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Circular Economy Strategies and the UN Sustainable Development Goals

Edited by
Michael Odei Erdiaw-Kwasie
G. M. Monirul Alam

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To all the authors who provided novel insights into the book's topic. Your relentless efforts made this book project a reality.

Preface

In this book, circularity is introduced and discussed as a driver of the UN Sustainable Development Goals (SDGs) and its progress in emerging and developing countries. As we move forward, we want to capture the realities of the circular economy concept as much as possible by moving quickly to the fascinating theoretical and practical progress across various sectors in these economies. The circular economy approach is inherently accompanied by a wide range of other issues, which one must address while exploring its progress path: early in the book, a state-of-the-art review provides a theoretical framework for mapping the subtle characteristics, scope, and progress of emerging and developing economies, while the diverse case studies provide insight into the real stories—the progress and challenges.

This book was written to help students at universities, and other institutions of higher education find empirical case studies on circular economy from emerging and developing countries. It is also intended for people pursuing a professional career in sustainability and readers with a general interest in circular economy and the SDGs. At an advanced level, this text can also be used as a handbook, providing an overview of current theoretical and empirical debates and controversies regarding circular strategies and SDGs. As well as providing a non-technical entry point towards circular economy strategies in emerging and developing economies, the book provides a broader perspective on circular economy as an emerging field.

This indispensable reference is written by a team of international scholars from a variety of disciplines, including development, education, business, ecology, geography, and planning, and presents the current state of circular economy research within emerging and developing economies.

Darwin, Australia — Michael Odei Erdiaw-Kwasie
Gazipur, Bangladesh — G. M. Monirul Alam

Introduction

Developing and emerging economies rely heavily on the availability of bountiful and inexpensive natural resources, which are key drivers of a linear economy. In most cases, raw natural resources are taken (TAKE), transformed into products (MAKE), and get disposed of (WASTE). A linear economy is characterized by two unsustainable processes—resource scarcity, and excessive pollution load, which are occurring at an unprecedented pace in many developing and emerging countries.[1] Complicating matters further, many of these economies are already set to become the global drivers of consumption. Recent sustainability calls have emphasized a shift from linear-based strategies to circular ones,[2] although such a transition is far from straightforward. The ambition to understand the processes and pathways for a linear-to-circular transition has mostly remained in the background, particularly in the developing economy context. This book aims to contribute to emerging discussions around understanding and theorizing the pathways, mechanisms, diversity, determinants, impacts, and interactions of circular business strategies towards meeting the SDGs.

[1] Schröder, P., Anantharaman, M., Anggraeni, K., & Foxon, T. J. (Eds.). (2019). *The circular economy and the Global South: Sustainable lifestyles and green industrial development*. Routledge.

[2] Wu, Y., Zhu, Q., & Zhu, B. (2018). Comparisons of decoupling trends of global economic growth and energy consumption between developed and developing countries. *Energy Policy, 116*, 30–38.

The book captures contemporary themes, including circular food systems, product-to-service design, waste management, net-zero emissions, eco-innovativeness, circular operations model, and many others. The book contains theoretical, empirical, experimental, and case study research contributions that address key themes of the book. The book is categorized broadly into three Parts: Part I contains contributions that offer an extensive review of the extant knowledge on the topic. The contributions offer insights into key theoretical gaps in the current literature stream, particularly in the emerging and developing countries' context. Chapters captured in Part I aim to offer an understanding of the existing theoretical debates relevant to the book's topic and set the pace for further conceptual and empirical discussions. Part II of the book presents chapters extending the review's knowledge to offer conceptual insights about the topic. The chapters offer conceptual models that open new discussion points and themes on how circularity impacts SDGs in developing economies. Part III of the book presents intriguing case studies across various developing regions worldwide. Empirical studies captured in this part touch on circular issues across developing and emerging countries such as Ghana, Nigeria, Iran, Mauritius, Uganda, Malaysia, Turkey, and among others, highlighting the lessons learned from the experiences of all case countries. The empirical chapters help to validate some of the theoretical arguments and multiple hypotheses levelled in the previous parts using various robust methodological approaches to increase evidence and knowledge on the topic. The multi-case study approach taken in this book will allow a wider discovery of theoretical evolution and arguments to increase the reliability and validity of the findings presented in this book.

Conclusion

This book project aims to look beyond the linear economy model and to change the longstanding take-make-dispose approaches that have characterized many economies in the Global South. The book is categorized broadly into three parts, and to achieve this goal, the book captures review, conceptual and empirical chapters that address each aspect of the book's overall goal. Part I contains contributions that offer an extensive review of the extant knowledge on the topic. Part II of the book presents chapters extending the review's knowledge to offer conceptual

insights about the topic. Part III of the book presents intriguing case studies across various developing regions worldwide. The findings from each part in this book demonstrate and address the book's core themes, and the discussions illustrate how the respective parts complement each other in addressing the book's overall goal.

Praise for *Circular Economy Strategies and the UN Sustainable Development Goals*

"This is a useful book with a significant collection of articles written by forty-eight researchers and experts on circular economy and the SDGs. The book presents appropriate policies, cases and theoretical frameworks which give a thorough idea of the paradigm shift from the EPCD2 (Extract-Produce-Consume-Dispose-Deplete) concept of the linear economy to the regenerative circular economy for sustainable futures. The collection is comprehensive in its coverage of various issues, focusing on the transitional requirements for countries. This book will definitely make a significant difference to the understanding of the readers about the circular economy, globalisation, and the SDGs".

—Prof. Sadhan Kumar Ghosh, *Research Director, SDCERC, ISWMAW, India*

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Abbreviations

CE	Circular Economy
EU	European Union
FICF	Finland's Independence Celebration Fund
SMEs	Small and Medium-sized Enterprises
UK	United Kingdom
WBES	World Bank Enterprise Survey

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Circular Economy in Turkish Manufacturing Sector: The Roles of Green Manufacturing and Innovation

Nuran Çakır Yıldız, Zehra Binnur Avunduk, and Michael Odei Erdiaw-Kwasie

1 Introduction

Today, manufacturing systems are responsible for 35% of all global electricity use, generating 20% CO2 emissions and accounting for a quarter of all extractions of primary resources (World Economic Forum, 2018). To prevent environmental damage, companies need to transform their

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production systems circularly. This can be possible by developing creative and innovative methods in product/service, process, marketing, and management systems. Innovation is a critical success factor for transforming manufacturing techniques into greener methods. According to Florida (1996), adopting process innovations creates incentives for adopting environmentally conscious production strategies D4. Therefore, all innovation types (product/service, process, etc.) actualised by firms to realise sustainable production within the scope of a CE are more expressed explicitly with the concept of eco-innovation. For instance, a successful example of eco-innovation in the automobile industry is demonstrated by BMW's automobile recycling strategy in Germany. BMW has initiated a design for disassembly, which may result in the first 100% fully recyclable cars (Hart, 1995; Sezen & Çankaya, 2013).

