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Circular Clock Model for Circular Economy Implementation in Firms: Balance Between Theory and Practice

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Abstract:

Purpose: The circular economy is a key issue for any company, city, or institution. The linear economy model, based on "take, make, use and waste" of products and resources, has discarded potentially valuable resources and caused serious contamination problems. In contrast, the circular economy (CE) model is a strategic paradigm whose purpose is to regenerate and conserve resources through closed material loops and the sustainable use of energy in its processes. Therefore, a growing number of companies are applying different tools and techniques to implement the CE principles to innovate their products, services, and processes, achieving promising results. Thus, the main objective of this study is to suggest an implementation model named "Circular clock" based on a set of tools and techniques which firms may use for implementing CE.

Design/methodology/approach: The paper presents an empirical analysis based on the triangulation method that includes three different data sources: semi-structured interviews in Spain, academic literature and books, and non-academic publications from institutions and consultancy firms.

Findings: The most relevant result of this study is the proposal of a Circular Clock model for circular economy implementation is based on six fields of action define in the academic literature: take, make, distribute, use, recover, and industrial symbiosis. Moreover, this study may serve as guidance in facilitating the strategic adoption of eco-innovation practices in firms' transition to a CE.

Research limitations/implications: The sample of companies that participated in the triangulation is exploratory; however, this limitation is overcome by reviewing academic literature and institutional reports. On the other hand, academics could expand the selection of tools with subsequent studies.

Practical implications: The current study is based on the triangulation method, which was vital to balance the theory and practice provided by academic sources, reports, and books. In addition, this study has improved our understanding of the goals or intentions that may motivate firms to implement the CE and align them with the suggested set of tools. Consequently, this study is relevant to support practitioners in selecting a tool based on the goal they want to achieve towards circular economy implementation.

Social implications: This research suggests several tools; however, each organization could adapt some that it already knows. Therefore, firms and implementation leaders should customize the circle with short lines in each case. Moreover, the clock bells represent the deadline considering that every CE implementation process requires a deadline to ensure its success in micro-level or firms.

Originality/value: The “circular clock” provides a didactic way for sustainability leaders, consultants, or companies to facilitate the implementation of the circular economy by choosing the field of action on which they want to focus and the most appropriate tool according to their strategy, objective, and budget. Therefore, this model is based on the balance between theory and practice.

Keywords: circular economy, strategy, tools, competitiveness, environmental management, implementation

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1. Introduction

In addition to the existing environmental challenges, the new status quo imposed by the COVID-19 has triggered the deepest global recession since World War II. From a macro and meso perspective, the COVID19 post-pandemic period requires identifying strategies that make economic recovery possible, without neglecting the environmental challenges defined at COP21 (United Nations, 2015) and social prosperity. In response, the circular economy (CE) is a feasible strategy to tackle sustainable development goals as an alternative economic system. CE is “an economic system that represents a change of paradigm in the way that human society is interrelated with nature and aims to prevent the depletion of resources, close energy and materials loops, and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions and governments) levels. Attaining this circular model requires cyclical and regenerative environmental innovations in the way society legislates, produces, and consumes” (Prieto-Sandoval, Jaca & Ormazabal, 2018).

The European Union has raised on numerous occasions the importance of the Green Deal as a means of economic recovery within the framework of the CE (World Economic Forum, 2020), with priority in areas such as the development of clean energy sources, sustainable industry, efficient renovation and construction, mobility sustainable, Biodiversity, farm to fork, and zero pollution (European Commission, 2019). In this line, it is essential to support companies of different sizes and sectors to implement CE successfully. At the micro-level, applying the CE implies strategic and operative challenges for firms. Also, it involves new opportunities in terms of business models, value creation, and competitive advantage in the market (Pieroni, McAloone & Pigosso, 2019). Likewise, multiple studies point out the opportunities that arise from a CE model, such as the increase of prestige, cost reduction and financial profitability, recovery of the local environment, and the sustainability of the company in the long term (Ormazabal, Prieto-Sandoval, Puga-Leal & Jaca, 2018; Rizos, Behrens, van der Gaast, Hofman, Ioannou, Kafyeke et al., 2016).

However, the CE implementation involves barriers and challenges for society and companies, especially for those embedded in a linear economic model. Those barriers can be classified into two categories: “hard barriers”, which are related to the lack of financial resources, technology, inadequate information systems, etc.; and “human-based barriers” or soft barriers associated with issues as company leadership or the lack of customer interest in the environment (Ormazabal et al., 2018).

