The development of CE business models in firms: The role of circular economy capabilities

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Abstract

This paper investigates how the capabilities that are related to the circular economy (CE) affect the development of products and processes that are compatible with CE business models. From the dynamic capabilities perspective, we assume that the development of CE in the firm implies the use of firm capabilities and the alignment of these in the development of a dynamic process of innovation towards the development of CE in firms. The analysis is based on a cross-sectional database from the EU survey on the Circular Economy in the year 2015, including 870 respondents. Our study extends the current literature on the factors that affect the development of CE business models in organisations. Our results suggest that CE-related capabilities have a positive effect in the implementation of CE business models in the organisation. In particular, we find that competences, standards and information are important in the context of the CE, playing a key role in the developing CE product and process.

Introduction

The circular economy (CE) is an economic model whose main purpose is to reconcile economic and environmental goals through the adoption of an innovative approach that tackles the relation between organisations and the environment (Ghisellini, et al., 2016; Bocken et al., 2017; Zucchela and Previtali, 2018). The CE model aims at achieving sustainability of production and consumption through the implementation of closed cycles (closed-loops) for regeneration and restoration, and the combination of processes for maintenance, reparation, reuse, renovation, remanufacturing and recycling (Bocken et al., 2014; Kirchherr et al., 2017; Hazen et al., 2017; Perey et al., 2018).

The increasing relevance of CE activities in firms has been reflected by the central role that institutions and public administration have taken in the introduction of the CE in organisations (Bocken et al., 2016; Lewandowski, 2016; Katz-Gerro and López Sintas, 2019). For instance, the European Union has developed the Circular Economy Action Plan, composed of 54 actions that set down the institutional framework for the implementation of the CE (European Commission, 2019), the World Economic Forum has launched the Platform of Accelerating the Circular Economy (PACE), a joint project with the World Resources Institute, Philips, the Ellen MacArthur

Foundation, the United Nations Environment Programme (UNEP) and over 40 other partners (World Economic Forum, 2019).

Moreover, academic research has not been oblivious to the study of the CE in the firms. Despite the literature of circular economy are just emerging, their practical and academic relevance have boosted the number of studies recently published on the topic (Katz-Gerro and López Sintas, 2019; Lüdeke-Freund et al., 2019; Pieroni et al., 2019; Ferasso et al., 2020). These studies have provided several contributions, including conceptual developments such as typologies of circular business models (e.g., Bocken et al., 2016; Lewandowski, 2016; Lüdeke-Freund et al., 2019), providing insights into their different aspects such as processes, roles, or management mechanisms, (e.g., Frishammar & Parida, 2019; Khan, Daddi, & Iraldo, 2020; Parida, Burström, Visnjic, & Wincent, 2019; Zucchella & Previtali, 2019). Despite these valuable contributions, Ferasso et al. (2020) point out that given the complexity of the implementation of the CE in the firm, it is necessary to understand its development from a strategic point of view. That is, the literature should investigate the identification of enabling and impeding conditions that can influence the successful implementation of CE development strategies, and make clear the role of strategic collaborations with supply chain partners in the implementation of circular strategies (Lewandowski, 2016; Evans et al., 2017). More specifically, studies should identify new capabilities and practices that contribute to the transition to circular business models. In fact, following Hopkinson et al. (2018), few field studies have addressed these research questions, such as what management competences and capabilities are required to develop circular economy models.

This paper explores this gap, using data from the EU survey on the Implementation of the Circular Economy in the year 2015, which includes 870 respondents (European Commission, 2015). From a strategic point of view, this paper takes as departure point the assumption that for the introduction of CE models, organizations must transform the classical linear models into circular models (Ghisellini et al., 2016; Perey et al., 2018). Using dynamic capabilities as the theoretical framework, we assume that the development of CE in the firm consists in a dynamic capabilities process (Aragon-Correa and Sharma, 2003; Russo, 2009; Bag et al., 2019; Khan et al., 2020; Scarpellini, 2020). This is in line with Eisenhardt and Martin (2000), which presented dynamic capabilities as specific and identifiable processes, and with Teece et al. (2007) that defines dynamic capabilities as the firm's ability to integrate and reconfigure its capabilities to address rapidly changing environments. Therefore, from this conceptualization, we can point out that the development of CE in the firm implies both the use of firm capabilities and the alignment of these in the development of a dynamic process of innovation towards the implementation of CE in the firm.

In line with previous works, we consider the need to analyse how the firm's capabilities affect the development of CE activities. Unlike previous works that have used the generic capabilities of the company to analyse how these affect the development of CE (for example, Inigo et al., 2017); we explore, following Demirel and Kesidou (2019) in their distinction between generic and specific eco-innovation capabilities, the impact that CE-related or CE-specific capabilities (CE capabilities) have in the development of CE in firms. This is an important question since as Demirel and Kesidou (2019) point out, the firms should develop sustainability-oriented capabilities, in order to meet the rapidly changing regulatory, technology, and market demands. Second, unlike previous works that consider a single process (Scarpellini, 2020), we consider that the development of CE implies the development of a double process, perfectly differentiated, linked to product-focused practice and process-focused. Firstly, the development of a product-focused process in the firm needs to consider the sustainability and recyclability of its products, assuming the innovative development of CE products. That is, the circular economy is presented as a system for taking advantage of resources, and betting on the reuse of the elements that due to their properties cannot return to the environment, involving an innovative process where the products are reused, remanufactured, and recycling. Thus, we propose a first research question, *how do the CE's capabilities affect the development of CE products*? Secondly, process-focused, the circular economy is conceptualized as an economic model for closed-loop production and consumption systems, where the development of the CE product implies cooperating and collaborating with other institutions and organizations (Fischer and Pascucci, 2017; Lewandowski, 2016; Witjes and Lozano, 2016; Prieto-Sandoval et al., 2018). In fact, previous studies have found that collaboration is essential in the implementation of CE business models and in addressing environmental challenges (De Marchi, 2012; Khan et al., 2020; Mousavi et al., 2019). Thus, we propose a second research question, *how the CE capabilities of the company affect the development of the CE process*?

