



Business incubators as effective tools for driving circular economy

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ARTICLE INFO

Article history:

Received 22 October 2019

Received in revised form

21 April 2020

Accepted 29 April 2020

Available online 4 May 2020

Handling editor: Prof. Jiri Jaromir Klemes.

Keywords:

Circular economy

Entrepreneurship

Material flows analysis

Incubator

CE incubator

Circular economy incubator

ABSTRACT

The circular economy (CE), which reimagines waste as economic opportunity, has been largely overlooked by traditional entrepreneurs. One explanation for this oversight is that limited information flow and cognitive bias limit their ability to recognize and develop CE opportunities. We propose a framework for a CE-focused incubator that removes these barriers to circular economy entrepreneurship. The framework defines how multiple stakeholders interact in order to provide critical information for CE development. Stakeholders include firms seeking economical ways to handle waste, firms that might use waste as value-added input, government agencies, and circular economy analysts that can provide potentially beneficial information, e.g. via Material Flow Analysis. Entrepreneurs would be recruited to develop CE ventures. The government would be asked to support initial financing, but the final start-ups would stand on their own as enterprises worthy of venture capital funding. The collaborative environment would promote profitable CE behavior. CE entrepreneurs need access to relevant information and a supportive network, both of which the CE-focused incubator we propose provides. Future work is needed to implement CE-incubators to engage entrepreneurs to realize economic and environmental benefits.

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1. Introduction

The circular economy (CE), which reimagines waste as economic opportunity, has been largely overlooked by traditional entrepreneurs. This oversight becomes more significant every day as society grows increasingly concerned with the environment (Govindan and Hasanagic, 2018; Longo et al., 2019; Ruiz et al., 2020; Sassanelli et al., 2019). One explanation for this oversight is that limited information flow and cognitive bias limit their ability to recognize and develop CE opportunities (c.f., Zhou et al., 2020). Meanwhile, the CE literature has focused more on established companies (c.f., Henry et al., 2020).

The core concept of industrial symbiosis (IS) can be described as 'traditionally separate entities in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and by-products' (Chertow, 2000; c.f., Chertow and Park, 2016). IS networks and benefits are an important part of a circular economy (Andersen, 2007; Lewandowski, 2016; Henry et al., 2020; Martín Gómez et al., 2018), an economic system that finds or creates value for waste, and sustainable development, from the level of the product and its design to national economies (Kirchherr et al., 2017). An IS network is characterized by a minimum of three

different organizations involved in an exchange of at least two separate resources, not including recycling (Chertow, 2007; Chertow and Park, 2016). Reaching, and exceeding, this threshold might be challenging for unaffiliated entrepreneurs. This may be why the literature focuses on collaboration among established companies, as in eco-industrial systems.

Proponents of eco-industrial systems seek to improve environmental and economic performance via collaborative IS efforts (Chertow, 2000; Chertow and Park, 2016; Côté and Cohen-Rosenthal, 1998; Mathews and Tan, 2011). Eco-industrial parks (EIPs), physical sites where companies pursue IS collaboratively, are typical eco-industrial systems, and the synergies they develop can improve the environmental and economic performance of resident firms (Côté and Hall, 1995; Gibbs and Deutz, 2007; Lowe, 1997; Mathews and Tan, 2011). EIPs require waste and emission flow infrastructure (Tudor et al., 2006), which can be expensive to develop. The mixed success for planned EIPs (Chertow, 2007; Gibbs and Deutz, 2005; Mirata, 2004) has led to a call for additional business approaches (Siskos and Van Wassenhove, 2017). There is an emerging, still-evolving understanding of the nature of CE business models (Bocken et al., 2016; Henry et al., 2020; Tunn et al., 2019). We hope to contribute to this understanding with a new framework for business incubators that produce new CE ventures.

Incubators could promote IS activity (Chance et al., 2018; Mulrow et al., 2017) among entrepreneurs with no vested interest in existing linear-economy processes. Their affiliation with the CE

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incubator would also resolve the networking problems faced by an unaffiliated entrepreneur trying to establish an IS system. We thus believe the CE incubator, as a means of engaging entrepreneurs in developing profitable and environmentally sustainable ventures, deserves in-depth examination.

The article is organized as follows: In [subsection 1.1](#) we discuss the gap in the literature. We then, in [section 2](#), review elements to consider in modifying the traditional incubator framework to promote CE: what CE is, barriers to its adoption, the role of opportunity recognition in entrepreneurship, current understanding of the role of networks in promoting industrial symbiosis, material flows analysis, and the traditional incubator framework and why it needs modification. In [section 3](#) we lay out our proposal for a modified incubator framework, i.e. the flow to processes from ideation to selection incubation to post incubation, and roles for stakeholders needed. Circular economy incubators are compared with the centrally planned eco-industrial park approach in [Section 4](#). [Section 5](#) presents thoughts on applying the circular economy incubator framework in the real world.

1.1. Literature gap

There is limited prior work on CE incubators. In Sweden, an incubator has identified new industries for waste materials and energy ([Aid et al., 2017](#)), and developed start-up opportunities that support EIP actors and CE development ([Bellantuono et al., 2017](#); [Wen and Meng, 2015](#)). While there is certainly a need for more efforts to implement CE incubators, there is also a need for a theoretical framework that informs their design. [Murray et al., 2017](#) note that the lack of alternative business models limits the transition to CE, and [Gray et al. \(2019\)](#) call for the use of a more businesslike approach to such challenges as climate change. Meanwhile, in a comprehensive review of sustainable entrepreneurship, [Terán-Yépez et al. \(2020\)](#) call for more work on how entrepreneurs can recognize and develop sustainable business opportunities. In this work we propose a modified conceptual framework for incubators intended to address specific obstacles to entrepreneurship for CE, including barriers to recognizing and developing sustainable (CE) opportunities. The word framework is used in this context to mean a flow of processes mapping the development of an idea to a business, with roles in each process specified for different stakeholders. Our proposed CE incubator collects and disseminates CE-related information from many participants and develops collaborative business opportunities related to sustainable entrepreneurship. With these additional knowledge-based resources, entrepreneurs can improve their performance ([Aagaard, 2018](#); [Alvarez and Busenitz, 2001](#); [Wiklund and Shepherd, 2003](#); [Zhu et al., 2018](#)). Expanded informational inputs developed by the CE incubator are expected to yield stronger venture ideas and better opportunity development related to environmental performance. We thus hope to contribute both to the knowledge-based view of opportunity and its related entrepreneurial concepts, and to our understanding of how CE entrepreneurship works and can be encouraged. In practical terms, we hope our framework can be used to bring additional firms into the CE mechanism by using entrepreneurs to identify solutions to waste challenges resulting from industrial and manufacturing activities.