In order to promote the development of CE as an effective strategy that takes advantage of various opportunities and overcomes the barriers raised, this paper is structured as follows: first it develops a conceptual framework regarding CE as a business strategy, then the methodology of the investigation, later the results and the discussion where the circular clock is proposed as a model that groups a diversity of tools for the implementation of CE in its six fields of action. Finally, a series of conclusions are raised.

1.1. CE at Business Strategy Levels

CE has been considered a new strategy, both at the macro and meso levels, as well as at the micro level. Thus, the European Commission adopted the CE Action Plan for a cleaner and more competitive continent (European Commission, 2015). Parallel, the CE can be applied as a firm's strategy "which aims at reducing both inputs of virgin materials and outputs of wastes by closing economic and ecological loops of resource flows" (Haas, Krausmann, Wiedenhofer & Heinz, 2015). Besides, CE represents a cyclic flow of materials and energy, thus, its performance can be summarized in six fields of action: take, make, distribute, use, recovering materials and energy, and the industrial symbiosis (Jaca, Ormazabal, Prieto-Sandoval, Santos & Viles, 2019; Park, Sarkis & Wu, 2010; Stahel, 2016).

This multilevel perspective entails incorporating the framework of the three levels of the strategy to deepen the dynamics of CE implementation in the organization (Figure 1). They are the corporate, business, and functional levels proposed by different authors (e.g., Andrews, 1971; Ansoff, 1965; Beard & Dess, 1981; Christensen, Andrews, Bower, Hamermesh & Porter, 1978; Hoffer & Schendel, 1978). In a corporate-level strategy, the firm should think about how and where it must grow, which is coherent with Bocken, de Pauw, Bakker & van der Grinten (2016), who explain that CE strategy is a mix of product design and business model. For that reason, it could make decisions about the relationship between product and the market, the internationalization, the business model design, cooperation and alliances opportunities, merges and acquisitions, and vertical and horizontal integration. Thus, there are CE best practices at this level, such as Industrial symbiosis (Chertow & Ehrenfeld, 2012), open strategy and innovation (Chesbrough, 2003; Chesbrough & Appleyard, 2007), Industry 4.0 technologies (Tseng, Tan, Chiu, Chien & Kuo,, 2018), and Corporate Social Responsibility considerations (Elffers, 2014), all of them to define a particular circular business model (Lewandowski, 2016; Pieroni et al., 2019; Ünal, Urbinati & Chiaroni,, 2019).

At the business-level, the strategies are focused on the way to compete by defining the value creation strategies in each CE field of action, the green product attributes, and associated prices as in conventional business models (Porter, 1987; Porter & van der Linde, 1995). Therefore, it is relevant to consider the product life cycle impacts (Mattila, Lehtoranta, Sokka, Melanen & Nissinen, 2012), and sustainable design strategies like biomimicry and cradle to cradle towards green product creation (de Pauw, Karana, Kandachar & Poppelaars, 2014). Moreover, it is essential to develop sustainable products, implement dematerialization, eco-labeling (Prieto-Sandoval, Mejía-Villa, Ormazabal & Jaca, 2020), and environmental certification (Fonseca, Domingues, Pereira, Martins & Zimon, 2018; Merli & Preziosi, 2018), among other practices.

Finally, companies must translate the two previous levels at the value system and the operative activities at the functional level. Any initiative for improving the firms' operation must consider the CE fields of action. For example, operations should include optimization models on energy consumption, water, and the use of raw materials (Bassi & Dias, 2019) to reduce the ecological footprint. Likewise, the manufacturing area must change to lean manufacturing and technological modernization (Zhu, Geng, Sarkis & Lai, 2015).

Regarding the CE implementation as a firm strategy and the potential barriers and opportunities described in the literature, this study aimed to address the following research question: Which business-oriented tools can support firms in developing a CE strategy for the functional level? Moreover, how can the tools be classified? In this way, the aim of the paper is to provide a typology of business-oriented tools for CE implementation in firms and a set of those tools to make CE a feasible functional level strategy that could help firms to integrate them and develop more sustainable processes and products and thus facilitate their transition to a CE. (Figure 1)

2. Methods

Our empirical analysis used the triangulation method, which refers to the use of two or more data sources and the perspectives, methodological approaches, theoretical perspectives (Denzin, 1989; Kimchi, Polivka & Stevenson, 1991), and analytical methods (Kimchi et al., 1991) of different researchers within one study to build an objective analysis (Saunders, Lewis & Thornhill, 2009). In this study, we used three different data sources. First, we conducted semi-structured interviews with different department top managers, including sustainability managers, from Spanish firms. Next, we consulted a selection of CE reports from institutions and consultancy firms, and reviewed academic literature and books (Figure 2).

