Circular Economy in action: uncovering the relation between Circular Business Models and their expected benefits

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Abstract: The main aim of this research is the development of new business models and industrial strategies for three novel supply chains in order to enable value-added product-services. Through a set of success stories coming from the application of circular economy principles in different industrial sectors, the authors want to demonstrate in practice the real benefits coming from its adoption. In addition, Key Enabling Technologies (KETs) have been integrated within the selected processes to improve the efficient recovery of secondary resources. In particular, the intent of this paper is the identification of the most suitable Circular Business Models (CBMs) through a literature review. In the current stage of the research, a state of the art analysis of existing CBMs have been executed and the most common classification framework have been exploited to define the archetypes of CBMs. As further development, a set of interviews with selected industrial partners will allow to identify the most important benefits expected from the adoption of CBMs. At the end, the integration of these two views will allow the definition of the most suitable CBMs.

Keywords: Circular Economy, Circular Business Models, Industrial benefits, Product-Service Systems, Sustainability

1. Introduction

Since the advent of globalization, the European manufacturing sector is coping with both an increasing lack of stability in the market and a need for quicker responses to customers' demands. With time, these two elements discouraged long-term investments of companies in tangible fixed assets, by shifting their attention in high-value markets characterized by lower volumes than mass production. Subsequently, plant's capacity use rates have felt down quickly, since the production was moved abroad. In particular, this negative scenario affected the overall performances of SMEs (European Commission, 2012). In parallel, in Europe there has been an increasing awareness about the environmental impact of products and processes and the importance of the sustainable use of resources (Reuter *et al.*, 2013). In this context, the circular economy (CE) paradigm is getting more and more success. Trying to demonstrate in practice the real benefits a CE can offer, the FENIX project wants to reproduce at small-scale a CE able to reintroduce materials recovered from e-wastes in different supply chains. The present article is structured this way. Section 2 describe the research objectives. Section 3 assesses the current literature on Circular Business Models (CBMs) and expected benefits from the industry. Section 4 discusses about the key findings. Section 5 gives some concluding remarks and future activities.

2. Research objectives

The main objectives of this literature review are: 1) identify the existing CBMs and CBM classification methods and 2) identify a set of industrial benefits expected by companies related with the adoption of CE practices. In the next section, the research method used to achieve these objectives is explained.

3. Literature review

Depending on the experts, CBMs (also named Circular Economy Business Models – CEBMs) can be classified under the wider umbrella of either Green Business Models (GBMs) and/or Sustainable Business Models (SBMs). Trying to gather some interesting details on current aspects related with CBMs, a systematic literature review on scientific articles published from 2000 up to the first quarter of 2018 and provided by the most popular academic search engines (e.g. Google Scholar, SAGE, Science Direct, Springer, Taylor & Francis Online and Wiley Online Libraries) have been implemented. To this aim, a multiple search in titles, abstracts and keywords of scientific articles has been conducted by putting together the keywords 'circular/circular economy/green/sustainable' with 'Business Model' (e.g. 'Circular Business Model').

Current findings say that the attractiveness of CBMs increased especially during the last years, when international environmental protection organizations started in defining and promoting even more restrictive regulations. The total amount of articles (283) reveals the relevant attention devoted to this topic (from 2000 up to 2018-first quarter) by the experts, especially in 2016 and 2017. A total of 158 articles were published in scientific journals with impact factor, 26 in scientific journals without impact factor, 64 in proceedings of scientific conferences, 24 scientific reports, 8 book chapters and 2 industrial reports.

In general terms, the literature usually assesses CBMs following two different strategies: 1) a theoretical view and 2) a practical view. In the first case, the intent is the definition of concepts or the proposal of mathematical models supporting companies willing to shift towards a more circular business. In the second case, the final aim is the description of best practices through case studies or the assessment of the sentiment of either companies or private citizens about circular economy effects, mainly through ad-hoc surveys. The following picture demonstrates that there is an unbalanced situation towards theoretical studies (theoretical and analytical assessment together) constituting 73.1% of the overall literature on circular economy and CBMs.

Then, considering the nationality of authors, it is possible to say that the highest number of contributions comes from northern European countries, followed by China and Italy. Considering the nationality of the articles' first author indicates United Kingdom as the major contributor, with 36 articles (19.6%), followed by Sweden (10.2%), The Netherlands (8.1%), China (6.0%) and Italy (4.9%).

