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INTERSECTIONS OF PLATFORM ECONOMY, SUSTAINABILITY, SYMBIOSIS, RESOURCE EFFICIENCY, RENEWABLE ENERGY AND THE CIRCULAR ECONOMY

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Abstract

At the center of global change is the rise of platform economy, sustainability, green economy, industrial symbiosis, circular economies, industry 4.0 paradigm, and resource efficiency models, which appear in an interrelated conceptual confusion of innovative paradigms. These emerging platforms and the competitive dynamics in the network society revolve around collecting and analyzing data from their interactions to achieve network effects, attracting users to a platform that can generate socio-economic value with environmental sensitivities. This study argues that the circular economy, platform economy, renewable energy and resource efficiency have intersections and close relations with digitalization. It is tried to identify the points of harmony and intersections in this field's great confusion of concepts. In addition, it is argued that the digitization accelerated by Industry 4.0, supports a more sustainable circular economy, platform economies, and therefore industrial symbiosis, and solutions are suggested for the perfect order by revealing the close linear inter-relationships. This study examines the impact of digitalization, circular economies, and sustainability on the development of more efficient processes. It aims to mimic the wasteless and flawless order found in the universe to reduce waste, transaction costs, and ensure the production of healthier products. Here, it is argued that the environmental and intelligent engineering of Industry 4.0 should be guided by a more sustainable, symbiotic, platform-based, digital, and circular operating way and should include theological dimensions besides the material production dimension.

Keywords

Sustainability
Platform Economy
Circular Economy
Symbiosis
Energy Efficiency

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PLATFORM EKONOMİSİ, SÜRDÜRÜLEBİLİRLİK, SİMBİYOZ, KAYNAK VERİMLİLİĞİ, YENİLENEBİLİR ENERJİ VE DÖNGÜSEL EKONOMİNİN KESİŞİMLERİ

Öz

Küresel değişimin merkezinde yenilikçi paradigmaların birbiriyle ilişkili kavramsal karmaşası içinde ortaya çıkan platform ekonomisi, sürdürülebilirlik, yeşil ekonomi, endüstriyel simbiyoz, döngüsel ekonomiler, endüstri 4.0 paradigması ve kaynak verimliliği modellerinin yükselişi yer alıyor. Ortaya çıkan bu platformlar ve ağ toplumundaki rekabet dinamikleri, ağ etkileri elde etmek için etkileşimlerinden veri toplama ve analiz etme etrafında dönerek, kullanıcıları çevresel hassasiyetlerle sosyo-ekonomik değer üretebilen bir platforma çekiyor. Bu çalışma, döngüsel ekonomi, platform ekonomisi, yenilenebilir enerji ve kaynak verimliliğinin dijitalleşme ile kesişimleri ve yakın ilişkileri olduğunu tartışmaktadır. Bu alandaki büyük kavram karmaşasında uyum ve kesişme noktaları tespit edilmeye çalışılmaktadır. Ayrıca Endüstri 4.0 ile hızlanan dijitalleşmenin daha sürdürülebilir bir döngüsel ekonomiyi, platform ekonomilerini ve dolayısıyla endüstriyel simbiyozu desteklediği savunulmakta ve yakın doğrusal ilişkiler ortaya konularak mükemmel düzen için çözümler araştırılmaktadır. Bu çalışmada, evrende kurulan israfsız ve kusursuz düzeni taklit ederek daha verimli süreçler geliştirmek, bu sayede israfı ve işlem maliyetlerini en aza indirmek ve ürünlerin daha sağlıklı olmasını sağlamak için dijitalleşme, döngüsel ekonomiler ve sürdürülebilirliğin katkısı değerlendirilmektedir. Burada Endüstri 4.0'ın çevreci ve akıllı mühendisliğinin daha sürdürülebilir, simbiyotik, platform tabanlı, dijital ve döngüsel bir işleyiş biçimiyle yönlendirilmesi ve malzeme üretim boyutunun yanı sıra teolojik boyutları da içermesi gerektiği savunulmaktadır.

Anahtar Kelimeler

Sürdürülebilirlik
Platform Ekonomisi
Döngüsel Ekonomi
Simbiyoz
Enerji Verimliliği

Makale Hakkında

Araştırma Makalesi

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INTRODUCTION

This study argues that the circular economy, platform economy, sustainability and resource efficiency have intersections and close relations with digitalization as it optimizes cost minimization and profit maximization. All of them are based on efficiency, economy, and renewability of energy resources. The points of harmony and intersections in the great confusion of concepts and paradigm shifts as Thomas Kuhn argued with his renowned 'paradigm shifts theory', are searched on accelerating digitalization with Industry 4.0, a more sustainable circular economy, platform economies, renewability of energy and industrial symbiosis. So, it can accelerate the correct conversion and help close material cycles by providing accurate information about the availability, location, and condition of products. It is argued here that the green and intelligent engineering of Industry 4.0 is driven by a more sustainable, symbiotic, renewable, platform-based, digital, and circular operating path. At the same time, the significant contribution of digitalization is evaluated in terms of providing more efficient processes in helping to minimize waste, ensuring longer life of products, cycling energy sources, and minimizing transaction costs. Thus, it has been found that digitalization can strengthen circular economy business models by helping to close cycles, slow down the material cycle, and narrow the cycle with increased resource efficiency. We have set up our problem statement, assumptions, and hypothesis accordingly n the following section.

1. Method and Literature

The rise of platform economy, sustainability, industrial symbiosis, circular economies, and resource efficiency models are leading to an interrelated conceptual confusion of innovative paradigms. This confusion of concepts can limit the development of sustainable and efficient business practices, leading to potential negative impacts on the environment and society.

1.1. Assumptions

1. The circular economy, platform economy, renewable energy and resource efficiency have intersections and close relations with digitalization.

2. The digitization accelerated by Industry 4.0, supports a more sustainable circular economy, platform economies, and therefore industrial symbiosis.

3. Environmental and intelligent engineering of Industry 4.0 should be guided by a more sustainable, symbiotic, platform-based, digital, and circular operating way and should include theological dimensions besides the material production dimension.

1.2. Research Hypothesis

H1: The intersections and close relations between the circular economy, platform economy, renewable energy, and resource efficiency with digitalization can lead to more sustainable and efficient business practices.

H2: The digitization accelerated by Industry 4.0 supports a more sustainable circular economy, platform economies, and therefore industrial symbiosis.

H3: Environmental and intelligent engineering of Industry 4.0 can be guided by a more sustainable, symbiotic, platform-based, digital, and circular operating way that includes theological dimensions besides the material production dimension.

1.3. Literature

A literature search was conducted on the Google Scholar database, and the reports pertaining to the relevant sector and establishment were evaluated. These searches generate quick reports based on the occurrence of words anywhere in the publications. In this regard, the search for 'platform economy' yielded 23,400 results, 'circular economy' produced 268,000 results, 'symbiosis' showed 820,000 results, 'resource efficiency' yielded 170,000 results, 'sustainability' presented 4,310,000 results, 'industry 4.0' provided 281,000 results, and when all the research words were searched together without any asterisks, 19,100 results were found. However, it was observed that none of the publications included all these words in their titles. Therefore, our study is believed to contribute to the literature by offering a comprehensive and enriched approach to the various paradigms in this context.

