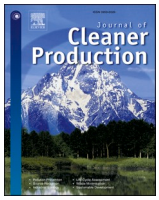
Journal of Cleaner Production 481 (2024) 143970

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro



Building innovation ecosystems for circularity: Start-up business models in the food and construction sectors in the Netherlands

Thomas Bauwens [a], Kris Hartley [b,*], Marko Hekkert [c], Julian Kirchherr [c]

[a] Rotterdam School of Management, Erasmus University Rotterdam, the Netherlands
[b] School of Sustainability, Arizona State University, USA
[c] Innovation Studies Group, Copernicus Institute of Sustainable Development, Utrecht University, the Netherlands

ARTICLE INFO

Handling Editor: Zhifu Mi

Keywords:
Circular economy
Start-ups
Market transformation
Sustainable entrepreneurship
Innovation systems

ABSTRACT

The circular economy is a resource-efficient production model that is believed by many policymakers, business leaders, and academics to promote sustainability. Academic literature suggests that circularity is achievable across business scales and types, from multinational corporations to start-ups. One condition for circular transition is the presence of a thriving market and a policy context that supports development and uptake of circular innovations. This study is among the first to analyze the business models of circular-focused start-ups from a systems-based perspective on technological innovation. Examining the Dutch food and construction sectors, the study compares business activities that foster innovation ecosystems. Based on 53 interviews with start-up founders and actors, we examine how firms respond to financial, cultural, and market drivers based on their respective industries' market structures, cultural norms, and growth histories. The results also indicate variability in the practical impacts of circular strategies. While there is some evidence of strategic impact among food start-ups, impacts among construction start-ups are potentially undermined by power imbalances between start-ups and incumbents and by the sector's relatively conservative culture. This comparison is used to develop recommendations for start-ups and policymakers to accelerate circular transition through the development of innovation ecosystems.

1. Introduction

With mounting evidence of environmental degradation, climate change, and the insidious impacts of both on social, economic, and political systems, society has turned to numerous frameworks and paradigms to affect long-term solutions in the form of broad systemic transformation. The notion of sustainable development – perhaps the most widely recognized – underscores the political mandate to fortify prevalent economic and social systems against the growing specter of environmental change. Among the numerous policy visions and practical templates for sustainability, the notion of the circular economy (CE) has received particular attention in the past decade. The CE is perceived by many scholars, business leaders, and policymakers as a pathway to sustainability transition (Geissdoerfer et al., 2017). Many definitions of CE have been proposed (Kirchherr et al., 2023), and the concept continues to evolve with technological, economic, and political dynamics. This study assumes the following definition of CE: "an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations" (Kirchherr et al., 2017, pp. 224–225).

The transition to a CE requires innovations not only in products and services but also in production and distribution processes. Enablers of such innovations include novelties in technology, organizational practices, employee skills (Straub et al., 2023), and business models (Bocken et al., 2021; de Jesus et al., 2018; Pieroni et al., 2019; Ranta et al., 2018). Discussions about the role of the private sector in CE transition have become more nuanced with recognition of how CE transition is pursued by differing types of firms, including multi-national corporations (MNCs) (Ajwani-Ramchandani et al., 2021), small- and medium-sized enterprises (SMEs) (Zhu et al., 2022), and start-ups (Henry et al.,

* Corresponding author. Arizona State University, School of Sustainability, 777 E University Dr, Tempe, AZ 85281, USA.
E-mail address: kris.hartley@asu.edu (K. Hartley).

https://doi.org/10.1016/j.jclepro.2024.143970
Received 21 March 2024; Received in revised form 10 September 2024; Accepted 13 October 2024
Available online 16 October 2024

2020). While early literature focused primarily on the activities of larger enterprises, the potential roles of circular start-ups in developing circular products, processes, and business models has received growing scholarly interest (Ferreira et al., 2024; Cullen and De Angelis, 2020; Henry et al., 2020). One better-known example of this type of circular start-up is Fairphone, an Amsterdam-based company that designs and produces modular and easily reparable smartphones (Haucke, 2018). The company's stated objective is to be a leader in the smartphone industry's transition towards more circular electronics.

While circular start-ups, in principle, aim to promote transition away from linear production and consumption practices, the impacts of their collective efforts are best achievable in the context of a supportive external environment – what is often labeled in the sustainability transition literature technological innovation systems, innovation ecosystems, digital innovation ecosystems (Tijani et al., 2023), and circular economy ecosystems (Aarikka-Stenroos et al., 2021). A defining characteristic of such systems is novelty in products, processes, and business models and the diffusion of this novelty among actors within a community or network (Bergek et al., 2008; Hekkert et al., 2007; van De Ven, 1993). A technological innovation system can be defined as "a set of networks of actors and institutions that jointly interact in a specific technological field and contribute to the generation, diffusion and utilization of variants of a new technology" (Markard and Truffer, 2008, p. 611). System-building activities refer to "the deliberate creation or modification of broader institutional or organizational structures in a technological innovation system carried out by innovative actors" with the aim of creating a supportive environment for emerging technologies (Musiolik et al., 2012, p. 1035). System-building is typically a collective undertaking involving actors like entrepreneurs, incumbent firms, knowledge institutions, and government agencies, rather than the action of individual entrepreneurs (Tuladhar et al., 2023; van De Ven, 1993).

While an increasing number of studies has focused on activities enabling a facilitative innovation ecosystem and on actors engaging in collective system-building activities (Planko et al., 2016; Musiolik et al., 2012; Garud et al., 2007), more research is needed to understand the conditions for successful system-building (Musiolik et al., 2020). Existing studies of system-building have focused largely on technological innovation, often overlooking other types of innovations (e.g., market, network, and collaborative). Moreover, there is a paucity of research and theorizing about whether and how certain business models call for unique types of strategic and collective system-building activities. This research gap potentially encourages misleading generalizations about system-building activities, even as differing types of system-building activities are relevant for differing business models and industries (Planko et al., 2016).

To fill this research gap, this study addresses the following research question: do the strategic system-building activities of individual circular start-ups vary across types of circular business models, and how? To answer this question, this study conducts qualitative comparative study of circular start-ups based in the Netherlands. The qualitative approach is deemed appropriate for identifying the nuanced data that differentiate types of circular business models and their strategic endeavors. The case context, the Netherlands, is selected because it is considered to have one of the most robust start-up ecosystems in Europe (European Startup Initiative, 2019) and, from both a policy and practice perspective, has been a global leader in the pursuit of CE transition (Marino and Pariso, 2020). The two industrial sectors scrutinized in this study, construction and food, are selected because they generate substantial waste streams and thus hold potential for meaningful circular transition (Bastein et al., 2013). As a further justification for studying these sectors, the majority of circular start-ups currently active in Europe operate within them (Henry et al., 2020).

The study is based on a qualitative dataset developed from 53 semi-structured interviews with circular start-up founders and key actors (i.e., people intimately familiar with their firm's business functions and holding some decisionmaking power) in organizations constituting innovation ecosystems (e.g., other start-ups, large incumbents, government organizations, network platforms, incubators and accelerators, research and educational institutes, and financial institutions). This study is one of the few medium-N empirical studies focused on CE (Kirchherr and van Santen, 2019). The remainder of this article presents the theoretical underpinning of the research (Section 2), methods used to address the research question (Section 3), findings (Section 4), and a discussion of findings and their practical implications (Section 5).

2. Theoretical background

2.1. Circular start-ups and their business models

The potential contributions of circular start-ups to CE transition have been highlighted only recently (Henry et al., 2020). Start-ups are defined as entrepreneurial ventures that are 'new' (i.e., typically operating for four to six years) and 'independent' (i.e., they are neither a subsidiary nor a branch of an existing firm). Start-ups are characterized by business models that are scalable (i.e., increased sales and profits without proportionate increases in costs), replicable (i.e., generating recurring sales with decreasing marginal effort), and financially durable beyond the short-term (Blank et al., 2012). A distinctive feature of circular start-ups is that they seek to develop innovative products, processes, and business models oriented towards reducing, reusing, recycling, and recovering materials in production, distribution, and consumption. Henry et al. (2020) distinguish five circular start-up types: design-, waste-, platform-, service-, and nature-based. This typology of start-ups forms the basis for this article's analysis, and is thus described as follows.

