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Summary

The Circular Economy concept has emerged to face current unsustainable economic trends. Circularity requires to go beyond mainstream linear business models in favour of new design strategies and production processes able to support an efficient use and a continuous flow of resources. Clarifying and promoting tools for embedding circularity in firms' business models is becoming crucial to increase resource productivity and achieve competitive advantages. Notwithstanding eco-innovation has been recognized as a fundamental link to connect circular economy with business models restructuring, still little consensus exists on the boundaries and interlinkages among the concepts of Eco-Innovation, Circular Economy and Circular Business Models. This research contributes to the intersection of these different streams of the literature, and aims to understand which innovations can favour the transition from linear to closed-loop processes, and then to identify circular business models. Relying on a review of circular-oriented innovations, we recognize three main groups of innovations that are expected to change firms' way of doing business in accordance with circularity, leading to the identification of an original Product Life-Cycle Archetype. Finally, relying on survey data in Emilia Romagna region, we check for the reliability of our theoretical framework in practice, analysing firms' business strategies from a practical perspective and assessing the current implementation of an innovative path in accordance with circular priorities. The analysis reveals a positive engagement amongst the analysed firms in Emilia Romagna, in terms of cleaner production strategies. By contrast, any business innovation linked to the circular use of products has been found to be implemented.

Keywords: Resource Efficiency, Eco-Innovation, Circular Economy, Circular Eco-Innovation, Circular Business Models, Small and Medium Enterprises

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Which innovations for Circular Business Models?
A Product Life-Cycle approach

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Abstract

The Circular Economy concept has emerged to face current unsustainable economic trends. Circularity requires to go beyond mainstream linear business models in favour of new design strategies and production processes able to support an efficient use and a continuous flow of resources. Clarifying and promoting tools for embedding circularity in firms' business models is becoming crucial to increase resource productivity and achieve competitive advantages. Notwithstanding eco-innovation has been recognized as a fundamental link to connect circular economy with business models restructuring, still little consensus exists on the boundaries and interlinkages among the concepts of Eco-Innovation, Circular Economy and Circular Business Models. This research contributes to the intersection of these different streams of the literature, and aims to understand which innovations can favour the transition from linear to closed-loop processes, and then to identify circular business models. Relying on a review of circular-oriented innovations, we recognize three main groups of innovations that are expected to change firms' way of doing business in accordance with circularity, leading to the identification of an original Product Life-Cycle Archetype. Finally, relying on survey data in Emilia Romagna region, we check for the reliability of our theoretical framework in practice, analysing firms' business strategies from a practical perspective and assessing the current implementation of an innovative path in accordance with circular priorities. The analysis reveals a positive engagement amongst the analysed firms in Emilia Romagna, in terms of cleaner production strategies. By contrast, any business innovation linked to the circular use of products has been found to be implemented

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1. Introduction

Last decades have demonstrated the necessity of detaching economic growth from resources exploitation and waste accumulation. The increase in population, urbanization, and of wealth standards have compromised raw materials' quantity, quality and accessibility. While the economic growth has provided prosperity and alleviated poverty in many countries, an *ecological debt* has gained a foothold, which threatens the natural system's ability to continue guaranteeing future human wellbeing.

Resources-related issues are exerting increasing pressure on industrial business (Lieder and Rashid, 2016). Price volatility, resource supply risks, and accessibility to scarce materials have indeed become factors of major concern for firms' competitiveness. In this scenario, the concept of Circular Economy (from now on CE) has been recognized as a centre-piece in the reorientation of the traditional economic approach, calling for a change in firms' linear mind-set. This model places the conservation of resources at the heart of

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the industrial business. While in the traditional economic structure raw materials are extracted, processed, consumed, and straightforwardly discarded, the CE allows preserving materials in a unique closed flow. In this way, «the value of products, materials, and resources is maintained in the economy for as long as possible, and the generation of waste is minimised» (European Commission 2015). In this view, «products need to be designed with the awareness of CE» (Lieder and Rashid, 2016). Industries must, therefore, endorse new Business Models (form now on BM), which create value based on material input minimization, economic output maximization and respect environmental limits (Flachenecker and Rentschler, 2019).

