a similar way to sustainable development but at a quicker, Neal Milla emphasizes that the concept of SD has been criticized for being imprecise and vague, leading to a loss of impetus (Millar et al., 2019). In addition, the SD does not seek to provide a clear alternative to current development practices. Rather than establishing explicit criteria and methods, it has presented a basic adjustment to include social and environmental issues in established models.

Circular design strategies

Resource cycles in Circular Economy

In order to facilitate the transition to a circular economy, Stahel defined two fundamentally types of loops: (1) reuse of goods, and (2) recycling of materials. In addition, suggested three approaches for the transition to a circular economy based on these: slowing loops (reuse), closing loops (recycling), and narrowing loops (efficiency)(Bocken et al., 2016):

- **Slowing resource loops** strategy aims to extend product/material life and long lasting where the material is maintained as long as possible. This could be achieved through a long-time life while the design of goods (Bocken et al., 2018)
- **Closing resource loops** is about reducing the leakage of natural resources through recycling whereby the loop between after-use and manufacturing is closed (Zhou & Smulders, 2021)
- **Narrowing loops strategy** intended to resource efficiency by focusing on fewer raw materials for each product. The narrowing strategy motivates enterprises to reach the same objectives with fewer resources. Therefore, the target of circularity is not to narrow, but rather to minimize the resource use in products and processes (Gibson, 2021).

Design strategies in Circular Economy

The goal of product circularity in the CE industry is to extend the useful life of product materials and components. The main economic and social concept is product life extension, which can be accomplished through repair, remanufacturing, and refurbishment. The challenge in moving toward CE is in understanding how to minimize the use of natural resources while trying to promote beneficial societal and environmental benefits by rethinking the strategies assisting in enhancing the value in the products provided. Therefore, along with "customer value proposition, supply chain, value networks of the companies, and capturing the value of new products," product design strategies are crucial in value creation (Ellen MacArthur Foundation, 2024).

Design strategies slowing effects

The creation of long-life products and extension of the product's life are the typical design approaches for slowing resource strategies.

- **Design for long-life products** it is focused with assuring that goods are used for a long time. Creating products that customers will love, like, or trust for a longer period of time is referred to as "designing for attachment and trust" within this classification, *Table 2* includes the strategies related to for designing for long-life.

Strategies	Definition
Design for Reliability	The likelihood that, when maintained as recommended by the manufacturer, a product made to a certain design would function for a given time without incurring a chargeable failure.
Design for Durability	Durability can relate with enduring long-lasting empathic partnerships between consumers and goods flourish where the goods are guaranteed to operate without breaking down. A crucial step in the design process is obtaining durable materials.

Table 2. Design strategies slowing effects
Source: own construction based on Ellen MacArthur Foundation (2024)

- **Design for product-life extension** is involved with extending the duration that products can be used by using of service loops, *Table 3* summarizes the strategies.

Strategies	Definition
Design for efficient repairing and maintenance	Is about the capacity to be sustained in a good condition through repairing and inspection. In addition, trying to make products expandable and adjustable in the future is a second strategy.
Design for adaptability and upgradability	The capacity of a product to remain useful by enhancing its quality, value, and efficacy or performance is known as upgradeability.
Design for standardization and compatibility	is about designing and developing goods whose components can fit into different interfaces and other products.
Design for dis- and reassembly	Ensure that the product can be disassembled and reassembled again in order to be reused in the future. This strategy aims to raise the rates of material reuse.

Table 3. Design strategies for product-life extension
Source: own construction based on Ellen MacArthur Foundation (2024)

Design strategies for Closing resource loops

Many businesses and designers have been encouraged to adopt an ambitious circular approach to product design by the "Cradle to Cradle" design concept, which was introduced by McDonough. There are only two potential long-term implications for waste products: dissipative loss or recycling and reuse (e.g., lubricants).

Dissipative losses should always be fully compatible with biological system in order to fit into the "biological cycle", whilst other materials must be totally recycled in order to fit into the "technological cycle."

- **Design for a technological cycle** This design approach is appropriate for products of service, or items that provide a service (as compared to products of consumption). The goal of technological cycle design is to create goods that can be continually and securely recycled into new materials or products (also known as technological nutrients).
- **Design for a biological cycle** is appropriate for "products of consumption," or goods that customers wear or consume during use (resulting in a dissipative loss of resources). With the cooperation of these "biological nutrients," which serve as food for natural systems throughout their life cycles, items for human use are created. Materials in a biological cycle are biodegraded to initiate a new cycle.
- **Design for dis- and reassembly** is a practice that contributes to the Design for a Technological and Biological cycle by overlapping with it. It involves making sure that components and products can be quickly disassembled and rebuilt. Additionally, this approach is essential for segregating materials that will be used in several cycles (biological from technological).

Circular Economy Indicators

China has developed an integrated circular economy policy aimed at ensuring the transition to a low-resource and low-carbon model. This policy is based on assessment tools which, although still insufficient, are distinguished by their systemic and multidimensional nature. These instruments are in many respects unique and constitute an original contribution to the field of sustainability indicators (McDowall et al., 2017).

Ghisellini et al. (2016) point out that there are few published studies on circular economy indicators. The implementation of indicators to measure the performance of the circular economy is not very easy. Indeed, the consideration of different points, namely the sectors of industrial activities, the professions, the most relevant actions, the determining issues are to be

analysed in the development of indicators. Thus, indicators are being studied but are not yet final, given the complexity of this concept, its multidimensional nature which includes several levels of analysis, in particular its seven pillars. This is also one of the weaknesses of the circular economy given that it lacks comprehensive indicators for evaluating and measuring its performance.