2. Review of critical elements

2.1. Circular economy

Economic development (and entrepreneurial activity) is normally linear ([MacArthur, 2015](#)), with resources identified,

extracted, used, and – rather than waste emerging as a valuable resource ([Perey et al., 2018](#)) – discarded. But sustainability is increasingly providing entrepreneurial opportunities to those capable of finding and recognizing them ([Boons et al., 2013](#); [Perey et al., 2018](#)). To ensure long-term sustainability, economic growth needs to be decoupled from increasing resource consumption and its environmental impacts ([Henry et al., 2020](#); [Schandl et al., 2016](#)). This emerging need for decoupling is an entrepreneurial opportunity. Entrepreneurs can use CE to disrupt linear economies and linear-economy incumbent companies ([Henry et al., 2020](#)).

Unlike other approaches for decoupling economic growth and environmental impacts, CE addresses industrial as well as economic, resource, and environmental concerns ([D'amato et al., 2017](#)). It reduces the use of finite natural resources, diverting waste from landfills and the environment and capturing the inherent value of waste streams ([Aranda-Usón et al., 2020](#); [Siskos and Van Wassenhove, 2017](#)). CE can provide macroeconomic benefits ([Geissdoerfer et al., 2017](#); [MacArthur et al., 2015](#)) and helps build resilient infrastructure, promote sustainable industrialization, foster innovation, and create new jobs ([MacArthur et al., 2015](#); [Morgan and Mitchell, 2015](#); [Rossi et al., 2020](#)). CE opportunities can reduce a nation's dependency on foreign economies by generating revenue and products from waste ([Mulrow et al., 2017](#)). They can potentially even reverse that dependency by exporting products that use waste as raw material ([Perey et al., 2018](#)). Thus, entrepreneurs that take advantage of CE opportunities can reduce expenses and strengthen their economic performance. It is worth noting that not all proponents of CE view it as means to economic growth; a study of scholar opinions indicated some negative opinions on economic growth ([D'amato et al., 2019](#)). These scholars, however, seemed to consider economic growth a bad thing in itself, rather than to deny that CE can lead to economic growth. We consider CE to be a path to sustainable consumption by reducing the negative impact of consumption on the environment, or even total consumption ([Tunn et al., 2019](#)), while providing opportunities for sustainable economic growth.

Because a circular economy uses renewable and reusable resources instead of virgin materials, it produces financial benefits and reduced environmental impacts ([Geissdoerfer et al., 2017](#); [Govindan and Hasanagic, 2018](#); [Haupt et al., 2017](#)). Circular economic entrepreneurial activity can improve economic development in an environmentally sustainable manner by developing CE's 'closed loop' ([Henry et al., 2020](#); [Mulrow et al., 2017](#)). Closing the loop in product and materials systems provides financial savings, resource resilience, additional income streams, and innovative new products ([Ellen MacArthur Foundation, 2018](#); [Mulrow et al., 2017](#)) while potentially reducing consumption at the same time ([Millette et al., 2019](#); [Tunn et al., 2019](#)).

Governments that encourage CE can expect more entrepreneurial activity, increased employment, improved environmental conditions, less waste sent to landfills, improved economic sustainability, and reduced raw material requirements ([Aranda-Usón et al., 2020](#); [Giudici et al., 2017](#); [Rossi et al., 2020](#)). Legislative and policy support of circular economics can help entrepreneurs reduce resource use, waste generation, and the release of carbon dioxide ([Ruiz et al., 2020](#)). Financially, CE is well worth pursuing, with an estimated \$340 billion in potential savings for the European Union alone ([Andersen, 2007](#)).

CE, with its roots in industrial ecology ([Andersen, 2007](#); [Saavedra et al., 2018](#)), specifically industrial symbiosis, provides opportunities to profitably disrupt unsustainable environmental exploitation ([Chertow, 2007](#); [Chertow and Park, 2016](#); [Ghisellini et al., 2016](#)). Focused incubators can thus help entrepreneurs find and recognize CE opportunities and develop profitable ventures to exploit them by:

- finding and helping develop areas of industrial coordination,
- creating projects that increase existing areas of cooperation,
- providing short-term incentives (e.g., admission to the incubator) to identify, evaluate, create, and grow new interactions.

Entrepreneurs willing to be environmental if it's profitable can benefit from being networked in a CE industrial ecosystem, through an incubator or otherwise. CE can mitigate global price instability, encourage innovation, increase employment, and add resilience to the local economy (Ellen MacArthur Foundation, 2018; Gower and Schroder, 2016). And CE entrepreneurs tend to be more circular than existing companies trying to catch up (Henry et al., 2020), and potentially earn better profits on their CE investments (Lin et al., 2019).