In order to categorize the assessed literature, works have been gathered together basing on micro topics, or better their main focus found in title, abstract and keywords of each document. Indeed, there are several perspectives from which circular economy and CBM can be approached: best practices (10.2%), opportunities and challenges related with circular economy (9.2%), conceptualization of circular economy (7.8%), BM innovation frameworks (7.4%), BM challenges and BM decision-support tools (6.0% each), Chinese CE policies, design decision-support tools and future trends (5.7% each). The sum of the mentioned topics represents about 50% of the available literature.

Then, micro topics were grouped in macro categories basing on their consistency: as a result, business model design is the most discussed in literature (23.3%), followed by industrial strategies (20.1%), governmental policies (19.1%), environmental impact (11.7%), circular design of products (9.5% each), theoretical analyses (8.5%), societal impact (5.3%) and new technologies (2.5%).

3.1 Current CBM classification methods

Considering only the literature about CBM classification methods, the number of articles to be taken into account is limited to 21 papers. In general terms, it is possible to distinguish these works in three macro segments: 1) papers referring to the ReSOLVE framework proposed by (The Ellen MacArthur Foundation, 2015), 2) papers referring to the Business Model Canvas (BMC) methodology proposed by (Osterwalder and Pigneur, 2010) and 3) papers proposing hybrid models, exploiting both the previous ideas. The ReSOLVE framework is a set of principles defined by (The Ellen MacArthur Foundation, 2015) focused on supporting companies and governments during the definition of circular economy policies. This framework identifies six different ways to be circular like: a) Regenerate, b) Share, c) Optimize, d) Loop, e) Virtualize and f) Exchange. Within the "Regenerate" group there are actors focused on: 1) shifting on renewable energy and materials, 2) reclaiming/retaining/restoring health of the ecosystem or 3) returning recovered biological resources to the biosphere. Within the "Share" group there are actors focused on: 1) sharing assets, 2) reuse/second hand or 3) prolonging product lifetime through maintenance/DfX rules. Within the "Optimize" group there are actors focused on: 1) increasing performance/efficiency of products, 2) removing waste in production and supply chains or 3) leveraging big data, automation, remote sensing and steering. Within the "Loop" group there are actors focused on: 1) remanufacturing of products/components, 2) recycling of materials, 3) anaerobic digestion of wastes or 4) extraction of biochemicals from organic wastes. Within the "Virtualize" group there are actors focused on direct/indirect dematerialization of products. Within the "Exchange" group there are actors focused on: 1) replacing old materials with advanced non-renewable ones, 2) application of new technologies or 3) transformation of products/services.

Even if the ReSOLVE framework (The Ellen MacArthur Foundation, 2015) cannot be referred as a real classification method, many experts start from it to develop their own classification methods. (Charter, 2016) initially distinguishes CBMs in two macro classes, like disruptive and hybrid/incremental. Then, he identifies six different sub-segments: 1) produce on demand, 2) dematerialization, 3) product life-extension, 4) reuse/remanufacture/recycle, 5) PSS (Tukker, 2004), 6) sharing economy/collaborative consumption. These last categories try to translate in practical terms what theoretically defined by the ReSOLVE framework. (Manninen *et al.*, 2018) exploit the ReSOLVE framework to develop an environmental value proposition table (EVPT). (Mendoza *et al.*, 2017) adds to the original ReSOLVE framework the "Implement" level, trying to reduce the gap between the theoretical principles presented and their practical adoption. This way, a new iReSOLVE framework is proposed. Finally, (Chiappetta Jabbour *et al.*, 2017) start from the

ReSOLVE framework to map the relation between CBMs and big data analysis.