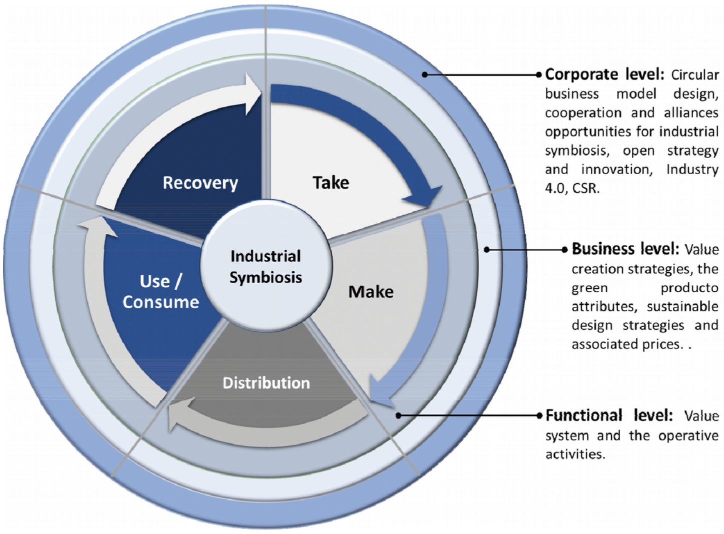

Figure 1. Strategy levels. (Prieto-Sandoval et al. 2020; Porter 1987)

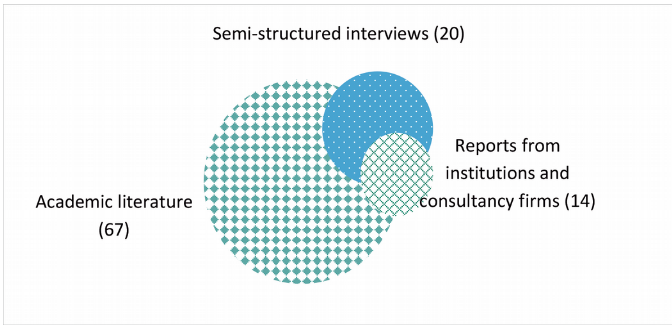

Figure 2. Triangulation sources

First, a group of Spanish companies (20) from the industrial sector were selected. The primary criterion for selecting the firms was that they must have environmental certification. This criterion was established because certified firms will have already developed incremental or radical environmental innovation processes as a condition for being awarded certification (Ormazabal, Rich, Sarriegi & Viles, 2017; Prieto-Sandoval, Alfaro, Mejía-Villa & Ormazabal, 2016). This way, the identified tools come from companies working on environmental management. Then, more than 20 practitioners, the majority of whom were managers from different departments of a total of 14 companies, were interviewed to obtain information about the CE's application in their companies and the tools used for that purpose. As Table 1 shows, interviews were not limited to SMEs, as the idea was to find as many tools as possible that could be useful for every firm. The practitioners were asked about managers' interest in environmental sustainability for their organization's corporate strategy of their organization? If they apply design strategies to recover their used products or remanufacture them? What tools did they use to valorize waste and energy or recirculate (reuse or recycle) materials? In addition, they were asked about the information or accompaniment they gave to the user to raise awareness about the proper maintenance, recovery or disposal of waste.

Second, we reviewed the literature using the "snowball" technique. This data collection method is often used when there is difficulty in identifying a representative sample through official sources (Geissdoerfer, Savaget, Bocken & Hultink, 2017; Ricci & Gunter, 1990). During the snowballing process, we found 66 scientific articles that directly propose tools validated by scholars in the last 20 years. Third, 14 reports were reviewed to analyze the non-academic literature for valuable tools for CE implementation. Nonetheless, most of the reports have been cited by scholars in scientific publications.

The three data sources were analyzed in terms of the six CE fields of action to propose a set of tools for each field of action that can help firms implement the CE.