Cleary, Eco-Innovation (from now on EI) has been recognized as a catalyst for BMs conversion. The holistic transformation required to turn the conventional way of doing business toward circularity cannot be set without the support of new technologies, processes, and organizational structures. On the other side, these changes must be necessarily able to re-orient BMs trajectories in line with the circular priorities. As a consequence, the circular transition not simply demands innovative BMs, but especially eco-innovative BMs. However, despite the relation among the concepts of EI, CE, and Business model innovation (from now on BMI) seems quite intuitive, it is still not clear in which ways and in which dimensions EI can support CE and therefore circular-oriented BM innovations. On the one side, indeed, despite multiple contributions have been advanced to provide a clearer framework of the interlinkages between CE and EI e.g. (De Jesus et al., 2018); (De Jesus and Mendonça, 2018); (Prieto-Sandoval et al., 2018), a clear picture of CE-related innovations is still lacking, as observed in Cainelli et al., (2020). On the other side, multiple analysis have been provided to clarify how the CE principle can be applied to BMs through different categorization of Circular Business Models (from now on CBMs), such as in Bocken et al., (2016); Bocken et al., (2018); Linder and Williander (2017); Geissdoerfer et al., (2018) and Diaz et al., (2019) to mention a few. However, assessing how theoretically define the innovation in BMs for CE remains an open issue. In addition, the literature provides an insufficient number of case studies in this field, which also affect firms' capacity to understand how to innovate their BMs and identify circular design alternatives (Evans et al., 2017).

Against this background, this paper is concerned with the exploration of the links among EI and CBMs. Specifically, it attempts to draw a red line that links the theoretical concepts of EI and CE to the business level, by having BMI and CBMs as key factors. The purpose is therefore understanding which innovation types fit with CE and hence favour the passage from mainstream BMs to CBMs. This implies first the identification of eco-innovative strategies able to vehicle CE principles within BMs, and second the understanding of the effects of such innovations at BM level, hence identifying which CBMs will be created. Our analysis starts with the selection of eco-innovative practices throughout the existing literature on the topic. These innovations can act on different stages of products' life, which are connected with different BMs. We, therefore, classify the selected circular-oriented practices according to whether they bring changes on the input, use, or end of life products' phases, and in light of this we create a new key of interpretation for CBMs. It results into an original products' life based CBMs archetype, that we call Product Life-Cycle Archetype. In addition, giving the lack of practical research on the topic, we have conducted a survey analysis on Emilia Romagna firms in order to try to verify the adaptability of our theoretical archetype with field information, matching the CE-oriented innovations identified from the literature with the measures that firms are actually putting in practice.

This study contributes to the existing literature in three ways. First, we systematize and deepen current analysis on the connections among CE-EI and CBMs through the creation of an original archetype of CBMs based on circular BMI classified per products' life stages. Second, by relying on firms' representative data, this study tries to verify the applicability of academic results from the literature, hence on the one side it gives a wider perspective to the theoretical analysis on the topic, and on the other it provides useful hints to local actors to better understand how to apply CE to their business, to learn from their peers, and therefore adjust their efforts. Third, the identification of circular-oriented innovations, in theory and in practice, allows us to contribute to the debate on the interlinkages among EI and CE.

The paper is structured as follows. Section 2 examines the link between the concepts of CE and EI. Section 3 goes through the existing literature on BMs and CBMs with the extent to first identify a list of CE-oriented practices and then to classify them into a broad CBMs archetype. Section 4 presents the practical application of our archetype, qualitatively analyses the result of the Survey conducted on 8 firms in Emilia Romagna, and matches the case studies with the CBMs archetype. Finally, Section 5 leads the conclusions.

2. The link between EI-CE

The existing scientific evidence about natural disasters, scarcity of resources, and climate change, among others, have triggered significant research and reactions at firms, consumers and public authorities' level. The related challenges require a deeper transformation involving the three different dimensions of sustainability: economic, social, and environmental. As O'Riordan (1993) has argued this represents a political and social goal instead of a practical application. In this context, the concept of CE appears disruptive belonging to the *strong* version of sustainability (Dietz and Neumayer, 2007) having as priority the design of products that at the end-of their life already have the way marked for a second one. In other words, products should not be planned for disposal, but to be used as resources for new production processes. Murray et al., (2017) defined the CE as a regenerative process that aims to set up new routines in the production processes, and a new way of thinking about the final product obtained.

CE and EI are two concepts covered by the same umbrella. The not so young literature on CE cannot disregard the analysis of EI, being two essential tools for achieving sustainable transition. CE is not only an operational principle to be applied to the current production system but, representing a complete reconfiguration of the current model, it requires transformative changes, i.e. the process of breaking-out to a sustainable and sustained trajectory of development (Schot and Steinmueller, 2016;Schot and Steinmueller, 2018). In this process of change and transformation, EI acts as a support tool investing the micro, meso, and macro levels.

As de Jesus et al., (2019) argued CE refers to a systemic innovative strategy rather than solely improving resource use, stressing the role of being innovative to be circular. This broad definition, the current debate has adopted different analytical perspectives in order to better understand the dynamics, characteristics and determinants of EI (Arundel and Kemp, 2009; Beise and Rennings, 2005; Berkhout 2011; Cainelli and Mazzanti, 2013; Marin, 2014; Jabbour et al., 2015) and its link with the circular transition process, since the transition path towards CE cannot be separated from intensive innovation and EI activity (Cainelli et al., 2020).