2.2. Barriers to circular economy

If CE entrepreneurship is to be profitable and environmentally sustainable, financial, economic, and knowledge-based barriers need to be overcome. Barriers to ecofriendly behaviors are rooted in individual beliefs, attitudes, and cultural and social norms (Carmi et al., 2015; Govindan and Hasanagic, 2018; Hoffman, 2010; Jin et al., 2017). Environmental knowledge and action are not necessarily linked (Kollmuss and Agyeman, 2002; Longo et al., 2019), and 'scientific fact' must become 'social fact' before the challenges of climate change can be addressed (Carmi et al., 2015; Longo et al., 2019). Lack of scientific and technological knowledge, and of government and community environmental awareness, are barriers to eco-friendly startup development (Giudici et al., 2017; Govindan and Hasanagic, 2018). Another barrier is the failure of scientific knowledge to achieve social acceptance and awareness. Exchange of knowledge among scientists, the government, and the community at large is important but may not be a priority for any of them. Unshared knowledge can lead to market failure, an opportunity that can be filled by the CE entrepreneur (Dean and McMullen, 2007). Recognizing opportunities and developing ventures to exploit them (for example, marketing the practical implications of the scientific knowledge in the form of products) is the natural role of the entrepreneur (Vogel, 2017). Supporting these entrepreneurs is the natural role of the incubator.

2.3. Opportunity recognition, entrepreneurial orientation, and connecting dots

Recognizing opportunities and developing ventures are essential to entrepreneurship (Kazanjian et al., 2002; Leonard-Barton, 1995; Vogel, 2017). The knowledge-based view suggests that novel information may be the ultimate competitive advantage (Albort-Morant et al., 2018; Grant, 1996; Kazanjian et al., 2002). Differences in information, the bounds of entrepreneurs' information focus, and their attitude about that information are critical to the choices entrepreneurs make (Covin et al., 2006; Hull et al., 2019; Jin et al., 2017). Recent work on CE has found that information limitations is a significant barrier to pursuing CE opportunities (Rossi et al., 2020; Zhou et al., 2020). Further theoretical work on venture idea generation and venture opportunity development and exploitation has been called for (Vogel, 2017).

Entrepreneurial opportunities arise from market failures, and environmental degradation can be considered such a market failure (Cohen and Winn, 2007). Lack of information (information asymmetry) creates market imperfection and thus opportunities (Dean and McMullen, 2007). Sustainable entrepreneurial activity can bridge this information gap, if the needed information is available to nascent entrepreneurs (Jin et al., 2017; Schaltegger and Wagner,

2011; Zhou et al., 2020). CE opportunities, such as reuse, remanufacturing, or recycling, have been under-explored by traditional entrepreneurs (Ellen MacArthur Foundation, 2018). CE, as a socially responsible activity, may be seen as a distraction or as in conflict with creating economic wealth. But, if approached strategically, social responsibility such as CE increases financial performance (Tang et al., 2012).

Entrepreneurs may fail to recognize and pursue valuable opportunities because they lack relevant knowledge (Jin et al., 2017; Simon, 1997). Entrepreneurs, like other leaders, create a bounded rationality that focuses their attention on particular information sources and types (Jin et al., 2017; Simon, 1997), and so miss opportunities embedded in information outside of their focus. Strategic choice (Child, 1972) is based on the concept that decision makers make choices rooted in an evaluation of the existing position of the organization (Tatoglu et al., 2019), influenced by the expectation and relationship with key stakeholders: If stakeholders have little expectation of sustainable behavior from a firm, it would not be included in the choices considered, so CE opportunities will be overlooked. For CE opportunities to be recognized and pursued, entrepreneurs must be able to recognize CE opportunities for what they are as well as being presented with information that includes real CE opportunities.

Opportunity-recognition research, consistent with the knowledge-based view, emphasizes the importance of information (Eckhardt et al., 2018; Ozgen and Baron, 2007; Patzelt and Shepherd, 2011). Accessing this information requires that entrepreneurs are plugged into a network that provides diversity of information, adjusting their mindsets and making them aware of opportunities beyond their general experience (Hull et al., 2019; Nogueira et al., 2019). New material flow analysis results (MFA), such as waste flows explained and presented as opportunities, would qualify as such information (c.f. Millette et al., 2019). Thinking of things in a different way (e.g., MFA) to make sense of unrelated events and information helps entrepreneurs invent products and services (Baron, 2006; Baron and Ensley, 2006; Longo et al., 2019). The propensity to seek out information from diverse sources can be viewed as part of entrepreneurial orientation (EO).

Entrepreneurial orientation (EO), a tendency toward entrepreneurial decision styles, methods, and practices (Lumpkin and Dess, 1996), has been linked to the propensity to recognize opportunities and achieve growth, and both EO and access to information resources are linked to innovation (Covin and Slevin, 1989; Covin et al., 2006; Hull et al., 2019; Ismail et al., 2015; Lumpkin and Dess, 1996; Miller, 1983). EO is an alternative way of thinking, incorporating flexibility and proactiveness, that can lead to the development of sustainability amongst new ventures (Jansson et al., 2015; Nidumolu et al., 2009). MFA (Millette et al., 2019; Sassanelli et al., 2019) and other CE analyses (Rossi et al., 2020) would thus, presumably, work best as a source of information for entrepreneurs high on EO.

Their degree of EO will impact the ability of entrepreneurs admitted to the incubator to recognize opportunities, develop appropriate ideas, and marshal the necessary resources, including networks, to make their ideas a success (Bank et al., 2017). EO is a group of entrepreneurial attitudes and behaviors, such as innovativeness, risk-taking, and proactiveness (Covin and Slevin, 1989; Covin et al., 2006; Ismail et al., 2015; Lumpkin and Dess, 1996; Wiklund and Shepherd, 2003), that have a positive impact on firm growth (Covin et al., 2006). EO increases recognition and pursuit of opportunity, and thus the role that information plays in spurring innovation. Recruiting and connecting entrepreneurially oriented entrepreneurs with new CE information can thus play a pivotal role in their innovation (Bank et al., 2017).