In the next section, we present a concise overview of relevant literature on CE and dynamic capabilities in order to generate hypotheses. The following section describes our research methodology, including data collection and measures. Afterwards, our data analysis and results are provided. Then, we present the discussion and managerial implications of the findings, and we conclude with limitations and suggestions for future research.

Conceptual Background

The circular economy in the firm

The circular economy is conceptualized as an economic model for closed-loop production and consumption systems, where waste is designated a valuable resource (Bocken et al., 2017). Compared to the traditional linear economic model, which has a '*take, make, dispose*' model of production, the model of the circular economy is based on product maintenance, reuse, remanufacture and recycling, which implies switching the production's and consumption's concept of *end-of-life* for *restoration* (Boons and Lüdeke-Freund, 2013; Zucchella and Previtali, 2019). This is because more efficient use and reuse of resources and the resulting lower overall resource inputs, energy, emissions, and waste leakage could reduce negative environmental impacts without jeopardizing growth and prosperity, all while achieving a better balance between the economy, environment, and society (Kiefer et al., 2019; Geissdoerfer et al., 2018; Manninen et al., 2018). The circular economy is a cyclic system that aims to eliminate waste by turning goods that are at the end of their life cycle into resources for new ones (Stahel, 2016). Closing material loops in industrial ecosystems can create a continual use of resources. This can be achieved through long-lasting design, proactive maintenance, recycling, repairing, refurbishment and remanufacturing (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). Thus, the CE model is an economic system of recycling and reusing of resources where the reduction of the elements is imperative; that is, reducing the production to the minimum and opting for the reutilization of the elements that because of their properties cannot be returned to the environment.

The CE's premise is the transformation of the way resources are used by shifting from existing open production systems (i.e., traditional linear systems where resources are used to produce finished products and become waste after their consumption) to closed production systems (i.e., circular systems where resources are reused and kept in a loop of production and consumption) (Urbinati et al., 2017). As defined above, the aim of this kind of closed-loop cyclic system is to eliminate waste by turning goods that are at the end of their life cycle into resources for new ones (Stahel, 2016). By maximizing the efficient use of resources, this fundamental redesign of materials, products, and value creation systems should ultimately reduce the negative environmental effects of emissions and resource waste that naturally accompanies the consumption of physical goods (Cheng and Shiu, 2012; Rosa et al., 2019). The CE is often facilitated by means of product-life extension, redistribution/reuse, remanufacturing, and recycling (Urbinati et al., 2017). The notion of the circular economy has been approached in the scientific literature from several interdisciplinary perspectives, including industrial ecology; product design practices; and environmental, political, and social science (Bocken et al., 2016; Urbinati et al., 2017).

The implementation of CE principles often requires new visions and strategies and a fundamental redesign of product concepts, service offerings, and channels towards long-life solutions (Lewandowski, 2016). This is in line with the reassessment of suppliers and partners as well as value chains that focus on long-term instead of short-term efficiency (Geissdoerfer et al., 2018).

Dynamic Capabilities and the development of CE in the organisation

Our paper is framed in the dynamic capabilities theory (Barreto, 2010; Eisenhardt and Martin, 2000; Teece, 2007, 2014; Ferreira et al., 2020). Dynamic capabilities consist of a set of higher-level activities that allows firms to orient their ordinary activities to high-payoff endeavours (Faridian and Neubaum, 2020; Fainshmidt et al., 2016; Teece, 2014). This requires managing and coordinating firms' resources to address rapidly changing business environments (Teece, 2014). Dynamic capabilities encompass two important elements for achieving competitive advantage: dynamic and capabilities (Bitencourt et al., 2020). The term "capabilities" refers to the capacity of firms to deploy resources usually in combination, using organizational processes to achieve an objective (Cetindamar et al., 2009; Barreto, 2010; Fainshmidt et al., 2016). Firms' capabilities result from learning, organisational resources and organisational histories (Suddaby et al., 2020; Teece, 2014). Learning is an outcome of practice and experimentation, permitting tasks to be performed more effectively (Teece, 2014). The term "dynamic" refers to the changing nature of the environment and highlights the role of innovation in the context in which timing is critical (Bitencourt et al., 2020). Thus, dynamic capabilities refer to the ability of firms to change its own capabilities, for instance by developing new products, to deal with changes in the external environment (Zahra et al., 2006). Dynamic capabilities not only encompass capabilities but also firms' processes and routines (Barreto, 2010). Similarly, Teece et al. (2007) consider dynamic capabilities as the firm's ability to integrate and reconfigure capabilities to address rapidly changing environments.

The creation and development of circular economy skills constitute an example of the development of dynamic capabilities (Aragon-Correa and Sharma, 2003; Bag et al., 2019; Khan et al., 2020; Russo, 2009; Amui et al., 2017; Scarpellini, 2020). First, the CE and environmental management require the integration of a number of resources and competences such as information systems, technical systems or tacit knowledge that resides in the organisation. Second, the growing pressure from consumers for environmental stewardship has pushed firms to increase their responsiveness as well as their flexibility and ability to change quickly. Finally, path dependencies and continuous improvement are inherent in tasks that characterise the circular economy and environmental management (Russo, 2009; Scarpellini, 2020; Zhu et al., 2013).