	Number of companies	Percentage
Number of employees		
<50	0	0%
51-150	2	14.3%
151-250	5	35.7%
> 250	7	50%
Firm area/department		
Quality / Environment	9	45%
Production	6	30%
Marketing / Product Design / Organizational Communication	1	5%
Transportation and Distribution Logistics	1	5%
Supply of Materials / Purchases	1	5%
Commercial / Customer Service	1	5%
Human Talent Management / Human Resources	1	5%

Table 1. Sample description

3. Results and Discussion

This section suggests an implementation model named "Circular clock" based on the CE fields of action and the set of tools based on three different sources' content analysis, as the triangulation method recommends (Figure 3). The small hand indicates the field of action in which you want to work, and the large clock hand should indicate the tool represented by short lines that indicate the minutes as in a clock. The tools may be understood as tangible or intangible things, devices, or applications employed to perform a job (Oxford, 2010); in this case, the job is implementing the CE in firms. We also explain the goal or intention of these tools and the data sources employed to define them. This research suggests several tools; however, each organization could adapt some that it already knows. Therefore, firms and implementation leaders should customize the circle with short lines in each case. Moreover, the clock bells represent the deadline considering that every CE implementation process requires a deadline to ensure its success in micro-level or firms.

Thus, the "circular clock" provides a didactic way for sustainability leaders, consultants, or companies to facilitate the implementation of the circular economy by choosing the field of action on which they want to focus and the most appropriate tool according to their strategy, objective, and budget.

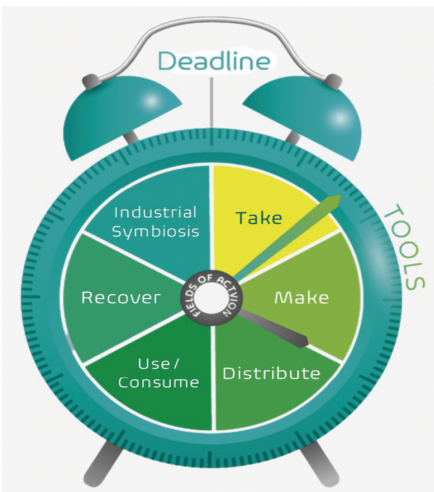

Figure 3. Circular clock

3.1. "Take" Tools

The first group of tools refers to the "take" field of action, which is associated with relevant decisions such as materials selection, energy sources, and process design. In this way, the sustainable supply, traceability of raw materials in the value chain and materials innovation is a constant concern in the literature and for the interviewed participants (Table 2). Given this, the certification requirements for the firm's suppliers have been a broad welcome and the recently established Materials Passport or Product Passport. The suppliers can be awarded multiple certifications to ensure the environmental quality and traceability of their products. One of the interviewed firms requires its suppliers to adhere to the International Food Standard (IFS) for the food industry; the IFS is an international standard, and the accreditation criteria are based on standard EN 45011 for product certification. Therefore, product passports function on a business-to-business level, providing "a set of information about the components and materials that a product contains, and how they can be disassembled and recycled at the end of the product's useful life" (European Commission, 2016). This kind of passport is becoming digital based on governments' and institutions' interest in facilitating the recovery and reuse of materials across a products' life cycle (European Commission, 2021; Munaro & Tavares, 2021).

Firms are also trying to refrain from using the pollutants and scarce materials, not only due to their impact on the environment but also to diminish dependence on resources that may be exhausted or become more expensive over time (McDonough & Braungart, 2002). Accordingly, firms can use a materials assessment as a tool for defining criteria for procurement processes such as Material Circularity Indicator, green procurement criteria, and hiring manuals, or they can use a protocol such as the MBDC Materials Assessment Protocol, which includes human and ecological health criteria and a flow chart that describes how each chemical in a process is evaluated (McDonough, Braungart, Anastas & Zimmerman, 2003) (Table 2).

Goal/Intention	Tools	Source
Traceability of products (supplies), and transparency in management and materials information.	Supplier Certifications. For example, The International Food Standard (IFS). Materials Passport or Product Passport	Semi-structured interview, Lieder and Rashid (2016), McDonough and Braungart (2003), European Commission (2016, 2021), Munaro and Tavares (2021)
Materials innovation towards more circular options	Materials assessment protocols to design products (e.g. MBDC). Material Circularity Indicator by the Ellen MacArthur Foundation.	Semi-structured interview, Evans and Bocken (2013), Ellen MacArthur Foundation and Grata Design (2015), McDonough and Braungart (2002), Witjes and Lozano (2016), Rossi, Charon, Wing and Ewell (2006), McDonough et al. (2003).
To identify and measure the specific level of materials circularity in order to improve it	Materials and products circularity	Niero and Kalbar (2019), Puente, Arozamena, and Evans (2015)
A green public procurement leading to a sustainable consumption	Green purchasing and contracting manual as a tool for sustainable production A green office manual as a guide to responsible practice Motivating green public procurement	Farahani, Peterson and Westfall (1998), Pacheco-Blanco and Bastante-Ceca (2016), Testa, Annunziata, Iraldo and Frey (2016), Zhu, Geng and Sarkis (2013)

Table 2. Tools for the "take" CE field of action

3.2. "Make" Tools

Since this field of action refers to how companies "make" or develop their transformation processes, this study proposes several tools that are related to the goals of raising environmental awareness among employees, reusing production "waste", reducing materials mixing and costs, disassembling products for future materials recovery, and using resources efficiently (Table 3).