Today, the world is witnessing an advent of the fourth Industrial Revolution or Industry 4.0 which is driven by two main factors, artificial intelligence (AI) automation and data analytics, and aims to minimize or eliminate waste and greenhouse gas emissions by redesigning production processes and activating industrial symbiosis so that waste from an industry can serve as raw material and input. This fact links Industry 4.0 with sustainability, circular economy, platform economy, and resource efficiency (Patil et al., 2020). That is why innovative platforms are increasingly powered by global digital technology infrastructures that help scale engagement and collaboration (deloitte.com, 2017). However, this can be a facilitator rather than a prerequisite for a platform. Therefore, while the Platform economy by itself does not affect the circular economy, it can provide other circular economy building blocks such as performance and sharing economies, and trade and exchange of B2B (business to business), B2C (business to consumer), and C2C (consumer to consumer). Today's eBay buyers can be seen as tomorrow's sellers and today's Uber customers as tomorrow's drivers. These dynamically changing roles and online interactions of B2B, B2C, and C2C create network effects more significant than ever before and continue to grow at an unprecedented rate and can reach a value of approximately 4.5 trillion Euros (Taranic et al., 2016). Therefore, the platform economy can help performance and sharing economies overgrow, potentially positively affecting the circular economy. The researchers also point out that the circular economy is a way of living in harmony with and restoring our ecological systems. It advocates using Industry 4.0 (Reduce, Reuse, Recycle) Life Cycle Analysis tool, mainly nano and digital technologies. Researchers also suggest that change in circularity and sustainability will be better appreciated and embraced by every individual when their education becomes a part of the curriculum worldwide (Murray et al., 2017, p. 375).

Digitization can be seen as one of the Circular Economy (CE) providers. It provides a thoughtful perspective on products, relationships, and assets such as location visibility, location, status, and availability of assets. One of the critical points in CE-based business models is renting, using, or sharing durable products instead of purchasing as much as possible (Ellen, 2013; Bocken et al., 2016, p. 310). Therefore, the transition to product-service

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systems is recommended as one of the critical solutions in accelerating the transformation to CE, and digitalization stands out as an essential facilitator in this process (Ellen, 2016).

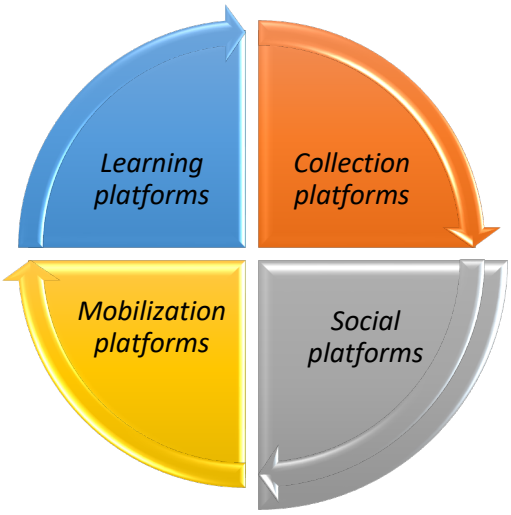
1.4. Method

This study, based on the review of the relevant literature and institutional reports, firstly the topic of Platform economy, its differences according to the traditional way of working, and then the topic of Circular economy are discussed. In the context of the platform economy, a platform environment like Uber; the power structure between platforms and platform employees, and the environmental footprint of the Platform economy are covered. Different usage and operating models are examined in the circular economy context by paying attention to their differences. Finally, the associated paradigms are evaluated in the context of digitization.

2. The Platform Economy Differing from The Traditional Approaches

It has been determined that there are 985 results in total regarding the platform economies in article titles. Therefore, it can be said that it is a new and emerging paradigm. It is essential to understand not only the structure but also the dynamics of different types of platforms (deloitte.com, 2017):

Figure 1. Key Sub-Platforms That Can Be Considered Within Platform Economies



As is shown in the figure above, our sub-platforms can be considered within paradigm of the platform economies. The technological landscape has witnessed the rise and evolution of various platforms catering to diverse user needs. Collection platforms, as examined by Pickering and Keightley (2016), serve as repositories where users can accumulate, organize, and share digital resources, be it personal media, documents, or other forms of content. Social platforms, on the other hand, have dramatically reshaped how individuals interact and

communicate, with scholars like Van Dijck (2013) assessing their societal impacts and the dynamics of user engagement.

Mobilization platforms, often integral to political and social movements, enable grassroots organization and collective action, as delineated by Tufekci (2017). Lastly, learning platforms have revolutionized education, providing avenues for digital pedagogy and online resource sharing. Studies by Selwyn (2016) delve into their transformative potential, challenges, and the changing nature of educational experiences. Therefore;

1. *Collection platforms* bring together a wide variety of relevant resources, helping users connect with the most relevant resources. These platforms generally tend to be transaction or task oriented works as Guarda (2020) bulleted as such:

- Expressing a need
- Providing an answer,
- Making deal,
- Ensuring continuity.

Companies that manufacture intangible or tangible products, such as the traditional auto industry, software, and computer-based information services, where product platforms are widely used, can also benefit by implementing an effective product platform strategy. Collection platforms operated on a hub model, where the platform owner and regulator mediate all transactions (Zifla and Wattal, 2016, p. 2-10).

Moreover, broker platforms such as eBay and Etsy are well-known examples that use platform strategies to support their rapid growth and broad e-commerce-based products, trying to do the following operations (Lin et al., 2007, p. 130-140):

- Conducting online auctions,
- Processing the payment transactions of the products received,
- Providing peer-to-peer communication for its users
- Providing software and services to people over the Internet

2. *Social platforms* are similar in that they also bring so many people together. Facebook, Twitter, and Instagram are prominent examples. However, instead of completion of a transaction or a task, they tend to support interaction and foster more networking among people with common interests.

3. *Mobilization platforms* seek to empower people to work together to achieve something beyond the abilities of any participant.

4. *Learning platforms* facilitate learning by bringing participants together to share insights over time. Participants tend to develop deep, trusting relationships as they can realize more significant potential by working together.

As the figure 2 shows, connecting people with demand (customers) to suppliers (workers) is the platform's core business. Although the platform does not have the means of production, it only provides a connection.

