Rethinking Circular Business Models: The Role of the Learning Factory

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Abstract. There is a need for both increased knowledge and for effective solutions in the transition from linear to circular business models. Circular hubs are increasingly regarded by academia and policy makers as facilitators of circularity in industry. This paper investigates how a circular hub can better integrate circular economy principles into existing business models, through conducting case study research where we analyse 16 months of data about a circular hub, which appeared to effectively aid the participants both in the transition towards the circular utilization of resources and the pursuit of Sustainable Development Goals. The case is a circular hub for the reuse, repair, remanufacture and repurpose of furnishing in Norway. The findings of this paper include a framework for the assessment of the impact of circular hubs on existing business models, as well as the following facilitators: (i) organizing the circular hub as a learning factory for pupils and other stakeholders in collaboration with local schools, (ii) the municipality coordinating the learning factory, (iii) researchers ensuring that high-level concepts of circularity are explored by the stakeholders, and (iv) public financial support. Proposed avenues of future research include investigating the role of network action learning principles and methods in achieving higher circularity and hub maturity levels.

Keywords: Circular Economy, Sustainability, Circular Business Model

1 Introduction

There is a call for research and innovation on the transition from linear to circular business models (CBMs). Thus, academics and practitioners are increasingly engaging in co-creative processes to develop economic value in a manner that eases the pressure on collective resources such as energy and virgin raw materials. This is the core of what we refer to as at the circular economy (CE) challenge. Central to solving the CE challenge is to develop CBMs. A CBM refers to how "[…] a company creates, captures, and delivers value with the value creation logic designed to improve resource efficiency through contributing to extending useful life of products and parts (e.g., through long-life design, repair and remanufacturing) and closing material loops" [1]. Illustrative examples of CBMs in practice include circular loops where companies take back components from the market and recycle materials with sufficient quality to make new

products [2], and product designs that enable repair and upgrades while the products are still in use [3]. The state-of-the-art reflects that CBMs do not emerge in a vacuum because closed material loops and extended product loops imply inter-organizational collaboration and co-creative development processes [4]. Moreover, disruptive innovation theory suggests that start-ups might yield more effective solutions with more CE impact, yet without the risks of radically transforming existing BMs [5]. Thus, it is interesting to investigate the role played by industrial hubs with different actors in developing functioning CBMs [6]. This paper explores a CBM development process, and the following question guides the research: *How can a circular hub better integrate CE principles into existing BMs?*

2 Research Design

Given the practical nature of the investigation and the how-type research question, we select case study research as our primary research method [7]. We draw on insights from a longitudinal study in which, together with practitioners from the participating organizations, researchers studied, guided, and engaged in learning over a 16-month period. The major stakeholders in the project were the manufacturer and the users (the municipality, local secondary schools, and a non-governmental organization (NGO)).

During the research process, data was both collected and generated (created) in action. Section 4 describes various learning interventions in more detail, and presents the results in the form of emergent, actionable knowledge.

3 Analytical Framework

The framework used to analyse the role of the industrial hub in the in-depth CMB innovation study is based on literature about *industrial symbiosis* (IS), circular hubs, network action learning, and on Geissdoerfer et al.'s CBM framework [5]. IS is the use by one company or sector of underutilised resources (including waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment and materials) from another, with the result of keeping resources in productive use longer [8]. IS can arise through: i) direct interaction among companies (*self-organised*), ii) the facilitation of public investment networks and/or commercial brokers (*facilitated*), iii) the initiative of the users of an ICT system that manages data on resource availability and potential synergies (*ICT-supported*), and (iv) the initiative of the public sector (*strategic/planned*) [8]. Generally, the *steps* involved in establishing IS are: i) an exchange of resources (e.g. one company's waste is another company's raw material), ii) an awareness that a long-term CE strategy through IS is advantageous, and iii) a joint business model (BM) that is mutually beneficial [6]. *Barriers* to IS include a lack of a culture of trust and cooperation between independent actors, the investments needed, rules and regulations, and the unavailability of data on waste streams as attractive raw materials. Potential *facilitators* include: (i) the local proximity of the actors for increased trust, lower transportation cost and efficient infrastructure (e.g. shorter pipelines), (ii) appropriate agreements and blockchain technology for confidential data management, (iii) digital twins for process visualisation and control (e.g. to cope with fluctuations in the supply of renewable energy), (iv) proactively evaluating financing options, (v)