Starting from the standard definition of EI given by economic literature (Cleff and Rennings, 1999; Barbieri et al., 2016), the analysis of the CE-EI link requires accounting for several heterogeneous dimensions such as design, productive process and governance. The heterogeneity of these aspects and their possible combinations can play a strong proactive role in fostering the transition. Carrillo-Hermosilla et al., (2009) have shown the capacity of EI to enhance new business opportunities and strategies, helping to generate a change in the whole economic system and accelerating in this way the transition from linear to circular model.

The traditional brunch of EI literature distinguishes among product, process, and organizational innovations, but considering the link between EI and CE the most recent contributions highlighted the difference between incremental and radical forms of EIs. Carrillo-Hermosilla et al., (2010) have defined incremental EIs as those that bring gradual modifications and improvements in products, processes and organization settings, while they described radical EIs as a disruptive concept bringing to deeper modifications capable of introducing new systems. Following this school of thought overall environmental sustainability can only be achieved with radical EIs which have the potential to completely replace the current polluting mechanisms. In this context, the need for radical innovations seems to be necessary to exert the turnaround required by the new CE paradigm. Radical changes would go beyond the standard innovation (product, process and organizational) in order to achieve a systemic change that would influence also the institutional and social setting. Structural changes require particular dispositions of decision-makers, institutional commitment, technological development and user acceptance which constitutes the many facets of EI.

From a circular point of view, undertaking the transition path implies the interaction of different trajectories. Companies have to modify their products, processes, and organizational structure, but they also have to consider if these changes are enough to bring them in line with a circular-oriented strategy. The latter needs the interplay between incremental and radical innovations, with incremental innovation acting as a tool in support of more radical changes.

On the basis of these considerations, the “new” strategy requires that BMs are able to adapt to the new paradigm, to shape themselves according to different needs, and interacting with the EI to change perspective. At the same time, innovative BMs may also represent an opportunity for companies, which, while reducing the impact on the environment, they might contemporary increase the value created.

Given these assumptions, the discussion highlights that the link between EI and CE requires a deeper analysis, which concerns, among the others, the identification of BMs types coherent with the implementation of CE priorities, without which the transition to CE cannot be achieved.

3. From Business Models to Circular Business Models

BMI in the domain of CE represents a strategic value-added for business. From this perspective the contribution of EI appears necessary in modelling new circular business strategies, highlighting how crucial for BMs is being eco-innovative in order to be circular. The current need for decoupling resources consumption from output requires changes in the way firms do business as a means to avoid environmental degradation while gaining economic benefits (Pieroni et al., 2019). In this regards, CBMs will help to «reconcile resource efficiency with creation of commercial value» (Salvador et al., 2019, p. 5). However, there is no conceptual consensus around the terms *business models*, *business model innovation*, and *Circular Business Models* (Evans et al., 2017), and it exists a lack of agreement on the empirical boundaries and the interception of these concepts.

The concept of BM has spread in the 1990s. Since this period, hundreds of papers have been published to define the term. Generally, BM refers to organisation's *value proposition*, *value creation and delivery*, and *value capturing* (Geissdoerfer et al., 2018). In a nutshell, BM indicates the way a firm does business by transforming resources into economic value. The most used tool to frame BM is the BM Canvas, a methodology proposed by Osterwalder and Pigneur, (2010) to visualize and express the main concept of business in nine building blocks i.e. key activities, key partnerships, key resources, value proposition, customer relationships, channels, customer segment, cost structure and revenue streams.

In parallel to this literature, the notion of BMI has received increasing attention over the past 15 years. It refers to changes of single or multiple components in the BM, which guarantee a novel way to create, deliver, and capture value while ensuring companies' survival and growth (Bocken et al., 2018). In this view, BMI is considered on the one side, as the enabler of structural innovative (product/process) changes, and on the other as the source of firms' competitive advantage (Pieroni et al., 2019).

Given the above-mentioned considerations, the economic literature has recently started to examine BMI in the specific area of CE. However, research related to the synergies among these concepts (BM, BMI and CE) is still recent and scarcely explored. This body of the literature has primarily focused on the theoretical systematization of the concept in Lewandowski (2016); Nußholz (2017); Merli et al. (2018); Pieroni et al., (2019); Rosa et al., (2019). Then, several analyses on how CE principles can be incorporated into BM have been conducted in Bocken et al., (2016); Geissdoerfer et al., (2018), which recognize the role of specific design and different business strategies in supporting a resource efficient CE. From a CE perspective, companies must think differently: «they need to think in systems around products and reinvent how they can generate revenue by creating and maintaining value over time» (Bocken et al., 2018). Although this process is aimed at creating positive organizational and environmental impacts, CE-oriented BMI may be associated with a high level of uncertainty, challenges and complexity. For instance, some authors (Tura et al., 2017; Linder and Williander, 2017;Evans et al., 2017; Salvador et al., 2019) have focused on the barriers and drivers of CBMs implementation. Finally, existing differences between sectors of the economy require a different application of CE-oriented innovations. In this concern, still few authors have driven empirical analysis around CE-BMI (Ünal et al., 2019; Bocken et al., 2018; Heyes et al., 2018).