2.4. CE networks and eco-industrial parks

Networks can provide information (Boons et al., 2017; Chertow, 2007; Mortensen and Kørnø, 2019) and increase opportunity recognition (Amankwah-Amoah et al., 2018; Arenius and Clercq, 2005). West Coast Rubber Recycling (WCRR, 2019), for example, started by trucking used tires to the dump, then realized through its network that the market for recycled tires was more lucrative and better for the environment.

CE systems seek to keep materials in use as long as possible through industrial networks that promote resource sharing and reuse (Chertow, 2007; Martín Gómez et al., 2018; Valenzuela-Venegas et al., 2018, 2020). Industrial environmental ecosystems benefit the public more than standard industrial networks do (Ehrenfeld, 2003), but may require external assistance (Chertow, 2007). This sort of network relies on collaboration and synergy derived from geographic proximity (Siskos and Van Wassenhove, 2017; Valenzuela-Venegas et al., 2020). Such networks can occur without intervention, evolving from the desire to improve profitability, resource efficiencies, innovation, learning, and resilience via communication and trust (Ashton, 2008; Chertow et al., 2008; Eckelman et al., 2014; Henry et al., 2020; Mulrow et al., 2017). However, planned EIPs designed to replicate the success of naturally evolved industrial symbiosis systems like Kalundborg – where a natural system evolved (bottom-up) to share resources including waste streams (Lehtoranta et al., 2011; Mcdowall et al., 2017) – can be found the world over (Massard et al., 2014).

CE networks, including EIPs, facilitate the necessary industrial symbiosis by-product (waste) exchanges (Gregson et al., 2015; Valenzuela-Venegas et al., 2018, 2020) needed to create CE. Planned EIPs in China have been used to promote CE and experiment with policies meant to encourage the development of CE (Mcdowall et al., 2017). In response to financial, economic, and knowledge-related barriers to the development of CE, the development of a synergistic management services company (SMSCO) has been suggested as a component of the EIP (Siskos and Van Wassenhove, 2017). A SMSCO shifts the financial burden from participating CE firms to an interested third party (Siskos and Van Wassenhove, 2017).

As CE networks become established, they may come to include the exchange of materials, energy, water, and by-products described in the IS literature (e.g., Chertow and Park, 2016), and involve collaboration among multiple firms to improve profitability for all (Chertow, 2007; Henry et al., 2020). Planned and self-organizing EIPs seek to pool resources (including knowledge resources) and resource-sharing business support services. They also seek increased legitimacy, extension of networks, and co-location and clustering of businesses (Armanios et al., 2017; Li et al., 2015; Mirata, 2004). The recent use of incubators as part of the EIP structure (Aid et al., 2017; Bellantuono et al., 2017; Elmassah, 2018) seems to indicate that incubators can enhance EIP performance, if not replace them.

2.5. Material flow analysis

Material flow analysis (MFA) provides information on material and substance flows associated with products and activities within a system and tracks the flow of those materials, identifying quantities and accumulations (Haupt et al., 2017). CE is predicated upon understanding material flows, so a current MFA can be a source of valuable and rare new knowledge for entrepreneurs (Sassanelli et al., 2019), a potent source of competitive advantage (Barney, 2018; Jin et al., 2017; McMullen and Shepherd, 2006; Millette et al., 2019) which CE-focused incubators can create for their tenants regularly. MFA enables opportunity recognition but can also

offer improved efficiency, competitive advantage, and stakeholder engagement (Amankwah-Amoah et al., 2018). Revealing CE entrepreneurial opportunities can lead to a closed-loop economic system for various products and materials exploitable by SMEs and nascent entrepreneurs.

MFA is a material-accounting procedure that can be used at the firm, city, regional, or national level to track the flow of materials (Bringezu and Moriguchi, 2018; Brunner, 2001). Governments can use it to design environmental policy, resource allocation, and urban systems. MFA provides the same benefits to firms, yielding competitive advantages such as reduced material costs and product differentiation in markets with increasing environmental awareness. Since industrial wastes can have value, using MFA to identify waste reservoirs can identify revenue streams. MFA is adaptable, and can produce useable results from partial or limited information when that is all that is available (Millette et al., 2019). MFA's ability to track the impacts of industrial activity makes it particularly useful to CE incubators focused on encouraging new businesses that can profitably disrupt the linear consumption pattern of 'take-make-dispose' (Ellen MacArthur Foundation, 2018). This framework for a CE-focused incubator thus depends on the availability of a detailed, current MFA and on the incubator functioning as a mechanism for (information and waste) resource sharing (Chertow, 2007).

Access to knowledge resources relevant to opportunity and venture development is important to nascent entrepreneurs (c.f., Vogel, 2017). Tools such as material flow analysis (MFA) can provide such access that is particularly useful in breaking out of the selective perception that limits opportunity recognition (Simon, 1997). MFA provides information on material and substance flows associated with products and activities within a system and tracks the flow of those materials, identifying quantities, and accumulations (Haupt et al., 2017). Previously unidentified flows and accumulations are opportunities for entrepreneurs (Hull et al., 2019; Jin et al., 2017; Vogel, 2017). Linking firms in this way so that waste can be exchanged and used by other firms as production inputs creates synergies, easily recognized and exploited by members of the network (Chertow, 2007; Chertow and Park, 2016; Ehrenfeld and Chertow, 2002). Mulrow et al. (2017) provide a structure for the development of third-party support to bring industrial symbiosis to a facility-scale level. This structure can include a business incubator. Our proposed CE incubator is a conceptual model for what that business incubator can look like and how to implement it.

2.6. Traditional incubator framework

Fig. 1 shows the traditional incubator framework. Note that the process is divided into four phases. Entrepreneurs develop ideas for potential start-ups, the incubators assists in refining ideas and selects promising ones for initial support. The incubator assists in identifying private investors and established business may get involved in providing mentorship.