Considering the BMC-based classification methods, some interesting perspectives are offered by the authors. In general terms, papers pertaining to this category try to modify the original BMC up to make it able to map also circular business models and not only linear ones. A first example is offered by (Antikainen and Valkokari, 2016). Here, the authors add to the original BMC other two evaluation levels (ecosystem and sustainability) with the intent to better map all the existing links between a reference company and all the actors involved in its supply chain. Another perspective is given by two works of (Nussholz, 2017a); (Nussholz, 2017b). Here, the author embeds in the original BMC a method to assess the added value coming from a cyclical exploitation of resources. This way, the BMC is replicated for each of the three phases of a product lifecycle (e.g. BOL, MOL and EOL). Again, (Lewandowski, 2016) adds to the original BMC two dimensions, like take-back system and adoption factor, trying to map also CBMs with the same model. (Stratan, 2017) has a similar intent, but a different perspective. The author adds to the original BMC the social entrepreneurship side for making it able also to assess not-for-profit businesses. Finally, (Chiaroni, Urbinati and Chiesa, 2016); (Urbinati, Chiaroni and Chiesa, 2017) focus on two specific BMC elements, like value proposition and relations with suppliers. These two elements are considered by the authors like the most important KPIs to control when a circular economy strategy has to be implemented. Considering papers proposing hybrid models, also in this case some interesting perspectives are presented by the authors. (Nerurkar, 2017) classifies sustainability impacts related with CBMs in four classes: 1) environmental 2) social, 3) financial and 4) mixed. (Bocken *et al.*, 2014) propose a set of CBM archetypes starting from circular product design principles. (Lozano *et al.*, 2016); (Witjes and Lozano, 2016) identify in their works how the relation between public and private sectors is essential for the development of circular economy strategies. (Tolio *et al.*, 2017) focus on the operational issues related with CBM implementation strategies and information exchange among actors involved in circular value chains. (Heyes *et al.*, 2018) put together BMC and ReSOLVE trying to map service-oriented companies. (Morioka, Bolis and Carvalho, 2018) do a similar thing, but for assessing an entire business model through a sustainable value exchange matrix (SVEM). (Janssen and Stel, 2017) map the sustainability of the value proposition through a redefinition of the balanced score card (BSC). (Bocken *et al.*, 2016) try to classify CBMs basing on the concept of resource flows. This way, CBMs are classified into three groups: 1) those prolonging product lifecycle, 2) those closing material loops and 3) those reducing material consumption. (Haanstra, Toxopeus and Van Gerrevink, 2017) propose a morphological matrix linking product lifecycle stages with organizational procedures. Finally, (Prendeville and Bocken, 2016) propose the service design like a fundamental element supporting circular economy practices.

3.2 CBMs proposed in literature

The CBMs macro classification adopted is the common ReSOLVE framework constituted by six classes. Instead, the micro classification was adapted from the last OECD's report (OECD, 2017) on circular business models and it is composed by fourteen classes considering the full amount of different business models related with circular economy existing in literature. The "Regenerate" class embeds those CBMs related with renewable energy, bio-based and secondary materials exploitation instead of traditional production inputs. This way, adopting firms can reduce the environmental pressures emanating from their supply chains, while ensuring that the materials embedded in their products do not eventually become waste. The "Share" class is constituted by CBMs related with sharing either the ownership or the access to some resources. Within this classification there are mainly five elements: co-ownership, co-access, user-oriented PSSs, reuse and repair. The co-ownership involves the lending of physical goods, especially those capital intensive, infrequently used, and having a low ownership rate. The co-access, instead, involves allowing others to take part in an activity that would have taken place anyway. A typical example is carpooling. User-oriented PSSs can be considered like sharing CBMs. Customers pay for temporary access to a particular product, typically through a short- or long-term lease agreement, while the service provider retains full ownership of the product. Reuse occurs when wasted products can be directly reused either by other actors or in other sectors. Finally, repair occurs when products need to be repaired before reusing them. The "Optimize" class considers together those CBMs related with the reduction of wastes within supply chains. There are two ways to do it. First, industrial symbiosis involves the reuse of by-products from one firm as input material by another. This way, resources can stay within the economy for more time. Second, it could be possible to extend the lifetime of products just adding after-sale services on them, like maintenance or reconfiguration. The "Loop" class groups together CBMs focused on refurbishing/remanufacturing and recycling. In the first case, products can be refurbished or remanufactured before reusing them. This step is often done to reset the lifetime of products or adding new functionalities on them. In the second case, products are recycled to recover secondary raw materials. This process involves three main activities, each of which is typically undertaken by different market actors: collection, sorting and secondary production. After collection of the wasted materials, sorting acts the separation of a particular waste stream into its constituent materials. Then, secondary production involves the transformation of sorted waste material back into finished raw materials to be sold into the market. Basing on the final market of secondary production, there are two different businesses: recycling and industrial symbiosis. Recycling involves the transformation of waste into secondary raw materials to be sold in the materials market. Depending on the quality of recovered materials compared with virgin ones, it is possible to speak also about downcycling (low quality) or upcycling (high quality). The "Virtualize" class embeds those CBMs focused on reducing the exploitation of resources through dematerialization of products and/or processes. Even if dematerialization of products is not well-assessed in literature (no articles were found), a promising way to dematerialize processes is represented by result-oriented PSSs. This way, customers will pay for outcomes coming from processes that will no more pertain to them. Finally, the "Exchange" class considers those CBMs exploiting key enabling technologies instead of common ones during their production processes. The final intent is the improvement in sustainability. A typical example is the adoption of additive manufacturing.

