Developing and implementing circular economy business models in service-oriented technology companies

Graeme Heyes, Maria Sharmina, Joan Manuel F. Mendoza, Alejandro Gallego-Schmid, Adisa Azapagic

Tyndall Centre for Climate Change Research, School of Mechanical, Aerospace and Civil Engineering, University of Manchester, M13 9PL, Manchester, United Kingdom
Sustainable Industrial Systems Group, School of Chemical Engineering and Analytical Science, University of Manchester, M13 9PL, Manchester, United Kingdom

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Abstract

The service sector has the potential to play an instrumental role in the shift towards circular economy due to its strategic position between manufacturers and end-users. However, there is a paucity of supporting methodologies and real-life applications to demonstrate how service-oriented companies can implement circular economy principles in daily business practice. This paper addresses this gap by analysing the potential of service-oriented companies in the information and communication technology (ICT) sector to build and implement circular economy business models. To this end, the Backcasting and Eco-design for the Circular Economy (BECE) framework is applied in an ICT firm. BECE, previously developed and demonstrated for product-oriented applications, has been developed further here for applications in the service sector. By shifting the focus from a product-oriented approach to a user-centred eco-design, the paper shows how ICT firms can identify, evaluate and prioritise sustainable business model innovations for circular economy. The two most promising business model innovations are explored strategically with the aim of designing circular economy models consistent with the company’s priorities of customer satisfaction and profitability. The findings suggest that ICT companies may be able to support the deployment of a circular economy in the service-oriented technology sector. Importantly, micro and small organisations can play a fundamental role if provided with macro-level support to overcome company-level barriers. Finally, the BECE framework is shown to be a valuable resource to explore, analyse and guide the implementation of circular economy opportunities in service-oriented organisations. Further research to verify the application of the findings to other service-oriented organisations is recommended.

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1. Introduction

A circular economy (CE) is based on restorative and regenerative production and consumption systems. Such systems aim to keep products, components, and materials at their highest utility and value for as long as possible within technical and biological cycles (EMF, 2012, 2013, 2014). The CE can therefore provide multiple value creation mechanisms, decoupled from the consumption of finite resources and the generation of wastes and environmental impacts, thus acting as a gateway towards a more sustainable and prosperous economy (Jackson, 2009; UNEP, 2011).

The CE aims to enhance resource efficiency and environmental performance at different levels, for example individual businesses (e.g., Liu and Bai, 2014), industrial areas (e.g., Wen and Meng, 2015), and the city and regional levels (e.g., Tukker, 2015). The CE goes beyond concepts such as the 3Rs – reducing, reusing, and recycling wastes – to maximise resource efficiency (Bocken et al., 2014; Boons and Lüdeke-Freund, 2013; Wells, 2013). Rather, the CE model embraces innovative concepts such as designing out waste and pursuing eco-effectiveness instead of eco-efficiency (EMF, 2012, 2013). CE thinking has the potential to motivate and support sustainable business innovation to close, slow, and narrow resource loops (Bocken et al., 2016). In this way, the transition to the CE implies a whole-system change, through technological and non-
technological innovations throughout an entire organisation. Such innovations range from product design and industrial manufacture to the conception of entirely new business models, including the way value is created, captured, and delivered to customers (Osterwalder and Pigneur, 2010).

The inherent differences between sectors of the economy mean that they require different approaches to the CE, depending on their particular circumstances (Lacy and Rutqvist, 2015). Several frameworks have emerged in the literature to guide CE thinking and decision-making within companies in different sectors (Mendoza et al., 2017). These frameworks typically focus on assisting companies in the development of CE solutions for products and their production processes (for example, Bakker et al., 2014; Rashid et al., 2013). However, the frameworks that only improve the circularity of products are not enough to deploy CE across the entire economy.