China has been developing indicators to measure circularity performance since 2007. Geng, point out that China is the first country to publish indicators of the circular economy, so that it is recognized as credible. The indicators considered valuable for the Chinese government have been established by political and academic experts with the support of other stakeholders (consumers, NGOs, industries, etc.) whose use is mandatory for all. China has based its indicators on the principle of the "3Rs" grouped into two different sets of indicators: the first used at the macro level (regional and national) and the other used at the meso level (industrial park). However, reflections on the appropriate indicators for measuring the performance of the circular economy in China are still ongoing (Geng et al., 2012).

According to the scale of the territory concerned, there are variations in the types of indicators used. *Table 4* lists the indicators used at the macro level in China, 22 indicators are classified into 4 groups.

1.	**Resource production rate**
1.1	Mineral resources production
1.2	Energy production
2.	**Resource consumption rate**
2.1	Energy consumption per unit of GDP
2.2	Energy consumption by industrial added value
2.3	Energy consumption per unit produced in key industrial sectors
2.4	Water consumption per unit of GDP
2.5	Water consumption by industrial added value
2.6	Water consumption per unit produced in key industrial sectors
2.7	Irrigation water utilization coefficient
3.	**Resource reintegration rate**
3.1	Solid industrial waste recycling rate
3.2	Industrial wastewater reuse rate
3.3	Recycling rate of recovered municipal water
3.4	Domestic waste treatment rate
3.5	Scrap metal recycling rate
3.6	Recycling rate of non-ferrous metals
3.7	Paper recycling rate
3.8	Plastic recycling rate
3.9	Rubber recycling rate
4.	**Waste management and pollutants**
4.1	Total amount of industrial solid waste for final treatment
4.2	Total amount of industrial wastewater discharged
4.3	Total amount of SO2 emissions
4.4	Total amount of chemical oxygen demand

Table 4. Circular economy indicators
Source: own construction based on the literature of the Chinese circular economy program

These indicators have been introduced into the circular economy programs since 2007. All stakeholders (companies, and industrial cities) have to measure the performance of their project in this area and had to set their targets using this system of indicators.

Non-acceptance of Circular Business Models

Why have CE business models not yet improved around the world since the advantages of a circular economy are so evident and the fundamental ideas have existed for more than three decades? The reasons are numerous and have their roots in both the inherent irrationality of consumer behaviour and conceptual weaknesses in our current global economic system. From an

economic perspective, one of the primary reasons for poor product design is an unaligned profit share along the supply chain. If the benefits of a better design are only realized at the point of sale, such as when a product is returned for reuse or recycling, then this creates a situation where product design optimization is primarily driven by cost and production efficiency. This explains why, even though it can be more cost-effective than product replacement from a lifecycle perspective, the majority of consumer products today are not constructed with repair and re- manufacturing in mind. Even though switching to a more expensive but more durable product would be more cost-effective, consumers often encourage this development by simply considering the transaction cost at the point of sale (buy price). The list of challenges to business models for the circular economy are summarized in *Table 5*.

Reason	Brief example	Origin
Irrationality of customer	Consumers only consider the transaction cost (purchase cost) at the time of sale, even when it would be more cost-effective in the long run to upgrade to a more expensive but more lasting product. Even though temporary usage is more cost-effective, consumers prefer owning a thing.	Customer behaviour
Corporate conflict of interest	To enhance an existing product design or switch from a sales-based to a usage-based revenue model, more capital or cash is needed.	Short-term strategies and visions
Inconsistent profit-sharing throughout the supply chain	If the benefits of a superior design would only be realized at the end of use, there would be imperfect design at the start of the supply chain.	Inconsistent regulations involving the end-of-life cycle of items
Geographical distribution	National initiatives frequently lose their potential influence since the value chain of today's products spans several nations.	Lack of national cooperation and international organizations

Table 5: Non-acceptance reasons of Circular Business Models
Source: own construction based on the literature review

Conclusion

Existing literature on the design of circular business models identifies a variety of these models, a small number of business activities related to the circular economy, and some suggestions for converting existing business models to the circular economy. The idea of developing a circular business model is discussed in this study from the perspective of companies. It explains how the circular economy's guiding principles relate to a well-known business model framework and enhances it with extra circular economy-related elements. This research has contributed also to the limited body of literature in the field and shed light on one potential way for evaluating the new circular business models. Lastly, more operational circular business models are required to evaluate their effects following adoption and direct further business model development.

As a result, the study gives the possible strategies for Circular Economy implementation. Our map of circular modes of adoption appears to effectively distinguish several methods in which Companies create their Circular Economy Business Models, i.e. how they leverage Circular Economy ideas from a business model standpoint. This study covers some themes and research questions that have been investigated at the interface of business models and the circular economy. The field's present challenges were recognized by the study's findings, which also included information on the field's new research directions and unexplored areas. Future research will likely be encouraged by this. We anticipate that our analysis, conclusions, and suggestions for additional study will motivate new business model and circular economy research efforts.

However, we agree that our contribution to the discussion regarding the Circular Economy presents academics a useful taxonomy to test and modify in order to more accurately categorize and distinguish businesses adhering to the implementation of the Circular Economy principles to move towards a Circular Economy Business Model. As consequently, we invite future theoretical and empirical studies to investigate the contextual factors that can have an impact on developing Circular Economy Business Models.

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