Turkey, whose greenhouse gas emissions have increased by 130% in the last 30 years, may experience severe losses in its exports to European Union (EU) countries if it does not reduce its emission intensity (World Wide Fund for Nature) because "in December 2019, the EU announced the European Green Deal to create a climate-neutral continent by 2050 (Acar et al., 2022, p. 8162)." "A national circular economy roadmap has not been devised yet in Turkey to date; however, the *Green Deal Action Plan* announced in July 2021 by the Ministry of Industry and Trade has considered the implementation of circularity principles in Turkey. Furthermore, as part of Turkey's efforts to integrate into the EU, legal harmonisation has been undertaken to match the EU's current legislative frame on waste and circularity issues" (KPMG & SKD Türkiye, 2022, p. 6). According to the EU Commission's "Fit for 55" legislative package, a carbon emission limit value will be set for each product imported by the EU, and an additional customs duty of 55–60 Euros on average will be applied for each ton of excess carbon emission for products exceeding these limit values, environmentally friendly (Yılmaz, 2022). This situation may reshape the concept of competitive advantage and closely affect countries exporting to the EU, such as Turkey. This situation may reshape the concept of competitive advantage and closely affect countries exporting to the EU, such as Turkey. This is because low-emission countries can trade with the EU tax-free or with low taxes; additional carbon costs will arise for countries with high emission values, such as China and Turkey.

Emerging countries must contend with many challenges because increased economic activity causes a simultaneous upward movement in energy demand (especially fossil fuels such as oil, gas, coal, etc.) (Shan

et al., 2021). Along with the industrial revolution, the intensive increase in production since the nineteenth century, the excessive and wasteful use of natural resources, the mixing of toxic chemicals and greenhouse gases due to production into nature, and the pollution/destruction of wastes have adversely affected the environment and resources (Mao & Wang, 2018). As a result, the earth is under threat of deterioration due to greenhouse gas emissions from the excessive use of fossil fuels (Alam et al., 2021; Ding et al., 2021) and the harmful methods used in the industry. Thus, enterprises face pressure to change production methods from linear to circular, reinforcing the need to evaluate their performance on sustainability issues (Erdiaw-Kwasie et al., 2023; Gupta et al., 2021). The CE is an economical approach that replaces the "end-of-life" concept by recycling, reducing, recovering, and reusing materials in manufacturing processes (Kirchherr et al., 2017). Therefore, CE can be used to minimise the usage of resources, decrease waste generation (Abreu & Ceglia, 2018; Bag et al., 2020; Kalmykova et al., 2018; Schroeder et al., 2019), and reuse wastes by processing and recycling instead of being garbage, etc., can be seen as most appropriate and a holistic way of how to transform the manufacturing methods towards a sustainable manner.

Integrated CE reduces waste, retains value for long periods, reduces the use of primary resources, and provides socio-economic benefits within closed loops (de Jesus & Mendonça, 2018; Hailemariam & Erdiaw-Kwasie, 2022; Kirchherr et al., 2018). Besides promoting sustainable development, CE decouples economic growth from resource depletion and environmental degradation (Babbitt et al., 2018; Hofmann, 2019; Murray et al., 2017). It is widely acknowledged that accelerated transitions from linear to circular paradigms are required (Haas et al., 2015) despite significant efforts and attention given to circularity. The global circularity rate is just 8.6% (Haas et al., 2015). Organisational adoption of CE practices is less well understood in emerging economies (Blomsma et al., 2022; Haas et al., 2015). Kirchherr and van Santen (2019) found that only 5% of articles on circular economies were written by authors from emerging and developing countries.

CE can be effectively categorised into three layers: micro, meso, and macro (Yuan et al., 2006). Enterprises act first by innovating at the micro-level or individual firm-level (Ruggieri et al., 2016), and CE mainly focuses on GM and eco-design strategies and applications. Second, the

aim is to develop an eco-industrial network that benefits regional manufacturing systems and the environment at the meso-level. Finally, the macro-level comprises CE in regions, provinces, and cities (Sousa-Zomer et al., 2018; Yuan et al., 2006). This study examines CE in terms of the micro-(firm)level. To tolerate the damage to natural resources and to reduce environmental, economic, and social costs, it is urgently vital for firms to abandon production methods that harm nature and adopt GM (clean production) methods. GM is "the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment" (UNEP—UN Environment Programme). It includes a condition for achieving environmental improvements in new products/services, process development, and contribution to a more sustainable world (Glavič & Lukman, 2007). Firms are changing their processes from traditional methods to circular models to become sustainable.

Considering the significance that the use of renewable resources, waste recycling, redesign, eco-innovation, remanufacturing, and such production techniques will play in meeting future needs, it is surprising that so little work has been done on understanding the transformation of businesses applying GM and innovation to transition to a CE in emerging country settings. The discussion about CE is still highly shallow, and the implementation could be more (Franco, 2017; Lieder & Rashid, 2016). Thus, this paper aims to contribute to the literature from the perspective of an emerging country by exploring, understanding, and inferring the motivation behind the sustainable—GM practices of Arçelik, which is Turkey's largest white goods company and Europe's second-largest manufacturer of, according to the market share ranking based on quantity. As it is one of the leading firms in sustainability and has succeeded in being carbon neutral in global manufacturing with its carbon credits that is the reason we have chosen the case of Arçelik in this study. Furthermore, this study follows the Natural Resource-Based View (NRBV) theory as it offers a valuable lens for evaluating the context of the circular organisation.

Following the introduction section, the rest of the paper is structured as follows: in Sect. 2, the theoretical background of the field has been revealed by literature review; in Sect. 3, the methodology is described; and in Sect. 4, the research findings are given. Finally, Sect. 5 includes the conclusion of the research, implications, and discussion.

2 Literature Review

In the linear economic approach, starting from the production process planning, businesses continue their activities with a low-cost structure, high sales, and excessive profit motive, ignoring the fact that natural resources, which have a crucial place in production factors, are scarce and can be exhausted. On the other hand, consumers throw these products as garbage when the ability of the products to meet their needs is lost or when their intended use is over. Businesses and consumers who are not yet aware of the importance of sustainability do not question what happens to the products after they are thrown away. In this respect, the linear economy approach is called the "take-make-dispose" system. In contrast to the "take-make-dispose" linear model, a CE is regenerative by design and purpose to decouple growth from the consumption of limited resources (Ellen Macarthur Foundation, n.d.).