In its report for the European Commission, BIO Intelligence Service (2013) estimates that business services account for approximately 1 billion tonnes of annual raw material inputs in the European Union (EU), which is more than double the overall resource consumption of this sector 20 years ago. Service businesses can be defined as businesses whose principal activity is to provide service products which represent “entities over which ownership rights cannot be established. They cannot be traded separately from their production” and are “produced to order and typically consist of changes in the conditions of the consuming units, due to the activities of producers at the demand of the consumers” (Eurostat, 2009, p.2). Today, the service sector represents over 73% of the EU’s total gross value added (Eurostat, 2013). Although the service sector is not energy-intensive (EMF, 2013: JRC, 2015), it is responsible for 13% of energy consumption in the EU28 (Eurostat, 2016a). It also had a larger increase in energy consumption (30%) than any other sector over the period 1990–2014, now accounting for more than 1600 TWh of final energy consumption in the EU (Eurostat, 2016a). Consequently, the service sector is also a significant contributor to greenhouse gas (GHG) emissions, contributing over 5% (310 Mt) of the total GHG emissions in the EU (EEA, 2015). The scale of this resource (material and energy) consumption and GHG emissions suggests that service-oriented businesses have the potential to play a significant role in improving resource efficiency and climate change mitigation. In fact, Johannsdottir (2014a) highlights that the development of closed-loop business models in service-oriented organisations, such as insurance companies, can increase business resource efficiency and sustainability performance. Likewise, the use of sustainable technologies by service providers can lead to achieving environmental and climate change mitigation goals on national, regional, and global levels (Johannsdottir et al., 2014b).

Information Communication Technology (ICT) support firms play a key role in the service sector, by supporting public and business activity that is reliant on technology use. An estimated 10 billion physical objects with embedded information technology exist today (HBR, 2014). Furthermore, the number of connected devices is expected to grow to 25–50 billion by 2020 (EMF, 2016). This number of products poses significant challenges in terms of the consumption of material and energy resources, as well as the generation and disposal of electronic waste (e-waste). In fact, e-waste generation represents the largest source of waste in the world (EC, 2015; 2016). According to Cucchiella et al. (2015), around 30 to 50 million tonnes of e-waste are disposed of globally, with e-waste disposal rising by 3–5% annually. Current recycling technologies and business models have limited ability to recover precious and scarce metals embodied in the e-waste. Consequently, material recovery rates remain relatively low, although the value to European markets of bringing e-waste streams into the CE could be equivalent to €2.15 billion, potentially rising to almost €3.7 billion with greater volumes (EC, 2015; 2016). By tracking material flows and monitoring the products’ life cycles, the potential to identify CE opportunities for closing material flows can increase substantially. The Ellen MacArthur Foundation (EMF) (2016) describes how pairing digital technology with CE principles could transform the economy’s relationship to material resources, bringing substantial environmental savings. For example, the ability to monitor and manage equipment remotely can drive the optimisation and performance of products, processes, and systems (McKinsey and Company, 2015). There are good reasons for the ICT sector to engage in the CE as it relies on scarce materials for manufacture; hence the increase in material recovery from wastes (Ng et al., 2016). The sector has high rates of product obsolescence whilst products are still fit for purpose (LeBel, 2016). Moreover, there is potential gain for ICT business that engages in the CE. Examples include implementation of sustainable business models, such as the virtualisation of products (EMF, 2015a) and the potential of big data to contribute to energy and material efficiencies. For instance, Cisco and IBM help clients to maintain products better through data monitoring and predictive analysis (EMF, 2016). The ICT industry, therefore, represents an important lens for assessing the potential for service-oriented technology companies to contribute to the CE.

As highlighted by Wever et al. (2008), the way users interact with assets, such as computer hardware, may influence resource consumption and the associated environmental impacts. Hence, the development of CE business models in the ICT service sector has the potential to contribute to the CE by utilising the sector’s strategic position between manufacturers and customers. The ability of the ICT service sector to contribute to the CE is also evidenced by the fact that one of the instrumental pathways towards the CE is the deployment of a service-oriented business model (Stahel, 2006; EMF, 2015a), through which users pay for the use of a service, rather than the purchase of a product. Nevertheless, there is a lack of CE frameworks and applications of CE principles in the service sector, including the ICT support sub-sector. This finding is supported by Johannsdottir (2014c), who argues that the redesign of non-manufacturing companies towards sustainable business models has not been covered properly by the literature. Moreover, there is limited research on the ability of micro and small organisations to adapt to the CE, particularly in terms of the drivers and barriers to doing so (Rizos et al., 2015). Considering that such businesses account for 99.9% of all private sector businesses in the UK (FSB, 2016) and other European countries (Eurostat, 2016b), understanding how such firms may be engaged to adapt to CE requirements should be considered an important research gap.