Design-based circular start-ups develop innovative products and/or production processes that reduce resource use, increase material efficiency, or avoid residual waste streams. Waste-based circular start-ups extract value from unexploited waste streams (e.g., post-consumer waste) and/or use post-producer waste from one production process as feedstock for another product or process. Platform-based circular start-ups facilitate the trade or sharing of excess or idle resources in the form of products, services, knowledge, or infrastructures via business-to-business (B2B), business-to-consumer (B2C), or consumer-to-consumer (C2C) marketplaces. Service-based circular start-ups provide customers with temporary access (and, in some cases, private ownership) to product-service systems that minimize the use of raw materials and increase their usage efficiency. Finally, nature-based start-ups deliver products and services based on natural ecosystems and nature-based solutions that reduce the use of non-renewable resources. These differing start-up types are associated with varying types of innovations.

2.2. Technological innovation systems and strategic collective system-building activities

According to the innovation systems perspective, many innovations in products, processes, and business models developed by circular start-ups risk failure without a supportive innovation system (Dedehayir et al., 2018; Alvedalen and Boschma, 2017; Spigel, 2017; Ács et al., 2014; Drakopoulou Dodd and Anderson, 2007; Neck et al., 2004; Fritsch, 2001). An innovation system can deliver resources (e.g., financial, human, and social capital) that benefit actors throughout the innovation process (Musiolik et al., 2012; see Silva et al. [2024] for a framework that integrates innovation processes and ecosystem fields). Beyond processes necessary for innovation systems to be effective (often referred to as 'functions of innovation systems'), scholars have also studied the actors (e.g., entrepreneurs, firms, and government agencies) who purposefully engage in system-building.

Research on actors engaging in system-building suggests that incumbent firms with superior market power, financial resources, and process innovation capabilities are better positioned to foster the development of innovation systems than are small entrepreneurs (Kukk et al., 2015; Musiolik et al., 2012). Yet, these advantaged firms seldom produce innovations that transcend existing designs and dominant ways of thinking, as they are likely to be locked into legacy investments, well-established supply chains, and entrenched business models that can be difficult to change (Hockerts and Wüstenhagen, 2010). Conversely, small entrepreneurs are seen as more willing and able to embrace disruptive innovations (Hill and Rothaermel, 2003; Christensen, 1997; Henderson and Clark, 1990). Diverging from the practices of incumbent firms gives these entrepreneurs a first-mover advantage in defining and accessing new markets. Additionally, more horizontal management styles, less bureaucratic organizational structures, and less formal communication channels allow entrepreneurs and other new market participants to be more flexible and responsive to changing circumstances (Bos-Brouwers, 2010). At the same time, lack of resources and less influence over market actors can limit the ability of entrepreneurs to build innovation systems. Under such circumstances, entrepreneurs often rely on collaborations and collective efforts through networks of actors (Dzhengiz and Patala, 2024; Primario et al., 2024; Planko et al., 2016; Musiolik et al., 2012; Garud et al., 2007; Garud and Karnøe, 2003).

Strategic approaches have been a growing focus of recent CE research. For example, Fehrer et al. (2024) propose six strategies for shaping circular innovation ecosystems, including collaboration, concept-framing, learning from alternative perspectives, adopting living laboratories (beyond incubator environments), and taking a 'fractal'--based perspective on requirements at the micro and macro levels. Similarly, de Vasconcelos Gomes et al. (2023) propose an empirically-tested theoretical model that describes the processes by which firms promote circularity transition in the broader competitive ecosystem: governance (rules and norms), interdependence and integration among ecosystem partners, and complementarity with external and independent partners. Integrating insights from the strategic management and technological innovation systems literatures, Planko et al. (2016) identify strategic activities for system-building carried out by entrepreneurs to strengthen the environment for innovations (Table 1). Activities in the area of product-development and optimization aim at delivering well-functioning, commercially viable new technologies and complementary products and services (see Bakry et al. [2024] regarding the role of commercial viability and technical system development in fostering sustainability innovation ecosystems). Market-creation activities include fostering customer interest in new technologies, supporting producers through legislative reforms, and introducing producer incentives to stimulate product adoption. Activities concerning socio-cultural change seek to embed the new technology in society by altering societal values and norms in a way that raises the need or desire for the new technology. Finally, coordination refers to the alignment (i.e., systemic orchestration) of individual and collective system-building efforts to enhance the efficiency of resource use and accelerate system-building processes (Planko et al., 2016).

While the literature highlights the various ways entrepreneurs engage with other actors to shape the market environment, little consensus has emerged about how these insights apply to actors in CE and to what extent the activities identified by Planko et al. (2016) apply to various types of innovation (see Koval et al. [2022], Pietrulla [2022], and Suchek et al. [2022] for reviews). Not all activities are equally relevant across product types, process, business model innovations, and sectors. This study seeks to empirically fill this research gap by examining start-up activities that foster innovation ecosystems.

Table 1
Strategic collective system-building activities (based on Planko et al., 2016).

System-building activities	
FIRST-ORDER CATEGORY	Second-order category
PRODUCT[1] DEVELOPMENT AND OPTIMIZATION	• Testing new technologies, applications and markets • Knowledge development • Knowledge exchange • Development of commercially viable products • Co-creation of products and services • Feedback loops with user groups
MARKET-CREATION	• Generate new business models • Business model replication • Creation of temporarily protected niche market • Collaboration with government for enabling legislation • Collaborative marketing to raise user awareness
SOCIO-CULTURAL CHANGES	• Creating new facilitating organizations • Establishing collaboration-prone organizational cultures • Changing user behavior • Changing the education system
COORDINATION	• System orchestration • Creating a shared vision • Defining a common goal • Standardization of the new technology • Thinking in system-building roles instead of company objectives • Creating transparency of all activities going on in the field

[1] As mentioned by Planko et al. (2016) the term 'technology' should be replaced by 'product' (or process or business model) to be applicable to other sectors where innovations are not necessarily of a technological nature (e.g. in the health care sector).

3. Methods

3.1. case selection

To address the aforementioned research gap, empirical data have been collected through interviews of start-ups in two industries: the built environment (construction) and the food manufacturing and retail sector. These industries are selected here for their high CE potential, as they handle large volumes of both organic and non-organic materials and are responsible for substantial waste streams. In the Netherlands, roughly 50% of resource consumption, 40% of total energy use, and 30% of total water use comes from industry activities related to the built environment (Government of the Netherlands, 2016). Furthermore, 25% of food produced in the Netherlands every year is wasted (i.e., disposed of without any form of recycling or secondary use). These two sectors are among the five prioritized by the Dutch government in pursuit of a fully circular economy by 2050.[1] They also correspond respectively to the two main cycles of the CE: technical and biological.[2] As such, these sectors are a useful empirical setting for comparing start-ups handling differing types of materials (e.g., building materials as opposed to food products). While the two sectors have some differing conditions, we posit that they are similar enough to usefully compare due to our focus on start-ups, the common context of pursuing circular innovation, and firms' reliance on common types of strategies to accomplish the later (e.g., collaborations, platforms, and market-building) (see Yin [2009] for a discussion of case comparison methods). This study is conducted in the Netherlands in order to ensure a consistent geographical scope.

[1] The other three sectors prioritized by the Dutch government are plastics, manufacturing, and consumer goods.

[2] The technical cycle refers to flows of inorganic or synthetic materials. The biological cycle refers to flows of food and biologically-based materials (e.g., cotton and wood) designed to return to the natural environment through processes like composting or anaerobic digestion.