The focus and perspective shifted towards a circular economy model from 2005 onwards, mainly due to the realisation of the increasing future supply–demand mismatch and the limited nature of resources (Goyal et al., 2018). CE involves creating a closed-loop ecosystem for effectively utilising resources and conscious consumption. This implies reconfiguring the material flows from a resource-product-waste (linear) approach towards a resource-product-renewed resource (closed-loop) system. This new economic model to use natural resources efficiently creates a waste-free and resilient ecosystem, thanks to adopting the 3Rs principle (reducing, reusing, and recycling). Joshi et al. (2006) propose to fulfil the 6Rs concept (*recovering*, *reusing*, *recycling*, *redesigning*, *reducing*, *and remanufacturing*) to achieve the goal of sustainable production, which consists of six stages of material flow in a product life cycle, compared to the traditional 3Rs concept (Yan & Feng, 2014). Moreover, Kristensen and Mosgaard (2020) classified micro-level CE in nine dimensions beyond 6Rs according to the results of data-driven coding in their research. These are *recycling*, *remanufacturing*, *reuse*, *resource efficiency*, *disassembly*, *lifetime extension*, *waste management*, *end-of-life management*, and *multidimensional indicators.*

The CE approach has gained growing attention in business and academia (Geissdoerfer et al., 2017). However, analysis and discussions about CE development are mostly done from resource deficiency and environmental impact perspectives, leaving the economic benefits of industrial actors and the firm level missing (Lieder & Rashid, 2016).

Nevertheless, particularly at the micro-level, CE implementation is still limited (Ghisellini et al., 2016; Linder & Williander, 2017; Sousa-Zomer et al., 2018). This shortcoming in the CE research is crucial because fundamental activities for successful CE implementation, such as the application of GM, new product/service design, the transformation of processes, business models, usage of renewable energy, restructuring/greening of the supply chain, and choice of materials are in control and therefore finally determined by production firms with the underlying motivation of gaining economic benefits (Lieder & Rashid, 2016). Moreover, the micro-level requires multiple changes, such as the collaborative new business model development (Lieder & Rashid, 2016) and distinctive strategies to develop the circularity of the manufacturing systems (Winkler et al., 2011) (i.e., GM/cleaner production) in the CE adoption.

There is increasing attention being paid to CE adoption in scholarly discourse. Recently, several studies have highlighted the importance of speed in systemic transitions, despite the widespread applications of circular strategies (Blomsma & Brennan, 2017), as well as the rapid adoption of circular approach by many sectors (Bauwens et al., 2022; Haas et al., 2015; Mathivathanan et al., 2022). Therefore, CE research is now focused on creating a circular disruption (Droege et al., 2022; Neligan et al., 2022). The circular disruption process results in a systemic, widespread, and rapid shift from the destructive "take-make-use-dispose" model (Blomsma et al., 2023). It uses circular strategies to reduce resource consumption and structural waste (Bauwens et al., 2022). The effects of a circular rebound are reduced or negated by a circular disruption, as Zink and Geyer (2017) noted. Over the past few years, it has become increasingly apparent that CE adoption and disruption are hindered by barriers (de Jesus & Mendonça, 2018; Kirchherr et al., 2018). As a critical driver of eco-innovative practice in developed economies, organisational factors and CE adoption have been extensively theorised and discussed (Bag et al., 2020; Bossle et al., 2016; Yadav et al., 2020), but little empirical evidence exists for the manufacturing sector in emerging economies.

Eco-innovation has been recognised as a critical factor in developing competitive technologies and new business models that allow "environmental benefits," including greater efficiency in consumption and use of resources. Eco-innovation acts as a catalyst in the transition from a linear to a CE model (Pichlak & Szromek, 2022) and plays a central role in transforming the linear system into an economic system characterised by

circular flows of resources (Doranova et al., 2016). Eco-innovation has also been a key economic growth driver (Sezen & Çankaya, 2013).

In the manufacturing system of the firm, GM is one of the essential strategies that can be considered preparatory towards CE (Bilitewski, 2012; Ghisellini et al., 2016). Pollution prevention and zero waste (Veleva et al., 2017), two of the CE's main goals, can only be achieved through GM principles (Bilitewski, 2012). Florida (1996) drew attention to the importance of zero emissions, which emphasises eliminating all environmentally damaging byproducts from the production process within the scope of GM. Florida also stated that the types of pollution prevention in production to process improvement are: *recycling*, *improved process technology*, *new product and process technology*, *closed-loop system*, *conversion to substitute fuels*, and *others*. However, firms' processes to implement a circular business model are still unclear at the micro-level (Urbinati et al., 2017). Jayal et al. (2010) propose adopting the 6Rs approach, i.e., recycle, reduce, reuse, redesign, remanufacture, and recover, which ensures diminished resource usage and energy in the production process. Although some CE implementation strategies involve GM, eco-innovation, and waste management (Ghisellini et al., 2016), further studies are needed to explore the extent to which these strategies are implemented and individual companies' journeys to the CE transition (Franco, 2017). This need creates a research gap in the field.

GM expresses a cumulation of activities in the production area oriented to decrease pollution, reduce the environmental impact of the production process, and adequately manage waste following legal and normative compliance with CE principles. It is strongly connected with greening the production processes, cleaner production, clean technologies, recycling, remanufacturing, and reusing waste, focusing on reducing greenhouse gases. Cleaner production is accounted for processes (saving raw materials and energy, reducing the use of toxic substances, emissions, and waste) and products/services (reducing impacts along the life-cycle) (Afum et al., 2020; Draghici & Ivascu, 2022; Huiling & Dan, 2020). Dheeraj and Vishal (2012) defined GM as adopting reliable, fast, and energy-efficient manufacturing processes and equipment towards reducing waste and enhancing productivity. GM also includes generating processes that utilise inputs with lower environmental impact, as well as processes that are profoundly productive with nearly zero waste and pollution (Ghazilla et al., 2015), perceived as highly efficient production systems and processes that utilise inputs that generate minimal/zero pollution

and eliminate waste, thereby significantly reducing the negative impacts. To prevent contamination, some of the GM practices are; decreasing the usage of raw materials, energy, and solid waste, reusing products as well as renewable materials, recycling water and clean energy, redesigning processes and products, and employee training regarding product stewardship practices (Ghazilla et al., 2015). Also, GM provides several benefits: cost reduction, reduced carbon footprint, the efficiency of the number of raw materials, and improved production time, image, and brand (Draghici & Ivascu, 2022). Thus, the essential rationale is that GM provides sustainability by increasing productivity in CE.

3 Methodology

This research adopts the case study method to understand how businesses are transforming their manufacturing methods to become more sustainable and greener by adopting CE principles. The case study approach is defined as "a research strategy which focuses on understanding the dynamics present within single settings," and "case studies typically combine data collection methods such as archives, interviews, questionnaires, and observations" (Eisenhardt, 1989, p. 534). Qualitative research, in terms of its in-depth interviews, enables us to understand the organisation's fundamental issues, motivations, and intentions (Arda et al., 2017). We utilised a case study design to investigate a contemporary phenomenon about the limited extent of information over which the researchers had little control (Yin, 2009).

Researchers generally assume that case studies should merely rely on qualitative data. This is a misconception, as no empirical research methods use a single data type. Data in the case study method are collected by multiple means that may consist of potential qualitative data sources, such as interviews, direct observations, documentation, historical records, and quantitative data sources (e.g., surveys). Multiple data sources enhance data credibility (Patton, 1990). In addition, case study data often provide advantages in integrating perceptual and objective data. This integration is particularly significant in business research. Thus, using a variety of data, including the combination of subjective and more objective factual knowledge, may add much to our understanding of organisational processes and outcomes. Each data source is one piece of the puzzle, with each element contributing to understanding the phenomenon. This convergence adds strength to the results.