In an attempt to address the gap, this paper aims to explore how service-oriented ICT firms can build CE business models to implement CE principles in everyday business practice. This aim is achieved through an application of the Backcasting and Eco-design for the Circular Economy (BECCE) framework (Mendoza et al., 2017). Previously demonstrated for product-oriented applications, BECCE has been adapted here for implementation in the service sector, as explained in the next section. The results are presented in Section 3, demonstrating how, despite complex barriers, the firm can develop and implement a CE business model. Section 4 discusses the findings, highlighting that the ICT industry has significant potential to contribute to the CE, if barriers for implementation can be overcome. Finally, concluding remarks and implications for future research and practice are provided in Section 5.
2. Methods

2.1. Methodological framework

2.1.1. The BECE framework

A number of frameworks to help companies to develop CE innovations have emerged in the literature in recent years. Literature review carried out by Mendoza et al. (2017) found that most have the potential to contribute to building CE business models to some extent, but that gaps existed in their ability to fulfill CE requirements, or to support their implementation. For example, the widely used Framework for Strategic Sustainable Development (Broman and Robert, 2017) has a strong focus on implementing new strategic approaches to sustainability, but it does not consider specific aspects of the CE included in the ReSOLVE framework (EMF, 2015a). Conversely, Bocken et al.’s (2014) sustainable business model archetypes address all aspects of the ReSOLVE framework but fail to offer guidelines and step-by-step support for embedding the concept of the CE into corporate decision-making and for implementing the CE by integrating operational and strategic thinking. A focus on implementation is important as organisations face a number of barriers to the adoption of CE business models, including an uncooperative culture towards environmental issues, financial barriers, limited government support, administrative burden, lack of information and technical skills, and little support from the supply and demand network (Rizos et al., 2015). To overcome these barriers, Mendoza et al. (2017) proposed a participative BECE framework to help to conceptualise and develop CE business innovations. The framework enables organisations to understand how they may implement CE innovations by combining strategic business planning (backcasting) and operational (eco-design) tools. Backcasting develops normative scenarios aimed at exploring the feasibility and implications of achieving a certain desired end-point in the future (Sharmina, 2017). Eco-design, on the other hand, systematically incorporates environmental considerations into product and process/service design to minimise resource use and environmental impacts (Lifset and Graedel, 2002).

As illustrated in Fig. 1, the BECE framework (Mendoza et al., 2017) comprises three main parts and ten iterative steps: envisioning a CE business (steps 1–3), designing what that business may look like (steps 4–6) and developing pathways for the implementation of that future business (steps 7–10). Participatory backcasting (Eames et al., 2013; Dixon et al., 2014) is introduced into the framework in steps 1–3, where an overarching vision compliant with the CE is developed (step 1). After considering drivers of, and constraints to, this vision (step 2), participants identify specific CE business innovations (step 3). The subsequent steps enable users to apply eco-design techniques (van Boeijen et al., 2013) to characterise the business model and service portfolio in accordance with the vision specifications (step 4), select relevant services for evaluation (step 5) and generate and evaluate alternative approaches to delivering value to customers (step 6). Finally, steps 7–9 develop strategic action plans and pathways for implementing feasible CE business innovations, before they are implemented in step 10.

2.1.2. The Business Model Canvas

To analyse the company’s business model (steps 2–4 of the BECE framework) and develop and evaluate alternative business models (steps 6–8), the Business Model Canvas (Osterwalder and Pigneur, 2010) has been used. The Business Model Canvas, which is used widely in business model analysis and research (Li et al., 2016; Vezzoli et al., 2015; Wainstein and Bumpus, 2016), consists of nine building blocks divided into two sides. One side explores how value is delivered to customers and involves four blocks: customer segments, the customer relationships, the channels, and the revenue streams (Osterwalder and Pigneur, 2010). The other side describes how this value is created, i.e. the efficiency of the firm’s operations, and comprises the remaining five blocks: key activities, key resources, key partners, cost structures incurred in the production, and delivery of the value to customers. Combined, the building blocks have the dual purpose of describing the focal firm’s business model and defining what a business model actually is (Osterwalder and Pigneur, 2010). This dual purpose ensures that participants have the same definition and can visualise how it applies to their own business, minimising the potential for confusion.