3.2. Data collection

53 in-depth semi-structured interviews were conducted with founders of circular start-ups and with key actors in their innovation systems, including representatives of incumbent firms collaborating with start-ups, incubators and accelerators, research institutes, networking and collaborative platforms, and government organizations (see Appendix for a complete list). This combination of actors across industry and the public sector often constitutes an innovation system (Dedehayir et al., 2018; Stam, 2015). Interviewees were identified via the snowball sampling technique (Kirchherr et al., 2018; Biernacki and Waldorf, 1981). The sampling strategy started by identifying circular start-ups through platforms such as LinkedIn and the Start-up Delta database; from this search, a database comprising 60 circular start-ups was assembled (27 in the construction sector and 33 in the food sector). Additional companies were identified at start-up-related events held for the two sectors (e.g., Horecava [a hospitality trade fair] and the Social Impact Factory Entrepreneurship event). The identified start-ups were approached with a request to participate in an interview, and interviewees were later asked to recommend additional interviewees.

The semi-structured interviews consisted of two parts. First, circular strategies and business model innovations were discussed in order to derive a thorough understanding of start-ups' circular practices. In the second part, interviewees were asked about strategies they undertake to influence actors in their ecosystem to adopt circularity, and about the drivers and perceived impacts of these strategies. Interviews lasted between 45 and 90 min and were conducted between March 2019 and July 2019. The interview process proceeded until thematic saturation was reached; that is, when no new information was gained after three consecutive interviews (see Green and Thorogood, 2018). 30 interviews were conducted face-to-face and 23 via telephone. All interviews were recorded, transcribed, and translated when necessary from Dutch to English.

3.3. Data analysis

We used the qualitative software NVivo to record, code, and analyze the data. Interview data were coded based largely on the framework of Planko et al. (2016). The coding process began deductively, with adjustments made throughout an iterative data-review and subsequent alignment to framework elements. The coding process was conducted by applying either short, summarized descriptions or NVivo codes for the interview transcripts. Based on interview transcriptions, we alternated between the collected evidence and given concepts from the literature to align with existing coding categories from the Planko framework. Accordingly, we employed both deductive categorization, which uses higher level existing categories (see Cachat-Rosset and Klarsfeld, 2023), and inductive categorization, which uses lower level codes (e.g., novel identified strategies that circular start-ups use to shape their innovation systems) that were grouped into higher level codes (see Hsieh and Shannon, 2005). The resulting coding categories were ultimately deemed to be mutually exclusive and collectively exhaustive.

Following this, a frequency analysis was performed to measure the quantitative counts of all individual codes, identifying the number of start-ups engaging in each strategy. This process enabled us to assess the relative importance of various activities and potential differences across start-up types. These quantifications are intended to be seen as indicative only, as they are not representative, by formal statistical criteria, of the population of circular start-ups in the Netherlands overall.

4. Results

This section analyzes system-building strategies according to the analytical framework presented in Section 2. This section addresses design-based, waste-based, platform-based, service-based, and nature-based startups separately, with both industries (construction and food) represented across each set. As shown in Fig. 1, significant differences among circular start-up types can be observed.

4.1. Design-based start-ups

Findings indicate that design-based start-ups engage primarily in product-development and optimization, which may be explained by the relatively technically complex nature of their innovations. This issue is raised by the founder of Ekotex, a start-up that designs sustainable alternatives to wallpaper and wall finishes without fossil petroleum derivatives or additional plasticizers. "We create a product made from various waste flows. This is the essence of our business model, but it's so complex. Therefore, we mainly focus on optimizing our technology" (interview 6).

Design-based start-ups often conduct product-development and optimization activities in collaboration with incumbent actors such as universities and established firms. An example of such collaborations is the partnership between the start-up Hillblock and Martens Beton, an established producer of construction materials. Together, these partners developed sustainable dike stones that use 30 to 50 percent less concrete than existing dike blocks and thereby reduce transport weight. Hillblock developed the product idea and undertook the associated marketing activities, while Martens Beton oversaw testing, production, and sales. Collaborations of this sort enable start-ups to benefit from the larger R&D and technology resources of established partners in testing their innovations and executing pilot projects. According to interviewee 1, "We are also testing our dyke stones, but these tests are very expensive and often we cannot do them ourselves." From the incumbent firm perspective, partnering with a start-up offers opportunities to test innovative ideas that could be developed into commercialized products.

The second most common cluster of activities for design-based start-ups is market-creation. Within this cluster, a salient activity is collaborative marketing among market actors to raise user awareness. Interviewees state that to create a market and raise interest for their products, it is especially important to raise consumer awareness about the positive environmental impact of the products. "If we don't succeed in convincing our customers that our product is more sustainable than other products, it is going to be very hard to create sales" (interview 13).

Coordination activities are given relatively less attention by design-based start-ups. Interviewees indicate that lack of coordination may be a consequence of the conservative culture of their respective sectors. According to interviewee 14, "We are talking about a very conservative sector where no one wants to take risk or responsibility. By defining a common goal, I believe we could optimize the collaboration between actors within the value chain. However, for this we need everyone's participation, which is extremely hard to accomplish in my experience."

Design-based start-ups also engage relatively less in efforts related to socio-cultural change. Although interviewees recognize the importance of this activity for successful adoption of their innovations, they indicate that other actors, such as the government, would be better suited. "I do believe it is critical that the government is involved within this activity, [and] to create incentives for those who actually are willing to make the 'circular choice.' I cannot achieve this on my own" (interview 3). Lesser engagement in socio-cultural change may also be explained by a primary focus on innovations in core technology, which typically entails relatively little change in user behaviors.

4.2. Waste-based start-ups

Product-development and optimization is the highest scoring cluster of activities for waste-based start-ups. Findings indicate that, similar to design-based start-ups, the salience of this activity reflects the technically complex nature of their products. For example, the founder of Smartcrusher, a start-up that developed a technique for recovering sand, gravel, and cement from concrete, explains: "What we aim to create is

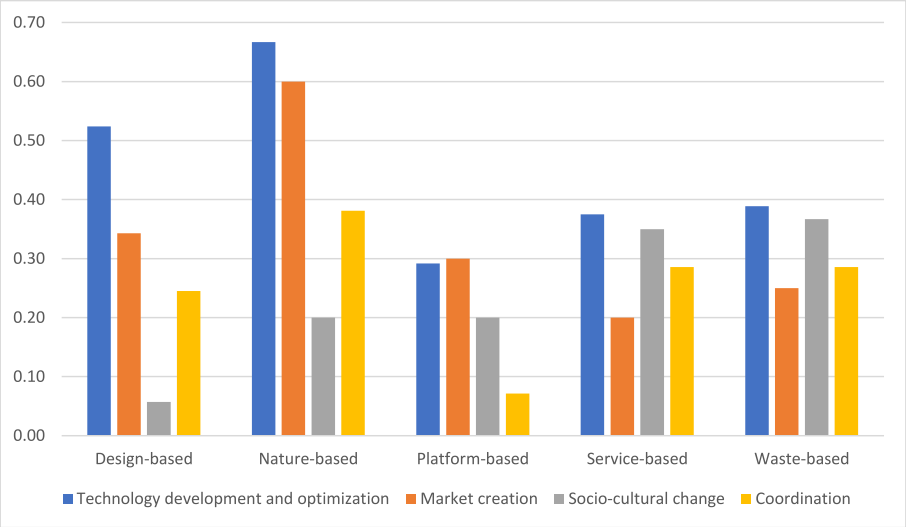


Fig. 1. System-building activities by circular start-up types.

technically so complex and new that testing and optimizing our technology is so incredibly important. The fact that we can outcompete our competitors technologically-wise, whereby development of our knowledge is critical, is for me our essential key proposition" (interview 15). This finding accords with that of Thakur and Wilson (2023), who propose a framework highlighting the importance of knowledge-management platforms in circular innovation ecosystems.