Considering what reported in literature, some information can be gathered about the current focus of CBM literature and existing gaps. Just numbering the amount of articles basing on reference CBM classes, it is possible to see that some types of CBMs are more frequently taken into account than others. For example, the most common BMs described in literature when speaking about CE are represented by recycling practices and user-oriented PSSs. Then, there are other BMs widely considered like a real application of CE. These are focused on bio-based/secondary materials exploitation, reuse and refurbishing/remanufacturing practices, result-oriented and product-oriented PSSs and industrial symbiosis. Finally, there are other CBMs not so commonly described in literature. These are focused on renewable energies, co-ownership and co-access, repair practices, product dematerialization and new technologies.

3.3 Industrial benefits proposed in literature

Some articles already proposed and listed these sustainable benefits, based on both theoretical assessments and practical evidences. Therefore, a study has been performed to gather, list and classify them, also keeping in account the triple bottom line perspective of sustainability (economic, environmental and social) (WCED, 1987). Grounded on this appraisal, these benefits have been then grouped and gathered in macro categories in order to enable industrials to easily detect the main benefits they expect to reach through the adoption of a Circular Business Model (CBM). A relevant contribution was given by (Schaltegger, Lüdeke-Freund and Hansen, 2011) who defined the concept of business case for sustainability. Based on this concept, they proposed six core drivers: a) costs (Epstein, 1996); (Christmann, 2000), b) sales and profits (Porter and Van der Linde, 1995); (Porter and Van Der Linde, 1995), c) risks (Schaltegger and Wagner, 2006), d) reputation and brand value (Jones and Rubin, 2001), e) attractiveness as employer (Ehnert, 2009); (Revell, Stokes and Chen, 2010) and f) innovative capabilities (Pujari, 2006); (Cohen and Winn, 2007); (Schaltegger and Wagner, 2011). Among these drivers, (Collins, Roper and Lawrence, 2010) identified as the most important for moving towards an environmental and social direction the reputation and brand, employees' demands, risk management and potential cost reductions. (Schaltegger, Lüdeke-Freund and Hansen, 2011) also dealt with the links existing between environmental and social activities and companies' success from an economic point of view, trying to explain how these links can be managed, enhanced or renewed in order to improve economic outcome through voluntary social and environmental activities. (Park, Sarkis and Wu, 2010) investigated the challenges and opportunities of how firms and organizations can and will be able to strike a better balance between economic growth and environmental stewardship in the context of China's emerging 'circular economy' policy paradigm and based on ecological modernization theoretic approaches. (Roos, 2014) discussed about business model innovation. Related to this point, (McKinsey Global Institute, 2011) identified resource related value creation levers for businesses, grouping them in three macro areas: growth, return on capital and risk management.

Since, at the micro level, several firms across different industries have unveiled their intentions to move towards circularity by implementing cleaner production and eco-design initiatives, (Franco, 2017) conducted an inductive qualitative study to investigate circular economy at this level. (Sannö, Wallin and Fundin, 2014) detected the main challenges and perspectives composing an environmental sustainability framework. He detected four sub-research categories on which this framework is based: resource efficiency, enablers for change and innovation, circular business model research and emerging sustainable technologies including product and production technology. (de Lange and Rodić, 2006) found that at least three aspects have to be considered to shift towards circular economy: a) product design and manufacturing, b) business models, c) nature of relationships between and among stakeholders. Based on these three aspects, delineating how to perform a transition towards circularity, they also contributed to define which actions should be practically performed in product manufacturing. (Rizos *et al.*, 2016) investigated the barriers and the enablers for SMEs in their attempt to set up a circular economy business model. Among the main results, saving material costs, creating competitive advantages and new markets are the main reasons for European SMEs to take action in this sense. (Romero and Rossi, 2017) aimed to contribute to the creation of customer-oriented solutions that minimize resources consumption and enhance the ultimate value-added to the end-user. To do this, they attempted to demonstrate the compatibility of circular economy and lean principles in the context of PSSs.

Based on the analysis of the literature conducted above, the detected benefits have been categorized based on the three levels of sustainability (economic, environmental and social) and then grouped and gathered in macro categories in order to enable industrials to easily detect the main ones they expect to reach through the adoption of a Circular Business Model (CBM).