2.1.3. The ReSOLVE checklist

ReSOLVE is a checklist of CE requirements proposed by the Ellen MacArthur Foundation (EMF, 2015a) that consists of six actions: regenerate, share, optimise, loop, virtualise, and exchange, each presenting an opportunity for CE implementation. Each action is compliant with three underlying principles that define the CE: preserving and enhancing natural capital; optimising resource yields by circulating products, components, and materials at the highest utility and value at all times within technical and biological cycles; and fostering system effectiveness by revealing and designing out negative externalities (EMF, 2015a). ReSOLVE can be used as a guiding checklist for CE innovations by both helping to define what the CE is and by providing examples of CE solutions in given case settings that could inspire innovations.

2.2. Application of BECE

2.2.1. Overview of the company

The BECE framework (Mendoza et al., 2017) was applied to a micro-ICT business in the UK to identify and analyse opportunities for building CE business models. A micro-sized business is one that has fewer than 10 employees and a turnover of less than €2 m per annum (EC, 2017). Currently comprising four employees, the company was founded in 1955 to offer a mechanical typewriter repair service and has innovated since to ensure that its product offer is relevant to the needs of the market. Today, it offers a range of services to both businesses and the public, including computer systems installation, access to secure servers, repair, maintenance and general assistance, email access, data back-up, security, and website design and hosting. The majority of the company activity is business-to-business sales, with the public representing a small share of their customers. The company’s employees spend a significant amount of time on site visits, travelling long distances using the company vehicle fleet. The company provides ICT services across the entire Greater Manchester region.

This company was selected for several reasons. Firstly, it provides a useful lens to investigate the potential for ICT firms to drive the implementation of CE principles both in the service sector and in other businesses receiving ICT support. Secondly, as a micro organisation, it presents an opportunity to identify how the CE can be implemented in micro businesses that have distinctly different characteristics to larger organisations in terms of innovation (Nieto and Santamaria, 2009). For example, larger firms are more likely to engage with universities when innovating (Bayona et al., 2002) and to deliver large economies of scale (Cohen and Klepper, 1992), whilst smaller firms are more flexible, have greater proximity to markets and, hence, can quickly implement innovations that suit niche market demands (Nootboon, 1994; Vossen, 1998). The selection of a real-world case firm also helps to explore further the finding of Fusion (2014) that the majority of micro- and small- or medium-sized businesses either have not heard of the CE concept, or do not understand it fully.

According to Yin (1994), taking a case study approach to
research is useful in instances where a researcher investigates a contemporary phenomenon in a real-life context. Furthermore, case study research enables researchers to study practices occurring within a case, whilst “retaining the holistic and meaningful characteristics” (Yin, 2011: 4) of the wider setting, thus making extrapolation of theory possible. The researchers acknowledge their position in this participatory research process as workshop facilitators and observers, as well as interpreters of the research findings (Resnik and Kennedy, 2010). The researchers took a reflexive stance to ensure that they were aware of themselves being the instrument of research and any potential biases this role might bring (Borg et al., 2012). Following Pain and Francis (2003), the research was carefully designed to ensure that results could be reported back to the case company at relevant stages of research (see Fig. 2). Participants were given opportunities at all points in the research process to ask any questions or raise any concerns about the work being undertaken and its findings.

2.2.2. Workshops design and development

In line with the participative nature of this research, the BECE framework was applied through two workshops facilitated by the authors and attended by the General Manager and Managing Director of the ICT firm. Fig. 2 illustrates how BECE was applied across the two workshops. Each workshop lasted for 3 h to prevent information overload and minimise interruption to the company’s daily operations; an important factor for most organisations and particularly those of a smaller size. Having two shorter workshops, rather than one longer, also provided additional time for reflection by both the company participants and the researchers. Discussions during the workshops and their outcomes were captured by detailed note taking by the research team and sketching on flip charts (e.g. the Business Model Canvas and the evaluation matrix).

