Chapter 2

Circular Business Models Identification

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Abstract The main objective of FENIX is demonstrating the benefits coming from the adoption of CE practices through a set of circular business models adequately configured within the project. These CBMs have been selected basing on the three use cases requirements pertaining to different industrial streams (metal powders, 3D-printed jewels and advanced filaments for 3D printing applications). The chapter starts with a literature assessment of both current CBMs and current CBM classification methods. Subsequently, existing CBMs have been mapped basing on the most common classification method (i.e. the ReSOLVE framework), evidencing the most suitable CBMs to be adopted in FENIX. In parallel, a literature assessment of industrial benefits expected from the adoption of CE practices have been implemented. Subsequently, FENIX industrial partners have been interviewed in order to select the most relevant benefits expected from the project. A final comparison of available CBMs and expected benefits allowed to select the most suitable CBMs to be demonstrated in FENIX.

2.1 Current State of the Art on CBMs and Their Classification Methods

Circular Business Models (CBMs) can be considered as the interpretation of circular economy principles within the company's boundaries. Depending on the experts, CBMs (also named as Circular Economy Business Models—CEBMs) can be classified under the wider umbrella of either Green Business Models (GBMs) and/or Sustainable Business Models (SBMs). About this topic, a systematic literature review has been carried out by Rosa et al. [22]. Results unveil that in terms of CBMs the most discussed research areas are (i) practical implementation of CBMs, (ii) challenges related with the adoption of CBMs and (iii) decision-support tools. Considering just

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works on CBM classification methods, it is possible to distinguish three research streams: (i) papers referring to the ReSOLVE framework [24], (ii) papers referring to the Business Model Canvas (BMC) methodology [19] and (iii) papers proposing hybrid models mixing both the previous methods. The ReSOLVE framework [24] aims at supporting companies and governments during the definition of circular economy policies. It identifies six different ways to be circular (e.g. Regenerate, Share, Optimize, Loop, Virtualize and Exchange). Each of them is subsequently detailed in specific actions. Even if the ReSOLVE framework cannot be considered a real classification method, many experts started from it to develop their own models.

Considering the BMC-based classification methods, papers pertaining to this category try to modify the original BMC in order to map circularities.

Considering hybrid models, the experts try to mix the previous classification methods in order to reinforce them. Given the popularity of ReSOLVE and BMC methods, the FENIX project considered them as reference CBM classification methods. Specifically, the ReSOLVE framework has been exploited for the identification of CBM archetypes at macro level. Subsequently, the BMC method has been considered for the detailed description of CBMs at micro level. In addition, a meso classification of CBMs archetypes was adapted from the last OECD's report on CBMs (consisting of fourteen classes considering the full amount of different business models related with circular economy existing in literature) [18].

Considering tables reported by Rosa et al. [22], it is possible to see that some types of CBMs are more frequent than others. The most common CBMs described in literature are represented by recycling practices and use-oriented PSSs. They are followed by bio-based/secondary materials exploitation, reuse and refurbishing/remanufacturing practices, result-oriented and product-oriented PSSs and industrial symbiosis. Not so commonly described in literature are those CBMs related on renewable energies, co-ownership and co-access, repair practices, product dematerialization and new technologies. However, it is evident from the assessed literature the presence of a big research gap in terms of (i) how practically transform linear BMs in circular ones and (ii) how to involve common people in current industrial CBMs. The FENIX project wants to fill in these gaps by proposing practical ways of enabling circular practices in all companies.

2.2 Current State of the Art on Industrial Benefits Related with CBMs

Basing on another systematic literature analysis, Rosa et al. [21] detected and categorized expected benefits related with the adoption of CE. These benefits have been initially classified basing on the triple bottom line of sustainability (i.e. economic, environmental and social) and subsequently grouped in macro categories to ease their detection at industrial level:

- Economic benefits:
 1. Reducing overall costs,
 2. Reducing business risks,
 3. Opening new revenue streams,
 4. Reducing product/process complexity,
 5. Improving competitive advantage,
- Environmental benefits:
 6. Complying with environmental regulations,
 7. Reducing environmental impacts,
 8. Improving resource efficiency,
 9. Improving Supply Chain sustainability,
 10. Reducing Supply Chain,
- Social benefits:
 11. Enhancing reputation and brand value,
 12. Reaching new markets and countries,
 13. Improving health and safety in workplace,
 14. Developing innovative skills and knowledge.

Considering the tables reported by Rosa et al. [21], it is possible to see that some industrial benefits are more frequently considered than others. The most common industrial benefits related with CBMs are resource efficiency, costs and environmental impacts. They are followed by brand reputation, revenue streams, product/process complexity, competitive advantage and supply chain. Not so commonly described in literature are industrial benefits related with business risks, skills and knowledge, new markets, regulations and health and safety. However, it is evident the limited importance given by experts about either social aspect related with CE adoption and the involvement of final users in CBMs. This last point represents one of the key elements for the final selection of the FENIX CBMs.

2.3 Identification of the FENIX Industrial Benefits

In order to select among those detected in the literature review the industrial benefits expected by FENIX partners from the adoption of CBMs, a set of both face-to-face interviews and periodic consultations via phone/web calls have been implemented. The interviews were not based on a pre-defined questionnaire but exploited a set of open questions about both the current and future perspective of some of the FENIX partners. Considering tables reported in Rosa et al. [21], an interesting result is the high importance reached by social aspects (e.g. development of innovative skills and knowledge and enhancement of brand reputation and value) compared with economic (e.g. overall costs reduction) and environmental (e.g. resource efficiency improvement) ones. They are followed by the reduction of the environmental

impacts, reduction of business risks, improvement of competitive advantage and supply chain sustainability and provisioning share the same ranking. Subsequently, opening new revenue streams and reducing supply chain complexity seem to be less important. Finally, complying with environmental regulations, reaching new markets and countries, reducing product/process complexity and improving health and safety of workplaces seems to be out of scope for the FENIX partners.