In general, this process fails to identify profitable CE ventures. As discussed above, the identification of CE entrepreneurial opportunities calls for information on material flows of wastes and needs of other industries for value-added inputs. This information is needed at the pre-incubation phase when CE ideas are being developing. Such information is not typically available to individual entrepreneurs and collaboration network as constructed in the traditional incubator framework. Also, many CE start-up ideas involve established firms, i.e. a generator of waste and potential clients that would purchase the waste or a converted form of it. These firms need to be engaged in the incubation process to provide details on technical and business issues. Such client firms are also potential investors as the start-up is addressing an environmental and/or economic need.

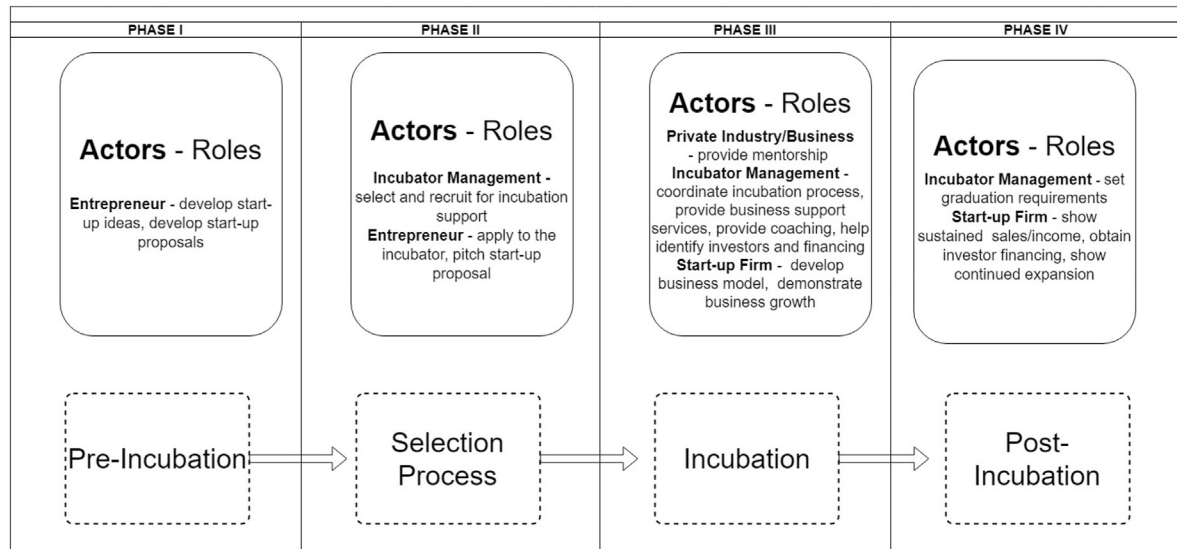


Fig. 1. Summary of actors and roles for the traditional business incubator process, by phase.

3. Circular economy incubator

We develop a conceptual framework for a circular economy business incubator (see Fig. 2). This framework addresses challenges identified in Section 2 by incorporating, from a broad set of stakeholders, a diversity of information in the form of environmental data and greater engagement in triple-bottom-line concerns as outlined in the convergence process model of sustainable entrepreneurship (Belz and Binder, 2015; Nogueira et al., 2019). Fig. 2 shows the expanded roles of different stakeholders for the proposed CE-focused incubator. These roles and stakeholders are explained in greater detail below, but in summary:

- Insufficiency of information needed to identify CE entrepreneurial opportunities is addressed by bringing in existing industry, government, non-governmental organizations (NGOs) and academics to clarify the scale and types of waste generated

and potential demand for these wastes as value-added inputs to manufacturing.

- Societal demands for CE opportunities are clarified by bringing NGOs into the network, and government may help with access to patient capital (e.g., through funding made available as part of the Green New Deal currently contemplated in the US Congress).
- Incubator management brings these inputs together to identify CE opportunities and recruit and support entrepreneurs to pursue them.

This CE-focused incubator includes a well-structured process including idea formation based on the diverse needs and perspectives of the various participating stakeholders (Nogueira et al., 2019) during pre-incubation (not usually part of the traditional incubator model), a well-networked collaboration environment with access to relevant experts, and patient capital for longer-term