Before the first workshop, a pre-workshop engagement phase took place via email to obtain ‘buy-in’ to the research by the participants (Brewerton and Millward, 2001). This pre-workshop engagement was achieved by presenting the proposed structure of the workshops and introducing the concept of the CE, as well as the importance of, and opportunities for, businesses taking action. Additionally, it enabled the collection of information about the company that proved useful in designing and developing the workshops themselves. For instance, conversations with the participants indicated that they believed that the provision of support services constituted approximately 80% of company’s activity. They estimated that the remaining 20% accounted for re-selling products from the company’s suppliers. Likewise, the researchers obtained a sense of the scale of the organisation’s operations, the types of activities undertaken, the limited level of expertise held within the firm regarding both the CE and sustainability. The researchers also identified that the company had a strong desire to adopt innovative business models, albeit from an economic growth perspective rather than to improve sustainability performance. Accordingly, the application of the BECE framework was shifted from a product-
centric to a user-centric focus, by using the Business Model Canvas in step 4 of BECE. A detailed business model description at this stage enabled the identification of its relative strengths and weaknesses as well as potential areas for CE implementation.

Accordingly, workshop 1, focusing on BECE steps 1–4, began by developing an ambitious future vision by asking the participants: “What do you think your company might look like in a sustainable, low-carbon and zero-waste society?” This question enabled a desired future state to be discussed and agreed, encouraging participants to think creatively and ambitiously, rather than in terms of marginal adjustments. Importantly, as well as creating a broad vision that guided thinking throughout both workshops, this step helped the participants to begin thinking about the CE as a viable option for the company. Next, participants were asked, as part of BECE step 2, to identify the drivers and constraints to this vision, based on their current business. This activity would prove useful in workshop 2 as a means to understand how these barriers may be overcome. In BECE step 3, the researchers asked the participants to identify, through a brainstorming session, the key priorities they had as a business. Following the generation of priorities, the participants were asked to pick the three priorities most vital to their business and to rank their importance. This list would allow the assessment of developed innovations in the company business model during the second workshop. Finally, during step 4 of BECE, the participants completed a Business Model Canvas of their organisation, to develop a shared definition of what the company does to create, capture, and deliver value to its customers.

Workshop 2 covered BECE steps 5–8, aiming to build CE business models based on the outcomes of workshop 1. As a holistic business model approach was taken in the research, BECE step 5 can be considered a continuation of BECE step 4 in that, rather than individual offerings, the entire services portfolio of the company was considered with the aim of identifying how the company could provide resource-efficient and more environmentally sustainable services.

Alternative business models were generated in BECE step 6, using the ReSOLVE checklist (EMF, 2015a) and examples of how ReSOLVE actions have been implemented in other sectors, to inspire the participants on how such innovations could take place in their own business. To facilitate this step, each of the ReSOLVE actions was introduced in turn, with examples provided of how businesses had found commercial success through their application.

The five most promising actions for the CE were evaluated (BECE step 7) using an evaluation matrix to prioritise the actions compliant with the company’s core strategies (determined in BECE step 3). To complete the evaluation matrix, criteria were derived from assessing the company’s core strategies, namely profitability and customer and supplier satisfaction. These criteria were then weighted by study participants to indicate their importance to the organisation on a scale of 1 (not very important) to 5 (extremely important). Such weighting can either be quantitative or qualitative, with a qualitative valuation used in this instance to reflect the nature of the research. During the second workshop, the identified promising actions were rated low (scoring 1), medium (scoring 2), or high (scoring 3). These ratings were then multiplied by the weight of that criterion to derive a total score per criterion. Total scores across all criteria were then added to give a final evaluation score for each promising action. The highest scoring actions were selected as the most appropriate for the participants. Finally, the two highest scoring actions were developed into full business models using the Business Model Canvas (BECE step 8).
of this process can be found in Section 3.2.

3. Results

3.1. Understanding the company and vision setting

3.1.1. The CE vision, barriers and key business priorities

Workshop 1 began with BECE step 1, in which participants developed an overarching vision that would define what their business would look like in a future CE. Participants agreed that the following statement was an ambitious commitment that would act as a vision to guide their journey towards the CE: "To provide profitable zero-waste and zero-emission services to our customers by 2025".

Table 1 details potential barriers and drivers to the CE, identified by the participants in step 2 of BECE. These results indicate that the participants were aware of potential benefits of CE innovation, but that the barriers represented a significant challenge for an organisation of their limited size and resources.