It emerges that researchers' discourses seem to focus on identifying implementation levers and designing BM concepts for CE, while overlooking the importance of in-depth practical research. (Pieroni et al.,2019). In addition, notwithstanding multiple attempts to create comprehensive conceptual archetypes, still no common framework to define, design, and implement CBMs exists. It seems that the rapid growth of this reasearch field and the multidisciplinary contributions, have generated confusion and ambiguity in the interpretation of BMI and its synergies with CE. Against this background, next sections attempt to move a step forward both the clarification of the boundaries of CE and BMI, and to provide useful evidence for embedding circularity within BMs of specific firms. Specifically, from now on we try to 1) Identify CE practices related to BMI, 2) Cluster the practices into main categories for the creation of a unique archeype, and 3) Match circular oriented BMI and CBMs.

3.1 Classification of CE-oriented practices

As clarified so far, implementing circular business strategies requires eco-innovative approaches capable of transforming the notion of BMI toward a circular version. In light of this, the first step is identifying which are the innovative strategies linked to CE innovations that companies must endorse to re-define their managerial choices. We define CE-BMI as the implementation of technological and non-technological practices by companies with the aim to achieve an increasing resource efficiency, resource longevity, and economic growth.

In relation to this, we reviewed recent contributions describing CE-oriented practices in industry to select our measures, see **Table 1**. Further to this, we condensed the long list into a shorter format following the different stages of products' life.

Table 1 CE-oriented practices

Main category	Example of CE-oriented practices	Related Literature
Input based practices	Use Renewable Energy Use bio-based, biodegradable, compostable materials Use Recyclable materials Reduce material/energy use per same output Use secondary raw materials Design for durability Design for reliability Design for trust Design for repair/remanufacture Design for upgrade Design for dis-reassembly Design for compatibility	(Bocken et al.,2016) (Ellen MacArthur Foundation 2015) (Lewandowski, 2016) (Nußholz, 2017) (Diaz et al., 2019) (Salvador et al., 2019) (Van Renswoude et al., 2015) (Ünal et al., 2019) (Guldmann, 2016) (Heyes et al., 2018) (Søgaard J. and Remmenb, 2018)
Use based practices	PSS lease Product renting PSS Product rent or pooling PSS performance based Product sharing Product co-ownership Virtually access	
End-of-life based practices	Upgrading Remanufacture Repair Upcycling Recycling Energy recovery from non-recyclable waste Supply of waste materials Reverse logistic	

Source: own elaboration based on the literature

In accordance, **Table 1** clusters CE-oriented practices in three main categories: input-based practices (concerned with how to produce the product or how to develop the process of production) use-based practices (concerned with how to deliver and use products) end-of-life-based practices (concerned with the management of products after their end of life phase). Notice that the above-mentioned strategies are not necessarily related to BMI, but they are all concerned with a novel conception of business in line with CE that are likely to stimulate BMI.

3.2 Classification of CE-oriented Business Models

Doing circular business implies turning the core of profit from the sale of goods to the flow of materials and products over time (Bocken et al., 2016). Thus, a CBM is concerned with gaining profits from the maintenance of the *value in use* (Evans et al., 2017) by recurring to innovative strategies. To distinguish linear BMs to closed-loop models we recognize specific strategies that characterize their implementation providing a new key classification. In the existing literature, other authors have classified CE practices supporting BMI for CBMs according to the changes in resources' flow i.e. by slowing, narrowing, and closing (Bocken et al., 2016), or according to CE actions i.e. regenerate, share, optimize, loop, virtualize, exchange (Ellen MacArthur Foundation 2015); rather we follow a logic based on the life-cycle of products.

Indeed, starting from the list of practices in **Table 1** we identify three main groups of CBMs: BM based on circular input, BM based on circular use, and BM based on circular output. The results of our effort are reported in **Table 2**.

Next to the traditional structures presented in the literature so far, the following archetype is built using innovative circular practices and placing them along products entire life. This exercise leads to a new categorization of CBMs that from now on we define Product Life-Cycle Archetype.