The second highest scoring cluster of activity for waste-based start-ups is socio-cultural change. However, our findings indicate differences between the two sectors and between types of activities. Interviewees in the construction sector did not believe they had the power to change the educational system. "[It] would take me a lot of time and effort, while not knowing if it would lead to any result" (interview 4). By contrast, food start-ups view collaborations with schools as a way to address a lack of consumer awareness around food waste, which is mentioned by many interviewees as a barrier to the diffusion of circular business models in the food sector. "The awareness among students of the environmental impacts of food is lacking, definitely in primary and secondary school" (interview 51). Food start-ups see an opportunity for impact by addressing students' eating habits, collaborating with schools to educate students about the importance of preventing food waste. Kromkommer, a start-up producing soups from discarded vegetables, has been developing a primary school curriculum that "teaches young children that curved vegetables are perfect as well" (interview 34). Another example is Potverdorie! (translated as 'darn it!'), an anti-food waste start-up that organizes cooking workshops with students to make jams from discarded fruit.

Differences can be observed between both sectors regarding market-creation activities, with six start-ups in the food sector and two in the construction sector engaging in positive marketing to raise user awareness. An example of collaborative marketing in the food sector is the platform Verspilling is Verrukkelijk ('Waste is Delicious'), founded in 2018 by the Taskforce Circular Economy in Food[3] and enlisting 18 circular start-ups. Participating start-ups combine efforts to create collaborative marketing initiatives and stimulate demand for circular products (e.g., promotion of products on the platform website and collaborations with food retailers to offer display space for circular products).

Food waste-based start-ups also use negative marketing to raise user awareness. For example, Potverdorie! was approached in 2018 by a plum grower holding 60,000 kg of plums rejected by Dutch supermarkets because they were 3 mm too small (a consequence of that year's weather conditions). At the same time, a Dutch supermarket chain was selling small plums from Chile. Potverdorie! shared this story on social media to highlight how supermarket standards regarding the esthetic aspects of fruit and vegetables can encourage food waste. Receiving critical reactions from the public (van der Vleuten and Balkenende, 2018), the supermarket chain contacted the start-up to find a solution. The start-up then bought part of the farmer's harvest and produced 36,000 jars of jam, which were sold to the supermarket.

Food start-ups also engage relatively frequently in start-up replication, while no case of replication is reported in the construction sector. This process may be proactively encouraged by an individual entrepreneur who seeks to shape the ecosystem by fostering the creation of start-ups with similar commitments to circularity. An example of a replication strategy in the food sector is Rotterzwam, a mushroom-growing company that uses training and online courses to helps entrepreneurs apply its business model to launch start-ups in other locations. As the founder of The Fungi Factory, another mushroom-growing company, explained, this replication process enables the sector as a whole to grow while preserving the local anchorage of individual businesses. "If other businesses come to us and say they have an interesting opportunity in Rotterdam, we will send them to Rotterzwam. That way you can maintain your local [anchorage] and you help each other" (interview 30).

Collaborations with policy-makers to create favorable policies and regulations are relatively rare across both sectors, with only three start-ups in the sample engaging in such activities. One reason may be that such collaborations involve lengthy and resource-intensive processes, in accordance with a resource-based view of firms' political activities (Dahan, 2005). This challenge is acknowledged by several interviewees across both sectors. "We are not spending our time on it, because we know it is a really tough battle to make changes within the legislation" (interview 43). Such perceptions can compel start-ups to proceed without waiting for legislative changes. "The government is certainly not positively involved. If we are going to achieve the circular objectives, it is despite the government" (interview 12). "We can't wait for legislations to change. This takes over three years. We need to act now'' (interview 42). Reminiscent of the 'act now, ask permission later'

[3] The Taskforce is a coalition of companies across the food supply chain, including national and local authorities, a civil society organization, and other invited members. Its objective is to contribute to preventing and reducing food waste, and to become an international frontrunner in the promotion of agri-food residual streams.

attitude of peer-to-peer platforms such as Airbnb and Uber (Pelzer et al., 2019), this mindset reflects the potentially disruptive element of circular innovations, which are often misaligned with existing regulations (Gidley, 2020).

Of all clusters of activities, coordination is the least common among waste-based start-ups, which consider such activities more relevant for a later development stage. "Currently, these are not the activities we try to achieve. It would of course be amazing if we could orchestrate the system. However, I do feel that at this moment we still need to mainly focus on optimizing our service and make it the standard within the market. When this happens, and our customer group has grown, then we can focus more on the coordination activities."

4.3. Platform-based start-ups

Our findings indicate that market-creation is the most common cluster of activity for platform-based start-ups. This finding is consistent with the literature on platform-based business models (see Marantes et al. [2023] for a framework concerning digital platforms for CE), which holds that one of the hardest challenges for creating platform models is to quickly attain a critical mass of users (Hagiu and Rothman, 2016; Eisenmann et al., 2006). For example, Madaster, a start-up that couples a material identity to a certain location and registers it in a material 'passport' that contains information about the quality, origin, and location of materials to facilitate their minimization and reuse. However, "not everyone is using materials passports, or even knows what it is and what its added value is. So, we are constantly listening to our clients and the market to see how we are doing" (interview 11). Platform-based start-ups often appear to cultivate their market by collaborating with government agencies to establish favorable legislation. For example, Madaster partnered with the Amsterdam Metropolitan Area (MRA) (government body) to promote the material passport in MRA municipalities, delivering a 'Madaster Certificate' to those best implementing the initiative. Madaster also promotes material passports within CB'23, a collaborative platform launched in 2018 at the initiative of several governmental agencies[4] that committed to drafting guidelines for the Dutch construction sector to shift towards a circular built environment. Within this platform, Madaster participated in developing guidelines for passports in building construction.[5]

Product-development and optimization is the second most common cluster of activities for platform-based start-ups. Within this cluster, developing feedback loops with user groups is seen by interviewees as particularly important. Knowing what users thought about the functionalities and convenience of their platforms also enables start-ups to continuously adjust to meet users' wishes. "We have a special helpdesk which the visitors of our platform can contact, to leave comments or remarks about our platform. We organize bi-weekly 'sprints,' where we internally come together to discuss this" (interview 11).

Regarding socio-cultural change, differences between sectors can be observed. In the food sector, changing user behavior appears to constitute the core of platform-based start-ups' business models. Bestelbewuster is a platform that develops innovative solutions to reduce food waste, helping users obtain left-over meals from restaurants and offering a platform to efficiently meet catering demands. By contrast, platform-based start-ups in the construction sector do not perceive socio-cultural change activities as a primary objective. "For us it is important that when users visit our platform for the first time, it has to be comfortable, clear, and work well for them. If not, you probably lost them forever. I believe this is much more important than focusing on socio-cultural factors" (interview 11). Coordination activities are the least common for platform-based start-ups, due possibly to a 'winner-take-all' approach in platform markets that discourages coordination.

4.4. Service-based start-ups

The most common cluster of activity for service-based start-ups is product-development and optimization. Within this cluster, activities related to developing feedback loops with user groups are found to be particularly salient. According to interviewees, 'products-as-a-service' (PaaS) is a customer-centric business model best optimized through user feedback. "We have noticed it takes time before consumers accept the 'PaaS' concept, as we call it. People are not used to 'purchasing' PaaS and therefore it is necessary to capture users' experiences and views on this concept. How can we change or frame the PaaS concept in a way people will be more willing to adopt the PaaS concept? This is the critical question for us." This finding is consistent with literature on consumer acceptance of the product-service system model (Elzinga et al., 2020; Piscicelli et al., 2015, 2018). PaaS may help start-ups orient their business models more towards the extension of useable life of given products, prompting innovation not only on technological dimensions but also in the user experience with the product and the way customers interface with the start-up itself.