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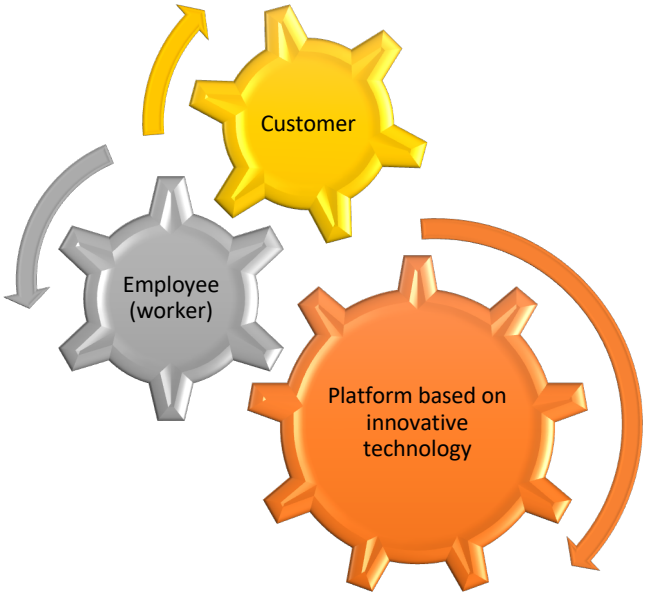
Figure 2. Platform Economies Requires Three Basic Actors (Employee, Customer And Innovation)



The strength of the platform economy lies in its ability to use increased information sharing and data circulation among different players to its advantage, eliminating trade barriers. This creates a much more open economic system with much greater participation of its users (deloitte.com, 2017).

2.1. A Platform Environment Like Uber

The Uber ecosystem is now Uber Eats (meal delivery), Uber Health (transporting patients), Uber Jump (bikes), Uber includes Freight (logistics), and they recently added Uber Works (Self Employed) and provided rental and collaboration agreements. For example, collaborations with car companies and credit card companies support drivers. Thus, a complete ecosystem is built around original business models, life becomes easier, and all parties created on the platform can monetize such interactions. Uber has now grown into one of the largest food delivery companies worldwide. Although it evolved as a side-effect of the original business model, it still works very well. Because there are infrastructures, drivers on the road that can fill their empty capacities by distributing food and deliveries (Schneider, 2017, p. 40-45). The potential efficiency here is much higher than with a regular pipeline model. Because drivers can switch between activities, they can earn more money by delivering food, conveying passengers, and transporting sick people.

2.2. Power Structure Between Platforms and Platform Workers

There is a variety of the type of platform workers. The types of workers are:

- *Partially dependent*: The employee uses the platform as a part-time job.

- *Priority dependent*: The employee is assured and confident in the platform's earnings.

- *Complementary*: Employee uses the platform to generate additional earnings.

The level of platform income dependence greatly influences platform employees' (negative) experiences regarding such factors as autonomy, security, satisfaction, and income. The critical questions in the discussion about the power structure of platforms revolve around:

- Does the platform economy re-distribute any wealth or accelerate inequality?

- Are the platform employees, independent contractors, or simple employees?

- Can platforms be seen as disrupting the current business order, destructive of classical mechanisms, and therefore a way of unfair gain?

A common criticism is that the platform economy can lead to job marketing and reduced worker protection. Because while platforms increase competition and reduce barriers to entry, they can cause more pressure on wages and working conditions. This also means that full-time workers can lose their jobs if it becomes more cost-effective for employers.

2.3. The Environmental Footprint of The Platform Economy

Currently, very few research results (mainly quantitative) are available on the subject. Some key factors of the environmental footprint of the platform economy can be mentioned concerning the following (Möhlmann, 2015, p. 200-205):

(1) Technology,

(2) Digitization and

(3) Consumption and production patterns.

Technology

Its production consumes resources, and new models are constantly appearing based on innovation. Various devices such as smartphones, tablets, computer etc., are needed to access the platforms in the most hands-on sense of technology. Short-lived, out-of-date devices end up as electronic waste. The rise of what has been called the sharing economy is one of the most daring challenges for cities worldwide. The sharing economy has expanded particularly due to its characteristic conforming to Islamic economics in which Islamic funds are to be attracted more. While sharing platforms provide opportunities for efficient market exchange, they also create negative externalities for city dwellers. A challenge for city authorities is that platforms can be launched without considering externalities and public interests. The platform innovation logic that prevents participatory planning and constructive technology evaluation is called 'reverse technology evaluation' (Koen and Peter, 2020, p. 22-25).

Digitalization

New digital innovations and the gradual expansion of powerful platforms such as Airbnb and Uber are also putting pressure on the development of legislation globally (Jakosuo, 2019, p. 79-85). Often platforms find a way to mix the virtual and physical worlds, in some cases also speeding up material transactions. In addition, digitalization using virtual reality, block-chain, artificial intelligence, and big-data analytics can increase global logistics as it provides global reach more efficiently, and effectively with cost minimization.

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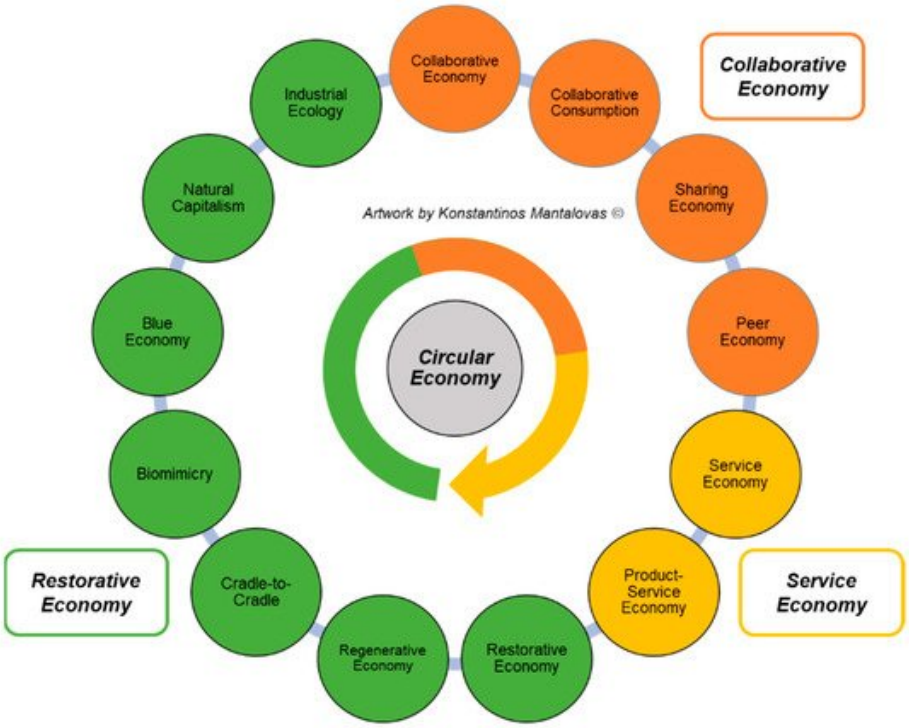
Consumption and production

Optimally, the platform economy can align with these concepts. For example, innovations in practice that encourage efficient access, such as 'imece' or shared machinery, can be implemented instead of ownership. Producer-to-consumer applications form the basis of platform economies in general. However, although consumer participation in platform economies has steadily increased, consumer-to-consumer (C2C) activities in general and resale exchange have not been adequately studied. More specifically, it is severely lacking in understanding how secondhand shopping is embedded in the platform economy and how traditional retail brands alongside platform brands can play a critical role in facilitating this type of shopping. In addition, the technological environment has expanded consumer connections, changing exchanges between consumers (Soule and Hanson, 2021, p. 10-14).