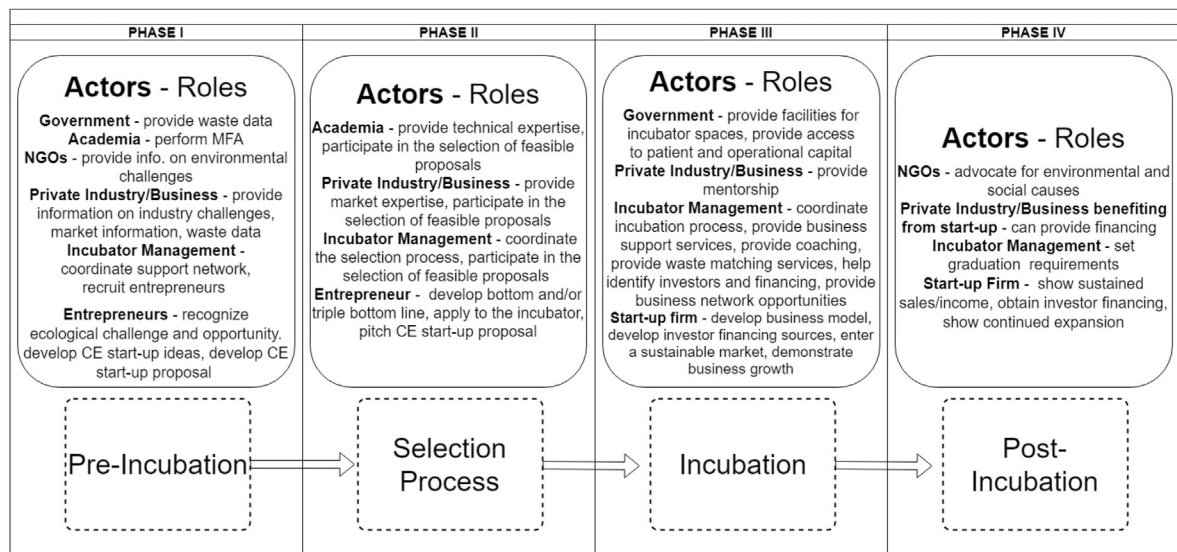


Fig. 2. Framework for Circular Economy business incubator: Government, industry, NGOs, and academia are involved to provide information to identify entrepreneurial opportunities. NGOs clarify the needs to be addressed. Government may provide access to patient capital. Incubator management connects entrepreneurs with CE opportunities. MFA = material flows analysis. CE = circular economy.

projects (Bank et al., 2017; Belz and Binder, 2015).

This CE-focused incubator expands the role of the traditional incubator and seeks to develop an IS system at a smaller scale than do the usual planned EIPs. The CE incubator calls for innovation in waste management, promoting eco-friendly practices and financial success by matching large waste generators with entrepreneurs and small start-up firms. Our framework is built upon the concept that innovation and information have a positive impact on the development of successful startups (Covin et al., 2006; Covin and Slevin, 1989; Simon, 1997; Vogel, 2017). The framework seeks to replicate the networks of IS as seen in industrial areas like Kalundborg, Denmark, which are successful due to collaboration and the information diversity in its networks, among other factors (Chertow, 2007; Mirata, 2004). Investment in a focused incubator of this type may provide benefits beyond the identification and development of environmentally sustainable entrepreneurial opportunities – including greater advocacy for environmental legislation, transfer of knowledge and technology, closure of material loops, awareness of the various types of capital relevant to CE entrepreneurship, and collaborations among tenants and with external actors (Bocken, 2015; Nogueira et al., 2019).

As a repository for environmental information, the CE incubator can give entrepreneurs access to the more diverse information they need to recognize and capitalize on eco-friendly opportunities (Tatoglu et al., 2019). An appropriately focused incubator could fill the SMSO role, directing entrepreneurial attention toward specific, previously unrecognized opportunities (Bellantuono et al., 2017). Our CE incubator would foster symbiotic interfirm relationships, promoting material and knowledge exchange within a single CE facility between larger polluting and smaller innovative CE firms (Mulrow et al., 2017). The incubator, as a trusted third-party service, would help collaborating firms overcome financial and economic challenges that would require more investment than they could afford (Diestre and Rajagopalan, 2012; Oxley and Wada, 2009; Siskos and Van Wassenhove, 2017).

To ensure that it is seen as a trusted third party, the CE incubator's management and tenants will need to build a collaborative network focused on building an ecosystem that develops and supports sustainable entrepreneurs (Siskos and Van Wassenhove, 2017), and facilitates the necessary communication and information exchange (Ashton, 2008; Chertow, 2007; Harris et al., 2008). CE-focused incubators near universities can support and promote research on creating solutions to waste problems. Universities can encourage the flow of new startups from various fields of study as seen in the Green Garage incubator (Bank et al., 2017). A successful CE-focused incubator helps transfer and disseminate technology through its network (Rubin et al., 2015) and recruits appropriate entrepreneurs and collaborators (Bank et al., 2017).

The convergent process for sustainable entrepreneurship (Belz and Binder, 2015) suggests there is no one approach to developing a triple bottom line (the consideration of economic, social, and environmental concerns). The convergent process takes on multiple phases where social or ecological challenges are recognized, and the potential opportunity is articulated. These phases can be incorporated into the incubator framework (Fig. 2), creating a CE-focused incubator which can share waste data with nascent entrepreneurs, recognizing ecology problems as opportunities (Belz and Binder, 2015). In this framework, a sustainability entrepreneur would move from a double-bottom-line to a triple-bottom-line solution prior to seeking funding and entering a sustainability-focused market as a sustainable enterprise.

The pre-incubation phase focuses on stakeholder engagement, with various actors contributing diverse information and potential forms of capital, to generate and develop profitable CE ideas (Amankwah-Amoah et al., 2018; Nogueira et al., 2019). For example,

the local government actor may provide material flow data that can be mined to find flows and accumulations of useable 'waste', and NGOs may provide information on local environmental challenges. Local businesses can discuss waste management challenges and raw material needs, and they, as well as local trade associations, can lend market expertise so that incubator idea development is market focused.

Financial gain is a major motive for businesses to participate in CE (Ashton and Bain, 2012). But our CE incubator would focus on entrepreneurs who also pursue sustainable practice. Because this would mean a smaller talent pool to draw from, it might be hard to find enough tenants (Bank et al., 2017; Bank and Kanda, 2016). The CE incubator should thus develop talent in the pre-incubation phase, when environmental challenges are being recognized as opportunities (Belz and Binder, 2015).

By collaborating with universities and environmental groups, the CE incubator can 'feed' potential entrepreneurs into the incubation phase by providing environmental information and data not ordinarily available, as well as sponsoring and participating in entrepreneurial and networking events.

By recruiting and immersing nascent entrepreneurs in a setting designed to solve local environmental problems in both a profitable, sustainable way, the CE incubator can help generate profitable double- and/or triple-bottom-line solutions to waste challenges.