Next, the participants identified three key priorities they had as a business (BECE step 3), including, in order of importance: customer satisfaction, profitability, and good supplier relationships. These priorities, therefore, represented aspects of the company's current business that should not be compromised by any alternative business models generated in the process of following the CE approach.

3.1.2. Understanding the current business model

The results of the Business Model Canvas mapping of the company (BECE step 4) are presented in Fig. 3, identifying key priorities across the nine building blocks of the canvas. The numbers against each element within the canvas represent the order in which they were approached in the workshop. These elements are discussed below, with building blocks denoted in bold.

The company’s main customer segment (1) was highlighted as being service-oriented SMEs, such as accountants and law offices, whilst their brand and reputation for providing good service was rated during workshop discussion with the participants as being their most important value proposition (2). This finding supports customer satisfaction as being a key company priority. Members of the public were identified as another customer segment; however, they represented only a small part of existing company operations.

The fact that engineers have to visit clients (a key channel (3) for delivering value) to provide ICT support to customers suggests that travelling could be a potential area for a CE intervention, particularly as the company has an online presence and already offers email, data back-up, security, web design and web hosting. As a micro organisation, the company had no direct upstream influence on the design and manufacture of the products. Key resources (8) can be split into the two categories of physical and intangible resources. The former relates to equipment, vehicles and stock, whilst the latter refers to capital, knowledge and expertise as well as fast and reliable internet.

Whilst reducing the number of on-site visits generally impacts on cost structure (9) (i.e. through reduced vehicle fuel use and travelling time), it is congruent with the ‘virtualise’ principle of the ReSOLVE checklist and, hence, with CE principles. Moreover, reducing company’s mileage would reduce emissions from its vehicle fleet, corresponding to the ‘optimise’ principle of ReSOLVE.

3.1.3. Company’s existing actions towards implementing its CE vision

The key activities detailed in the canvas for the company’s existing business model (Fig. 3) suggest that implementing a future vision to provide profitable zero-waste and zero-emission services and products to customers by 2025 would be challenging, but not impossible. Remote support and daily maintenance result in energy usage at company premises, which suggests that business models that can maximise energy efficiency or provide renewable energy will have greatest positive effect. Company management believed that on-site support would have the greatest potential for contributing to the CE due to clients’ energy use and company vehicle emissions from visiting different sites. Although the company is not directly responsible for clients’ emissions, it can help the clients to save energy through the purchase of more efficient equipment, better data management, monitoring of energy usage, and the use of renewable energy. The workshop did, however, reveal that this would be challenging, as customers generally want the latest equipment on a first-hand basis and that energy efficiency is not a selling point to them. Vehicle emission reductions are possible through more efficient vehicles, or by reducing number of site visits.

The company produces waste from electronic products and packaging; however, electronic waste is disposed of in compliance with the Waste Electrical and Electronic Equipment Directive (EC, 2016), whilst they recycle all other waste through local authority collection schemes. The company also offers a ‘take-back’ scheme to collect waste from clients; however, few clients use this service. The long-term, close relationships with customers suggest that there could be intervention here, for instance, by leasing, rather than selling products, or for products to be collected after use for remanufacturing and reselling, further reducing waste and increasing circularity. Again, lack of support from suppliers means that such activities may need to be done by the business itself.

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown demand</td>
<td>A marketing tool (as a sustainable supplier)</td>
</tr>
<tr>
<td>Difficult to influence suppliers alone</td>
<td>Stronger supplier relationships</td>
</tr>
<tr>
<td>Financial and time costs and investments</td>
<td>More future-proof to policy, resource risk, and costs (proactive vs. reactive)</td>
</tr>
<tr>
<td>Risk of radical innovation</td>
<td>Potential for a new product offer resulting in new revenue streams</td>
</tr>
<tr>
<td>Risk of low profitability of new systems</td>
<td></td>
</tr>
</tbody>
</table>
unless a new key partner could be identified who would be able to offer such a service through collaboration.