3. Circular Economy

There is an urgent need to reduce overall resource consumption (European Commission, 2015). In the scientific literature, many studies see the circular economy as a political concept that supports the principles of economic transformation that will move towards environmental, social, and economic sustainability (Schwanholz and Leipold, 2020). It has been determined that there are 11.100 results in total having it in the article title. Therefore, it can be said that it is a new and emerging paradigm since it has started a paramount interest in the academia.

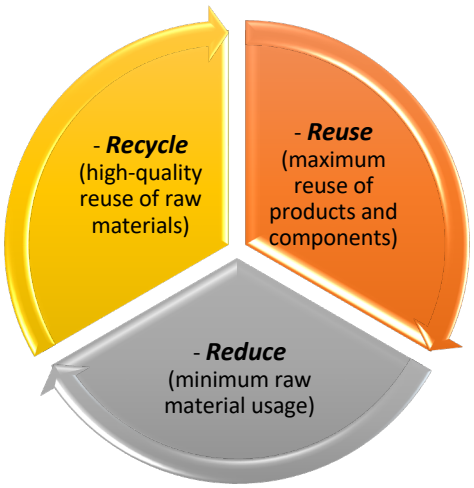
Figure 3. Circular Economy Paradigm is Divided Amongst Restorative Cooperative and Service Economies in Essence



Source: *Mantalovas et al., 2020.*

Figure 3, the circular economy is considered concerning many of its paradigms within collaborative platform economies, service economies, and environmental reparative economies (Ellen, 2014). A cooperative economy is a type of economy that is decentralized and includes networks of individuals and communities rather than institutions. This type of economy aims to replace the current production, consumption, finance, and education (Botsman and Rogers, 2010, p. 30). In such an economy, inventors and investors are brought together to compile the entire procedure for sharing, selecting, producing, and distributing new products (Mantalovas et al., 2020, p. 2). By changing this economic model, a service provider reduces resource expenditures and energy consumption in the production process (Froderman, 2018, p. 55; Stahel, 1997, p. 1310). Thus, the three main aspects of a collaborative economy can be defined as shifting power from institutions to networks of individual actors, innovative and efficient product use, and technological innovation, changing values, economic realities, and prominent environmental pressure drivers (Ellen, 2015). This economy can replicate and integrate nature's mechanisms into industrial systems to restore rather than degrade the natural environment. Products in this economic context are not products that can be reused as a material input to the life cycle of another system or easily broken down and reused with the goal of increasing biodiversity, or vice versa (Hawken, 1993). Other similar approaches inspired by nature are: 'cradle to cradle', 'biomimicry', 'blue economy', 'industrial ecology and natural capitalism' (McDonough and Braungart, 2002, p. 44; De Pauw et al., 2014, p. 180; Llorach-Massana and Farreny, 2016, p. 715). There are many different definitions in use as the concept has been applied by various researchers and professionals. The diversity of definitions also makes it challenging to make circularity measurable. Definitions often focus on raw material use or system change. Definitions that focus on resource use generally follow the following approach in the figure (Wilts and Berg, 2017, p. 1-3).

Figure 4. Circular Economy Definitions



Since the circular economy is a comprehensive concept with a wide variety of goals and principles, it generally *proposes a circular system in which the value of products, materials, and resources are retained as long as possible, as opposed to a take-and-go economy* (Merli et al. 2018, p. 710). Sharing products (as a service), mainly through digital sharing platforms, can increasingly be a facilitator for a circular economy depending on the temporary and

collaborative use of products and services, including 'leasing, gift-giving or bartering' (Frenken and Schor, 2017, p. 8-9). The sharing economy is conceptualized as part of the circular economy, and product sharing practices the extent to which it contributes to circular economy goals and principles is under investigation. In practice, however, there is a wide variety of sharing practices and business models (Muñoz and Cohen, 2017, p. 25), and digital sharing platforms' economic, social, and environmental impacts are either mostly beneficial or harmful (Heinrichs, 2013, p. 230; Cherry and Pidgeon, 2018, p. 940).

Circular economy within the scope of Islamic economics is of great importance because it 'shows Allah's wasteless and perfect order in the universe'. Islam et al. (2021) conducted a study on the production of renewable energy from animal waste for the adoption of circular economy in a developing country like Bangladesh. Reducing greenhouse gas emissions from the livestock sector can be achieved by converting animal waste into energy. The study was designed considering that the conversion of animal wastes into energy would contribute to reducing the negative impact on the climate. Campra et al. (2021) studied the relationship between the circular economy and Islamic countries from a theoretical perspective. In their work, they compared the study between circular and linear economy in detail and included circular economy policies and practices from Dubai. The authors stated that the study constitutes a theoretical framework for future studies on circular economy and Islamic systems. In addition, they stated in their studies that the circular economy is very important, but it is left incomplete in terms of the Islamic dimension, and that there are not adequate number of studies on the subject. Farhand et al. (2020) proposed the establishment of a waste industry center to be financed by the issuance of proxy sukuk funding model as a solution to Indonesia's waste problem. The authors stated that it is necessary to establish a facility to solve the waste problem, as waste generation will increase in Indonesia, especially between 2030 and 2050. In the study, information was given about the concept of proxy sukuk, and they stated that proxy sukuk could be a solution to meet the financing needs of the facility to be established to solve the waste problem. Khan (2020) discussed the use of the Islamic mixed finance model in achieving sustainable development goals. The Islamic mixed finance model, designed as a product of financial engineering to ensure sustainable development in developing countries, is expected to contribute to the sustainable development of Small and Medium Enterprises (SMEs). Because the basis of the funds provided according to the Islamic mixed finance model is benevolence rather than profit maximization. Compared to other non-profit organizations, the Islamic mixed finance model is the financial model used to support sustainable development projects. There is a win-win understanding in the Islamic mixed finance model. As a result of Khan's work, it has been concluded that there is a synergy between local aspirations, national priorities, and global goals, and between philanthropy, profit, and government incentive motivations, and that sustainable development can be achieved by circular economy applications without incurring additional costs for SMEs with the Islamic mixed finance model (Sumer and Yanık, 2021, p. 210-215).

Despite the wide variety of business initiatives that have recently emerged adopting sharing practices, the current literature primarily focuses on the accommodation and mobility sectors, the most notable examples being Airbnb and Uber (Hobson and Lynch, 2016, p. 20-22; Quattrone et al., 2016; Chi et al., 2020, p. 57; Chen and Zhu, 2020). However, many scholars

propose hypotheses as to why humans contribute to the sharing economy as consumers or providers of goods and services. Kathan et al. (2016) suggest that if ecological consumption is essential to consumers, it can be sustainable. On the other hand, Martin (2016) argues that the sharing economy has been successfully reshaped as a purely economic opportunity by the regime actors. If the sharing economy follows this institutional common option path, it seems unlikely to drive the transition to sustainability. Most studies on digital sharing platforms cover consumer perceptions (Piscicelli et al., 2018, p. 4580). At the same time, there is not enough information about the goals and self-perceptions of the people who provide or make these applications. Examination of stakeholder perceptions is emerging in both circular economy and sharing economy literature (Lazarevic and Valve, 2017, p. 60; Leipold and Petit-Boix, 2018, p. 1125; Lee, 2020). There are several emerging business models for businesses to implement the circular economy in their operations. Below are the two central circular business model categorization schemes, one proposed by Lacy et al (2014) and the other Recent Products (Delft University) can be mentioned.