investors focusing on sustainable finance, (vi) public financial support, (vii) the standardisation and publication of data on municipal waste streams, (viii) digital platforms for confident resource sharing, and (ix) IS included in education to ensure a sufficient skill base [6, 9]. Other facilitators include 'living labs' for experiments in real-life context together with users, and 'open innovation testbeds' with facilities and services for the upscaling of IS technology [6].

Moreover, the coordination and advancement of IS by a *circular hub*, and/or neutral actors such as the municipality, the chamber of commerce and/or an association of a cluster of companies are among the most important IS facilitators [6]. A circular hub can be defined as a cluster of interconnected industrial companies and/or public facilities within a given region, which collectively achieve a demonstrable level of circularity (including greenhouse gas (GGE) neutrality) in their use of materials/energy/water whilst boosting the global competitiveness of the industry and achieving sustainable growth [6].

A series of scholars and practitioners emphasize that the transition from linear BM (or lower levels of circularity) to CBMs (or higher levels of circularity) should be based on close stakeholder collaboration, co-creation through experimentation and iterative learning [e.g. 10]. At circular hubs, this process can be supported by the *network action learning* principles and methods, highlighting that learning (L) is an incremental process starting with the programmed knowledge (P), combined with the questioning process as individuals (Q), and with learning in action, first at organizational level (O) and then at inter-organizational level (IO). Thus, L=P+Q+O+IO [11].

In a recent article, [5] developed a *CBM framework* based on a systematic review of the existing literature. Table 1 applies this lens to IS by help of circular hubs, showing that this approach can be particularly relevant for circular *value propositions* and *value creation & delivery* methods that are based on the *recycling* strategy. However, arguably *extending*, *intensifying*, and *dematerializing* strategies (see [5]) can be implemented by individual actors, e.g. through network learning. Finally, IS by help of a circular hub can contribute to *value capture*, leading to: i) economic and environmental benefits due to the reduction of waste and GGE and the reduction of energy, water and materials used, and ii) economic and social benefits due to new sales, investments, jobs, start-ups, talent to the region, revenues from export of innovative solutions, and indirect jobs that are triggered by regional growth [6].

Table 1. CBM innovation through IS & circular hubs (based on [5])

Strategy	RECYCLING
Value proposition:	
Goods/services	Used/repaired/remanufactured/repurposed/recycled goods
Customer needs	Affordable & eco-friendly goods; circular end-of-life/ waste management solutions for their goods
Industrial symbiosis through circular hubs: The Recycling strategy is directly relevant, yet the other strategies can be implemented by individual actors (e.g., through network learning)	
Value creation & delivery:	
Key value chain activities	Design for sustainability; modular design; repair/remanufacturing/recycling/reprocessing operations

Strategy	RECYCLING
Core competencies/collaboration	Collaboration with suppliers/collectors/retailers/recommercers/reprocessors
Resources/capabilities	End-of-life goods; reverse supply chain
Industrial symbiosis through circular hubs: The Reycling strategy is directly relevant, yet the other strategies can be implemented by individual actors (e.g., through network learning)	
Value capture:	
Revenue stream	From residual values of goods
Cost drivers	Cheaper resource input (e.g., recycled materials)
Revenue model	Direct sales; trade of resources
Industrial symbiosis through circular hubs: Economic and environmental benefits due to reduction of waste/greenhouse gas emissions and reduction of energy/water/materials used; economic and social benefits due to new sales/investments/jobs/talent to the region/start-ups/revenues from export of innovative solutions, and indirect jobs triggered by regional growth	