As indicated by Aragon-Correa (2003), proactive environmental strategies such as the development of CE models constitute dynamic capabilities, which are linked to product-focused and process-focused practices. Product-focused practices refer to the development of products that are compatible with the CE (Zucchella and Previtali, 2019; Reike et al., 2018; Bocken et al., 2016; Katz-Gerro and López Sintas, 2019; Lewandowski, 2016). The CE advocates the use of biodegradable materials in the production of consumer goods so that once consumed, they can return to nature without harming the environment. In those cases in which eco-friendly alternative materials are not available, for example, for electronic and metallic components or batteries, the CE business calls for the production of easy-to-disassemble pieces that can be reused and incorporated into new products. When this is not possible either, the CE economy model envisions an environmentally respectful and friendly recycling process of those parts of the product that are neither biodegradable nor reusable. Therefore, firms face important challenges such as the innovation of CE products. Process-focused activities refer to the CE model's pillar of closed-loop production and consumption systems (Schaltegger et al., 2016; Lüdeke-Freund et al., 2018; Perey et al., 2018). As compared to the traditional linear economic model, circular models comprise not only the design, production, distribution and usage phases but also the phases of collection of the product at the end of life and feeding of materials back into the cycle, which not only spans producing organisations and users but also third parties (e.g. waste management organisations or raw material suppliers). Hence, a condition for the implementation of the closed-loop systems is the establishment of collaboration and cooperation among organisations, with the aim of facilitating the development of CE products (Fischer and Pascucci, 2017; Khan, 2020; Witjes and Lozano, 2016). Previous literature points out that the establishment of collaboration and cooperation agreements poses important challenges for the organisations, in terms of the introduction of innovations in their processes, such as new managerial modes or creation of information channels (Arranz et al., 2015).

For exploring how the CE-related dynamic capabilities influence the decision to implement CE product-focused and CE process-focused activities, we consider three factors. The first factor is the organisations' level of *competences to implement the CE model.* Competences refer to the collective learning in the organisation, especially how to coordinate diverse production skills and integrate multiple streams of technologies (Barreto, 2010; Prahalad and Hamel, 1990; Teece, 2014). Thus, competences are the potential to be effective, or the ability of an organisation to achieve its goals (Sanchez and Heene, 1997; Teece, 2014). Capabilities and competences are related in the sense that "capability" is the condition of having the capacity to do something, and "competence" is the degree of skill in the task's performance (Eisenhardt and Martin, 2000). Capabilities and competences are related in a bidirectional process: an organisation with capabilities can acquire a new skill set or knowledge by learning and doing, which increases the organisational competences. Moreover, the competences are antecedents of the capabilities, since having knowledge and skills in carrying out an activity predisposes to its realization. In the context of environmental studies, Kabongo and Boiral (2017) find that eco-efficient dynamic capabilities depend upon the integration and coordination of competences, innovations and new routines. Hence, the tenure of CE competences fosters the development of CE capabilities, and thus CE product and process-related practices.

The second factor refers to the possession of *national and international standards* that determine the acquisition of processes and organisational routines to develop the CE business model. The possession of standards is an example of path-dependent learning, which comprises an important aspect of the dynamic capability model (Aragon-Correa, 2003; Russo, 2009; Zhu et al., 2013). Moreover, Li and Yu (2011) note that the possession of standards by the organisation is the result of demonstrating an ability to plan and organize tasks. Similarly, Russo (2009) finds that path dependency in new process standards (e.g. ISO certifications) influences the ability of firms to improve environmental performance by reducing toxic emissions. Therefore, the possession of CE standards enables the CE-related capabilities, demonstrating knowledge and skills in the development of organisational routines.

Finally, the third factor is the possession of *knowledge and communication channels* that facilitate cooperation with external actors and promote organisational competences for the implementation of the CE business model. As indicated by Aragon-Correa (2003) and Inigo et al. (2017), a proactive environmental strategy involves stakeholders at multiple levels of the organisation. For example, product stewardship requires integrating the perspective of both internal and external stakeholders into the product design and product development processes (Aragon-Correa, 2003; Hart, 1995). In the context of environmental sustainability, the integration of stakeholders has been considered as a sensing capability, one of the three basic components of dynamic capability (Inigo et al., 2017; Teece, 2014; Granstrand and Holgersson, 2020).

Hypotheses

Development of CE-related products and CE-related capabilities

Hart and Dowell (2011) recognize that transition towards environmental sustainability presents numerous challenges for firms. To achieve environmental sustainability in firms, a fundamental pillar of CE, organizational change is required (Khan et al., 2020; Strauss et al., 2017). Wu et al. (2013) and Annunziata et al. (2018) indicate that whether a firm achieves environmental sustainability depends on its ability to develop and apply dynamic capabilities. Dynamic capabilities are comprised of key firm functions such as strategic planning, R&D and product development (Teece, 2014; Salvato and Vassolo, 2018). Product development is a dynamic capability because of its ability to alter the resource configuration of the firm (Danneels, 2002; Eisenhardt and Martin, 2000). The development of product innovations is a complex process from the managerial point of view, where the uncertainty of the process itself and of the market, as well as the management of organisational resources for the innovation, are a set of difficulties and obstacles that must be overcome (Rothaermel and Deeds, 2004; Arranz and Fernandez de Arroyabe, 2009).

As explained in the previous section, competences are antecedents of the capabilities. Thus, the first obstacle that organisations must overcome in the development of innovative products is reaching a minimum level of competences that allows producing an adequate output in a reasonable time and within the budget constraints (Arranz et al., 2019). Innovative competence refers to the quality or state of being able to develop an innovative product. Galende and Fuente (2003) find a positive impact on the knowledge and skills of organisations' staff on the development of innovation. Competences can be acquired through previous experience or training programmes (Jiménez and Sanz-Valle, 2011; Arranz et al., 2019). This is based on the cumulative character of innovation, where previous innovative experiences facilitate the future development of innovation. This experience is what Teece (2014) refers to as learning, an outcome of practice and experimentation that undergirds dynamic capabilities. For example, experience with biomass materials has allowed the development of innovative products such as biochar, a residue aimed at revitalizing degraded soils, at improving soil carbon sequestration, and increasing agronomic productivity (Spokas et al., 2012). We thus can expect that the acquired innovative competences in the development of 3Rs or 6Rs products[1], which enrich the knowledge and skills of organisations, will facilitate the future development of products compatible with CE models. Therefore, the implementation of products that comply with the CE business model will be facilitated by the existing CE-related competences, as this will mitigate organisations' uncertainty both in terms of time and results.