3.1. Accenture

Accenture has identified five business models to help companies address the four types of waste (resource, capacity, lifecycles, and built-in value) and create a circular value chain by separating growth from resource consumption. The five underlying business models are presented as follows (Lacy et al., 2014, p. 4-14).

3.1.1. Circular Inputs

In essence, a Circular inlet or Circular feed means replacing a linear type of source with a circular alternative. This business model can enable renewable energy, bio-based or potentially fully recyclable materials instead of linear ones.

NatureWorks

Natureworks is a chemical manufacturing company that provides cyclic materials. Natureworks offers commercially available biopolymers made from 100 percent renewable resources. Using the best technologies, they use plants to convert greenhouse gases into lactic acid. The cost and performance of biopolymers compete with petroleum-based packaging materials and fibers. The product is used in a range of end products, from packaging materials to plastic bottles (Minn, 2021).

Nike

Nike, a multinational footwear, and apparel company, combines at least 50% recycled leather fibers to create innovative leather materials that work as natural leather, reclaiming discarded leather fibers that ultimately end up in landfills. Its production creates a smaller carbon footprint compared to traditional leather production by reducing the impact of water-powered processes. Also, Nike refurbished Nike's latest circular consumption strategy. After a customer returns a pair of shoes, 'Nike Refurbished' can collect them and make them an excellent value for Nike customers (news.nike.com, 2021).

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Adidas

Parley's products with premium materials produced from recycled marine plastic waste are the first pillar of Adidas's sustainability strategy. In 2019, Adidas produced 11 million pairs of shoes containing recycled ocean plastic, stopping plastic waste on beaches, remote islands, and coastal communities, and is committed to using only recycled polyester in every product and every application for which there is a solution by 2024. From 2024, it is planned to use only recycled polyester in every product and application with a solution (adidas-group.com, 2019).

3.1.2. Sharing Platform

This business model facilitates the renting, sharing, bartering, or exchanging resources, typically using digital technologies, rather than offering the products themselves, by providing a platform to connect product owners with individuals or organizations who want to use them (Xie et al., 2020). It helps increase usage rates with a collaborative approach for access or co-ownership by renting out all idle and unused items, large and small, and exchanging them with sharing platform models.

Stokarti

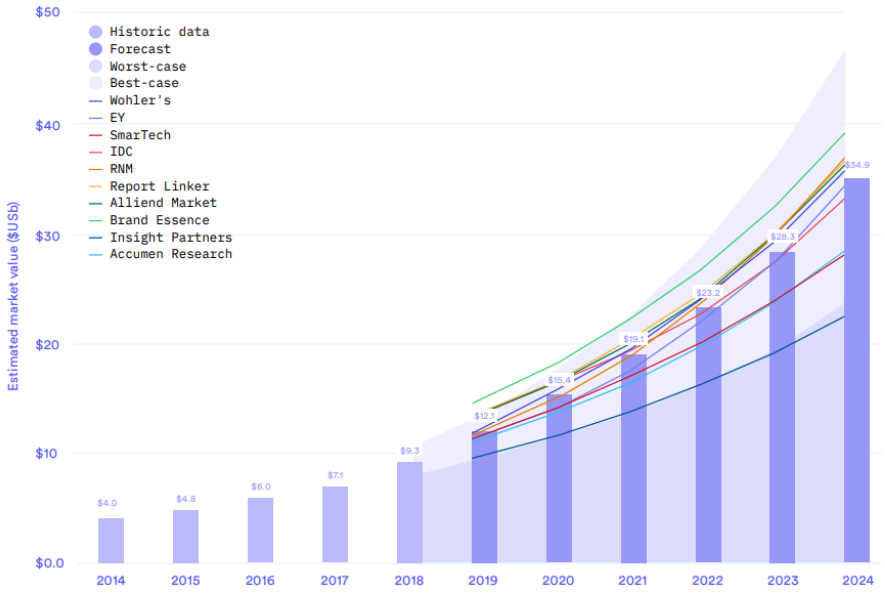
A digital transformation initiative that defines an aftermarket digital market, Stokarti allows companies to list and trade surplus materials and assets while maintaining the company name. Stokarti has approximately 500 members from 53 countries and 16,000 stock lists (stokarti.com, 2023).

Airbnb

The Airbnb platform provides a network that connects people who want to share their extra space. In Airbnb, one of the best-known examples of the sharing economy, customers benefit from their idle capacity or access to unused or underutilized assets and resources. It must be recognized that these have increasingly significant implications for planning policy and urban governance (Ferreri and Sanyal, 2018).

3D Hubs

Figure 5. 3D Printing Market Forecasts



***Source**: HUBS, 2020*

3D Hubs makes the 3D printer market more streamlined, enabling a printer to serve more people with quotes regarding material, lead time, pickup process, and price. As can be seen from the graph, it can be said that striking results emerge when the 3D market sizes in the future markets are estimated by considering the current and historical data of the big analyst companies in the market and the demand growth rates in the market.

3.1.3. Product As a Service:

This model focuses on the performance of products rather than sales volume. As customers use products with rent or payment-for-use arrangements, consumers pay for products by usage and increase resource efficiency by keeping products in use (Xu et al., 2019).

MUD Jeans

MUD Jeans introduced an innovative 'rent jeans' concept in 2013, allowing its subscribers to rent jeans instead of buying them. Thanks to the design and material selection, multiple users can repair jeans multiple times to extend product life and returned items can be turned into valuable materials for new jeans. MUDJeans' rental model aims to prevent overproduction and overconsumption. They increase resource efficiency by closing the loop with their concepts supported by reverse supply chains and mechanical recycling schemes. It also introduced seven critical principles for the circular economy (mudjeans.eu, 2023):

- Design for the future,
- Prioritizing renewable resources,
- Preserving and expanding what has already been done,
- Rethinking the business model

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- Using waste as a resource,
- Collaborating to create shared value and
- Combining digital technology.

Signify

Signify, formerly known as Philips Lighting, stands as one of the global pioneers in the lighting industry, offering top-tier, energy-efficient lighting products, systems, and services. Recognizing the growing demand for sustainable solutions, Signify integrates circular economy principles into its product design and service delivery. Unique to their approach, they champion a model where customers essentially lease lighting systems rather than purchasing them. This ensures that users derive value from the service and functionality rather than mere ownership of the product (signify.com, 2023).