In the pre-interview stage, the authors prepared specific questions on sustainability, CE, GM, and innovation (please refer to the Appendix for the questionnaire). The questionnaire was developed in a 3-stage process. Firstly, a theory-based version of the questionnaire was prepared. This version was reviewed by three academicians and high and middle-level managers from different fields in the company. Secondly, the initial questionnaire was modified to accommodate the suggestions and comments of these specialists. The final version of the questionnaire, which contains the feedback from the second interview, was prepared at the last stage. Then, the managers were contacted and requested to meet with a cover letter and a list of interview questions. Next, a set of semi-structured interview questions was prepared as mentioned above to start a research discussion. Finally, primary data were collected through face-to-face interviews with open-ended questions gathering views and opinions from senior middle-level managers and specialists in three departments (marketing, R&D, and sustainability) in Arçelik Global. The work experience years of managers vary from R&D specialists who began to work recently to senior managers with more than 15 years of experience.

In-depth interviews were conducted with 12 experts through a focus group study and took approximately 3 hours. Interviews were conducted in Turkish, then summarised and translated into English. Besides the primary data, supplementary data was collected from secondary sources such as published reports, company websites, newspapers, trade magazines, and other media reports. In the case of study research, documents are typically used to corroborate and augment evidence from additional sources. According to Kotlar and De Massis (2013), these secondary data sources provided a richer context to understand firms' goal-setting. Finally, the qualitative research findings aim to theoretically evaluate Arçelik's strategic practices in terms of NRBV.

4 Research Background and Findings

4.1 Company Profile

Arçelik has been chosen as the sample in this study to examine sustainable manufacturing strategies from a developing country perspective. This single case study was selected because it permitted an in-depth and rich investigation of the study's phenomena compared to multiple case designs (Siggelkow, 2007; Yin, 2009). As an emerging market leader

firm Arçelik, controlled by Koç Group, is the only Turkish conglomerate within the Fortune's Top 500 Global Companies list 2021 (Fortune Global 500 2021), and the company "had the highest score in the Household Durables category for the third year in a row in the Dow Jones Sustainability Index (based on the results dated November 2021)." Arçelik's corporate vision is "Respects the Globe, Respected Globally" as it passionately nurtures its global growth with GM, better utilisation of natural resources, and more sustainable business processes. As a result, it "was awarded a Gold Class Sustainability Award for the second time and recognised as an Industry Mover in the 2022 S&P Global Sustainability Yearbook" (S&P Global, 2022). In addition, Arçelik has become one of the first 45 firms in the world entitled to receive the Terra Carta Seal, presented by the UK's Prince of Wales to firms that have committed to struggle against climate change with specific targets within the scope of the Sustainable Markets Initiative. In addition, Arçelik is the only and first firm in the home appliances sector to receive this honour.

Arçelik has over 40000 employees worldwide in 51 countries, 28 production facilities in 9 countries, and 12 brands (Arçelik, Beko, Blomberg, Grundig, Arctic, ElektraBregenz, Defy, Flavel, Altus, Leisure, Dawlance, and Voltas Beko). Arçelik reached a consolidated turnover of more than EUR 6.5 billion in 2021. With 69.5% of its revenues coming from international markets, Arçelik is the R&D leader in Turkey—holding more than 3000 international patent applications to date through the efforts of more than 2000 researchers in 16 R&D and Design Centres in Turkey and 13 R&D Offices across nine countries. "According to the results published by the United Nations' World Intellectual Property Organization, Arçelik is the only Turkish company in the top 200 list of Companies with the Highest Number of International Patent Applications in the last ten years (Arçelik, 2020)."

4.2 Findings of the Research: Arçelik Case Within the Scope of NRBV

The qualitative data obtained from the interviews with Arçelik's managers and specialists are summarised below. In addition, by compiling the secondary data obtained from Arçelik's sustainability reports (2019, 2020, 2021), CE, GM, and innovation practices are examined within the scope of NBRV theory.

According to NRBV, there are three primary strategic capabilities; pollution prevention, product stewardship, and sustainable development. Decreasing emissions is the main aim of pollution prevention, whereas product stewardship guides the selection of raw materials and disciplines of product design intending to minimise the negative environmental impact of manufacturing systems. A sustainable development strategy, however, also dictates that efforts be made to sever the harmful links between the environment and economic activity in especially emerging countries (Hart, 1995).

5 Sustainable Development

The Arçelik Sustainability Board, chaired by the Deputy General Manager responsible for Finance and Financial Affairs (Chief Financial Officer-CFO), "was established to determine corporate sustainability and climate change policies and strategies and ensure their integration with company business processes and monitor sustainability performance." The Sustainability Directorate, affiliated with the Quality, Sustainability, and Government Relations (KSRI) Directorate, encourages the dissemination of the sustainability strategy to all business units within the firm as a business model. The department's duties include determining the long-term sustainability strategy of the firm, carrying out projects with the divisions within the firm, representing the firm in local and international organisations, and ensuring the continuity of its successful performance in the sustainability indexes. The Sustainability Board, which acts as the governing body of the Interfunctional Sustainability Working Groups, determines the strategy based on the reports of the Sustainability Working Groups. The Directorate consists of the following sub-units (working groups): Environmental Coordination, Energy Coordination, Green Chemistry Coordination, Sustainable Supply Chain, Occupational Health and Safety, and Human Rights Committee Working Group (Arçelik, n.d.-a).

Sustainable development vision is based on a triple pillar consisting of economic, environmental, and social components. The interviewees' statements are summarised, and their views on sustainability and CE issues are given below. The answer of each interviewee is shown by numbering with the abbreviation "I."

> Initially, the primary purpose is to follow the regulations and not fall behind the regulations…The main motivation here is to create a structure that determines the company's sustainability strategy and establish a relationship with the financial side. This department was established because of the need for a unit to consolidate with other units and create a different perspective. It has turned to how we can differentiate ourselves from the competition, and we greatly benefit from this right now. (I1)

Arçelik has 2030 targets. These are not only on the environmental side but also on the managerial side. The increase in the participation rate of women in the workforce and management can be given as an example.