Environmental awareness among employees can be increased with internal communication campaigns and environmental awareness training for employees, highlighting the critical role employees play in environmental management and the firm's environmental impact. Moreover, this kind of training can encourage openness to sustainable practices.

Energy efficiency and reduction of greenhouse effect gases are other crucial goal for firms (Table 3). In this aspect, the modernization of infrastructure plays a key role because the tools used to save energy are related to the use of efficient lighting (e.g. LED lighting systems) and devices that monitor the expenditure of energy in each process. Additionally, motion sensors and light sensors optimize energy use by taking advantage of natural light and decreasing the use of artificial light sources (Dikel, Newsham, Xue & Valdés, 2018).

The firms interviewed, and the literature findings revealed the high interest in reusing production "waste" in other product processes, reducing water consumption in the process development, and taking advantage of waste heat to generate more energy, mainly because it positively impacts cost reduction. In this sense, the participants pointed out the segregation and fusion of ferrous materials and other metals and the adaptation of machinery to reuse production remains, like a closed system. Then, the most common tool to reduce materials mixing and costs is product standardization through design simplification. However, the effectiveness of this tool depends directly on the final customers' requirements and expectations. Along the same line of action, sustainable design strategies (e.g. Eco-design, Cradle-to-Cradle, biomimicry) are the most recognized tools for creating products whose materials are recoverable in the future.

Goal/Intention	Tools	Source
Raise awareness among employees about critical waste and encourage openness to sustainable practices.	Internal communication campaigns. Environmental training for employees.	Semi-structured interview, EPSRC (2014), Simpson, Taylor & Barker (2004).
Reuse production "waste" in other products (when possible).	Infrastructure installation for segregation and fusion of ferrous materials and other metals. Infrastructure investment to adapt machinery to reuse production remains.	Semi-structured interview, European Commission (2014).
Reduce materials mix and costs.	Product standardization through design simplification.	Semi-structured interview, Evans and Bocken (2013).
Disassemble products for future materials recovery.	Sustainable design strategies	Prieto-Sandoval, Jaca and Ormazabal (2017), Pauw and Kandachar (2010), Van Hemel and Cramer (2002).
Energy efficiency	Efficient luminaires (e.g. LED lighting systems). Devices to monitor the energy expenditure in each process (e.g., Motion sensors and light sensors).	Semi-structured interview, Dikel et al. (2018), EPA (2017), EPSRC (2014).
Use resources efficiently.	Sensors in the machine to measure online consumption. Segregation and fusion of metallic materials.	Semi-structured interview, Dikel et al. (2018) Ma, Wen, Chen and Wen (2014)
Reduction of greenhouse effect gases when generating energy	Use of renewable energy sources	Gallagher, Basu, Browne, Kenna, McCormack, Pilla et al. (2019)
Reduction of water consumption in the process development	Sewage treatment/Recirculation of water	Voulvoulis, N. (2018), Sartal, Ozcelik and Rodríguez (2020), Sgroi, Vagliasindi and Roccaro (2018)
To take advantage of waste heat to generate more energy	Recovery of combustion heat	Song, Li, Wang and Markides (2020) Yuan-Hu, Kim, Kim and Han (2019) Zhang, Su, Lin, Zhou and Zhao (2020)

Table 3. Tools for the "make" CE field of action

3.3. "Distribute" Tools

In distribution, it is evident the critical role of logistics management in implementing the circular economy. An interesting variety of tools emerged to design packaging that optimizes storage space, transport routes, loading spaces, and stackability, and reduces the environmental impact of packaging (Table 4).

Eco-design is also an appropriate tool because it analyses every step of the product life cycle and gives useful guidance in designing packaging that optimizes storage space. Along the same lines, firms are also aware of the environmental impact of packaging, so they should focus on designing recyclable packaging, especially when they intend to recover those materials.