Economic benefits are: reducing overall costs, reducing business risks, opening new revenue streams, reducing product/process complexity and improving competitive advantage. The first point consists in reducing costs concerning both products and processes. In this context are considered also the reduced costs, mainly for the providers but also for customers, during the use, service delivery and disposal phases of the product/service lifecycle. The second point can be achieved through reputation management (getting credits and reducing reputation risks through proper stakeholder management) and operational risk management (managing risk of operation disruptions from resource scarcity, climate change impacts or community risks). The third point can be achieved through effective life cycle management of ICT products and of internal resources. Also, the business portfolio can be configured basing on resources trends. The fourth point can be reduced through the number of components needed to be specified and produced or procured. In this way, also the level of modularity of the product is enhanced. The development of basic materials and component parts plus the demand inducement from well-located players in the supply chain appeared to define the relative availability of circular products in the market. Finally, innovations (in terms of new products, functions, services and business models) can be introduced to gain competitive advantage.

Environmental benefits are: complying with environmental regulations, reducing environmental impact, improving resource efficiency, improving supply chain sustainability and reducing supply chain complexity. The first point can be reached through a coherent regulatory management (mitigating risks from regulation). The second point asks for an adoption of closed loop energy mapping (through renewable energy source), CO_2 neutral life cycle of the products, using pure materials with known and healthy properties. The third point can be achieved in products (use of renewable resources flows and the elimination of waste), in production (innovative sustainable production techniques, regeneration of energy in production, efficient use of machines on site management level) or in transport and logistic. The fourth point can be reached through organizational and supply chain resiliency (through environmental practices as recycling of wastes) or by resource management and reduced impact through the supply chain. Finally, the reduction of supply chain can be achieved through an accurate selection along the supply chain.

Social benefits are: enhancing reputation and brand value, reaching new markets & countries, improving health & safety in workplace and developing innovative skills and knowledge. In the first case, reputation and brand value can be increased also through strategic partnerships with sustainability leaders and through the enhancement of sustainability performance to achieve good rating in sustainability indices and funds. Brand value can also lead to attract employees through sustainable value proposition, to higher employee motivation, to better customer service, to enhance the quality of activities, resources and partnerships. The second case asks for the understanding of different market needs for efficiency and how to change behaviours and drivers of mind-set change. The third case is focused on improving health & safety of workers through a better management of hazardous substances and the adoption of ergonomic principles and safety regulations within workplaces. Finally, to allow for innovations to unfold may require new activities, resources and partnerships. Higher innovation potential and expectations for profitable innovations leading to an increased shareholder value.

Considering what reported in the literature, some information can be gathered about the current focus of CE-related Industrial benefits literature and existing gaps. Just numbering the amount of articles basing on reference CE-related industrial benefits classes, it is possible to see that some types of industrial benefits are more frequently taken into account than others. For example, the most common industrial benefits described in literature when speaking about CE are represented by resource efficiency, costs and environmental impacts. Then, there are other industrial benefits. These are focused on brand reputation, revenue streams, product / process complexity, competitive advantage and supply chain. Finally, there are other CBMs not so commonly described in literature. These are focused on business risks, skills and knowledge, new markets, regulations and health and safety.

4. Discussion and conclusions

This state of the art analysis allowed to identify the current gaps to be filled in by this research. At the current stage, a state of the art analysis allowed to define the most common types of CBMs that could be adopted. A further development will allow, combining both the literature review results and responses coming from the industrial partners, to define the most important benefits expected from the adoption of CE. Together, the integration of both the scientific and industrial perspective will allow the identification of CBMs to be considered. Furthermore, both the scientific and industrial gaps should be better clarified. From the CBM side, the literature shows a big research gap in terms of new ideas on how practically transform a linear business model in a circular one. Just in very few cases the experts present innovative ideas and implement them in practice. From one hand, theoretical concepts are given usually like a suggestion to companies and politicians, without explaining the logical procedure to follow for their implementation. From the other hand, best practices are described like a complex mix of mechanisms not always comprehensible and adoptable by companies. Again, the involvement of private users in current industrial CBMs is almost absent from the reference literature. From the industrial benefits side, the literature shows a big research gap in terms of new ideas on how to involve final users in circular economy. Just in very few cases the experts present innovative ideas and implement them in practice. In general terms, the social aspect related with CE adoption is rarely considered by the experts. Instead, the most common aspects considered by the literature are related with economics and environment.

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