> Increasing the rate of women on the board of directors from 17% to 25%, the number of all female employees in the company to 30%, and the number of women at the management level to a certain percentage and the proportion of women in turnover-generating positions. We have set some goals, such as increasing the proportion of women in science and technology positions. In other words, we are trying to pioneer the sector once again. (I2)

> We also have 100 female dealer projects to cover the entire supply chain. You know, the dealer ecosystem in Turkey is predominantly male. Unlike a male dealer's application, when a woman applies to become a dealer, she is first provided with a certain amount of initial investment support. In addition, certain pieces of training are provided by making some positive discrimination there, which cannot be done in a male dealership. In addition, training is given on which government incentive mechanisms can benefit from and receive grants and what she can do as a woman entrepreneur. (I3)

> At the same time, training is provided to women entrepreneurs to increase the number of women entrepreneurs in Anatolia with the Union of Chambers and Commodity Exchanges of Turkey. We also have a target of 500 female technicians. Here, too, we aim to increase the number of service technician women. We are a global company, a large structure with 28 factories in 9 countries, more than 40000 employees, our products and services are sold in 150 countries and so on. Therefore, we are planning to carry these and similar examples of good practices that we have done in Turkey abroad as another step. (I1)

It is expected that the methods changed with the GM mission will also affect the CE as an increase in social welfare by saving resources. The responses of the participants regarding this can be summarised as follows.

> We foresee that the steps taken towards a CE will also bring positive social effects. First, with the increasing population and the climate crisis, access to resources will become limited in many areas, especially food. At this point, providing resource efficiency with CE makes it possible to prevent social crises from occurring in geographies with limited opportunities in the world. In addition, it is calculated that the CE will create a significant amount of employment, especially in waste management. The World Bank projects global employment growth of 3% in the CE transformation by 2030. Reducing the manufacturing cost by recycling products and services will also contribute to social welfare. In addition, the CE as a system that excludes the negative effects of linear economic activities on human and natural systems positively impacts public health by reducing pollution and waste. (I4)

> Transitioning to a CE in the manufacturing sector requires significant changes in primary production and supply chain processes. According to the International Institute for Sustainable Development (ILO) report, employment growth in the manufacturing sector is expected by 0.5%, corresponding to approximately 4 million people… However, we can say that there will be changes in the skills and areas required for employees in the coming period. Furthermore, while a significant increase is expected, especially in repair, recycling, and remanufacturing businesses, a shrinkage is expected in areas working with fossil fuels such as coal and oil. (I5)

> The CE will increase the demand for and employment of skilled labour. It is also seen that the productivity of companies investing in CE innovation has increased. With the increase in the transition to the CE, companies will also need to transfer their investments to these areas. As Arçelik, we are working to create a resource efficiency-based circular business model in our sector by taking part in the EU Horizon 2020 project CSERVEES Project. With the transformation within the scope of the project we participated in with our washing machine and electronics businesses, our focus is on improving products according to the CE system and improving designs for recycling products that have expired. (I4)

> With LEOPET, which we have been working on since 2017, we have created a system in which recycled pet bottles are used as new raw material.

> Circularity is important for manufacturing companies to provide environmental and economic outputs. It will positively affect the business with positive economic outputs by reducing resource use, reducing waste, meeting customer and investor demand. (I5)

6 Pollution Prevention

Pollution prevention, "to meet the company's Near Zero Waste Target, Arçelik uses resources more efficiently, prevents and reduces waste resulting from the company's operations, and improves the effectiveness of separating waste as its source (Arçelik A.Ş., 2022, p. 9)." Arçelik also uses CE principles for designing their products' packaging volume and weight to produce minimum waste. They carry out recycling and reusing projects to reduce the environmental effects caused by packaging processes (Arçelik, n.d.-b). Arçelik develops products and services to prevent and reduce plastic pollution that harms the environment, health, and ecological balance. They manufacture white goods product parts from recycled plastics and washing machines that hold microplastics (Arçelik, 2021, p. 89). Arçelik is investing in R&D and developing new technologies to prevent plastics from their products from entering the natural resources. For example:

> Investing in R&D and developing new technologies to prevent plastics from our products from entering the sea…By 2030, improve water quality by eliminating dumping, reducing pollution, minimising the release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally. Prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution. (I6)

As a signatory of the Business Plastics Initiative, the following are examples of Arçelik's 2023 interim targets (Arçelik, 2021, p. 21):

- Increasing the recycled plastic content in products from 3000 to 15,000 tons per year
- Increasing the recycled plastic parts made from waste fishing nets from 8 to 25 tons per year

- Increasing the recycled plastic parts made from waste PET bottles from 28 to 60 million per year
- Using plastics generated from their Waste Electrical and Electronic Equipment recycling plants in oven, dishwasher, and tumble dryer product categories
- Recycling 600 tons of packaging waste from their manufacturing plants to be used in plastic parts.

7 Product Stewardship

Product stewardship is an umbrella term for a "shared responsibility" approach to managing products at end-of-life, also called "Extended Product Responsibility" (Lewis, 2005). According to The US EPA, "a product-centered approach to environmental protection" calls on those in the product life cycle—manufacturers, suppliers, retailers, users, and disposers—to share responsibility for diminishing environmental impacts of products. It recognises that producers must take on new responsibilities to decrease the ecological footprint of their products. However, manufacturers cannot accomplish real change alone: consumers, retailers, and the existing waste management infrastructure must help provide the most cost-effective and workable solutions (US EPA, n.d.). Arçelik's product stewardship process is shown in Fig. 1.

In the context of product stewardship, the eco-circularity approach aims to eliminate, rather than manage, waste and to redesign the linear model into a circular model in which products and packaging are kept in a system by improving recyclability, efficiency, and repairability. Under the European Green Deal, the EU Commission adopted a new CE Action Plan, focusing on the design and production of a CE to ensure that the resources used are circulated in the economy as often as possible. The implications of the EU Green Deal and the CE Action Plan are significant for Arçelik as a company generating almost half of its revenues from sales in Europe. To proactively manage the transition processes and implications in line with the Action Plan, in 2020, Arçelik was involved in the World Economic Forum Circular Electronics Partnership, which is a pre-competitive industry platform that sets a vision and roadmap committing to a CE for electronics by 2030 with a network of top electronics companies, and group of pioneering global organisations. Along with the partnership, Arçelik was also involved in preparing an

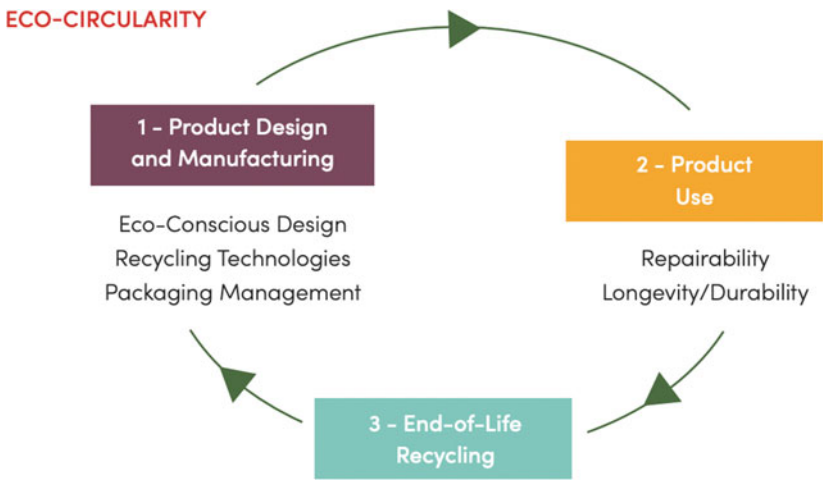


Fig. 1 Product stewardship process in Arçelik sustainability report (*Source* Arçelik [2020, p. 81])

action roadmap released in March 2021, which identifies six pathways to circularity. Furthermore, they actively participated in the working groups focused on these pathways: Circular Design, Take-Back and Collection, and, Recycling and Sourcing.