Transport route optimization can be achieved through tools that differ in cost and difficulty in implementation. Such tools include logistics management software, practices related to green logistics and transport management, or free geolocation software like Google maps, which can be adapted to a wide range of situations (Santos, Coutinho-Rodrigues & Antunes, 2011). Other optimization tasks can be easily achieved with internal logistics management software or well-known software like Microsoft Excel.

Goal/Intention	Tools	Source
Design packaging that optimizes storage space.	Eco-design analysis	Semi-structured interview, Moigne (2016), Lean Supply Solutions (2017), ECOEMBES (2015), EPSRC (2014), Van Hemel and Cramer (2002).
Reduce the environmental impact of packaging.	Design strategies for recyclable packaging	Semi-structured interview, ECOEMBES (2015), Van Hemel and Cramer (2002).
Optimize transport routes.	Internal logistics management software, free geolocation software like Google maps. Green Logistics Transport management	Semi-structured interview, MH&L (2016), EPSRC (2014), Santos et al. (2011), Tissayakorn and Akagi (2014)
Optimize loading space and stackability.	Internal logistics management software or well-known software like Microsoft Excel.	Semi-structured interview, Lean Supply Solutions (2017), MH&L (2016), Moigne (2016).
Packaging recycling and reuse	Economic feasibility	Kuo, Chiu, Chung and Yang (2019)
To reduce negative impact coming from the process of fabrication of new packages or decomposing the used ones	Second-hand package reusability	Chung, Ma and Chan (2018), Mahmoudi and Parviziomran (2020)

Table 4. Tools for the "distribute" CE field of action

3.4. "Use" Tools

The "use" field of action is challenging because firms usually lose their power to manage their products' waste, and consumers become responsible for the purchased products. Nonetheless, firms can decrease the environmental impact of their products by guaranteeing the availability of spare parts or accessories for the products, informing customers about the materials and quality of the product, the proper way to dispose of the products after use, recovering un-used products, and lengthening the lifetime of the products (Table 5).

A useful tool is Enterprise Resource Planning (ERP) software, which manages every company's process in an integrated way. An ERP system can be connected with the customer and supplier information systems (even when the software supplier is different). For example, in business to business models, the firms can see the customers' sales trends compared to their sales plans quicker than they will (Ross & Vitale, 2000), thus, customers and suppliers can better manage the stock and produce only the demanded units.

In addition, communication with customers is crucial for the proper use and recovery of a firms products' materials. Consequently, this study proposes adding labels for packaging recovery to identify a product's materials and quality.

Moreover, one of the interviewed firms pointed out that sales executives must be trained to be the firm's ambassadors and communicate their sustainable initiatives to customers and the public. An interesting proposed tool is to invite customers to visit the company's factory to be transparent and demonstrate their sustainable practices through experience. Another tool is to give customers user guides (instructions) at the time of purchase.

Moreover, the proper use and recovery of products can be communicated through press releases in collaboration with environmental institutions, for example, Ecoembes newsletter. In this way, the environmental initiatives developed by the firm can be visible to every stakeholder through the use of certifications (e.g. EMAS), eco-labels, environmental declarations, and the firm can prove its environmental management maturity through the systemization of its processes (Ormazabal, Sarriegi, Barkemeyer, Viles & McAnulla, 2015).

The firms interviewed seemed interested in recovering products that have been purchased by customers but not used, as long as the products maintain their value, and it is possible to do it with their logistics chain. Furthermore, firms are interested in lengthening their products' lifetime, which at the same time innovating their profit model with maintenance, repair, and upgrade services.