The second most common cluster of activity is socio-cultural change, with service-based start-ups focusing particularly on changing user habits. An example is Piece of Plate, a start-up that delivers sustainable cooking workshops about food waste streams from retail supply chains. "I feel that my workshops can flip that switch to make it fun and appealing. It does not have to be a burden to make sustainable choices; it is as simple as that … The platform provides weekly recipes because one workshop won't create behavioral change. [We do this] with the aim of building a community and keeping the momentum going" (interview 39).

To deliver such services, including those focused on socio-cultural change, start-ups often need partners and this has driven coordination. The founder of Piece of Plate states, "We collaborate now with a cooking school to put a completely new product on their portfolio. They have a lot of cooking workshops but there are no vegetarian or vegan workshops yet. I feel that the impact needs to be made at places where it is not being adopted yet" (interview 39). Market-creation is not identified as a salient issue. "I do not think this is the right way to achieve change in user behavior. The education system is so large and changes so slowly. I would rather spend time and money in marketing to achieve socio-cultural changes" (interview 39).

4.5. Nature-based start-ups

Nature-based start-ups put the strongest focus on product-development and optimization. An example is De Dakdokters, a start-up developing green rooftops. According to interviewee (4) representing this start-up, "The main thing now is to build the team and focus on core products and diversification." The second most common activity is market-creation, as the market for nature-based solutions is still at an early stage. Findings show that generating viable business models that incentivize investments in innovations is a particularly challenging task for nature-based start-ups. "A roof garden provides an enormous amount of added value, but it is difficult to translate it into a revenue stream. Monetizing the value of a roof garden is very difficult. That is the challenge for us" (interview 4; see de Jesus and Aguiar Borges (2024) for a case of circularity in urban agriculture). Nature-based business models also struggle to perform with respect to financing cycles and valuation mechanisms, for several reasons. First, the payoffs of nature-based solutions are in many ways collective or public in nature (i.e., environmental benefits) and thus cannot readily be captured as private profit.

[4] Participating agencies include the Directorate-General for Public Works and Water Management (Rijkswaterstaat), the Central Government Real Estate Agency (Rijksvastgoedbedrijf), De Bouwcampus, and NEN.

[5] See Vosman et al. (2021) for a discussion about innovation ecosystems in the construction sector and Wielopolski and Bulthuis (2023) for a discussion about the role of multi-stakeholder collaboration in fostering a circular innovation ecosystem in the construction sector.

Second, while nature-based solutions typically require high up-front investment costs, they tend to carry higher risk due to their innovative nature, while their payoffs are often realized only in the long-term. For example, the principal benefit of a green roof to the private building owner is the increased longevity of the roofing system – a benefit that may take decades to materialize (Carter and Keeler, 2008).

Coordination activities receive somewhat less attention from nature-based start-ups, which see these activities as important primarily at a later development stage. "I do believe that the activities within this cluster 'coordination' are highly important; this is something I am also planning to do. However, for now I'd rather focus on creating bigger market share and making sure our clients are 100% happy with our service. After that, my goal is definitely to crawl into the role of orchestrator in the ecosystem" (interview 8). This comment reflects how the activities adopted can depend on a start-up's stage of development, underscoring that decisionmaking is a function not only of the external market environment but also of internal circumstances.

Socio-cultural change scores relatively low for nature-based start-ups, as interviewees indicate that such efforts could be cumbersome while failing to provide direct and demonstrable benefits. "Changing the educational system would take me a lot of time and effort, while not knowing if it would lead to any result" (interview 8).

5. Discussion and conclusion

This study has examined the system-building activities of circular start-ups in an effort to understand whether and how they differ across business model types and circular innovations. The findings help to develop a more nuanced scholarly understanding of system-building, showing that types of system-building activities differ and that related activities differ in importance across circular innovation types. Product-development and optimization was found to be the most common activity for all types of circular start-ups. This finding indicates that, regardless of the type of business model, a well-functioning and viable product is a crucial component of a new innovation system. As Planko et al. (2016; p. 2334) states, "If the [product] is faulty, all other system-building activities may be in vain." Such activities are especially important for design-based and nature-based start-ups, for which innovations in core technology are a central aspect of business models.

Market-creation is found to be particularly common among nature-based start-ups, as the existing market for nature-based products is smaller than what interviewees maintain that it could be. This cluster of activities is also essential for platform-based start-ups, due to a competitive setting characterized by a 'winner-take-all' dynamic and the need for start-ups to quickly achieve a critical mass of users.

Socio-cultural change activities are found to be common among service-based and waste-based start-ups, but differences are observed in the latter between the two sectors. While waste-based start-ups in the food sector heavily promote the prevention of food waste among consumers (including students), waste-based start-ups rarely engage in this type of anti-waste awareness activity. Circular start-ups of all types engage relatively less in coordination activities, as these activities are perceived to be more relevant at a later development stage. Furthermore, start-ups often lack the individual means or power to achieve actor coordination.

Several limitations of this study point towards opportunities for further research. First, the study is limited to one national context and two industries. Future research should explore this issue in other sectors and national settings. Second, the study is exploratory and its sample size is limited, potentially compromising the study's external validity. Future work should expand the sample size, either through more interview research or through large-N surveys that can canvass a broader cross-section of the market. Third, the adoption of system-building activities may be influenced both by the characteristics of the start-up and by those of the sector itself or the immediate environment. Further research should compare multiple ecosystems as groups of actors, identifying within-group and cross-group differences in firm-level activities. Finally, the framework used for this study, based primarily on that of Planko et al. (2016), may need to be further adjusted, particularly where the focus is on strategies like negative marketing. As with this study's method of iterative adjustment to elements of the framework, so too would we expect the evolution of the literature to generate further refinement of this framework and the integration of others as additional empirical studies are conducted. Additionally, while the scope of this study did not include a systematic examination of facilitators of and barriers to the adopt of circular business models by start-ups, this salient issue deserves dedicated research; similar work conducted in the broader context of the circular economy (see Trevisan et al., 2023; Grafström and Aasma, 2021; Kirchherr et al., 2018) can serve as a template.

We conclude with policy and practical recommendations. This study has highlighted the importance of a well-functioning entrepreneurial ecosystem for the creation and up-scaling of circular start-ups. System-building activities, such as the adoption of more favorable regulations and social norms, can yield collective benefits and are crucial for fostering an environment for embedding circular innovations in socio-institutional systems. While it is often difficult for circular start-ups alone to conduct such activities, start-up networks and associations can generate the collective capacity needed to pool resources, encourage knowledge-sharing, develop technology, and enable system-building more generally (e.g., through collaborative marketing campaigns and policy-lobbying). As such, it is incumbent on individual start-ups to explore ways to connect and collaborate, despite competitive pressures that would have them withhold innovative ideas that could develop into industry-wide advantages. Circularity is a uniquely fertile issue on which to collaborate, as it is by nature strengthened through systemic efficiencies and capacities – particularly in the sharing of knowledge about the availability, condition, and use options of used materials.

Finally, governments can create public policies and regulatory instruments that apply to the unique needs of circular start-ups. Better understandings are needed regarding whether existing regulations constrain circularity adoption and how they can be redesigned in a way that still protects primarily policy objectives. Examples of are (i) legislation that impedes the use of food surplus or organic by-products, (ii) ambiguous or contradictory regulations concerning data ownership, privacy, and management, (iii) lagging standards on quickly developing technologies like AI, and (iv) accountancy rules to depreciate assets in a way that ignores the residual value of reused or remanufactured materials. Governments can also foster collaborations and communities-of-practice among circular start-up peers (Liu et al., 2023; Primario et al., 2024) and collaborations between circular start-ups and established firms by organizing and hosting platforms for B2B networks, following the aforementioned example of CB'23 in the construction sector (see Dzhengiz and Patala [2024] regarding cross-sector partnerships and van Bueren et al. [2023] and Arsova et al. [2021] regarding multi-level stakeholder participation). In such cases, policy efforts should seek to mitigate power asymmetries between start-ups and incumbents and ensure that the needs and interests of start-ups are adequately represented. In combination, efforts from both the public and private sector can help circular start-ups overcome barriers in fostering innovation ecosystems and, by extension, circular transition more generally.