3.1.4. Product Usage Extension:

The Product Life Extension business model is designed to prolong the lifespan of products, thereby generating revenue through increased durability. In this approach, aspects like durability, quality, and functionality of a product hold significant value (Bressanelli et al., 2018). The model encompasses various activities such as repair, rework, upgrade, and resale to ensure prolonged product use. There are many examples of this model:

Schneider Electric

Schneider Electric, a multinational energy management company, actively incorporates circularity in its business strategies. A key part of this strategy involves extending the lifespan of products through repair and upgrade processes. For instance, Schneider Electric enhances the utility of its switchboards by repairing, upgrading, or renewing switchgear. This approach results in cost savings of up to 65% compared to new installations, in addition to reducing CO2 emissions and conserving water. Further, all components are designed to be reusable, renewable, recyclable, or biodegradable (se.com, 2023).

Patagonia

Patagonia, a renowned American outerwear brand, offers professional repair services to its customers. It also promotes the resale of pre-owned clothing through its 'Worn Wear Program'. In collaboration with iFixit, a community-driven platform, Patagonia provides maintenance guides and detailed instructions for repairing damaged items. Committed to sustainability, Patagonia designs products to be durable and repairable, ensuring they remain functional for as long as possible. This commitment is underscored by the brand's lifetime warranty on all products. If an item becomes irreparable, Patagonia recycles it and compensates the customer with gift certificates (Hoang, 2017).

3.1.5. Resource Recovery

This model emphasizes the latter stages of the value chain. It effectively repurposes what might be considered waste, transforming it into resources with renewed economic value. Essentially, the model focuses on salvaging usable resources from items or by-products that

have outlived their original purpose. Techniques such as recycling, upcycling, and downcycling are the primary methods used in this model (Wilts and Berg, 2017).

Darwin's botanicals

Founded in November 2015, Darwin's Botanicals specializes in hand-dyed fabrics using natural, chemical-free colors derived from plants and food waste. Committing to 100% natural fibers, they collaborate with cafes, restaurants, caterers, and local florists to repurpose waste for paint production. Their product offerings include fabric accessories like scarves, hair bands, and bow ties (darwins.com.tr, 2018).

MyArch

MyArch produces food preservatives sourced from natural calcium. These preservatives, versatile in application, are suited for various industries including packaged food, fresh produce, pharmaceuticals, and cosmetics. Due to its natural composition, it extends product shelf life without adverse effects. Interestingly, this food preservative is derived from eggshell waste, presenting a prime example of upcycling. With its environmentally friendly attributes, it exemplifies the benefits of industrial symbiosis and the circular economy (TEMA, 2017).

3.2. Different Models

In the ever-evolving world of business, various models have been conceptualized to cater to the dynamic needs of consumers and to create sustainable, profitable ventures. While there are myriad ways to structure a business's offerings, understanding and categorizing them can pave the way for strategic decision-making. In this section, we delve into two distinct models that have captured the attention of modern enterprises: the Hybrid and the Gap Exploit Models. The former ingeniously merges two product types to yield a seamless user experience, while the latter capitalizes on the embedded value of a product over its lifetime. Both these models represent innovative approaches to product development and lifecycle management, reflecting the changing dynamics of consumer demand and environmental responsibility.

3.2.1. Hybrid models

Hybrid models integrate two distinct types of products, crafted to function symbiotically. This approach originated when long-lasting products necessitated the regular replacement of a short-lived component. Consequently, the primary revenue generation emanates from the consistent sales of these rapid-cycle consumables (Gatzioura et al., 2019). An exemplar of such a model is 'Diapers,' an American brand of reusable diapers boasting a cradle-to-cradle certification. Gdiapers offers not only an economical and accessible option but also one that is gentle on infant skin and crafted to be breathable. Equally crucial is its environmental ethos: Gdiapers are designed to regenerate the environment, rather than deplete it during their manufacturing and disposal. One of its standout features allows consumers to replace only the internal segment of the diaper using disposable inserts, emphasizing both convenience and sustainability.

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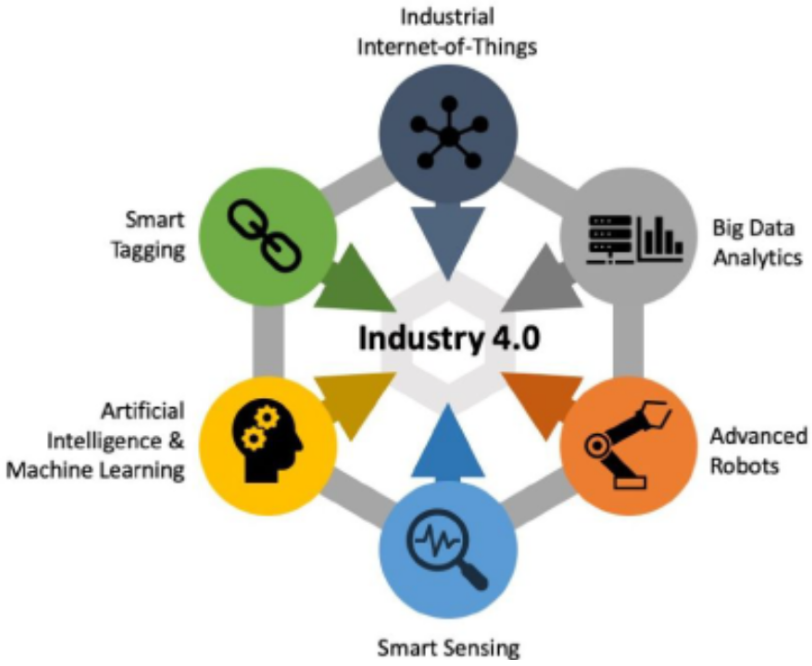
3.2.2. Gap Exploit Model

Internal loops allow the embedded value of a product to be captured over time systematically (Den Hollander and Bakker, 2016). This model takes advantage of the value gaps of products with a lifetime. The main revenue stream is derived from the sale of products, parts, and services based on the mixed product lifecycle of the components. The Gap exploiter model offers three options: repair, resale, and recovery.

4. Digitalization And Industry 4.0 Solutions in Circular Economy, Platform Economy, And Resource Efficiency Processes

The role of digitization as a critical enabler of CE is widely recognized (Antikainena et al., 2018). Digitization provides transparent access to data on the resource consumption of products and makes it possible to optimize product life cycles, thereby promoting progress towards CE (Kagermann, 2015). However, limited research on how digitization will drive the transition to CE (Bressanelli et al., 2018; Pagoropoulos et al., 2017; Tseng et al., 2018). Pagoropoulos et al. (2017) conducted a literature review of 12 articles on CE and digital technologies. Decisions must be made about the lifecycle stages of products, how waste materials should be reused, what kind of logistics arrangements are needed, and who the actors involved in the value network are (Salminen et al., 2017). This can reduce environmental impact and circular business models (Lewandowski, 2016). Digital technologies make it possible to keep data together with materials in the loop and use waste as a resource (Wilts and Berg, 2017). Digital solutions enable circular business models through automatic monitoring, control, and optimization of resources and material flows (Moreno and Charnley, 2016). It is very important to consider Industry 4.0 and sustainability together to get the maximum benefit from the advantages of Industry 4.0 and to be affected by the disadvantages to a minimum (Doğruel Anuslu and Fırat, 2020). Advanced digital technologies powering Industry 4.0 such as advanced robotics, machine learning, IoT, cloud services, big data, smart sensing, and smart labeling for manufacturing will transform manufacturing (weforum.org, 2019; Nascimento et al., 2019). Unlike the traditional approach, industry 4.0 technologies work with very large data. By collecting and analyzing data in appropriate ways, decision-making processes become much more effective and efficient (Karakoc et al., 2020). This manufacturing revolution based on the smart data processing will increase productivity, change the economy, and support industrial growth.