4 The Case of a Circular Learning Factory in Norway

This section presents the case of a circular hub that a furniture manufacturer (with 26 employees) established in 2020, in an empty factory hall (4000 m_2) in Norway. The manufacturer developed the hub as a learning factory for pupils and other stakeholders, in collaboration with the local municipality (18115 inhabitants), five secondary schools in the municipality (around 600 pupils), and a non-profit organization (NGO) promoting entrepreneurship as an education form and the SDGs among youngsters (12 employees). The hub currently hosts 10 *pupil companies* (with around 100 pupils), which (learn to) sell, repair, refurbish, remanufacture, and repurpose used furniture and décor from the manufacturer and from other public and private actors. For example, a tabletop can be repurposed as a flower container or shelves. The companies must create their own business plan, design their own products, take orders, and conduct marketing and sales. The municipal school manager informed that they were planning to offer the sustainability and entrepreneurship subject to all the pupils in the last but one secondary school grade (the 9^{th}). The manufacturer's CEO has also begun to establish an apprentice factory at the hub, in collaboration with the municipality, and an open innovation technology and digitalization centre for the local business community.

Since 2019, the manufacturer has been involved in a 3-year innovation project in collaboration with a private research institute (around 2000 employees). 40% of the project is financed by the Research Council of Norway and one of the work packages is dedicated to CBM innovation. The IS and the hub initiative arose through the investigation conducted by researchers in this project along with the manufacturer's interest in a long-term symbiotic agreement with an energy company (approx. 20000 employees). The agreement was signed in March 2020 and included both the sale of the manufacturer's own products to the company and circular end-of-life and waste management solutions for the company's used furnishing from offices and worker bedrooms. Thus, the *manufacturer's CBM value proposition* (see Table 1) included used goods (30% in 2021), repaired goods (20% in 2021) and remanufactured and repurposed goods (47% in 2021) to customers looking for affordable and eco-friendly furnishing.

The *schools' strategy and motivation* included offering a learning-by-doing education about sustainability and entrepreneurship to the pupils in the hub, and the manufacturer together with a few sponsors provided not only the space but also the machines and tools that the pupils needed for handling the used furnishing. "We want more motivated students. We want to make the school more relevant, and we know that practice is a great way to do this. In addition, sustainability is an important part of the new curriculum, so this fits very well. There is no better way to learn about sustainability than to be a part of it, instead of sitting in a classroom and hearing about it", informed the municipal school manager.

The development of the hub started in October 2019 and during the first 6 months, it was mainly *facilitated* by the researchers. While the school representatives focused on practicalities, such as what subjects to teach and apply in the hub, and transportation costs, the researchers presented (at workshops with the hub actors) and promoted high-level concepts of sustainable development, such as design strategies to minimize recycling, and the product-as-a-service strategy including furniture rental, maintenance, and repair. However, the municipality (school management) took gradually over the coordination of the learning factory at the hub, with support from the NGO. The facilitation appeared to have increased the energy company and the schools' trust in the hub initiative. Later, the manufacturer and the schools also dedicated one employee each to the administration of the hub and the supervision of the pupils.

Apart from repair, remanufacturing and repurposing operations, the *value creation & delivery* (see Table 1) of the manufacturer's CBM included the collaboration with a furniture collector and distributor and with suppliers of used furnishing. Apart from the energy company, the manufacturer's CEO established sale and end-of-life return agreements with the local university and several schools and kindergartens. Moreover, through the innovation project and the researcher's facilitation the manufacturer was investigating and implementing principles and methods within 'design for sustainability' (e.g., modularity and the use of regenerative materials) both in their own production and at the hub.