Table 2 CE-oriented practices and CBMs: the Product Life-Cycle Archetype

Main category	CBM	Example of measures
Circular input	Cleaner Production	Use Renewable Energy Use bio-based, biodegradable, compostable materials Use Recyclable materials Reduce material/energy use per same output Use secondary raw materials
	Extended-life span Production	Design for durability Design for reliability Design for trust
	Second-life Production	Design for repair/remanufacture Design for upgrade Design for dis-reassembly Design for compatibility
Circular Use	Product-service systems (PSS)	PSS lease Product renting PSS Product rent or pooling PSS performance based
	Collaborative Consumption	Product sharing Product co-ownership
	Product dematerialization	Virtually access
Circular Output	Second life for products	Upgrading Remanufacture Repair
	Second life for materials	Upcycling Recycling (Downcycling) Energy recovery from non-recyclable waste (Downcycling)
	Take back management	Supply of waste materials Reverse logistic

Source: own elaboration

3.2.1 Business models based on circular input

CE has to start from production. Not only firms must choose the least impactful options for the manufacturing of new goods (i.e. Cleaner Production), but above all, they must change products design to make their use compatible with the circularity transition (i.e Extended-life span Production) and for the optimization of the impacts of products' end of life (i.e. Second life-Production); the strategy is thinking about the end since the beginning. In particular, this approach is coherent with the CE literature referring to the “cradle to cradle” by McDonough and Braungart, (2002), which sustains the idea of thinking about products as if they should never become waste.

Cleaner Production is based on the choice of safe resources, their efficient exploitation, and capturing value from waste. In this type of business, firms select resources that have low impact but equal performance and that allow the closure of loops (e.g. renewable energy, bio-based, biodegradable, compostable, recyclable materials). In this concern, Bocken et al., (2016) distinguish biological and technological cycles. Indeed, goods produced with safe materials may be converted into nutrients for the natural system after product decay, and this may enrich the ecosystems. Whereas, generating products with *technical nutrients* implies using resources that can be continuously recycled and used for new goods since they maintain equivalent properties[4]. Further to this, Cleaner Production includes manufacturers that, through the development of new processes, are able to generate the same output by reducing the amount of raw materials needed (hence waste generated), and to substitute virgin materials with secondary sources.

BMs focused on *Extended-Life Span Production* are concerned with the design of long-lasting and high-quality products. This regards the manufacturing of durable artefacts that ensure a long utilization before breaking down. Similarly, designing reliable products provides users the warranty of the product’s functionality for a specific period of time without manifesting signals of deterioration. Besides *technical obsolescence* (not repairable or upgradeable), this type of business faces the problem of *emotional obsolescence* (Søgaard J. and Remmenb, 2018). In this case, the attention is addressed to the production of goods able to arouse emotional attachment, which will be liked and trusted longer, to contrast the rush to new products’ models. These types of businesses are therefore centred on quality, justifying a higher price, rather than on cheap mass consumerist products or built-in obsolescence.

Second-life Production considers products’ end of life and their impact since the design phase. For instance, manufacturers deliver not only products with longer life but also provide services that support the restoring of either the entire product or components. This business may overlap with Extended-Life Span Production. Notwithstanding, the difference is that while this last exclusively concerns creating long-life products, Second-life Production is especially focused on planning how to give them new life. Indeed, designing high quality/high-performance items, which ensure durability, also incentive the possibility of products to be reused, repaired, upgraded or remanufactured. Some firms, however, can decide to bring after-sale support or services (e.g. reparability, maintenance, warranty) as part of their business and provide users with the possibility to repair their products (this is linked with the Extended Producer Responsibility applied in EU to many products e.g. electronic) or reuse product within the second-hand market. Additionally, companies in this business can create interchangeable components, which can be used after one product decay. This process is also supported by designing for disassembly/reassembly, which makes products component easily separable or to be reassembled and reused for other products or to be disposed of safely.

[4] This refers to upcycling. Differently, downcycling refers for example to the transformation of waste into energy in which materials are transformed into low-value products and hence do not allow the continuous flow of resources.

3.2.2 Business models based on circular use

An emerging type of BM related to products use is the *product/service-based business concept*. These models integrate physical goods with intangible services able to satisfy customers' needs (Evans et al., 2017). Companies offer the use (use-oriented) or the results (result-oriented) from the product and consumers pay to accede or exploit its functionalities. In brief, instead of paying per ownership, users pay per use, or pay low period fees for access. Some examples are product leasing, renting, pooling, pay-per-service. It has been argued by e.g. (Linder and Williander, 2017) (Salvador et al., 2019), that since producers maintain the ownership over the product, the return flow of used goods is facilitated, hence these businesses support the practices of repair, remanufacturing, upgrading, recycling.

Similarly, the business of *Collaborative Consumption* is linked to product or service sharing or renting, in which customers share the full use and divide the payment with other customers. It concerns sharing e.g. house, car, office. In this context, the concept of using for a limited period of time overcomes the more deeply rooted concept of ownership. This complies with the emerging concept of "sharing economy" as a new way of thinking about goods' and services' use. Another type of this stream of business is the co-ownership, which is nonetheless still scarcely implemented (Rosa, et al., 2019).

Finally, companies may decide to change the way consumers use products through *dematerialization*. In this concern, the use phase is guaranteed for example through virtual access, as it is the case with streaming media services.