3.2. Generation and evaluation of CE business models

During workshop 2, the participants identified 20 actions to align their business model with CE principles. As Table 2 shows, a range of CE alternatives were generated for all ReSOLVE actions except for ‘exchange’. The participants felt the ‘exchange’ action did not apply to their business, since they do not have direct control over the manufacture of better performing technologies, products, and materials, that the ReSOLVE checklist requires. From the 20 actions, five (highlighted in bold italic font in Table 2) were considered to have the highest business potential for the company to provide CE-compliant and profitable services, considering the future vision developed in BECE step 1. Consequently, they were

Fig. 3. The Business Model Canvas, as generated in workshop 1 (BECE step 4), illustrating the current business model of the focal firm.

Table 2

<table>
<thead>
<tr>
<th>ReSOLVE action</th>
<th>CE actions identified by participants*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regenerate</td>
<td>Supply ICT equipment sourced from reclaimed materials and engage with upstream suppliers to request that such products are supplied to them. Smart energy monitoring systems (through monitoring devices), remotely analysed with recommendations provided to customers to minimise energy use. Partner with a green energy supplier to reduce direct company emissions.</td>
</tr>
<tr>
<td>Share</td>
<td>Provide physical products on a cost-per-use basis, i.e. as a service. Encourage employees to car share to reduce fuel emissions. Further prolong the lifespan of products (already practised on a small scale through occasional repairs). Encourage more use of second-hand products (already practised on a small scale but this could be pursued more aggressively).</td>
</tr>
<tr>
<td>Optimise</td>
<td>Engage with upstream suppliers for using more energy efficient products. Increased equipment functionality and modularity (already practised on a small scale but it could be pursued more aggressively). Data monitoring and analysis across customers to provide better support to improve energy-efficiency.</td>
</tr>
<tr>
<td>Loop</td>
<td>Implementation of take-back management systems of products and sending them for remanufacture. Look to return waste to suppliers for reclamation of materials. Offer a shredding and recycling service (currently not offered) to reduce client waste to landfill.</td>
</tr>
<tr>
<td>Virtualise</td>
<td>Increase the amount of server-hosting for clients as a proportion of the firm’s activities. Switch from physical software installations to on-line to reduce physical software packaging. Use virtual reality software to help to resolve issues remotely, thus reducing vehicle travel.</td>
</tr>
<tr>
<td>Exchange</td>
<td>No actions identified due to the nature of the business.</td>
</tr>
</tbody>
</table>

* Bold italic font denotes actions taken into the evaluation stage.
taken forward to the evaluation and prioritisation stage to select the most promising actions for implementation. Table 3 presents the evaluation matrix used to assess these alternative business models (BECE step 7). These most promising actions were evaluated against the company’s priorities identified in BECE step 2 after the participants had weighted them according to their strategic importance.

Each of these alternative business models offers a number of potential CE benefits for the firm and its customers. ‘Data monitoring and analysis’ of customer energy usage can reduce customer energy demands, thereby reducing the consumption of natural resources and environmental impacts associated with electricity generation. This action can contribute to achieving zero-emissions in the vision devised in BECE step 1. A ‘per-use fee’ would mean that the business retains ownership of physical products and charges customers on a per-use basis, for example, per kWh of energy use or number of pages printed. This approach would encourage users to minimise use, whilst retained ownership by the firm would ensure that products supplied had extended longevity, reparability, or upgradability to reduce future acquisition costs. Each of these has the potential to contribute to achieving zero-emissions and zero-waste in the company’s CE vision. With a ‘take-back service’, the company would scale up its current take-back service to become a central part of the business model, ensuring that products are refurbished or remanufactured into new products and sold to a different customer segment, such as the public. ‘Upstream engagement to reduce packaging’ relates to the fact that the company had noted that the products they procure often come with excessive packaging. This option would ensure collaboration with suppliers to reduce the amount of waste, or to be returned to them for recycling thereby contributing to the zero-waste goal they identified in the vision. Finally, ‘remote webcam support’ would enable the company to reduce vehicle mileage (and fuel consumption) by providing customer support remotely and contribute to achieving zero-emissions in the vision.