Figure 4. In The Industry 4.0 Paradigm Basis Technological Components Showing Gorse



Source: *Patil et al. 2020.*

Because these systems are intelligent, they can communicate within and between networks, self-diagnose problems, provide resources at the appropriate time, and interface with people to optimize processes. This results in less raw materials, lower energy use, savings in resources, and waste reduction. Thus, Industry 4.0 facilitates circular economy principles, as shown in the Figure (Patil et al. 2020).

The annual size of the Digital Universe, which is the data created and/or copied/used, is estimated to reach 180 zettabytes by 2025 because of the intense flow of daily data. This will result in the need for energy-efficient computing and memory with a lower resource footprint. Groundbreaking innovations in this area are crucial to the future of our Digital universe, and Intel is now a leader in this area (Patil et al., 2020).

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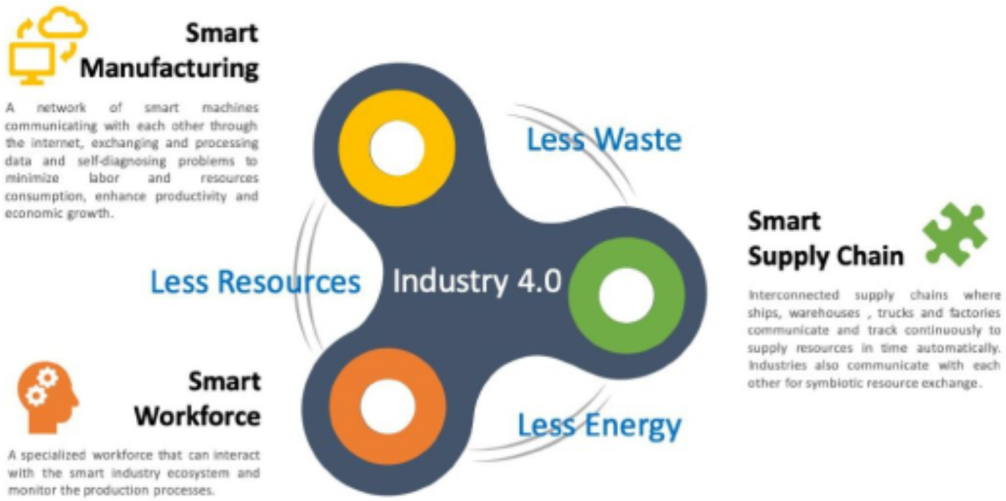
Figure 5. Industry 4.0 Paradigm in Cyclical of The Economy How Is Supported by Smart Manufacturing, Smart Workforce and Smart Supply Chain



Source: *Patil et al., 2020.*

5. An Assessment on Turkey and EU Policies

The EU Green Deal envisages a transition from industry to agriculture, transport to energy, to a 'carbon-free economy' model, and reshapes trade. While the Green Deal is a risk for Turkey, it also presents a new opportunity for sustainable development. The fact that the implementation of the 'carbon border tax - carbon regulation at the border - SKD' was on the agenda within the reconciliation framework significantly impacted our country. Despite the intense discussion and evaluation of border carbon regulation, the EU Circular Economy Action Plan has not yet been addressed to the same extent. In this sense, the EU will take the circular economy approach, and how the transformation it plans to make will create changes in which sectors.

It is crucial to examine the current Turkish legislation's relevant regulations and determine which revision studies are needed. Behind the EU's circularization effort is reducing foreign dependency, especially on critical raw materials. The recycled content criterion, which will be sought primarily in batteries, is an essential indicator of this policy to reduce foreign dependency on cobalt, lead, lithium, and nickel, defined as critical raw materials. The EU wants to achieve self-sufficiency in critical raw materials through resource efficiency, recycling, and recovery. Another example of a policy to reduce foreign dependency is Europe's efforts to end its dependence on vegetable protein imports for animal feed. For cyclical plant production, it is necessary to ensure that all by-products from food production, processing processes, and consumption are returned to the food system through reuse or recycling. The Green Deal has the potential to reshape trade not only with decarbonization but also by creating a circular sustainable product form within the framework of the Circular Economy Action Plan.

In summary, a cyclically sustainable product means a product that is more durable, repairable, upgradeable, has recycled content, its inputs are sustainably supplied, and its raw materials are obtained from secondary markets. According to this definition, producing a

product requires severe structural changes and a legal framework change. The actions in the EU Cyclic Action Plan and the calendar to be followed show that intensive legislative studies and long consultation processes are carried out in the background of these studies for cyclicality, making significant changes in the EU's production and consumption model. In addition, scientific studies are supported for data-based policy applications. Most importantly, it draws attention with its feature of being a general guide in this transformation process. The aim is not to wait for the parties to comply with these regulations by making legislative arrangements and not to impose sanctions on those who do not comply. The introduction of a circularity perspective into the legislation, especially regarding products with a critical value chain, emerges as a process that requires the joint work of many public institutions and organizations. Failure to address the issue may bring along the risks of disconnection between the arrangements to be made and causing contradictions. Coordination between public institutions and organizations will play an essential role in the success of the transition to the circular economy (Wasiul et al., 2021). Putting a circularity perspective in our legislation will not only bring about a change in practice. Like in the EU, it will trigger the transformation in production and consumption and initiate the transition to a different economic model. For this reason, to develop data-based decision processes, it will become even more critical than in the past that all kinds of data, especially waste inventory, are collected, evaluated, and accessible in a healthy way. In addition, in the legislative process; transparency, ease of access to relevant documents, giving sufficient time for the effective participation of the business world, sectoral organizations, and non-governmental organizations in the consultation processes are prerequisites for the success of the new system to be built (Emil and Bayülker, 2021).

DISCUSSION AND CONCLUSION

Beyond the sometimes-emphasized definitions of the circular economy, achieving a balanced approach with the wise use of resources is the basic philosophy of circularity. Life Cycle tools are also indispensable for being aware of the values of 'environment, economy and society', which are the three basic dimensions of sustainability, renewable energy, and green economy.