3.2.3 Business models based on circular output

The last category of CBMs is concerned with the after-use phase, which is related to the creation of new market offering through the exploitation of the value retained in used products. CE, indeed, consists of two supply chains, forward and reverse (Antikainen and Valkokari, 2016) and this requires the establishment of return flows. In accordance to this, circular output BMs refer to direct management of after-use products and the reintegration of entire products, components, materials into the production phase.

An example of these business are *Second-life for Product* through which companies, acting as third parties (different from producers), take the responsibility of maintenance services for reusing damaged products' otherwise discarded. This comprises upgrading, remanufacturing, repairing activities.

On the other side, *Second-life for Materials* includes business practices aimed at recovering valuable resources within discarded products - e.g. upcycling, recycling, energy recovery from non-recyclable waste - and reintroducing them into the market - e.g. supply of waste materials.

Finally, *take back management* systems tie the output phase with the input phase and ensure the closure of the resources' loop. Indeed, as suggested in Lewandowski (2016) in order to assure material circles, products/components/materials need to flow back in order to be reused/remanufactured/recycled and, besides collection, this requires reverse logistic systems.

4. Practical approach and survey analysis

After having theoretically defined what happens through the application of the life cycle logic to the circular business strategies , we try to move to a more practical level by considering firms as the protagonists of these changes. Firstly, we analyse some strategical options that firms have to consider before adopting a CBM. **Table 3** presents several cases and indicates, per each CBMs, possible business adjustments that a firm must undertake to convert its traditional business plan. This exercise helps us to better understand firms' choices in their trajectories towards CBMs. Given these assumptions, we subsequently present a survey analysis conducted on a selection of firms, heterogeneous per sector, situated in the Emilia Romagna Region.

Table 3. What changes in the business plan? Some examples with CBM classification

Main category	Cases	New needs	Business adjustments
Circular input	Use of recycled material in the production process (*Cleaner Production*)	Studying the current regulations	Need for legal advice
		Ensuring supply on the market of the second raw materials	Check cost trends
		The asset could be modified	Conduct specific product tests
	The company tries to replace the inputs and change the design (*Extended-life-Span* or *Second-life Production*)	There may be a product modification	Conduct specific product tests
		New machinery may be needed	Need for new fixed asset
	Extend product life (*Extended-life-Span*)	The volume of sales of new products may be affected	Recalculate sales estimates for the new warehouse
Circular Use	The company maintains ownership of the good used by the consumer (es, car sharing)	It is more difficult to get the guarantee of good condition (for example car condition)	It is necessary to increase the control costs
Circular Output	Repair maintenance service (*Second life for products*)	Need for new skills	Recruitment of new staff
		Need for new means	Need for New fixed assets
		The product must have the characteristics for the best possible reparability	Specific design study for the best reparability
		Customer loyalty	Acquiring new customers and increasing sales
	Possible reverse logistic (*Take back management*)	Inconsistent supply of goods	Encouraging the collection
		Need for collection platforms	

		and warehouses	Need for new fixed assets
		Need infrastructures for the collection	Increasing transportation costs
	Put a used product back to the market (*Take back management*)	Having a warranty on used equipment	Strengthen control activities
		Defining a competitive price compared to the new	Need for compensation of the reduced price

Source: own elaboration

To this aim, we have conducted a series of video interviews with 8 companies in the Emilia Romagna Region[5]. The choice of this region was due not only to its geographical proximity, but also because Emilia-Romagna is one of the most lively regions in Italy from a circular point of view. Indeed, according to the recent data of the ART-ER and Emilia-Romagna Region Report (2020)[6] in the three-year period 2016-2019, Emilia-Romagna has activated over 430 research and innovation initiatives on CE issues.

We have submitted to the companies a questionnaire of 8 questions, in order to investigate on the one side, their general approach to environmental and social sustainable innovation strategies, and on the other to verify which product or process CE-related innovations they implemented[7]. During the interviews, companies answered whether they had undertaken an innovation path and in what area they had decided to innovate. The questionnaire focuses the attention on the characteristics of this innovative path, investigating the weight of the ´circular` adjective in firms’ choices and the details about the adopted innovations. This has allowed us to frame the change in firms BMs and compare it to the Product Life-Cycle Archetype presented in the third section of this work.

a. Case study: Firms interviews and analysis

As mentioned above, firms’ set[8] tries to cover different processes in order to give a panoramic overview on what happens to the BMs when different companies try to embrace a circular perspective. We have chosen eight firms belonging to the following sectors:

- wood
- fiberglass
- agribusiness
- packaging
- FM transmitters

[5] Firms have allowed the treatment of sensitive data released during the interviews and reported in this paper.
[6] Accelerare la transizione verso l’Economia Circolare in Emilia Romagna, ART-ER and Regione Emilia Romagna, March 2020
[7] For the video interviews we used the google platform of meet due to the impossibility to visit companies for Covid19 security measures.
[8] Companies vary also in terms of size and age.