A second obstacle arises from the complexity of managing innovation in the firm (e.g. Arranz et al., 2019). As noted by Gilsing et al. (2008), firms need to develop, on the one hand, management systems for the acquisition of novel information on markets and technologies, and on the other hand, to conduct experimenting and searching activities to find new and emerging innovations that lead to the development of new products. Firms should also develop exploitation processes that entail the extension and refinement of existing technologies, paradigms and competences (Rothaermel and Deeds, 2004; Oh et al., 2016). The development of all these processes requires organisations to make use of dynamic capabilities to coordinate and integrate routines and reconfigure existing resources (Teece, 2014). In this context, the recent conception of different national and international standards compatible with the CE business model is being translated into the introduction of organisational routines, which is facilitating the CE model implementation process. These standards focus on continuous improvements in environmental management organisational processes, which aligns with path-dependent dynamic capabilities (Teece, 2014; Russo, 2009; Zhu et al., 2013). From this perspective, the possession of environmental standards may benefit from organisational learning derived from other organisational systems (Zhu et al.,

[1] Following Reike et al., (2018), the CE model is framed on the principles of the 3Rs (reduce, reuse, recycle), the 6Rs (reuse, recycle, redesign, remanufacture, reduce, recover) and the 9Rs (refuse, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recover).

2013). These learning effects are reflected in efficiencies in routinized handling of waste, recognizing opportunities for improvement and providing an adequate response to auditing and monitoring outcomes (Russo, 2009; Zhu et al., 2013). There are different standards and certifications that illustrate this. For example, the French Standardization Association (AFNOR) launched at the end of 2018 the certification XP X30-901, which refers to the development of good practices aimed at achieving the CE model (AFNOR, 2018). In the UK, the British Standard (BSI) introduced the certification BS 8001 with the aim of setting up a frame to implement the basis for the CE model in organisations (BSI, 2017). Similarly, Spain, through the Spanish Standardization Association (AENOR) has introduced the Zero Waste certification and, following Directive 2009/125/EC, has established a set of eco-design requirements for ecological products (Bovea and Pérez-Belis, 2012). Thus, holding these standards will facilitate organisations' development of 3Rs or 6Rs products, by fixing the processes of product development and by providing guidance for organisations' implementation of the CE model (AFNOR, 2018).

Finally, the third obstacle refers to the market uncertainty of the developed product. De Meza and Southey (1996) point out that two types of problems can arise. The first is that the uncertainty might lead to myopia that impedes launching of products. The second problem is an over-optimism that, as a result of the enthusiasm for an innovative idea rather than a clear assessment of the idea's real value, reduces the number and quality of solutions generated. Linked to this, the development of CE-compatible products is subject to market uncertainty, requiring high amounts of information to check their feasibility and adequacy. This means that 3Rs, 6Rs or 9Rs should include information on the materials, alternative uses and substitutes of the products (Hansen et al., 2009). The development of new products such as agricultural thermal blankets, which is composed of approximately 50% non-valuable components (e.g. soil, stones or organic material), or of the reutilization of automobile oils as inputs in the cement industry, are examples of how to use of information from the market to generate CE-compatible products (COTEC, 2017). Moreover, the development of 3Rs, 6Rs or 9Rs products will also require large inputs of information regarding the market as well as consumers' behaviour, in particular with respect to consumers' recycling behaviour or limitation of waste generation (Rizos et al., 2016). Firms need to engage with the external environment of the organisation to obtain information on changes in the external environment and improve existing products to accommodate these changes (Teece, 2014). Hence, by collecting information, in e.g. material flows, technologies and consumption patterns, the organisation will increase the knowledge of novel solutions in line with the CE principles and will allow for better adequacy of the products to the market. This continuous need to look at and adapt to the external environment highlights the dynamic and path-dependence dimensions of the dynamic capabilities theory.

Therefore, organisations' CE-related capabilities (competences, standards and information) will facilitate the development of 3Rs, 6Rs or 9Rs, and will diminish the difficulties related to CE-compatible products such as deviation from the budget caused by for example the inability to find the required technical solutions or markets' acceptance of the product. Hence, we propose:

H1. Organisations' capabilities for the development of CE business models positively influence the development of CE products.

H1a. Competences relevant to the CE model have a positive influence on the development of CE products.

H1b. The ownership of standards relevant to the development of CE business models has a positive influence on the development of CE products.

H1c. The increase in the amount of information relevant to CE business models has a positive influence on the development of CE products.

Development of CE-related processes and CE-related capabilities

As explained above, the CE business model is a closed-loop system. In this context, the implementation of process innovations to develop the CE product implies cooperating and collaborating with other institutions and organisations (Fischer and Pascucci, 2017; Lewandowski, 2016; Witjes and Lozano, 2016). Collaboration is a key microfoundation of dynamic capabilities that facilitates innovative behaviour and activities that leverage and adapt firms' resources and competences in response to the changing environment (Teece, 2014). In particular, previous studies have found that collaboration is essential in the implementation of CE business models and in addressing environmental challenges (De Marchi, 2012; Khan et al., 2020; Mousavi et al., 2019). Previous studies have also indicated that partnerships with suppliers, so-called strategic supplier partnerships, help firms in achieving sustainability goals and supply chain efficiency (Bai et al., 2017; Beske, 2012). For example, Mercadona, a Spanish supermarket chain with 1,636 stores in Spain and northern Portugal, has introduced innovations in its distribution processes, with the aim of increasing the efficiency in logistics at the same time as reducing the fuel consumption per transported ton (COTEC, 2017). To achieve this goal, Mercadona has set up collaboration and cooperation agreements with its suppliers, looking to increase the efficiency in the transportation of products and on the optimization of trucks' trips. In this sense, Arranz and Fernandez de Arroyabe (2016) depict the cooperation agreement as a process in which competences for the development of cooperation agreements such as prospective, negotiation or communication have a positive impact on the development of the cooperation agreement. Bocken et al. (2016) point out that organisations that have already implemented CE business models have already established cooperation and collaboration with other partners, which, through these experiences, have facilitated the acquisition of knowledge and skills in the establishment of cooperation agreements. This is the case of the firms that collect the waste from air-conditioned (AC) equipment, which need to cooperate with AC installation firms to properly disassemble this equipment to avoid the escape of CFC and HCFC gases and of refrigeration oil (COTEC, 2017). During this process, installing and waste collecting organisations acquire competences of communication, negotiation and coordination of the agreements established between both parties. Thus, when organisations possess competences to implement the CE model, the process to implement CE models is facilitated.