2.4 Identification of the FENIX CBMs

The final decision (based on majority judgement) was to focus on three different CBMs: (1) recycling, (2) result-oriented PSSs and (3) use-oriented PSSs.

- Case 1—The FENIX manufacturing company (recycling-based CBM). This company could produce either a full pilot plant or a specific product. The full pilot plant will either disassemble products, recover materials or manufacture 3D printed components/products. Instead (given a specific AM process), the product could be either a 3D printed jewel, a metal powder for AM processes or an innovative 3D printing filament.
- Case 2—The FENIX service company (use-oriented PSS-based CBM). All the three pilot plants constituting FENIX could act either together or independently (like service providers) focused on a specific process phase. This way, POLIMI's I4.0Lab could act as a provider of assembly/disassembly services for complex products. UNIVAQ's lab could act as a provider of material recovery/refining services. Finally, FCIM, I3DU and MBN labs could act as providers of AM services. However, the plants do not shift in ownership. The provider has ownership, and it is also often responsible for maintenance, repair and control. The customer pays a fee for the use of the plant. He could (or not) have unlimited and individual access (leasing or sharing/pooling).
- Case 3—The FENIX Fablab (result-oriented PSS-based CBM). Here, the final aim is sharing the whole process with final users. This way, the full potential offered by FENIX could be exploited also by private customers willing to implement their ideas. Among the FENIX labs, POLIMI's I4.0Lab is currently the only one already able to adopt this kind of CBM. Here, the PSS still has the three pilot plants as a basis, but the user no longer buys the product produced or the use of the plants. Customers only buy the output of the plants according to the level of use. The provider agrees with the client the delivery of a result. The provider is, in principle, completely free as to how to deliver the result.

In addition, given the high presence of both I4.0 and AM technologies, FENIX could also give a practical demonstration about the adoption of "Exchange" CBMs:

- POLIMI's I4.0Lab will constitute both the initial and final stage of the small-scaled circular supply chain represented within FENIX. This lab is a demonstration plant for the automatic assembly of complex products. FENIX will partially reconfigure

it for disassembly needs. Here, the adoption of a Fablab-like CBM is expected to be feasible.

- UNIVAQ's chemical Lab will constitute the central stage of the small-scaled circular supply chain represented within FENIX. This lab: (1) will receive disassembled PCBs from POLIMI, (2) will recover materials from PCBs and (3) will send recovered materials to other partners (e.g. I3DU, MBN and FCIM) for AM-related activities. FENIX will partially reconfigure this Lab for the recovery of selected materials with specific features (e.g. particle's shape, dimension, purity level). Given (i) the high specialization of the lab and (ii) the presence of patented processes, not all the selected CBMs will be feasible.
- FCIM, I3DU and MBN's AM-related Labs will constitute either the semi-final or final stage (depending on the final type of product to be made) of the small-scaled circular supply chain represented within FENIX. If the AM product will be a component of a more complex one, it will be sent to POLIMI's I4.0Lab for the final assembly. FENIX will partially reconfigure these labs basing on specific products/components needs. Given (i) the high specialization of labs and (ii) the presence of patented processes, not all the selected CBMs will be feasible.

2.5 Implementation of the FENIX CBM Assessment Matrixes

Once both CBMs and expected industrial benefits were identified, the final stage was the integration of these views in a common matrix. However, before integrating CBMs and industrial benefits, the focus of analysis must be selected, given the multiple perspective of FENIX considering both pilot plants and final products.

Starting with the pilot plant view, three kinds of PSS-based CBMs can be adopted (e.g. product-oriented, use-oriented and result-oriented ones). Firstly, a product-oriented BM could be adopted in Case 1 (see Sect. 2.4 for details). Secondly, a use-oriented BM could be implemented in Case 3. Finally, a result-oriented BM could be adopted in Case 2.

Considering the final product view, just two out of three kinds of PSS-based CBMs can be adopted (e.g. product-oriented and result-oriented ones). Firstly, a product-oriented BM could be adopted in Case 1 (see Sect. 2.4 for details). Finally, a result-oriented BM could be adopted in Case 2. Given the three pilots implemented within FENIX (all of them starting from electronic scraps sent to the plant by either private or industrial customers), six different CBMs could be adopted. Two of them are related with the production of green metal powders for AM processes, two are related with the production of 3D printed jewels from green precious metals and two are related with the production of either Additive Manufacturing (AM) materials or 3D printing filaments from wasted materials. What is evident from tables reported in Rosa et al. [21] is the absence of a CBM offering better chances to fill in great part of the expected industrial benefits. Instead, use-oriented and result-oriented PSSs will allow to better cope with social aspects related with CE.

2.6 Conclusions

This chapter presented the three Circular Business Models (CBMs) to be adopted within the FENIX project. These CBMs were identified in product-oriented, use-oriented and result-oriented PSSs. For their identification, a multi-perspective procedure has been adopted. First, a state-of-the-art analysis allowed to define the most common types of CBMs and their classification methods. Secondly, a set of dedicated interviews with all the FENIX partners allowed the definition of the most important industrial benefits expected from the adoption of circular practices. Together, the integration of both the scientific and industrial perspective allowed the identification of the most suitable CBMs to consider within the FENIX project, distinguishing among CBMs related to the pilot plant itself and CBMs related with specific products coming from the pilot plant.

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