Entrepreneurial orientation (EO) is important to the performance of a business venture (Covin and Slevin, 1991; Lomberg et al., 2017; Lumpkin and Dess, 1996; Moreno and Casillas, 2008), so selecting driven, energetic, high-EO entrepreneurs (and incubator managers) is crucial for the CE-focused incubator. Since selection of high-performing EO entrepreneurs is so important (Aerts et al., 2007; Hausberg and Korreck, 2018), a selection committee including members of industry, incubator management, government, and academic experts is recommended. This committee would gauge the validity of ideas, examine the candidates' entrepreneurial orientation, and select individuals or teams with growth and development potential. Selected entrepreneurs would implement plans in the incubation phase, and with the assistance of the incubator, seek and attract needed funding, refine the business model, and enter the market (c.f., Belz and Binder, 2015). Once startups can consistently reach revenue and sustainability targets, they can graduate from the incubator.

3.1. Stakeholder considerations in the proposed CE-focused incubator

A CE-focused incubator is intended to add value to material flow analysis data by identifying potential uses for waste for potential tenants. Participating firms in the CE incubator's network may find sources of revenue in waste, while earning reputational rewards for environmentally positive behavior.

By supporting nascent entrepreneurs through the startup process and networking them, CE incubators can lead to an improved financial performance from opportunities that previously would have been disregarded because of the way waste is traditionally viewed. This benefit can extend beyond the entrepreneurs themselves: for example, the reimagining of waste is seen in Canada's Plastic Bank's business model (Plasticbank, 2018) of fighting poverty by providing individuals an alternative source of income through collecting plastic that would otherwise end up in the ocean.

The proposed CE incubator (Fig. 2) engages many more stakeholders than the traditional one (Fig. 1), in particular government, academia, NGOs, and "client" firms. A major objective for adding stakeholders is address the availability of information at the pre-incubation phase. A second goal is to create closer ties between

the entrepreneur at client firms that would provide waste or purchase its value-added form. In this section we describe in more detail how different stakeholders are involved and their motivation for doing so.

All organizations depend on their surroundings for their development, growth, and profitability (Dess and Beard, 1984). Eco-friendly startups in a specific local economy need access to local scientific and technology knowledge, and need the local government and community to be environmentally aware (Giudici et al., 2017; Ruiz et al., 2020). Access to technologically advanced networks that include firms and universities supporting research is important (Bank et al., 2017; Wagner and Sternberg, 2004), as is local government involvement and support (Aranda-Usón et al., 2020). Following stakeholder theory (Freeman, 2010; Freeman and Reed, 1983; Jawahar and McLaughlin, 2001), we look at each stakeholder that is important to the success of the CE-focused incubator and their motivations and potential goals for the CE-focused incubator. The challenges of sustainability are rooted in complex interactions between actors including businesses, consumers, NGOs, and government agencies (Wittneben et al., 2012). Thus, the actors' motivation to participate should be considered. Table 1, at the end of this section, summarizes these stakeholder motivations.

Non-governmental organizations (NGOs) - NGOs identify environmental problems and take on a governance role, advocating on behalf of communities and the environment (Aagaard, 2018; Hodgson et al., 2019; Jasanoff, 1997). The CE incubator and its entrepreneurs can consider these NGO-identified problems as opportunities. Stakeholder theory indicates that good relationships with NGOs (and other stakeholders) can increase firm performance (Harangozó and Zilahy, 2015; Jones et al., 2018). Businesses should bear in mind that it is possible for both business and NGOs to benefit from mutual engagement (Aagaard, 2018; Harangozó and Zilahy, 2015). Not only can involving NGOs increase the legitimacy of the CE incubator, help clients recognize opportunities, and reduce the likelihood of disruptive behavior (Aagaard, 2018; Luxmore and Hull, 2011), but NGOs can be trusted to make sure that CE incubators do not drift off task.

Government - The government may be viewed as a partner in CE as it is a steward of the environment for the general population (Baumol et al., 1988). Our proposed role for government is rooted in the idea that environmental resources, including information, are 'public goods' (Baumol et al., 1988; Bovenberg and Van Der Ploeg, 1994; Vatn, 2018; Whitehead et al., 2014). The government can give the CE incubator land and buildings, etc., as well as access to information directly, or by providing information to academic researchers developing an MFA.

While government awareness does not necessarily guarantee action (Hoffman, 2010), it is a necessary step to creating an eco-supportive culture and CE-supportive policy (Aranda-Usón et al., 2020; McDowall et al., 2017). Government could also choose to invest in long-term CE projects by creating a green investment fund.

Private Industry - Industry associations and individual businesses are sources of information, particularly about the waste resulting from their own activity. Within the CE incubator, they can also play a role in transferring knowledge (Rubin et al., 2015), and in legitimizing knowledge from relevant academic research (Hoffman, 2010; Kollmuss and Agyeman, 2002).

Academia - Our CE incubator would be a collaboration networking universities, firms, and government. The incubator's ability to support tenants through their extended network is related to their access to, or capacity to develop, technology. Academic research can play a significant role in developing and transferring knowledge that supports various business activities, such as through developing an MFA (Adams, 2002; Millette et al., 2019). An incubator close to a university enjoys knowledge spillover and transfer to the incubator (Rothaermel and Thursby, 2005). Technological spillover can be very frequent among technologically focused firms and 'technical universities' (Giudici et al., 2017).

Clusters of knowledge create environments of innovative opportunity (Breschi and Lissoni, 2001; Qian, 2018). Universities help nearby firms innovate more than distant firms (Breschi and Lissoni, 2001; Qian, 2018). University research, information, and expertise may be more accessible to an incubator than similar information developed in industry (Adams, 2002; Liu et al., 2017; Phene and Tallman, 2014). University-linked incubator networks offer startups an environment where learning is accelerated, which in turn contributes to startup performance (Eveleens et al., 2017). However, given evidence that knowledge spillover into incubators has an opportunity cost for universities, extra incentives may be needed to persuade them to participate (Kolympiris and Klein, 2017). Participating in a CE-focused incubator may be of value to universities, as doing so gives them the opportunity to:

- build a more local-centric CE that enriches the local economy,
- contribute to environmental sustainability,
- foster student-managed successful startup companies,
- create good jobs for their students, and
- develop their networks with local businesses (and prospective employers of their students).