Possessing standards related to the implementation of the CE model is expected to have a positive effect on CE-related processes. As explained in the previous set of hypotheses, these standards provide organisations with the necessary competences to develop CE models and permit communication with other agents, which facilitates collaboration. These standards are designed to be compatible across different stakeholders with common core elements that define responsibilities, document standard practices, and outline internal audit and corrective systems and management reviews that are the basis for continuous improvement (Zhu et al., 2013). For example, ISO 14001 provides a framework for managing environmental issues and provides a set of globally accepted environmental management practices. The ISO 14001 does not focus on outcomes, such as pollution, but focuses on processes. Some of the elements included in the ISO14001 for an effective environmental management system are: the creation of environmental objectives and targets; the implementation of a program to achieve those objectives; the monitoring and the measurement of its effectiveness; and the revision of the system to improve the overall environmental performance and the system itself (Delmas 2001; Russo. 2009). Similarly, AFNOR's XP X30-901 certification is a management tool that a allows planning, setting up, evaluating and improving CE projects, and that facilitates the dialogue and communication across organisations and different stakeholders to reflect both the mode of production and consumption through a common language and shared definitions. Moreover, in relation to collaboration, previous literature has highlighted opportunistic behaviour as a major drawback in the establishment of agreements and partnerships (Bocken et al., 2016; Rizons et al., 2016). The introduction of certifications represents an avenue to mitigate the transaction costs derived from the opportunistic behaviour, as certifications standardize the behaviours across partners and facilitate the communication (Li and Yu, 2011). Moreover, these certifications act as a signalling device that eases the process of partner search and selection. For instance, Delmas (2001) and Vachon and Klassen (2008) note that the ISO14001 serves as an indicator to external stakeholders that the firm has a sound environmental management system in place.

The implementation of CE-related processes represents a development in which the interconnection and communication are key (Prieto-Sandoval et al., 2018). In this regard, Arranz et al. (2016) point out that cooperation agreements can be understood as a constant negotiation between partners. Thus, the information channels will assist the communication with partners and the coordination of processes. Following up with Mercadona's example in the food sector (COTEC, 2017), the increase in the efficiency and optimization of its logistics requires adequate coordination and interaction with the different logistics companies, innovating in the process of distribution of both suppliers and customers and setting up channels of communication with both groups. Overall, these information channels facilitate adequate coordination between partners and provide a knowledge base over technical information, which will be the base of the CE process development.

Therefore, possessing capabilities relevant to the implementation of CE business models (competences, standards and information) will facilitate the CE-related processes, and will diminish the difficulties in establishing cooperation agreements with partners. Hence, we propose:

H2. Organisations' capabilities for the development of CE business models positively influence the development of CE processes.

H2a. Competences relevant to the compatible with the CE model have a positive influence on the development of CE processes.

H2b. The ownership of standards relevant to the development of CE business models has a positive influence on the development of CE processes.

H2c. The increase in the amount of information relevant to CE business models has a positive influence on the development of CE processes.

Methodology and data

Our empirical analysis relies on a cross-sectional database from the 2015 EU survey on the Implementation of the Circular Economy (European Commission, 2015). The sample is composed of 870 organisations in different economic sectors. The main objective of the EU survey on the Circular Economy is to understand the level of adoption of CE business models, the motivations, and organisations' knowledge on the CE, as well as to explore avenues to promote CE business models. The survey, in line with previous research by Ghisellini et al. (2016), Rizos et al. (2016), Fonseca and Domingues (2018), and Lakatos et al. (2016), focuses on three themes. The first set of questions aims at characterising the organisation. The second set of questions is aimed at collecting data on the motivation, knowledge and intensity in the implementation of CE business models in the organisation. Finally, the last set of questions focuses on the actions targeted at promoting the implementation of CE business models.

The survey has a similar structure to those developed by previous research (Yuan et al., 2006; Fonseca and Domingues, 2018). The data were collected through an online database, following the methodology of "wave analysis" (Amstrong and Overton, 1977), verifying non-response bias, and finding no significant differences between early and late respondents. Previously, the survey was checked by a group of experts on CE models.

Dependent Variables

The first dependent variable measures the level of implementation of CE-compatible products. Following Reike et al., (2018), the CE model is framed on the principles of the 3Rs (reduce, reuse, recycle), the 6Rs (reuse, recycle, redesign, remanufacture, reduce, recover) and the 9Rs (refuse, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recover). The questionnaire includes a set of items that explore whether the products developed by the organisation fulfil the following characteristics: i) Durability; ii) Reparability: Product design facilitating maintenance and repair activities; iii) Reparability: Availability of spare parts; iv) Upgradability and modularity; v) Reusability; vi) Recyclability (e.g. dismantling, separation of components, information on chemical content); vii) Increased content of reused parts or recycled materials. The importance of these individual items is measured on a Likert scale, with 3 being very important, 2 important, 1 not yet important, and 0 not important. Based on these seven items, following Arranz et al. (2019), we generate one variable, *CE product development*, as a sum of all previous variables. To check whether the reliability of CE product development measure, we perform a Principal Components Analysis (PCA), obtaining a single factor for the seven items. This analysis explains 71.673% of the variance (KMO = .891; sig = .000). Subsequently, we perform a correlation analysis between the CE product development measure obtained as the sum and the one obtained through the PCA. The correlation value is 0.903, indicating a high correlation, and an affinity or similarity between the two variables. Hence, our first dependent variable measures the products' level of alignment with the CE business model.