CRediT authorship contribution statement

Thomas Bauwens: Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Kris Hartley:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology. **Marko Hekkert:** Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Julian Kirchherr:** Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Conceptualization.

Funding acknowledgment

This research was supported by funding from the Dutch Research Council (NWO) (DBM II - 438.17.904, Transitioning Towards a Circular Economy: The Role of Circular Start-up Hubs).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix. Overview of circular start-ups and innovation system actors interviewed

Sector	Type of actor	# Interview	Organization name	Business model/mission	Interviewee's function
Construction	Start-up	1	BlockMaterials	Applies Blockchain technology to real estate challenges and the circular economy	CEO and founder
		2	C3 Living	Develops housing units are based on used sea containers that are equipped with, among other things, Cradle2Cradle materials and solar panels	CFO
		3	Cybe	Develops mobile 3D concrete printers which can print concrete elements of buildings, mostly walls	Founder and CEO
		4	De Dakdokters	Improve urban health by transforming roofs	CEO and founder
		5	DenimTex	Produces circular wall decoration made of cotton and biobased textile fibers	CEO and founder
		6	Ekotex	Designs sustainable systems for wall finishing, both in- and outdoor	CEO
		7	Everuse	Produces high performance acoustic and thermal insulation made from waste and guaranteed to have everlasting life	CEO and founder
		8	FieldFactors	Develops a system for rainwater treatment, storage and reuse, based on biomimicry principles	CEO and founder
		9	Beladon	Designs and creates iconic, innovative, sustainable buildings and landscapes on the water	Founder and CEO
		10	HillBlock	Has developed a dyke stone that absorbs wave energy	CEO and founder
		11	Madaster	Couples a material identity to a certain location and registers this in a material passport	Partnership manager
		12	New Horizon	Extracts useable and raw materials from buildings	CEO
		13	QuickPanell	Produces circular wall elements based on a lightweight collapsible cardboard core	CEO and founder
		14	Repurpose	Promote the reuse of building materials, initiated by assignments, by bringing together the suppliers (demolition companies) and users (contractors) of used building materials	CEO and founder
		15	SmartCrusher	Has developed a technique for recovering the sand, gravel and cement from concrete	CEO and founder
		16	Sustainer Homes	Has developed a building software system which is able to generate various designs very rapidly, based on BIM-model and a self-developed physical circular module	CEO and founder
		17	The Box System	Builds prefabricated modules with 100% reusable materials	CEO
		18	WoodysHousing	Designs and turn-key building of sustainable business premises and offices	CEO
	Governmental institutions	19	Rijkswaterstaat	Responsible for the practical execution of the public works and water management	Board member
		20	Municipality of Heerlen	Manages the city of Heerlen	
	Incubators and accelerators	21	Climate Kic	Knowledge and Innovation Community (KIC), working to accelerate the transition to a zero-carbon economy	Board member
		22	Impact Hub	Network focused on building entrepreneurial communities for impact at scale	Board member
	Incumbent	23	Bam	European construction group that unites operating companies in construction and civil engineering	CEO
		24	NIBE	Global group that develops and manufactures intelligent, energy-efficient indoor comfort solutions for all types of properties	CEO
	Network platforms	25	Cirkelstad	Platform for private and public parties developing circular solutions in the built environment	Board member
		26	CB'23	Platform for private and public parties developing circular solutions in the built environment	Board member
	Research institutes	27	TU Delft	Dutch public technological university	Professor
		28	Eindhoven University	Dutch public technological university	Professor

(*continued on next page*)

(*continued*)

Sector	Type of actor	# Interview	Organization name	Business model/mission	Interviewee's function
Food	Start-up	29	Betuwse Krenkelaar	Produces ciders from rejected fruit streams	Co-founder and CEO
		30	Fungi Factory	Produces mushrooms from coffee ground residue streams	Co-founder and COO
		31	Get Chef's	Platform for consumers to get leftover meals from restaurants, and for municipalities to tailor catering demands for lunches	Founder and CEO
		32	Glorious Bastards	Produces ketchup and chutneys from rejected tomato streams	Founder and CEO
		33	GRO	Produces mushrooms from coffee ground residue streams	CEO
		34	Kromkommer	Makes soup from discarded vegetables	CEO
		35	Krusli	Produces breakfast cereals from beer and fruit waste streams	Founder and CEO
		36	Oma's Soep	Collective activity with lonely elderly by making soups from waste streams, the soups are consumed together and surplus of soups are sold within retail chains	Co-founder and CEO
		37	Peel Pioneers	Produces cosmetic products from fruit waste streams	Sales manager
		38	Pectcof	Develops bio-compounds from coffee-pulp biomass for the production of food ingredients, biochemicals and second generation bio-fuels	Co-founder and CEO
		39	Piece of Plate	Sustainable cooking workshop with food waste streams from retail supply chains. Raising awareness about seasonal, local, organic, vegan and vegetarian concepts	CEO
		40	Potverdorie!	Makes jams and chutneys from rejected fruits	CEO
		41	Rotterzwam	Produces mushrooms from coffee ground residue streams	Founder and CEO
		42	Wasteless	Develops artificial Intelligence-powered dynamic pricing system to recapture the full value of perishable products and reduce food waste	CEO
		43	Wastewatchers	Food waste monitoring tool and consultancy workshops for kitchen staff	CEO
		44	Zero Foodwaste	Automated food waste monitoring system for the catering industry	CEO
		45	Westerzwam	Produces mushrooms from coffee ground residue streams	CEO
		46	ZuiderZwam	Produces mushrooms from coffee ground residue streams	CEO
		47	De Zwammerij	Produces mushrooms from coffee ground residue streams	CEO
	Financier	48	Stichting DOEN	Foundation that financially supports sustainable enterprises, including circular start-ups, in the Netherlands and abroad	Financial expert
	Network platforms	49	Slow Food Youth Network	International network of young food enthusiasts, chefs, activists, students and food producers who bring about changes in food production and food consumption	Board member
		50	No Waste Network	Network created at the initiative of the Ministry of Economic Affairs aimed at entrepreneurs and organizations in the food chain, with the mission of preventing food waste and optimizing the economic value of unpreventable surplus food	Board member
		51	Samen Tegen Voedselverspilling	Sectoral network of circular actors within the food production and hospitality sector	Co-founder
	Research institutes	52	HAS University of Applied Sciences	Independent university of applied sciences, specializing in food, agriculture, horticulture, nature and environment	Lecturer
	Consultant services	53	Greendish Consultancy	Consultancy company specialized in sustainable food and food waste prevention	Project manager

Data availability

Data will be made available on request.

References

Aarikka-Stenroos, L., Ritala, P., Thomas, L.D., 2021. Circular economy ecosystems: a typology, definitions, and implications. In: Research Handbook of Sustainability Agency, pp. 260–276.

Ács, Z.J., Autio, E., Szerb, L., 2014. National systems of entrepreneurship: measurement issues and policy implications. Res. Pol. 43 (3), 476–494. https://doi.org/10.1016/j.respol.2013.08.016 ti.

Ajwani-Ramchandani, R., Figueira, S., de Oliveira, R.T., Jha, S., Ramchandani, A., Schuricht, L., 2021. Towards a circular economy for packaging waste by using new technologies: the case of large multinationals in emerging economies. J. Clean. Prod. 281, 125139.

Alvedalen, J., Boschma, R., 2017. A critical review of entrepreneurial ecosystems research: towards a future research agenda. Eur. Plann. Stud. 25 (6), 887–903. https://doi.org/10.1080/09654313.2017.1299694.