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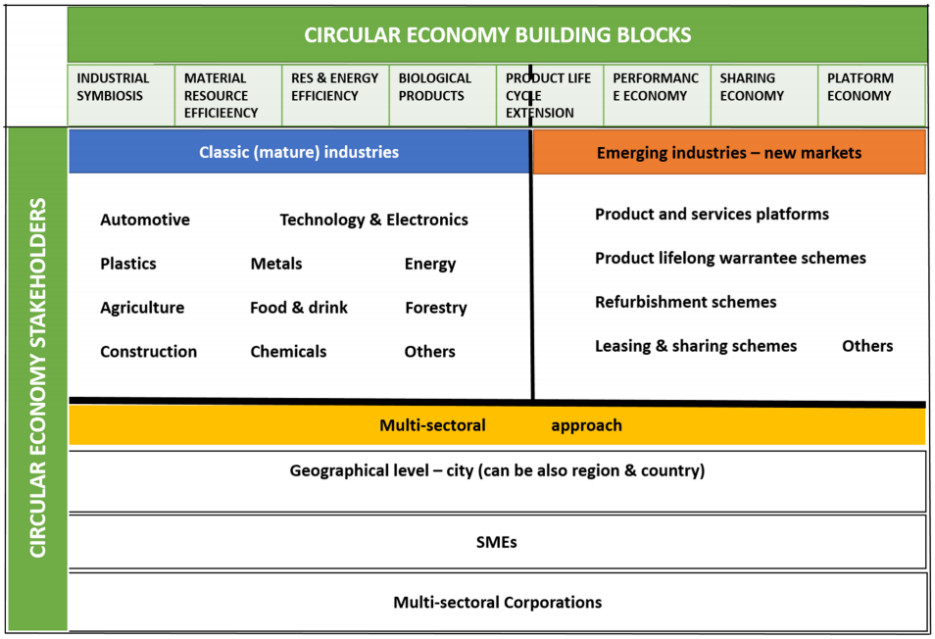
Table 1. Circular Economy Includes Symbiosis, Resource Efficiency, Performance Economy, Sharing Economy and Platform Economies.



***Source**: Taranic et al., 2016.*

One of the reasons for this is that the concept of the circular economy, which will eventually affect all sectors of the economy, seems complex. Political, thematic, or sectoral policy-making efforts may not effectively promote this transition. Raw materials and products mimic the circularity of elements in a natural ecosystem, such as a forest, as shown in Figure 6. It also relies heavily on renewable energy sources such as solar and wind rather than fossil fuels. Such a system is the key to achieving sustainability (Korhonen et al., 2018). Because nature and natural laws, a divine order, inspire the concept of circular economy, where resources are most valued. Every element of nature is used continuously by repeatedly converting waste into resources, as shown in Figure 6, using reduction, reuse, and recycling (3Rs). A circular economy encourages sustainable and greener energy production and consumption rather than burning non-renewable fossil fuels to mimic natural producers. From this perspective, there are several closely related trends that the manufacturing world is beginning to understand and appreciate, especially in its most advanced segments:

- Wastelessness, cooperation, and harmony, through nature,
- To make inventions to imitate the laws to which the creatures, which are works of art, are subject,
- Innovation based on digital technologies, namely Industry 4.0,
- Not limiting sustainability only to worldly life,
- Re-developing platform economies for the disadvantaged and those with limited opportunities,
- Reflecting resource efficiency in all material and moral areas,

- Procedural infrastructures for the transition to the circular economy.

Figure 8. Cyclical Economy Nature and Production Systems

***Source**: Patil et al., 2020.*

Although it can be thought that they express different processes and values, it can be said that similar paradigms, which are confusions of concepts, are expressed in different ways. The motives should lie in being ahead of the global competition, addressing human peace in harmony with the universe, and obtaining more value in the market with technologically innovative products that prevent increasing consumption of mass production resources with industrialization causing an increase in waste. The increasing environmental pollution has reached a level that will adversely affect human health. The welfare of future generations also makes it possible to seek various solutions in the international community. It shows that the desired results cannot be achieved in the linear economy, which is the current economic approach, with the prominence of the sustainable development approach. For this reason, it is tried to develop alternative approaches to the linear economy operating in the form of buy-build-discard. The circular economy emerges because of these efforts. The circular economy draws attention as a system in which the principles of recycling, reuse, and reduction are accepted to achieve sustainable development goals.

Increasing waste due to resource use brings along various problems. Our world's limited resources are decreasing rapidly, and the inevitable consequences of climate change are apparent. Due to the increasing environmental pollution and climate crisis, countries have started to seek various solutions. Many countries are developing policies related to the circular economy. We need to work hard on this issue. In this sense, the Paris Agreement is just the beginning, and it would be appropriate to say that our real work begins now (Şimşek, 2021). It effectively provides solutions in Turkey and the world with the technology infrastructure it provides in the fight against food waste and hunger. It is possible to prevent waste and contribute to the economy with a cyclical perspective with straightforward and basic steps. The important thing is that we, as the business world, have this point of view; it is to internalize the philosophy and act accordingly.

We are facing an unacceptable situation in any economic model or business. The world population is expected to increase by 28 percent in 2050 compared to the current situation and reach 9.7 billion. The per capita resource consumption of the world population is expected to increase by 71 percent. If necessary, measures are not taken to use resources effectively, the demand for metals, biomass, minerals, and similarly limited resources will reach 130 billion tons per year in 2050. In this respect, Sustainable Development's formula is Circular Economy fighting against any waste and damage while ensuring compliance with environmental regulations.

Here are some suggestions for the Ministry of Industry and Technology and the regional development agencies of Türkiye:

1. Develop policies that promote the transition to a circular economy and encourage the use of renewable energy sources, such as solar and wind.

2. Encourage businesses to adopt resource-efficient models and develop strategies for industrial symbiosis that promote the sharing of resources and waste reduction.

3. Foster innovation based on digital technologies, such as Industry 4.0, to support a more sustainable, symbiotic, platform-based, digital, and circular operating way.

4. Provide support and incentives to businesses to help them transition to circular economy models and adopt sustainable practices.

5. Develop procedural infrastructures for the transition to the circular economy and create awareness among the public about the benefits of circular economy models.

6. Promote research and development in the areas of renewable energy, resource efficiency, and circular economy models, and provide funding to support these efforts.

7. Work towards developing a theological dimension to the circular economy, recognizing that nature and natural laws inspire this concept and resources are most valued.

8. Collaborate with other countries and international organizations to share best practices and promote a global transition to circular economy models.

Future Research

Researching this complex issue could take several directions in the future. Here are a few suggestions for future research on the problem:

1. Conceptual Clarification and Standardization: To address the confusion of concepts, future research could aim to clarify and standardize the terminology and frameworks used in these interrelated fields. This could involve a detailed analysis of the existing literature, along with surveys and interviews with practitioners and policymakers to understand how they use these concepts in practice. The goal would be to propose a unified framework that brings together these different paradigms in a coherent way.

2. Interdisciplinary Collaboration: Researchers from different fields (economics, sociology, business, environmental sciences, etc.) could collaborate to bring diverse perspectives to the table. This could lead to a more comprehensive understanding of the

relationships between these concepts and how they can be integrated for the development of more sustainable and efficient business practices.

3. Case Study Analysis: Real-world examples of businesses that have successfully implemented these paradigms could be analyzed. This would provide concrete examples of how these concepts can be applied in practice and could help to clarify their meaning and significance.

Research and Publication Ethics Statement

I confirm that this work is original and has not been published elsewhere nor is it currently under consideration for publication elsewhere.

Contribution Rates of Authors to the Article

This article was prepared by a single author.

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