The second dependent variable measures the level of implementation of the *CE-compatible processes*. Following Schaltegger et al. (2016), Lüdeke-Freund et al. (2018), and Perey et al. (2018), CE processes involve the development of closed-loop production and consumption systems, establishing collaboration and cooperation among organizations, with the aim of facilitating the development of CE products. Furthermore, the CE process places special emphasis on the end-of-life product collection phases and the feeding of materials back into the cycle, through agreements with value chain partners and other organizations (Fischer and Pascucci, 2017; Khan, 2020; Witjes and Lozano, 2016). Following the questionnaire, this includes a set of items that explore whether the processes developed by the organisation fulfil the following characteristics compatible with the CE: i) Promote cooperation across value chains (e.g. through encouraging new managerial modes); ii) Support the development of innovative business models (e.g. leasing); iii) Promote collaboration between and among private and public sectors, including end-users; iv) Ensure availability of reliable data on material flows across value chains. The importance of these individual items is measured on a Likert scale, with 3 being very important, 2 important, 1 not yet important, and 0 not important. Similarly, we measure the *CE process development*, as a sum of the eight previous items, and with a Principal Components Analysis (PCA), obtaining a single factor for the four items. This analysis explains 65.181% of the variance (KMO = .702; sig = .000). Subsequently, we perform a correlation analysis between the CE process measure obtained as the sum and one obtained through the PCA. The correlation value is 0.854, indicating a high correlation, and an affinity or similarity between the two variables. Hence, our second dependent variable measures processes' level of alignment with the CE business model.

Independent Variables

The first independent variable refers to the *CE-competences* of the organisation relevant to the CE business model. The questionnaire measures competences with the level of knowledge and skills relevant to the CE that organisations possess, distinguishing between seven different knowledge and skills both in green product and innovative business models: i) innovative business models for the circular economy (e.g. leasing and sharing); ii) development of circular economy projects (e.g. technical assistance); iii) management of green products; iv) experience in industrial symbiosis and cascading use of resources; v) partnerships with public authorities to help innovative businesses; vi) establish rules on product design (e.g. minimum requirements on 'durability' under Ecodesign Directive 2009/125/EC). The importance for organisations of these competences in the implementation of the CE business models is measured on a Likert scale, with 3 being very important, 2 important, 1 not yet important, and 0 not important (Cronbach's Alpha: 0.899).

The second independent variable refers to the *standards* relevant to the CE that the organisation possesses. Following the questionnaire, the importance of these standards for organisations in the implementation and development of the CE business models is measured on a Likert scale, with 3 being very important, 2 important, 1 not yet important, and 0 not important.

The third independent variable refers to organisations' access to *CE-relevant information*. The questionnaire measures information using two items: i) collecting and providing CE-information; ii) accessing to information and data on material flows, technologies and consumption patterns. The importance of these information channels for organisations in the implementation of the CE business models is measured on a Likert scale, with 3 being very important, 2 important, 1 not yet important, and 0 not important (Cronbach's Alpha: 0.902).

Control variables

Firm Size. Previous empirical studies have found the size of the firm to be a determining factor in the implementation of CE (see, for example, Ferasso et al., 2020). To control for the influence of organisations' size, firms are classified as follows: the value 1 corresponds to micro-organisations (0 to 9 workers), 2 to small organisations (10-49 workers), 3 to medium-sized organisations (50-249 workers), and 4 to large organisations (> 250 workers)

Environmental management. The second control variable refers to the use of environmental management at the organisation. The questionnaire proposes the following items: i) EU eco-label; ii) Eco-Management and Audit Scheme (EMAS); iii) Another environmental management scheme; iv) No environmental management scheme. We create a binary variable that is equal to 1 when organisations use any of the above-mentioned environmental management schemes, and 0 otherwise.

Sector. The last variable of control identifies the sector in which the organisation operates. This variable equals 1 if the organisation belongs to the agricultural sector, 2 for the industrial sector, and 3 for the services sector.

Estimation models

To test the research question that explores the effect of the CE-relevant capabilities on CE-related product innovation development (Hypothesis 1), we use an Ordinal Logit Regression model. Based on the questionnaire, we use as the dependent variable the CE product development (Y_1), as independent variables the capabilities of the organisation (*Competences, Standards, Information*) and the above-mentioned set of control variables.

Model 1 (Basic Model):

$$Y_1 = constant + \beta_1(Size) + \beta_2(Environmental\ Management) + \beta_3(Sector) + e$$

Model 2:

$$Y_1 = constant + \beta_1(CE\text{-}competences) + \beta_2(CE\text{-}standards) + \beta_3(CE\text{-}information) + \beta_4(Size) + \beta_5(Environmental\ Management) + \beta_6(Sector) + e$$

For the second research question that explores the effect of the CE-relevant capabilities on CE-related process innovation development (Hypothesis 2), we use an Ordinal Logit Regression model. Based on the questionnaire, we use as the dependent variable the CE process development (Y_2), as independent variables the capabilities of the organisation (*Competences, Standards, and Information channels*), and the above-mentioned set of control variables.