The results of the interviews have been analysed and classified in light of the Product Life-Cycle Archetype presented in Table 2. **Table 4** cross-check firms' data and CBMs.

Table 4. CBMs in Emilia Romagna SMEs

Main category	CBM	Emilia Romagna SMEs
Circular input	Cleaner Production	Elenos Group – 24Bottles – Macè – Iperwood – Vetroresina – Unigrà – CPR System – Schiassi
	Extended-life span Production	Elenos Group – 24Bottles
	Second-life Production	Elenos Group
Circular Use	Product-service systems (PSS)	
	Collaborative Consumption	
	Product dematerialization	
Circular Output	Second life for products	
	Second life for materials	Vetroresina – CPR System
	Take back management	Elenos Group – Macè – Iperwood - Vetroresina

Source: own elaboration

We have conducted a qualitative analysis with the extent to examine firms' bottom line guiding their circular choices. We have, therefore, overlooked many factors which are generally recognized as drivers of firms' choices e.g. dimension, governance, region's geography. To note that, these data are not sufficient to make an inference from firms to sectors, nevertheless, they can provide useful information about the dimension of the phenomenon.

At first glance, as shown in **Table 3**, it is quite evident that Emilia Romagna companies (in all sectors considered) have little experience of CE-innovative practices linked with the *Circular Use.* This may derive from several factors. Firstly, the applicability of the circular use of goods and services is limited to certain types of business. Not every company have the possibility to decline the material usage of its products (Product Dematerialization), or to translate the supply of material artefacts into services (Product-Service Systems), or to provide consumers the shared access of goods and services (Collaborative Consumption). In addition, circular use models not only call for active participation of consumers, but also demands consumers ready to accept the idea of purchase without material possess. Therefore, risks linked to demand uncertainty may limit firms' decisions to shift their core business toward a circular use. Notwithstanding, it is of foremost importance to recognize the current increasing diffusion of circular-use practices, the symptom of an ever-flourishing market.

Table 3 further suggests that the majority of firms interviewed have adopted CE-oriented practices linked to the *Circular input*. In particular, Cleaner Production interests 100% of participants. This may partially derive from the positive impulses given by the recent legislation. The last decade has indeed been characterized by policy exacerbation against plastic diffusion. In this context, have emerged companies such as **24Bottles**, a producer of design water-bottles, settled in the Bolognese area. The company is aimed at reducing the impact of single-use plastic bottles while guaranteeing an offsetting of production's carbon footprint. 24Bottles also support the Extension of products' lives. Indeed, the accurate selection and test of materials e.g. stainless-steel ensure the durability and reliability of its products which secure the extension of their lifespan. In the packaging sector, **Schiassi** uses recycled materials for cardboard boxes production. Not only this means using Eco-sustainable materials, but since this new type of cardboard is much thinner and easy to transport, it also reduces the number of transport trips needed per same volume of product, hence it generates positive impacts on CO_2 emissions. On the other side, massive incentives addressed to photovoltaic installations and biogas have boosted the implementation of firms' energy-related innovative practices. In these concerns, **Macè**, a Ferrarese company part of the canned fruit industry, has innovated its production processes in order to reduce its energy audit and the impact of bio-waste generated. Macè has, indeed, firstly decided to exclude pasteurization, preferring treatments at a temperature lower than 12°C. Despite this implies the production of low-life span products, the reduction of transformation processes enables the saving of a large amount of energy. On the other side, the company's energy consumption is also positively influenced by the installation of a photovoltaic system and the delivery of organic waste for methane production. This allows the company to recover around 70-75% of the total energy used. A similar line is followed by **Unigrà.** Belonging to the agricultural and food sectors, Unigrà focuses on food sustainability, thanks to certificated vegetable oils chains, and on materials for energy production. In particular, belonging to ETS (Emission Trading System), Unigrà exploits two different typologies of residuals with two different plants: the oil waste and other agri-food residuals for the production of biogas, with the goal of creating another plant to produce bio-methane in the near future. Another example of Cleaner Production is given by **Iperwood-Novowood**. The company, part of the sector of wood and wood-related producers, has developed in collaboration with the Faculty of Materials Engineering of the University of Ferrara, a new Wood Plastic Composite (WPC) formula, able to substitute wood by providing better performances in terms of durability, mechanical strength and in absence of harmful substances, such as PVC. Since 2004, this new material is called Novowood. It is made with 70% of recycled wood and 30% of high-density recycled polyethylene. In the last instance, **Elenos Group**, part of the broadcast sector, has implemented innovations aimed at reducing material use. In accordance, prior FM transmitters' equipment was differentiated according to its power. More devices were developed to satisfy customers' power needs. Differently, the group has now projected a new unique machine, which allows to break down its power and guarantee different performances. In this way, customers will need only one device, since it will be able to adapt to multiple uses. Elenos Group has additionally focused on renewing products' design to extend the life of its instruments and favour a second-life to broken parts. In accordance, multiple studies have been conducted in order to facilitate products' disassembly. Currently, products' segments can be easily removed, by creating a positive impact on machine durability, reparability, and disposal. Accordingly, the backfire of a single piece will not compromise the life of the entire apparatus, since the piece will be removed to be repaired and recovered or substituted by a new one and taken back to be correctly disposed of.