Goal/Intention	Tools	Source
Guarantee the availability of spare parts or accessories for the products	Enterprise Resource Planning (ERP).	Semi-structured interview and Ross and Vitale (2000)
Inform customer about product materials and quality.	Add labels for packaging recovery.	Semi-structured interview, GreenBlue (2011).
Inform the customer of the proper way to dispose of the products after use.	Train sales executives to serve as a communication channel. Distribute efficient use guides (instructions), included at the time of sale. Plan customer visits to the factory. Use press releases in collaboration with environmental institutions, for example Ecoembes. Use certifications (e.g. EMAS), ecolabels, environmental declarations.	Semi-structured interview, Dangelico and Vocalelli (2017), Ormazabal et al. (2015), Testa, Iraldo, Vaccari and Ferrari (2015), Zorpas (2010).
Recover un-used products	Use logistics to receive the products and materials not used by customers.	Semi-structured interview, Lean Supply Solutions (2017).
Lengthen the lifetime of the products and develop new maintenance, repair and upgrade services.	Circular economy toolkit developed by Cambridge University. Ten Types of Innovation Model.	Lewandowski (2016), Evans and Bocken (2013), Keeley, Pikkel, Quinn & Walters (2013), Park et al. (2010).
To integrate circular economy principles in the final product to reduce environmental impact	Ecodesign	Talens-Peiró, Polverini, Ardente and Mathieux (2020), Mendoza, Sharmina, Gallego-Schmid, Heyes and Azapagic (2017)
Manufacture simple and easy-to-use products for everyone to use and understand	Universal design	Ayers, Khorsandi, Poland and Hilliard (2019)
To implement circular economy characteristics to enlarge product useful life	Durability eco-design	Zeng, Deschênes and Durif (2020)
To offer accompany after sales in order to retain customers and enlarge product useful life. To promote products through other services	After sales service Product Servitization	Murali, Pugazhendhi and Muralidharan (2016), Hojnik (2018)

Table 5. Tools for the “use” CE field of action

3.5. "Recover" Tools

The "recover" field of action is associated with closing the energy and materials loops instead of wasting them, losing its value for other processes. The firms are trying to use waste as an alternative fuel, which reduces emissions and costs. In the same vein, they are also reusing wastewaters to minimize their cost and environmental impact, undertaking gas analyses and emissions control of solid particles, reducing raw materials exploitation, and making and collecting production "waste" and rejected products an orderly way (Table 6).

This group of tools is mainly oriented toward technological modernization and the installation of infrastructure that can pay for itself over the long term with the profits accrued. It includes installing the appropriate ovens to get energy from waste, wastewater treatment, and reuse technologies, closed water circuits that prevent losses to the outside, specialized measuring and testing instruments, and the use of continuous gas analyzers. Therefore, some firms can deal with organic wastes through waste management treatments based on anaerobic digestion (Table 6).

In this field of action, the role of design is still present. A useful tool is the design and use of returnable packaging, as it saves costs and resources and is closely related to the industrial symbiosis field of action (discussed below). Moreover, applications from Industry 4.0 such as blockchain are more frequent and effective in following the traceability of materials and recovering them to reintroduce them in other value chains (Alves, Cruz, Lopes, Faria & Miguel, 2022). Additionally, specific waste can be better collected through bales, which can be made with a press and then placed into containers for later collection; this tool also facilitates external waste management when firms cannot do it. Nonetheless, tools such as the analysis of scrap generation should be employed to control, understand, and manage the type of waste generated.

Goal/Intention	Tools	Source
Use waste as an alternative fuel, reducing emissions and costs.	Installation of appropriate ovens, as the cement industry does.	Semi-structured interview and CEMBUREAU (2016)
Reuse of wastewaters, minimizing their costs and environmental impact.	Wastewater treatment and reuse technologies. For example, an industrial waste water treatment plant. Closed circuit of water without losses to the outside.	Semi-structured interview, Chertow (2007), McDonough and Braungart (2003).
Use gas analysis and emissions control with solid particles.	Installation of special measuring and testing instruments Use of continuous gas analysers.	Semi-structured interview, Patrick, Fardo, Richardson and Patrick (2006).
Reduce raw materials exploitation and increase materials recovery.	Design of returnable packaging. Blockchain for materials traceability	Semi-structured interview, Van Hemel and Cramer (2002), Alves et al. (2022)
Orderly collection of production "waste" and rejected products.	Bales can be made through a press that will then go to containers to be collected. Internal indicators of scrap generation.	Semi-structured interview, GreenBlue (2011).
Deal with Organic Waste	Anaerobic digestion	Sherwood (2020)
To obtain, recycle or recuperate energy from unviable waste chemically or mechanically	Energy recovery	Fu, Wang, Li, Yang, Xu, Ni et al. (2021), Tayeh, Alsayed and Saleh (2020)

Table 6. Tools for the "recover" CE field of action

3.6. "Industrial Symbiosis" Tools

Industrial symbiosis takes on its importance as a transversal CE field of action because companies see beyond competition and concentrate on the strategic advantages they can find in cooperation and alliances with multiple stakeholders. Moreover, industrial symbiosis is closely related to corporate level strategies like the business model design, as the way firms create, deliver, and capture environmental and economic value in the light of circular economy principles (Ünal et al., 2019). Thus, firms can develop sustainable business models through tools like the circular Canvas and the Ecocanvas (Table 7).