Model 1 (Basic Model):

$$Y_2 = constant + \beta_1(Size) + \beta_2(Environmental\ Management) + \beta_3(Sector) + e$$

Model 2:

$$Y_2 = constant + \beta_1(CE\text{-}competences) + \beta_2(CE\text{-}standards) + \beta_3(CE\text{-}information) + \beta_4(Size) + \beta_5(Environmental\ Management) + \beta_6(Sector) + e$$

Robustness of results

In our empirical analysis, we have also checked the robustness of our methods and results. First, we have tested the common method variance (CMV) and common method bias (CMB), following Podsakoff et al.'s method (2003). This analysis reveals eight distinct latent constructs that account for 91.04% of the variance. The first factor accounts for 19.09% of the variance, which is below the recommended limit of 50%. This result suggests CMV and CMB are not a concern in our results.

Second, we have checked for possible collinearity in our results. Table 2 shows the correlations among variables used in regression analysis. Moreover, Table 3 and 4 display the results of the reliability and robustness of these results, which show acceptable values for both the VIF and Durbin-Watson tests.

Results and Discussion

Table 1 displays the descriptive statistics and measure model for the variables, and Table 2 shows the correlations among variables included in regression analysis.

Table 3 displays the results for the analysis of Hypothesis 1. Model 1 displays a parsimonious specification, which only includes the control variables. As evidenced by the positive and significant coefficients in Model 2, Hypothesis 1 is confirmed. More in detail, in Model 2, we find that organisational competences have a positive and significant effect on the development of CE products (ß= 0.260, $p < 0.001$), which supports Hypothesis 1a. This result provides empirical evidence showing the positive effect of organisations' knowledge skills on the development of innovation (Galende and Fuente, 2003). Moreover, this result is in line with Demirel and Kesidou (2019) regarding the importance of specific capabilities related to the development of environmental innovations. Hypothesis 1b is supported by the results that show that there is a positive and significant effect of environmental standards and certifications on the development of CE products (ß= .745, $p < 0.001$). This result supports previous research pointing to the positive effects of international standards in the development of environment-friendly products, which facilitates their management process (Li and Yu, 2011; Fonseca and Domingues, 2018). Finally, Model 2 also supports the positive effect that the information channels have on CE product development (ß= .437, $p < 0.001$). In line with the work of Rogers (2003: 172), our results show that the decision to implement innovations is *"an information-seeking and information-processing activity"*. Moreover, the results support previous research highlighting the importance of information for the development of both environmental products and for adequate management of the CE implementation process (Hazen et al., 2017; Katz-Gerro and López Sintas, 2019).

The results for Hypothesis 2 are shown in Table 4. As with the first table, Model 1 presents a baseline model with just the control variables. Model 2 shows a positive and significant effect of organisations' competences on the implementation of CE processes, supporting Hypothesis 2a (ß= .572, $p < 0.001$). This result confirms the importance of competences in the development of innovation processes (Arranz et al., 2019). More specifically, the results are in line with previous research that shows the relevance of possessing CE-specific competences (Prieto-Sandoval et al., 2018; Fonseca and Domingues, 2018). Arranz et al. (2019) have highlighted prospective, communication and agreement management as key in the development of the CE business models. Model 2 also supports Hypothesis 2b, as shown in the positive and significant effect of the variable standards on the development of CE processes (ß=. 424, $p < 0.001$). In line with previous research, this result manifests how standards determine the execution of tasks on the CE processes, facilitating the communication between partners (Li and Yu, 2011; Ghisellini et al., 2016). In the context of cooperation agreements, our results provide empirical evidence of how standards facilitate the selection of the partner and mitigate the problems derived from setting up agreements (Li and Yu, 2011; Arranz et al., 2019), a critical point in the implementation of CE models. Lastly, our results also support Hypothesis 2c (ß= .679, $p < 0.001$), finding a positive and significant effect of CE information on the developing CE processes. In line with previous research, our results show how information facilitates the management of collaborations and agreements, which is a source of technical information for the implementation of CE. Overall, Hypothesis 2 is supported, suggesting that CE-related capabilities have an important effect on the development of CE processes.

Conclusion

The overall aim of this study is to investigate how CE-specific capabilities affect the development of products and processes compatible with the CE business models. First, our study extends the current literature on the CE by exploring the factors that determine the development of CE business models (Pujari, 2006; Bocken et al., 2016; Lewandowski, 2016; Hopkinson, Zils, Hawkins y Roper, 2018; Lüdeke-Freund et al., 2019; Ferasso et al., 2020). Thus, from a strategic point of view, we conclude that the development of CE models in the organization is a dynamic process, where firms' capabilities must align to achieve this objective. Moreover, we extend previous work in environmental innovation (Demirel and Kesidou, 2019), affirming that CE-related capabilities have a positive effect on the development of CE in firms. Thus, we see that the CE competences, the possession of environmental standards and certifications, and the access to information channels, have a positive effect on both the development of CE products and the CE processes in firms.

Our second contribution is in the policy-making area, where our results highlight how CE-relevant competences, standards and information channels play a key role in the implementation of the CE business model in organisations. This is an important question as it provides feedback on how the different actions aimed at fostering CE-related knowledge and skills (e.g. EU's Circular Economy Action Plan), at obtaining environmental standards (e.g. AFNOR certification in France, AENOR in Spain or BSI in the UK), and at creating flows of information and relevant advice, with the objective of increasing the CE-related knowledge base, have a positive effect on the implementation of CE models.

The last contribution is from the point of view of the management of the company, clarifying the complexity of the implementation of the CE in the firm. Thus, this paper contributes to clarifying the importance of developing CE capabilities in the firm. Unlike previous works that have pointed out that innovation capabilities are a driver of the implementation of environmental innovation in the firm (see, for example, Arranz et al., 2020), our work highlights the need to develop CE-capabilities in the firm as a driver for the implementation and development of CE. Moreover, we can highlight how developing specific training programs or acquiring experience in CE-products and CE-processes is a key factor in CE development in the firm.