Arsova, S., Genovese, A., Ketikidis, P.H., Alberich, J.P., Solomon, A., 2021. Implementing regional circular economy policies: a proposed living constellation of stakeholders. Sustainability 13 (9), 4916.

Bakry, D., Daim, T., Alzahrani, S., Dabic, M., Yesilada, B., 2024. Exploring innovation ecosystems to facilitate the adoption of sustainable entrepreneurship: looking beyond the Western World. J. Small Bus. Manag. 1–51.

Bastein, A.G.T.M., Roelofs, E., Rietveld, E., Hoogendoorn, A., 2013. Opportunities for a Circular Economy in the Netherlands, 125. TNO, Delft.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., Rickne, A., 2008. Analyzing the functional dynamics of technological innovation systems: a scheme of analysis. Res. Pol. 37 (3), 407–429. https://doi.org/10.1016/j.respol.2007.12.003.

Biernacki, P., Waldorf, D., 1981. Snowball sampling: problems and techniques of chain referral sampling. Socio. Methods Res. 10 (2), 141–163. https://doi.org/10.1177/004912418101000205.

Blank, S., Blank, S.G., Dorf, B., 2012. The Startup Owner's Manual: the Step-by-step Guide for Building a Great Company. K&S Ranch, Incorporated.

Bocken, N., Kraaijenhagen, C., Konietzko, J., Baldassarre, B., Brown, P., Schuit, C., 2021. Experimenting with new business model strategies for the circular economy. In: Research Handbook of Innovation for a Circular Economy. Edward Elgar Publishing, pp. 222–235.

Bos-Brouwers, H.E.J., 2010. Corporate sustainability and innovation in SMEs: evidence of themes and activities in practice. Bus. Strat. Environ. 19 (7), 417–435. https://doi.org/10.1002/bse.652.

Cachat-Rosset, G., Klarsfeld, A., 2023. Diversity, equity, and inclusion in artificial intelligence: an evaluation of guidelines. Appl. Artif. Intell. 37 (1), 2176618.