Lastly, a positive result, in view of closing resources' loops, is the combination among input CBMs and *output CE-oriented practices* undertaken by many firms. For example, **Macè** innovative processes not only have a positive impact on the production stage, but through the supply of bio-waste for biogas production, they also support the closure of materials' cycles at the end-life stage. Moreover, **Iperwood** solution is entirely recyclable at the end of their life cycle. Novowood and its products can be pressed and extruded again, and this operation can be repeated up to 20 times without adding other components. Novowood is therefore an example of entire circularity. Not only it is created with bio-based and recycled materials, but also its scraps can totally be reprocessed in order to re-enter into new products' cycles. In this context, also **Vetroresina S.p.A** plays a relevant role. The company is committed to improving the environmental sustainability of its production activities, by exploiting renewable energy sources and controlling styrene emissions (a potentially harmful hydrocarbon used to process fiberglass). On the one hand, Vetroresina S.p.A. is active in the field of Cleaner Production with an ambitious project that aims, in the near future, to cover the company's energy needs with 85-90% renewable sources. On the other hand, Vetroresina S.p.A is operating in the field of *Circular Output*, through the implementation of strategies aimed at giving Second

Life of materials and Take Back management activities. Accordingly, through a participated company (Vetroresina Recycling) Vetroresina S.p.A has acquired 30% of the quotas of Gis Recycling, which is a company dedicated to the recycling of fiber-reinforced fiberglass and fiber-reinforced plastics. The scope of this acquisition is the re-introduction of industrial waste, end of life fibereglass products, and non-thermosetting materials into the production process. The challenge for the next years is to involve customers in the collection of this kind of waste with the aim of being able to ensure a considerable supply of secondary raw materials and increasing in this way the production of new products having recycled waste as input. Finally, **CPR system** operates in the packaging sector and represents a promising reality in the region. The unusable packaging is re-granulated and re-printed, then going through the entire system, to be ready for a new distribution cycle. This methodology guarantees both Second-Life for materials and the exploitation of recycled material that, otherwise, would have been discarded.

5. Conclusions

The current way of designing and manufacturing products must be necessarily revised in order to allow a circular transition to happen. This is strictly connected with firms' vision of products' value and profit which affect their way of doing business. Hence, thinking about new ways of creating value and making profit from products' supply is becoming fundamental. Understanding the role of innovation in this process is equally important, especially focusing on the questions related to the desirable innovations that may support BM changes.

In the last decade, many contributions have been provided around these topics. However, it is still difficult to clearly recognize the conceptual boundaries among *Eco-Innovation*, *Business Models* and *Circular Economy*. This may partially derive from the absence of consensus around the role of innovation for CE in general, due to the width of the CE concept. In addition, the lack of clear "theoretical" guidance affects firms' capacity to understand how to put forward the circular shift in practice, further slowing down the transition process. This paper, though not comprehensive, aims at providing building blocks for a clearer understanding of key factors in firms' circular transition. We tried to shed more light on this issue by developing a new archetype of CBMs based on circular-based innovative practices: the Product Life-Cycle Archetype. The work represents the attempt to reduce the knowledge distance between the theoretical assumptions about EI and CE and the strategies effectively adopted at firm level. After having reviewed the current literature in order to identify a series of innovations that support CE achievement, we categorized the relevant ones according to products' life stages: input, use, output. This eventually allowed us to recognize and categorize the CBMs through a Product Life-Cycle Archetype, which, at the best of our knowledge, gives an original perspective on the topic, still not investigated in the existing literature. Furthermore, given the lack of practical analysis and empirical data on the topic, we examined how current firms are responding to CE stimulus, focusing on eight firms in Emilia Romagna, that have been interviewed in order to understand which measures they have effectively implemented. This has allowed us to cluster them according the Product Life-Cycle Archetype, and therefore provide it with a practical application. The contribution is twofold: on the one side, it allows to understand whether and how our theoretical framework applies in practice and, on the other, to understand firms' level of engagement. Notwithstanding, we recognise that our effort was not sufficient to cover the existing theoretical gaps around these concepts. Indeed, the link between eco-innovation, circular economy and business strategies appears deep and with not fully explored aspects, such as the role of technology, which remains open for future research to examine.

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