8 Pro-Activeness

> Since we report to international sustainability indices, some of the issues we constantly see in those indices force us to take us to different places. Because for example, we have been the leader in our category in the Dow Jones Sustainability Index for the last three years. For example, Electrolux was the leader for 13 years before us. Electrolux is a company in Europe where we normally compete very much in products. Especially since the issue has become critical in the retail channel; for example, our European customers are curious about what we do in the field of sustainability and how we differentiate from our competitors. Therefore, maintaining leadership in this and similar indices, acting before other companies, being more proactive, and communicating with our brands put us ahead of our competitors. Even my interaction with retail channel managers has increased a lot lately. Now they have started to talk about sustainability a

lot. Therefore, I can say that staying proactive has turned into a business continuity process. (I10)

Unlike our competitors, we have established a human rights department within the scope required by the sustainability indices. This is an independent department from the human resources department. We also have global business ethics principles. Within these principles and policies, we extended the legally paid maternity leave as a request of the sustainability indexes, unlike our industry. (I11)

9 Green Manufacturing

Examples of clean technologies applied by Arçelik within the scope of GM are given below.

Currently, our company aims to purchase 100% green electricity by 2030. We meet 69% of the electricity we consume from green sources. The share of energy-efficient products in the turnover of the products we sell is approximately 47%. The rate of turnover may decrease continuously because we are constantly growing. In the future, of course, we aim to increase this to at least 50%. In addition, Arçelik used green financing and issued a green financing bill of € 350 million last year. We allocated 189,000.000 € of the 350,000,000 € financing for cleaning production technologies. We carry out hundreds of energy efficiency projects in production every year. This year, I think we have realised more than 220 projects in this way. To reduce water consumption in production processes, we target to increase the use of recycled water to 70% by 2030. We also aim to reduce energy and water consumption in production by 45% per product. (I7)

We have used more than 140,000.000 recycled PET bottles in our products. How was this method discovered? A colleague from the R&D unit has had training. Our colleague learned in this training, that Glass fibre is used in Arçelik's washing machine tubs. There (s)/he learns that the formulation of this PET bottle with glass fibre can be used with a recycled PET bottle. (S)/he goes back to the company and tries it. Later, this became a patent exclusive to Arçelik, and this product, which started in the first washing machine, has now spread to air conditioners and dishwashers. We are expanding its use more and more. (I8)

> The Recycled PET Tub designed by Grundig for washing machines and washer-dryers is produced with recycled PET bottles and, thus, saves energy by reducing plastic waste. Furthermore, the Leopet plastic raw material, obtained from recycled PET bottles, developed by Arçelik's R&D Center and patented by Arçelik, is also used in air conditioners produced by Arçelik-LG. Of the plastic parts in all split air conditioners produced by Arçelik brands, 20% are made of recycled PET bottles, and up to 15 recycled PET bottles are used in each air conditioner. By the end of 2019, 300,000 recycled PET bottles were used in 30,000 air conditioners. (Arçelik, n.d.-c)

Arçelik innovates its processes and products to reach a closed CE model by increasing products' recyclability rates, using recycled material in products and adequately managing the end-of-life processes, including take-back-recycling. They increase product durability, repairability, reusability, and alternative end-of-life stages to contribute to a CE. Arçelik uses recycled raw materials while enhancing overall product recyclability in manufacturing. When products are sold to consumers, Arçelik supports longevity and repairability to minimise product environmental impact while preserving natural resources. Furthermore, the firm develops eco-innovative products by recycling natural resources with its pioneering R&D works. Arçelik CEO Hakan Bulgurlu gave examples of the eco-innovative products they produced: "Eco-friendly innovations with examples such as the washing machine with the world's first synthetic microfiber filtration system that captures up to 90% of the microfibers that would otherwise end up in the ocean, white goods produced with ghost fishing nets, washing machine, and washer dryer tubs and air conditioners manufactured with recycled PET bottles. Moreover, Arçelik took further upcycling efforts and produced small domestic appliances with biocomposite materials. For example, they used coffee grounds in manufacturing new coffee machines and tea fibers in Newline tea makers. These eco-product innovations will be released into the market in 2021" (Arçelik, 2021).

> Our holistic approach considers almost all the plastics in our products to maximise the recycled plastic content. We design recyclable products with reduced environmental impact and share product recyclability rates. The innovative solutions focus on becoming pioneers in the industry. Examples include using PET bottles, waste fishnets, bioplastics, eggshells, tomatoes, and coffee waste in products. Packaging wastes are also turned

> into valuable components to be used in products. The waste dishwasher components from Arçelik's own Waste Electrical and Electronic Equipment Recycling facilities are recycled to be used in Arçelik products again to close the loop in production. (I9)

Some examples of the value generated are provided below:

Using PET bottles in products: Approximately 58 million PET bottles have been recycled since 2017, when the project was first initiated, until the end of 2020. PET bottles are used in washing machines, dishwashers, and air conditioners. The studies are expanded into Koc Holding Group companies. The project was and is still the first in our industry. It was the first project that combined using waste and turning it into a valuable source. It proved that sustainability makes business sense by generating savings for the company and increasing brand value.

Using waste fishnets and textile wastes in products: Eight tons of recycled waste fishing nets and 111.7 tons of recycled industrial thread waste are used in the oven, washing machine, washer-dryer, and dishwasher parts.

"Fiber Catcher: First-of-its-kind microfiber filter integrated inside washing machines and dryers to filter up to 90% of the microplastics. The product will be released in different markets in 2021.

Products made from Organic Composites: The BioFridge uses biobased polyurethane insulation material (Bio-Cool) and biocomposite raw materials containing organic materials such as soy and castor oil. The egg trays are made of 20% eggshell waste and 80% bio-based plastics made from organic resources such as corn starch and sugarcane, and the fan cover is produced with 100% bio-based plastics. The door seal material is also partly made of soybean oil. As a result, the CO2 emission per unit produced is reduced by 6 kg, given biomaterials' 80% lower carbon footprint than petroleum-based traditional materials. The product will be released in different markets in 2021 (Arçelik, n.d.-d)."

10 Open Innovation

Developing collaborations with external stakeholders through a holistic approach enables firms to better address current social, economic, and environmental issues. In the scope of Arçelik's open innovation culture embedded in their business, they collaborate with various stakeholders such as universities, startups, suppliers, and companies across industries.

This creates diverse perspectives and ideas, especially in developing green innovations.