In terms of *value capture* and *economic benefits* (see Table 1), due to the circular hub initiative, the manufacturer gained new sales contracts and attracted a series of new national and international customers, which were looking for furniture producers that could handle product return and had a substantial commitment to environmentally sound products and processes. Provided that the hub was self-financed over time and the manufacturer continued to be active in innovation projects, the CEO estimated a fourfold turnover increase due to the hub. The revenue model of the hub consisted of weekly direct sales at the hub combined with online sale of used or repaired furnishing, and other repurposed and remanufactured goods. The hub was financed with around half of the sales revenue, while the pupil-companies benefited of the rest. The materials that were used were cheaper, as the pupils and the manufacturer were benefiting of practically free wood-based materials from the used furnishing. Moreover, the wood rests from the hub (3% of the returned goods in 2021) and from the manufacture's factory were converted into heat in the manufacturer's plant, which was sufficient to heat both facilities.

Potential *environmental benefits* (see Table 1) of the hub include the prevention of waste and pollution from discarded furnishing, and the reduction of GGE and the amount of wood, metal, energy, and water used when producing new products, due to

the extension of the goods' useful life. Thus, the hub can contribute to less pollution in the air, water and on land (SDGs 6 and 13-15) and to SDG 12, 'Responsible consumption and production'.

Potential *social benefits* (see Table 1) of the hub include professionals with relevant skills for sustainable development, and new jobs. At the hub, the secondary school pupils from the municipality are provided a tuition-free, learning-by-doing training on how to develop and run sustainable companies, create value adding jobs, and live and promote sustainable lifestyles. "We are happy to be up and running and see that this is where there is a potential to tear down some of the separation that you get in a regular classroom. Here, everyone can join and contribute with their own skills", said the school manager who regarded the practical education at the hub in close collaboration with the businesses as having a significant potential for reducing the school dropout and absenteeism. One of the manufacturer's employees, with over 30 years of experience as a prison employee highlighted that even if they only prevented one individual from a criminal life or long-term unemployment yearly, this would spare the society sums in the order of tens of thousands (e.g. around 120000 EUR/detention year at a juvenile centre). Thus, the hub can contribute to SDG 4 ('Good education') and SDG 3 ('Good health and wellbeing', e.g., by promoting sustainable lifestyles and striving to prevent school dropout). Moreover, the hub can also facilitate *socio-economic benefits*, by contributing to SDG 8 ('Decent work and economic growth', e.g., by supporting job creation, growing enterprises, and youth employment), SDG 9 ('Industry, Innovation, and Infrastructure', by opening the hub to other companies and contributing to upgrading the industrial community for sustainability), and SDG 17 ('Partnership for the goals', e.g. through the multi-stakeholder partnership including both public and private actors).

Nonetheless, the development of the circular hub was not exempt from salient *barriers* and challenges. These included different motivations among stakeholders, and different degrees of trust among the school representatives during the first meetings, with teachers having experience with similar teaching in collaboration with companies being more supportive. Salient examples also include the complexity of sustainability assessments, and of establishing a system for monitoring and reporting results, as well as a truly integrated joint CBM for the manufacturer and schools.

5 Discussion and Concluding Remarks

The previous section presented the case of a circular hub that appeared to be effective at integrating CE principles into the participants' BMs and strategies. It facilitated the integration of circular end-of-life and waste management services for furnishing owners, as well as the sale of affordable and eco-friendly goods. For the secondary schools, the hub eased the integration of learning-by-doing education about sustainability and entrepreneurship into their strategy. The CBM value capture and economic benefits for the manufacturer included new sales, long-term agreements with national and international customers looking for producers that can handle product return and are actively committed to sustainability, as well as a considerable projected turnover increase. For the schools, projected benefits included increased motivation among pupils, fewer school dropouts and less absenteeism. Moreover, the hub is expected to contribute to environmental benefits such as the reduction of waste, pollution and GGE from discarded furniture, and the reduction of materials and energy used for producing new

furnishing (SDG 6, 12 and 13-15). The hub is also expected to have a series of socio-economic benefits – such as professionals with relevant skills for sustainable development and new jobs and start-ups – and to contribute to SDG 3, 4, 8, 9 and 17. The impact of the hub on the manufacturer's BM was assessed by help of the *CBM framework* in Table 1, based on [5]. The framework captured the hub's most salient effects on the BM, suggesting its usefulness as an assessment tool for other circular hubs.