Finally, the study is not free from limitations. Although the database proved to be rich when considering innovation and eco-innovation, this work has some limitations derived from the questionnaire. The questionnaire measures the relevant competences for firms' CE business models by considering the level of knowledge and skills related to the CE that organizations possess. Future work should validate these measures, comparing them with the direct measurement of the CE capabilities, which is based on the development of CE products and CE processes in firms. Moreover, the questionnaire has been carried out at the European level, which could have a certain geographical bias. Therefore, in subsequent works, the geographic dimension should be considered, and both the development of CE models and CE capabilities should be analyzed considering this variable.

The present paper can serve as a basis for future research in the field of the circular economy. We have specifically focused on the investigation on CE competences, environmental standards and certifications, and information channels, and their effect on the development of CE products and the CE processes in firms. Future investigations should investigate the ways in which organizations transform linear business models into circular business models, examining key processes. In this context, studies should identify new managerial capabilities and practices contributing to the successful transition to circular business models. Moreover, our study has focused on CE capabilities and how they affect the development of the circular economy in the organization. Future research should investigate CE capabilities in interaction with the environment, considering not only competitive market pressures, but also customer requirements, and technological shifts.

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Table 1. Descriptive Statistics and measure model

Variables	Mean	Std. Deviation	Alpha Cronbach	CR	AVE
1. CE product development			0.905		
i. Durability	2.25	1.147		0.931	0.881
ii. Reparability: Product design facilitating maintenance and repair activities	2.08	1.354		0.877	0.809
iii. Reparability: Availability of spare parts	2.01	1.339		0.870	0.799
iv. Upgradability and modularity	1.85	1.348		0.802	0.765
v. Reusability	2.09	1.176		0.902	0.825
vi. Recyclability (e.g. dismantling, separation of components, information on chemical content)	2.50	.923		0.882	0.851
vii. Increased content of reused parts or recycled materials.	2.12	1.124		0.814	0.731
2. CE process development			0.807		
i. Promote cooperation across value chains	2.12	1.005		0.819	0.799
ii. Support the development of innovative business models	1.77	1.240		0.771	0.727
iii. Promote collaboration between and among private and public sectors, including end-users;	2.02	1.044		0.834	0.811
iv. Ensure availability of reliable data on material flows across value chains	2.00	1.054		0.783	0.758
Independent Variables					
i. Organisations' CE-related competences			0.899		
1. Innovative business models for the circular economy (e.g. leasing and sharing)	2.02	1.012		0.789	0.675
2. Development of circular economy projects (e.g. technical assistance)	2.11	1.032		0.894	0.818
3. Management of green products	2.25	.990		0.884	0.803
4. Experience in industrial symbiosis and cascading use of resources	2.18	1.078		0.880	0.836
5. Partnerships with public authorities to help innovative businesses	2.03	.927		0.731	0.624
6. Establish rules on product design (e.g. minimum requirements on 'durability' under Ecodesign Directive 2009/125/EC)	2.24	.975		0.801	0.783
ii. Organisations' CE-relevant standards and certifications	1.97	1.125			
iii. Organisations' access to CE-relevant information			0.902		
1. Collecting and providing CE-information	2.34	.928		0.902	0.867

2. Accessing to information and data on material flows, technologies and consumption patterns	2.16	.977	0.914	0.872
Environmental Management	%			
i. EU eco-label	8.7			
ii. EMAS	8.4			
iii. Another environmental labelling or management scheme	34.9			
iv. No environmental labelling or management scheme	48.0			
Sector	%			
i. Agriculture	8.0			
ii. Industries	37.0			
iii. Services	55.0			

Table 2. Correlations

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. CE-product	1							
2. CE-process	.094*	1						
3. CE-competences	.087**	.137**	1					
4. CE-standards	.163*	.044**	.189**	1				
5. CE-Information	.133*	.125*	.092	-.033	1			
6. Size	-.012	-.063	-.078	.051	-.003	1		
7. Environmental Management	.103*	.120**	.105*	.162*	-.083	-.004	1	
8. Sector	-.108	.010	-.063	-.078	.000	-.024	-.033	1

*p<0.05, **p<0.01

Table 3. Regression Analysis: CE Product Development Implementation/Capabilities

Variables	CE Product Development				
	Model 1		Model 2		VIF
	Estimated	**Error**	**Estimated**	**Error**	
CE-competences			.260***	.066	1.263
CE-standards			.745***	.057	1.552
CE-Information			.437***	.065	1.516
Size	.113**	.023	.109**	.011	1.366
Environmental Management	.201***	.030	.197***	.038	1.302
Sector:					
• Agriculture	0		0		
• Industry	2.093	1.337	2.112	1.401	
• Service	2.007	1.379	2.010	1.090	
-2 Log Likelihood	1107.615		2526.274		
Chi-square	125.005		342.286		
Sig.	.000		.000		
Cox and Snell	.109		.284		
Nagelkerke	.107		.284		
McFadden	.045		.151		

Model 1: Durbin-Watson (1.855); Model 2: Durbin-Watson (1.707). *p<0.05, **p<0.01, *** p<0.001

Table 4. Regression Analysis: CE Process Development Implementation/Capabilities

Variables	CE Process Development				
	Model 3		Model 4		VIF
	Estimated	**Error**	**Estimated**	**Error**	
CE-competences			.572***	.071	1.273
CE-standards			.424***	.050	1.544
CE-Information			.679***	.058	1.509
Size	.199***	.012	.151***	.034	1.358
Environmental Management	.256***	.035	.292***	.038	1.299
Sector					
• Agriculture	0		0		
• Industry	2.093	1.337	1.998	1.015	
• Service	2.007	1.379	1.867	1.234	
-2 Log Likelihood	992.044		1837.775		
Chi-square	110.863		321.783		
Sig.	.000		.000		
Cox and Snell	.126		.297		
Nagelkerke	.115		.310		
McFadden	.077		.189		

Model 3: Durbin-Watson (1.911); Model 4: Durbin-Watson (1.970). *p<0.05, **p<0.01, *** p<0.001