> Arçelik Garage leads design thinking and intrapreneurship mindset within the company, supporting the employees throughout the product development journey, from idea to prototype and product launch. (I12)

Arçelik considers sustainability a business model and emphasises the importance of acting with stakeholders. It leads change with its sustainability practices and continues its journey with a mission that shapes the future. Arçelik implements its sustainability strategy by setting goals in the fields of environmental, social, and governance. Arçelik's sustainable strategic priorities are Transition to Net Zero, Gender Equality and Diversity, Digital Transformation and Innovation, Circular Economy, Supporting Local Communities, Future Fit, Culture, Talent and Organisational Management, Water Management, Ensuring Healthy Lives and Well-Being for People Creating Value in, Supply Chain, Quality, Safety and Customer Management.

As a result, we summarised Arçelik's circular and GM strategies within the theoretical framework of NRBV in Table 1.

11 Discussion and Conclusion

This study contributes to understanding circular business models in Turkey. In recent years, all countries and organisations have developed policies to minimise the effects of global warming. However, if emerging economies such as Turkey cannot reduce emissions, they will not be able to export to EU countries, which may cause significant economic losses. For this reason, it has become necessary for developing economies to understand CE practices, especially at the micro-level.

The pioneering strategies and policies of the white goods giant Arçelik, which operates globally within the Koç Holding group, are discussed using a case study methodology. This paper will contribute to researchers, managers, and policymakers' understanding of how effective GM and innovation strategies are practised. By considering the NRBV of the firm, sustainability initiatives such as CE principles and GM practices are believed to create unique and long-lasting competitive advantages for companies. Arçelik, with its pioneering activities in its sector worldwide,

Table 1 Arçelik's CE and GM strategies within the scope of NRBV

Strategic capability	*Environmental driving force*	*Key resource*	*Competitive advantage*
Pollution Prevention	**Minimize emissions, effluents, & waste** • Total financial savings through waste reduction and water efficiency projects: EUR 1,593,000 • The rate of recycling and recovery in total waste was 96% in the manufacturing plants included in the reporting scope • The waste recycling rate increased to 98% in Turkey operations • The average hazardous waste per product was reduced by 30% in manufacturing in Turkey, Romania Gaesti, Russia, China, and South Africa operations, compared to 2012 • Approximately 1.3 million WEEE units were recycled between 2014 and 2020, a total of 326 GWh of energy was saved, nearly 160,000 tons of CO2 emissions were prevented, and around 6.5 million tons of water was saved	**Continuous improvement** In 2020, the performance management process continued to revolve around continuous improvement and feedback	**Lower costs** By using digital services such as ChatBot and robotic process automation more, productivity has been increased and costs have been reduced Eco-innovative Energy Factory Management System is an EU-funded Horizon 2020 project based on enhanced Life Cycle Assessment and Life Cycle Cost Analysis towards resource efficient manufacturing

(continued)

Table 1 (continued)

Strategic capability	*Environmental driving force*	*Key resource*	*Competitive advantage*
Product Stewardship	**Minimize life-cycle cost of products (in the context of CE):** • PET Tub: 28.2 million recycled PET bottles were used, adding up to 58 million in total since 2017. CO2 emissions were reduced by 2200 tons and 19,000 GJ of energy was saved • EcoSustain: The proportion of recycled plastic raw material, Eco-Sustain, has reached 31% in Atak vacuum cleaners, 17% in Jaguar vacuum cleaners, and 64%–73% in toast & grills. A total of 190.4 tons of recycled plastics were used in these product categories • 8 tons of recycled waste fishing nets and 111.7 tons of industrial thread waste were transformed into high-performance recycled polyamide compounds which were then used in oven, washing machine and washer-dryer and dishwasher parts • BioFridge: The version with bio-based fan cover and bio-composite with eggshells was released into the market, and the efforts to use bioplastics in SDAs were accelerated. Arçelik used coffee grounds in coffee machines, and tea fibers in tea makers	**Stakeholder integration** Business partners Technology entrepreneurs Suppliers Customers Government, public institutions Local and global NGOs Intergovernmental organizations Universities	**Preempt competitors** Proactive strategy

Strategic capability	*Environmental driving force*	*Key resource*	*Competitive advantage*
Sustainable Development	**Minimize environmental burden of firm growth and development** • *Products that Create Environmental and Social Value:* e.g. 50% of turnover was from energy-efficient products. Compared to 2019, average energy consumption was reduced for tumble dryers in Turkey by 23%, refrigerators, dishwashers, and washing machines by 4%, 3%, and 1%, respectively • *Biodiversity:* e.g. A part of Arctic Ulmi factory is near Natura 2000 area named "Lacurile de pe Valea Ilfovului" for Birds Directive Special Protection Area (SPA), so, according to the National Air Quality Law 104/2011, Arçelik has to measure PM10, NO2 and SO2 quarterly. This is the only production site near to the protected areas and Key Biodiversity Areas where 431.369 m2 of border area is located between Arçelik's production site and the protected area • *Healthy Living:* e.g. Beko —Eat Like A Pro, in collaboration with UNICEF, reached 172,000 children across Latin America region through school-based interventions, and approximately 76.500 teachers were provided with training During COVID-19, an estimated total of 25 million school children, and 3.5 million people were reached through different channels	**Shared vision** • Digitalization and Consumer Experience • Customer Satisfaction and Communication • Open Innovation	**Future position/2030 Targets** ***Increasing resource efficiency in manufacturing*** • Establish renewable energy systems with 15 MW capacity • Purchase 100% green electricity in global manufacturing plants • Make an additional USD 50 million investment in renewable energy and energy efficiency • Reduce energy consumption per product by 45% • Reduce water withdrawal per product by 45% • Increase the water recycling ratio to 70% in all manufacturing plants • Reduce Scope 1–2 GHG emissions by 30% • Increase the waste recycling rate to 99% in global operations • Reach the target of 450 MW Arçelik-branded PV panel sales per year by 2025 **Improving product efficiency and eco-friendly product range** • Increase recycled plastic content to 40% • Increase bio-based material content to 5% • Reduce Scope 3 GHG emissions from use of sold products by 15% • Standardize Arçelik Green Chemistry Management System in products and production globally

(continued)

Table 1 (continued)

Strategic capability	*Environmental driving force*	*Key resource*	*Competitive advantage*
	• *Food Waste:* e.g. Grundig—Respect Food, having met its 2023 targeting advance, helped to create + 450,000 meals and prevented 230 tons of food from being wasted, increasing the total number of prevented food waste to + 500 tons • *Social Investment Programs:* e.g. Over EUR 5.8 million was spent globally for social investment and corporate citizenship activities. 500 Women Technicians Project was launched in Turkey to support women in the workforce • *Products that Create Environmental and Social Value:* e.g. Beko—HygieneShield Range that provides more than 99% virus reduction, including coronavirus, was released in seven key markets including Spain, Germany, the UK, Turkey, the Balkans, Romania, and Poland, also was released into the Turkish market with Arçelik-branded Ultra Hygiene Series • *Products for Disadvantaged Groups:* e.g. Product donations: White goods and small domestic appliances were donated to 550 + hospitals across 20 countries In Turkey, more than 5000 Arçelik- and Beko-branded products were delivered to 202 hospitals across 75 provinces		

Source This Table was created by compiling the Arçelik (2020) sustainability report and interview information

considers sustainability an indispensable business model and competitive strategy to ensure CE with the vision of "Respecting the World, Respected Worldwide." Arçelik gains a global competitive advantage as it develops a proactive strategy in all aspects of sustainability. Adopting the principles required by the CE worldwide can contribute to the end of the climate crisis and increase development and welfare. Furthermore, Arçelik's planning to implement its activities to eliminate gender inequality, which is one of its sustainability goals, not only for Turkey but also for countries such as Pakistan and Bangladesh can be considered as steps that contribute to the increase in the welfare level of underdeveloped countries.