Carter, T., Keeler, A., 2008. Life-cycle cost–benefit analysis of extensive vegetated roof systems. J. Environ. Manag. 87 (3), 350–363. https://doi.org/10.1016/j.jenvman.2007.01.024.
Christensen, C.M., 1997. The Innovator's Dilemma: when New Technologies Cause Great Firms to Fail. Harvard Business School Press.
Cullen, U.A., De Angelis, R., 2020. Circular entrepreneurship: a business model perspective. Resour. Conserv. Recycl. 105300. https://doi.org/10.1016/j.resconrec.2020.105300.
Dahan, N., 2005. Can there Be a resource-based view of politics? International Studies of Management & Organization, 35. JSTOR, pp. 8–27, 2.
de Jesus, A., Aguiar Borges, L., 2024. Pathways for cleaner, greener, healthier cities: what is the role of urban agriculture in the circular economy of two nordic cities? Sustainability 16 (3), 1258.
de Jesus, A., Antunes, P., Santos, R., Mendonça, S., 2018. Eco-innovation in the transition to a circular economy: an analytical literature review. J. Clean. Prod. 172, 2999–3018.
Dedehayir, O., Mäkinen, S.J., Roland Ortt, J., 2018. Roles during innovation ecosystem genesis: a literature review. Technol. Forecast. Soc. Change 136, 18–29. https://doi.org/10.1016/j.techfore.2016.11.028.
de Vasconcelos Gomes, L.A., de Faria, A.M., Braz, A.C., de Mello, A.M., Borini, F.M., Ometto, A.R., 2023. Circular ecosystem management: orchestrating ecosystem value proposition and configuration. Int. J. Prod. Econ. 256, 108725.
Dzhengiz, T., Patala, S., 2024. The role of cross-sector partnerships in the dynamics between places and innovation ecosystems. R. Manag. 54 (2), 370–397.
Drakopoulou Dodd, S., Anderson, A.R., 2007. Mumpsimus and the mything of the individualistic entrepreneur. Int. Small Bus. J. 25 (4), 341–360. https://doi.org/10.1177/0266242607078561.
Eisenmann, T.R., Parker, G.G., Alstyne, M.W.V., 2006. Strategies for two-sided markets. Harv. Bus. Rev. October 2006 https://hbr.org/2006/10/strategies-for-two-sided-markets.
Elzinga, R., Reike, D., Negro, S.O., Boon, W.P.C., 2020. Consumer acceptance of circular business models. J. Clean. Prod. 254, 119988. https://doi.org/10.1016/j.jclepro.2020.119988.
European Startup Initiative, 2019. Startup heatmap report: startup city brands & highways. http://startupsandplaces.com/wp-content/uploads/2019/10/SHM2019_FullReport-1.pdf.
Fehrer, J.A., Kemper, J.A., Baker, J.J., 2024. Shaping circular service ecosystems. J. Serv. Res. 27 (1), 49–68.
Ferreira, J.J., Candeias Fernandes, A.J., Gerschewski, S., 2024. Innovative business models of SMEs: state-of-the-art and future research agenda. J. Small Bus. Enterprise Dev. 31 (3), 445–472.
Fritsch, M., 2001. Co-Operation in regional innovation systems. Reg. Stud. 35 (4), 297–307. https://doi.org/10.1080/00343400124434.
Garud, R., Hardy, C., Maguire, S., 2007. Institutional entrepreneurship as embedded agency: an introduction to the special issue. Organ. Stud. 28 (7), 957–969. https://doi.org/10.1177/0170840607078958.
Garud, R., Karnøe, P., 2003. Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. Res. Pol. 32 (2), 277–300. https://doi.org/10.1016/S0048-7333(02)00100-2.
Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J., 2017. The Circular Economy – a new sustainability paradigm? J. Clean. Prod. 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048.
Gidley, D., 2020. Creating institutional disruption: an alternative method to study institutions. J. Organ. Change Manag. https://doi.org/10.1108/JOCM-06-2019-0200. *ahead-of-print*(ahead-of-print).
Government of the Netherlands, 2016. A Circular Economy in the Netherlands by 2050: Government-wide Programme for a Circular Economy. Government of the Netherlands.
Grafström, J., Aasma, S., 2021. Breaking circular economy barriers. J. Clean. Prod. 292, 126002.
Green, J., Thorogood, N., 2018. Qualitative Methods for Health Research. Sage Publications.
Hagiu, A., Rothman, S., 2016. Network effects aren't enough. Harv. Bus. Rev. April 2016 https://hbr.org/2016/04/network-effects-arent-enough.
Haucke, F.V., 2018. Smartphone-enabled social change: evidence from the Fairphone case? J. Clean. Prod. 197, 1719–1730. https://doi.org/10.1016/j.jclepro.2017.07.014.
Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S., Smits, R.E.H.M., 2007. Functions of innovation systems: a new approach for analysing technological change. Technol. Forecast. Soc. Change 74 (4), 413–432. https://doi.org/10.1016/j.techfore.2006.03.002.
Henderson, R.M., Clark, K.B., 1990. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. Adm. Sci. Q. 35 (1), 9–30.
Henry, M., Bauwens, T., Hekkert, M., Kirchherr, J., 2020. A typology of circular start-ups: an Analysis of 128 circular business models. J. Clean. Prod. 245, 118528. https://doi.org/10.1016/j.jclepro.2019.118528.
Hill, C.W.L., Rothaermel, F.T., 2003. The performance of incumbent firms in the face of radical technological innovation. Acad. Manag. Rev. 28 (2), 257–274. https://doi.org/10.2307/30040712.
Hockerts, K., Wüstenhagen, R., 2010. Greening Goliaths versus emerging Davids—theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. J. Bus. Ventur. 25 (5), 481–492. https://doi.org/10.1016/j.jbusvent.2009.07.005.
Hsieh, H.-F., Shannon, S.E., 2005. Three approaches to qualitative content analysis. Qual. Health Res. 15 (9), 1277–1288. https://doi.org/10.1177/1049732305276687.
Kirchherr, J., van Santen, R., 2019. Research on the circular economy: A critique of the field. Resour. Conserv. Recycl. 151.
Kirchherr, J., Yang, N.H.N., Schulze-Spüntrup, F., Heerink, M.J., Hartley, K., 2023. Conceptualizing the circular economy (revisited): an analysis of 221 definitions. Resour. Conserv. Recycl. 194, 107001.
Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., Hekkert, M., 2018. Barriers to the circular economy: evidence from the European union (EU). Ecol. Econ. 150, 264–272.
Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005.
Koval, V., Arsawan, I.W.E., Suryantini, N.P.S., Kovbasenko, S., Fisunenko, N., Aloshyna, T., 2022. Circular economy and sustainability-oriented innovation: conceptual framework and energy future avenue. Energies 16 (1), 243.
Kukk, P., Moors, E.H.M., Hekkert, M.P., 2015. The complexities in system building strategies—the case of personalized cancer medicines in England. Technol. Forecast. Soc. Change 98, 47–59. https://doi.org/10.1016/j.techfore.2015.05.019.
Liu, Z., James, S., Walpole, G., White, G.R., 2023. A communities of practice approach to promoting regional circular economy innovation: evidence from East Wales. Eur. Plann. Stud. 31 (5), 988–1006.
Marantes, G., Soares, A.L., Silva, H.D., 2023. The design of digital platform ecosystem supporting circular economy. In: Working Conference on Virtual Enterprises. Springer Nature Switzerland, Cham, pp. 80–90.
Marino, A., Pariso, P., 2020. Comparing European countries' performances in the transition towards the Circular Economy. Sci. Total Environ. 729, 138142.
Markard, J., Truffer, B., 2008. Technological innovation systems and the multi-level perspective: towards an integrated framework. Res. Pol. 37 (4), 596–615. https://doi.org/10.1016/j.respol.2008.01.004.
Musiolik, J., Markard, J., Hekkert, M., 2012. Networks and network resources in technological innovation systems: towards a conceptual framework for system building. Technol. Forecast. Soc. Change 79 (6), 1032–1048. https://doi.org/10.1016/j.techfore.2012.01.003.
Musiolik, J., Markard, J., Hekkert, M., Furrer, B., 2020. Creating innovation systems: how resource constellations affect the strategies of system builders. Technol. Forecast. Soc. Change 153, 119209. https://doi.org/10.1016/j.techfore.2018.02.002.
Neck, H.M., Meyer, G.D., Cohen, B., Corbett, A.C., 2004. An entrepreneurial system view of new venture creation. J. Small Bus. Manag. 42 (2), 190–208. https://doi.org/10.1111/j.1540-627X.2004.00105.x.
Pelzer, P., Frenken, K., Boon, W., 2019. Institutional entrepreneurship in the platform economy: how Uber tried (and failed) to change the Dutch taxi law. Environ. Innov. Soc. Transit. 33, 1–12. https://doi.org/10.1016/j.eist.2019.02.003.
Pieroni, M.P.P., McAloone, T.C., Pigosso, D.C.A., 2019. Business model innovation for circular economy and sustainability: a review of approaches. J. Clean. Prod. 215, 198–216. https://doi.org/10.1016/j.jclepro.2019.01.036.
Pietrulla, F., 2022. Circular ecosystems: a review. Cleaner and Circular Bioeconomy 3, 100031.
Piscicelli, L., Ludden, G.D., Cooper, T., 2018. What makes a sustainable business model successful? An empirical comparison of two peer-to-peer goods-sharing platforms. J. Clean. Prod. 172, 4580–4591.
Piscicelli, L., Cooper, T., Fisher, T., 2015. The role of values in collaborative consumption: insights from a product-service system for lending and borrowing in the UK. J. Clean. Prod. 97, 21–29.
Planko, J., Cramer, J.M., Chappin, M.M.H., Hekkert, M.P., 2016. Strategic collective system building to commercialize sustainability innovations. J. Clean. Prod. 112, 2328–2341. https://doi.org/10.1016/j.jclepro.2015.09.108.
Primario, S., Rippa, P., Secundo, G., 2024. Peer innovation as an open innovation strategy for balancing competition and collaboration among technology start-ups in an innovation ecosystem. Journal of Innovation & Knowledge 9 (2), 100473.
Ranta, V., Aarikka-Stenroos, L., Mäkinen, S.J., 2018. Creating value in the circular economy: a structured multiple-case analysis of business models. J. Clean. Prod. 201, 988–1000. https://doi.org/10.1016/j.jclepro.2018.08.072.
Silva, L.E.N., de Vasconcelos Gomes, L.A., de Faria, A.M., Borini, F.M., 2024. Innovation processes in ecosystem settings: an integrative framework and future directions. Technovation 132, 102984.
Spigel, B., 2017. The relational organization of entrepreneurial ecosystems. Entrep. Theory Pract. 41 (1), 49–72. https://doi.org/10.1111/etap.12167.
Stam, E., 2015. Entrepreneurial ecosystems and regional policy: a sympathetic critique. Eur. Plann. Stud. 23 (9), 1759–1769. https://doi.org/10.1080/09654313.2015.1061484.
Straub, L., Hartley, K., Dyakonov, I., Gupta, H., van Vuuren, D., Kirchherr, J., 2023. Employee skills for circular business model implementation: a taxonomy. J. Clean. Prod. 410, 137027.
Suchek, N., Ferreira, J.J., Fernandes, P.O., 2022. A review of entrepreneurship and circular economy research: state of the art and future directions. Bus. Strat. Environ. 31 (5), 2256–2283.
Thakur, P., Wilson, V.H., 2023. Circular innovation ecosystem: a multi-actor, multi-peripheral and multi-platform perspective. Environ. Dev. Sustain. 1–24.
Tijani, B., Oyinlola, M., Okoya, S.A., 2023. Digital innovation ecosystem for the circular plastic economy. In: Digital Innovations for a Circular Plastic Economy in Africa, 76.
Trevisan, A.H., Lobo, A., Guzzo, D., de Vasconcelos Gomes, L.A., Mascarenhas, J., 2023. Barriers to employing digital technologies for a circular economy: a multi-level perspective. J. Environ. Manag. 332, 117437.
Tuladhar, A., Iatridis, K., Dimov, D., 2023. Collaboration among circular start-ups and incumbents in the circular economy context. Bus. Strat. Environ. 33 (4), 3317–3330.

van Bueren, B.J., Argus, K., Iyer-Raniga, U., Leenders, M.A., 2023. The circular economy operating and stakeholder model "eco-5HM" to avoid circular fallacies that prevent sustainability. J. Clean. Prod. 391, 136096.
van De Ven, H., 1993. The development of an infrastructure for entrepreneurship. J. Bus. Ventur. 8 (3), 211–230. https://doi.org/10.1016/0883-9026(93)90028-4.
van der Vleuten, O., Balkenende, F., 2018. Heel Nederland helpt Kees van zijn pruimen af. AD.nl. https://www.ad.nl/zeeland/heel-nederland-helpt-kees-van-zijn-pruimen-af~a7ce50c0/.
Vosman, L., Coenen, T.B., Volker, L., Visscher, K., 2021. Exploring the innovation ecosystem concept for a construction industry in transition. In: 37th ARCOM Conference and Annual General Meeting: Recover, Rebuild and Renew. Association of Researchers in Construction Management (ARCOM), pp. 449–458.
Wielopolski, M., Bulthuis, W., 2023. The better building initiative—a collaborative ecosystem involving all stakeholders as catalyst to accelerate the adoption of circular economy innovations in the construction sector. Circular Economy and Sustainability 3 (2), 719–733.
Yin, R.K., 2009. Case Study Research: Design and Methods, 5. Sage.
Zhu, B., Nguyen, M., Siri, N.S., Malik, A., 2022. Towards a transformative model of circular economy for SMEs. J. Bus. Res. 144, 545–555.