Earlier literature recommends implementing IS by help of a circular hub and including IS and sustainability in the education [6, 9]. This study can add to this, showing that by *organizing the circular hub as a learning factory for pupils and other stakeholders in collaboration with local education institutions*, the hub can integrate CE principles into existing BM in an effective way.

While the lack of a culture of trust and cooperation between independent actors can be a significant barrier for IS implementation, the IS coordination and advancement by neutral actors such as the municipality and the local proximity of the actors are among the most important facilitators [6, 9]. This study supports earlier literature, showing that the *coordination of the learning factory by the municipality* (school management) appeared to have increased the stakeholders' trust (the local schools and manufacturer's potential IS partner) in the circular hub initiative.

However, during the first 6 months, the *hub initiative was* mainly *facilitated by the researchers*. The *researchers ensured that high-level circularity concepts were explored by the stakeholders*, such as 'extended product life-time' [1] (e.g. design for sustainability), while the other actors were more concerned with practicalities and tended to focus on lower-level circularity concepts (e.g. 'recycle' and 'recover' [12]).

The IS-hub was a combination of a 'self-organized' and a 'facilitated' initiative, as it arose through the facilitation of researchers in a publicly founded innovation project involving the manufacturer, in combination with the manufacturer's interest in a long-term IS and sales agreement with a large company. Thus, this study also supports the literature findings recommending *public financial support* as an IS facilitator [6, 9].

Salient barriers in the case included the complexity of sustainability assessments, and of establishing a system for monitoring and reporting results and for proving sustainability benefits, as well as a truly integrated, joint CBM for the manufacturer and schools. By applying the maturity model for circular hubs that is proposed by SPIRE [13], the circular hub in the case would be at an 'intermediate' level. The authors contend that the *network action learning principles and methods* that were introduced in Section 3 *should be investigated in future research*, with the aim of accelerating and taking to higher maturity levels ('advanced' and 'mature') and circularity levels (e.g. higher 'R' levels [12]) the transition from linear BM to CBM through circular hubs. In the studied case, the learning process started with programmed knowledge (P) through workshops where researchers presented CE and sustainability principles and methods. Then, it continued with a certain degree of questioning insight (Q) by reflecting on strategies such as 'design for sustainability' as individuals. Thereafter, the actors engaged in action learning activities (O) at organizational level through, for instance assessments of the opportunities and challenges with the hub initiative. However, the actors did not engage in significant action learning activities at inter-organizational level (IO). Thus, examples of additional learning activities that can be investigated at circular hubs and learning factories include IO activities such as extended value stream mapping for the

stakeholder ecosystem [11], as well as Q activities such as visits at other circular hubs for inspiration [13].

To conclude, the purpose of this study was to investigate how circular hubs can facilitate the integration of CE principles into existing BMs. This topic was addressed through a longitudinal case study comprising 16 months of data about a circular hub, which appeared to be effective at integrating CE principles into the participants' BMs and strategies, and at easing the achievement of SDGs. The findings of this paper include a framework for the assessment of the impact of circular hubs on existing business models, and the following facilitators: (i) organizing the circular hub as a learning factory for pupils and other stakeholders in collaboration with local schools, (ii) the municipality coordinating the learning factory, (iii) researchers ensuring that high-level concepts of circularity are explored by the stakeholders, and (iv) public financial support. Proposed avenues of future research include investigating the role of network action learning principles and methods in achieving higher circularity and hub maturity levels.

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