Another critical practice of Arçelik is to reduce emission rates throughout the supply chain. In this way, Arçelik encourages its collaborating supplier firms, generally SMEs, to adopt cleaner production methods. Furthermore, Arçelik announced that it would stop working with suppliers not receiving ISO Environment and Energy quality management certificates. This can be considered a strategy that both increases the competition among SMEs and encourages eco-innovative product and process development of SMEs. Considering the cost–benefit analysis for CE, using recycled raw materials in manufacturing can sometimes turn into cost savings and cost increases. At this point, specific percentages of recycled materials can be tested in product design. Countries such as Spain and Italy impose a particular rate of cyclical materials on products. Those not fulfilling this criterion will be subject to tax, which may force companies financially. Before the new regulations, the company's proactive strategy, using cyclic materials in its manufacturing processes and searching for innovative ways, will bring the business to the breaking point after a while.

Despite the progress made by the case company, certain barriers limit CE implementation and the need for managers' attention. There is a paucity of technical and scientific knowledge of CE in many manufacturing companies, which makes it challenging for them to implement CE principles. According to managers, CE implementation is inhibited by process digitalisation and design challenge circular. By considering CE challenges in their planning, manufacturing industries can improve their processes in terms of eco-design, eco-innovation, remanufacturing, managing wastes, byproducts, and supply chains. In the manufacturing industry, integrated CE designs can lead to promising solutions, such as monitoring wastes and natural resources, revamping closed-loop supply

chains into technological supply networks, and reducing carbon emissions. To implement the eco-design principles, industry experts can rethink their CE business models to balance environmental and economic behaviour. Furthermore, integrated CE allows companies to customise their products by providing extreme customer service by facilitating customer-product communication.

It is crucial to introduce specific incentive mechanisms to the government to companies that have electrical-electronic waste facilities, use high rates of recycled materials in production, or report world-renowned sustainability indices and engage in similar activities. A settlement system can be introduced for businesses that make R&D investments and develop eco-innovation products and processes within the scope of GM. In addition, sustainable financing is a critical issue for the development of SMEs. For the development of sustainable finance, it is crucial to introduce specific tax incentives, in cash or other discounts, both to the credit institutions that use this financing and to the companies that will receive it. Another issue is to raise awareness for consumers to buy green products. Instead of paying high prices for green products, consumers tend to buy the cheapest product that meets their needs by considering their current budget. Businesses and organisations must explain that using water and energy-saving, long-lasting, and higher-quality products creates economic and environmental benefits. Moreover, there are no specific incentives for energy-efficient product sales. For example, introducing a stimulus to the consumer, value-added tax reduction, having a particular incentive mechanism, or introducing green financing practices to the consumers to buy energy-efficient products can increase the sales of green products.

CE practices are significant for manufacturing companies to provide environmental and economic outputs. It will positively affect the companies by reducing resource use, lessening waste, and meeting customer and investor demands. In addition, sustainable and responsible production activities are likely to the positively affect corporate reputation and image. In future studies, the impact of CE activities on investors and consumers can be examined empirically by considering the dimensions of sustainability.

The study also indicates that CE innovation reduces a firm's costs by using fewer resources. When these cost savings are reflected in the prices of the products by the manufacturing firm, the demand for the products is likely to increase in the long run. On the other hand, since CE innovations require incurring high investment costs in the short run, price

increases may be possible in the short run to cover these costs. This means that the firm's product demand decreases in the short run, hence its output and employment. It can be argued that U-shaped relationship that exists over time between CE innovations and firm-level employment. Therefore, CE will likely have an employment-enhancing effect in the long run.

As a result, CE and GM applications lead to lower-cost products in the long run; contribute to ensuring sustainability in economic, environmental, and social dimensions; and are most likely to have an employment-increasing effect of meeting the increase in demand for green products. In addition, CE innovations can make a company's products more attractive to the consumer (in terms of better recyclability, energy savings, etc.). Thus, the demand for the products manufactured by the firm and the employment level of the firm increase. But on the other hand, CE innovations increase the ecological value of the company's products, leading to a rise in consumers' willingness to pay. This, in turn, leads to increased demand for the firm's products and firm employment.

In the study, we explore and analyse GM and innovation to implement CE. According to the study, integrated CE strategies have the potential to enhance sustainability's triple bottom line by optimising waste, raw materials, and carbon emissions. Technology resources provide a great deal of data that can be used to make logistics and production decisions. Hence, the manufacturing industry can maximise revenue generation from post-usage products, byproducts, and production waste by recovering resources from different varieties of post-usage products, byproducts, and production waste. The significant barriers require automating the circular supply chain, semantic communication between machines and products, capturing information throughout the system, and improving production and consumption rates to enhance sustainability. Thus, manufacturing industries focus on improving the efficiency, precision, and accuracy of the sustainable supply chain by integrating end-to-end, as in the case of Arçelik.

Appendix: Questionnaire

Sustainable development
When and for what purpose did Arçelik begin its sustainability journey?
What are the main policies you have adopted within sustainability? Can you tell about your practices?
What are the possible social impacts of the transition to a CE?
What is to be expected regarding the social impacts if the CE transition continues rapidly?
If the manufacturing sector goes circular: What is the job impact?
Recent research (Repp et al., 2021) found significant job reductions in emerging economies in the textile industries when circularity increases. What is your opinion on that?
Product Stewardship (CE Practice—R&D, Innovation and GM)
Do you develop new products in which the materials from the collected old products are used by recycling?
Can you give examples of the circular material used products you have developed within the eco or green innovation scope?
What are the clean production technologies you use in your production system?
Is your in-house R&D department developing the cleaner production technologies you use? Are you developing those with your external stakeholders within open innovation?
"How do you apply the 6Rs (recovering, reusing, recycling, redesigning, reducing, and remanufacturing)" within the scope of CE in manufacturing and supply chain management? (How is the waste energy, wastewater, etc., generated during the manufacturing process treated and converted into a clean and reusable form?
Pro-activeness
Do you have a proactive nature as a company? In other words, can we say that you started sustainability attempts as a pioneer, not to follow something?
Pollution Prevention
What kind of activities do you do to prevent environmental pollution?
Do you have any projects you have developed on environmental issues to contribute to society?

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