Incubator Management - The incubator managers would be responsible for creating a conducive collaborative environment with a focus on opportunity recognition, evolving ideas into startups, and entrepreneurial development with a focus on both financial and environmental performance (Ebberts, 2014). The management team would be responsible for acquiring the resources and support of the outside actors, and the selection and mentoring of talented entrepreneurs.

3.2. Stakeholder motivations

Involving stakeholders in the incubation process can yield sustainable competitive advantages (Zahra et al., 2014). Because of its CE focus, our incubator will need more stakeholders than the

Table 1
Stakeholder motivations for participation in circular economy incubator.

Actor	Motivation to participate in circular economy incubator network
Government	Manage waste problems while promoting economic development
Private industry	Solve firm waste challenges, reduce costs of input materials, investment opportunities
Academia	Conduct and apply research Engage community and stakeholders Apply expertise in technology development
NGOs	Influence the development of environmentally conscious business
Entrepreneur	Gain access to restricted information for ideation and start-up Receive mentorship and coaching for development and growth Obtain business support in early-stage development

Table 2
Advantages and disadvantages of two approaches to promote circular economy

	Advantages	Disadvantages
Centrally planned Eco-industrial park	Co-location of waste generators and users reduces logistical costs Government commitment can attract/compel participation	Government costs Rigid Less focus on finding new opportunities
Circular economy incubator	Focus on identifying new opportunities and developing market potential Address issues of limited information and cognitive biases Flexible Can result in unplanned EIP	Calls for new collaboration of stakeholders with diverse interests.

incubator management to be involved in both the pre-incubation and incubation process. Table 1 summarizes the motives for them to engage in this activity.

4. Discussion

In this section we compare and contrast the potential effectiveness of CE with the past emphasis on building planned Eco-Industrial Parks (EIPs). A CE incubator versus centrally planned EIP are, in a sense, different business models for moving towards a circular economy. As described by Boons and Laasch (2019), different business models can have competitive and symbiotic relationships. Centrally-planned EIPs enjoy the lower costs of co-location of generators and users of waste streams, as well as benefitting from significant government investment, which may attract established participants more effectively than calls for collaboration emerging from a CE business incubator.

But planned EIPs tend to be more rigid than the flexible CE incubators we describe, and to focus less on finding and developing new opportunities. Incubators, as part of an EIP, improve partner access to environmental information, providing opportunities for network expansion and industrial symbiotic development (Aid et al., 2017; Bellantuono et al., 2017; Elmassah, 2018). Incubators focus attention on opportunities and the development of skills and other resources necessary to pursue them, and can develop CE networks that evolve naturally into unplanned EIPs. So, can a standalone CE incubator replace the planned EIP? That may depend on the context. Both have advantages and disadvantages (see Table 2).

Our impression from the history of centrally-planned EIPs is that governments treat them more as showcases rather than a basic strategy to be widely pursued nationwide. In other words, the central planning of EIPs has yet to be deeply institutionalized like other policy strategies, such as emissions regulation, taxes, and emissions permit trading schemes. This lack could conceivably be addressed through increased attention to circular economy and EIPs as a tool to realize CE. But circular economy incubators have the potential to bring the forces of the market and entrepreneurship to bear. This adds a critical element to circular economy development by enabling growth separately from government commitment. For circular economy to live up to its namesake, it must be market driven, not just rely on central government intervention and investment. And the relationship between CE incubators and centrally-planned EIPs is not antagonistic. Both can be pursued, in parallel.

5. Conclusion

In this work we proposed a framework for a CE incubator, i.e. a set of stakeholders and interactions organized to identify and develop CE entrepreneurial opportunities. While such a framework is intended to be informative, a framework is not implementation. There are many real-world decisions and actioned needed to bring

CE incubators into existence. In this conclusion we offer thoughts on the bridge from theory to practice.

First, the diversity of stakeholders engaged by the CE incubator presents organizational challenges (Nogueira et al., 2019). Hopefully the motivations for participating listed in Table 1 can bring these different groups to the table, but the larger the group, the larger the overhead associated with managing it. In practice both the value and willingness of stakeholders to participate will vary case-by-base. The proposed framework suggests what organizations to consider when building the incubator, but which to actually engage should be selected based on local conditions so as to maximize entrepreneurial potential.

Second, the source of driving impetus to create CE incubators must be identified. The circular economy delivers public benefits, the domain of government, but a CE incubator is oriented towards entrepreneurship and markets. Some governments are comfortable with direct interventions in industry, others less so. Depending on the context, governments can thus be an appropriate instigator of CE incubators. Universities are also promising instigators: Many are active in incubation, technology development and data analysis relevant to CE. Governments might support universities in starting CE incubators.

Third, emerging CE incubators should exchange experiences to develop a set of best practices. There is knowledge exchange between traditional incubators, via organizations such as the International Business Innovation Association (INBIA), the EBN Innovation Network and UBI Global. This exchange includes regular events such as the World Innovation Summit and International Conference on Business Incubation. One potential direction is for CE incubators to become a sub-space of the incubator community. A second is for incubation to increase its role in the CE community. Both directions can be pursued, and we argue it is particularly important to leverage experience and community knowledge from those engaged in traditional incubation for application in the CE space.

As linear economies face increasing resource constraints and environmental impacts (Bocken et al., 2014; Longo et al., 2019), we must choose to adapt to emerging realities – such as by developing CE-focused incubators – or fail when there is no longer a choice. Waste does not have to be waste. It can be reimagined as a profitable opportunity.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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.

CRediT authorship contribution statement

Sherwyn Millette: Conceptualization, Methodology, Writing - original draft. **Clyde Eiríkur Hull:** Conceptualization, Writing - review & editing, Supervision. **Eric Williams:** Conceptualization, Writing - review & editing, Supervision.

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