This study revealed that firms' business models and sustainability goals are geared toward recovering packaging that is reusable in their value chain and transporting product returns from their customers, developing, and managing circular material flows, and acquiring technological modernization to get cleaner production systems. Such goals can be achieved by sharing transport and distribution with customers, neighbors, and suppliers.

One of the tools proposed for developing and managing circular material flows is to develop the product system services business model, which allows the company to keep the product (and materials) ownership. This tool depends on customer willingness to rent products, but it was included in this group because it involves a relationship between multiple stakeholders. Moreover, the development of effective circular material flows can be facilitated by Industrial Symbiosis networks, Policy intervention and ICT Systems.

Finally, firms can share physical resource infrastructures, and they can also share knowledge. Thus, a suggested tool is developing research projects with universities and research centers to create new opportunities to close the loops with new technology. This kind of synergies can be followed up by economic and environmental indicators, as well as evaluating systems for the eco-efficiency of symbiotic transactions.

Goal/Intention	Tools	Source
Recover packaging transport	Personal communication. Joint negotiations. Digital platforms to manage the flows of materials, water and energy.	Semi-structured interview, Moigne (2016), Lean Supply Solutions (2017), Puente et al. (2015).
Sustainable business models	Circular CANVAS to design business models like the offer of Product as Services system. Ecocanvas	Fischer and Pascucci (2017), Stahel (1998, 2016), Lewandowski (2016), Mont (2002), Daou, Mallat, Chammas, Cerantola, Kayed and Saliba (2020)
Technological modernization to get cleaner production systems.	Development of research projects with Universities and research centres.	Semi-structured interview, Ellen MacArthur Foundation and McKinsey & Company (2014).
Develop and manage circular material flows	Industrial Symbiosis networks Policy intervention ICT Systems	Behera, Kim, Lee, Suh and Park (2012), Jiao and Boons (2014)
To identify eco-efficiency indicators	Economic indicators Environmental indicators Evaluating the eco-efficiency of symbiotic transactions	Park and Behera (2014)

Table 7. Tools for the "industrial symbiosis" CE field of action

4. Conclusions

This study's main objective was met by providing a specific model named the "circular clock" to implement the circular economy in firms based on the fields of action understanding and a corresponding set of tools for: take, make, distribute, use, recovery, and industrial symbiosis. Moreover, the current study is based on the triangulation method, which was vital to balance the theory and practice provided by academic sources, practitioners, reports, and books. In addition, this study has improved our understanding of the goals or intentions that may motivate firms to implement the CE and align them with the suggested set of tools. Consequently, on one hand this study is relevant to support practitioners in selecting a tool based on the goal they want to achieve; on the other hand this study.

Therefore, it seems that firms tend to focus their goals on the "take" and "make" fields of action, where they can easily manage the processes and get higher negotiation power than their suppliers to demand cleaner materials.

Moreover, the application of the corresponding set of tools in these fields directly impacts the product and value proposition of the company. The "distribute" field of action is especially oriented towards optimizing space, routes, and load in vehicles, probably because those aspects are of great importance for final profits and air emissions. In this regard, it is essential to point out that the main tools are accessible and do not require any investments in tools such as Google Maps and optimization simulations in Microsoft Excel. The tools related to the "use" field of action primarily focus on the communication channels between the company and the customer, in a close or personalized way through their own employees, or with the use of certifications that make the environmental management that the company does visible. The "recovery" tools are critical because they are of the most significant importance in closing the loops of materials and energy. In this regard, the goals examined in that field of action usually require large investments in technology and infrastructure, except for the tool related to product design and the orderly collection of production "waste". Finally, the industrial symbiosis "tools" are aimed at promoting the integration of the firms with their external stakeholders. It can be considered a "transversal" field of action because consumers, suppliers, and even universities and institutions may collaborate in closing the loop by sharing infrastructure and knowledge. Nonetheless, this integration is still a challenge because it used to be the product of relations that arise spontaneously or due to fostering from the government and various institutions.

Understanding the purpose of the tools and their connection with companies' strategic priorities is essential to advance in the realistic implementation of the circular economy and to understand this paradigm as a source of value creation in business. The circular clock facilitates its understanding orderly and suggests tools to facilitate workshops, university teaching, and consulting projects.

We expect that this research will serve as a base for future studies better to refine the present knowledge of each field of action and to expand the list of specific tools and goals that can be used by companies to attain the shift in paradigm. Further research might also explore a cross-national study involving firms shifting towards a circular economy.

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The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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