As indicated in Table 3, the two highest scoring alternative actions were ‘data monitoring and analysis’ (remote sensing of customers’ computer performance) and ‘remote webcam support’ (provision of webcams to clients to facilitate remote support where visual inspection is necessary). Accordingly, these two options were taken forward to the next stage of the BECE framework, where participants developed full business models for these alternatives (BECE step 8). The Business Model Canvas was used to identify how they might be taken from theoretical concepts to implementation, as presented in Figs. 4 and 5. The two business models would both be targeted at the larger organisations that the company serves (customer segments), due to the likelihood of their having more capital and of requiring such services. Furthermore, both business models would be low cost, but could represent significant benefits (revenue streams), for example reduced utility expenses and emissions for clients by using data monitoring and analysis, as well as reduced miles driven by the company vehicle fleet by using remote webcam support. Additionally, both business models presented in Figs. 4 and 5 are examples of models defined by EMF (2016) to find effective ways to maximise the utilisation of assets and keep them in the inner loops of their possible use cycles. For instance, data monitoring can change user patterns to maximise product performance, thereby extending the use cycle of an asset. This result has potentially significant implications for CE ambitions. Of the two models, remote webcam support would be the easiest to implement, as it could be done using existing devices (mobile phones with a camera). Data monitoring and analysis would require the company to purchase monitoring equipment and become proficient in their use and in the analysis of data.

3.3. Post-workshop findings

Following the workshops, the authors maintained contact with the company to assess progress in implementing the two business models developed in the workshops. The company reported that, whilst the ‘data monitoring and analysis’ business model had promise, they were not presently in a position to effectively pursue its implementation, due to workload and available resources. They had, however, been impressed with the ‘remote webcam support’ business model and had already found a supplier of a product that they would be able to use for this service. Furthermore, the company reported that they had taken the tools learned during the workshops, namely BECE (Mendoza et al., 2017), the Business Model Canvas (Osterwalder and Pigneur, 2010) and the ReSOLVE checklist (EMF, 2015a) to develop their own new business model. This model scales up the concept of remote ICT support to a wider, and potentially global market, following a similar approach taken by companies such as Uber and Airbnb, by empowering individual ICT specialists to provide support in their local areas as self-employed specialists who find work through the ICT businesses network. The company are planning to develop this idea further.

4. Discussion

4.1. The usefulness and limitations of the BECE framework in service-oriented technology companies

The application of the BECE framework with the focal firm helped to analyse its current business model in such a way that the company had not previously viewed itself. Twenty CE actions for the company were identified and, after evaluation, two were recommended for the company as priority innovations, one of which is currently being implemented.

To apply BECE to a service-oriented technology business, this study emphasised a user-centric focus, based on the value (defined by the employees in the focal firm), rather than by the products offered to customers. As stated in the introduction, Wever et al. (2008) suggest that the way users interact with assets, such as

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
<th>‘Data monitoring and analysis’</th>
<th>Per-use fee (e.g. printers)</th>
<th>Takeback service</th>
<th>Reduce supplier packaging</th>
<th>Remote webcam support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profitability</td>
<td>5</td>
<td>Low&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Medium&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Exceeding customer expectations</td>
<td>5</td>
<td>High&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Satisfying supply demands</td>
<td>3</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Evaluation score</td>
<td>29</td>
<td>18</td>
<td>21</td>
<td>18</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> 1 – least important; 5 – most important.
<sup>b</sup> High = 3; medium = 2; low = 1.
computer hardware, may influence resource consumption and the associated environmental impacts. Such services can, therefore, affect how such assets are delivered and used by customers through, for example, different revenue streams (asset sale vs. rental fee). Shifting to a user-centric focus in service provision may reveal opportunities for building fully circular business models, with no change in product design, but rather in the user interaction with existing products.

The focus on users was facilitated through the Business Model Canvas (Osterwalder and Pigneur, 2010) that expands the scope of eco-design analysis in BECE by considering an organisation’s entire business model in detail and the way in which it creates, captures, and delivers value to its customers. It enabled the participants to understand that they might deliver the same value to their customers, but in radically different ways. For instance, remote webcam support essentially answers the requirement for on-site support services, whilst being able to provide that service faster and with lower costs and pollutant emissions for the service provider, through reduced vehicle emissions.

Whilst the service-oriented technology sector may not directly manufacture products, its position between manufacturers and end-users means that it can influence the way in which customers use those products. Examples include product lease, per-use fees, and offering a take-back service to ensure that material value is maintained when customers dispose of products. Each of the five business models evaluated with the firm through BECE (step 7) can be categorised by the sustainable business model archetypes identified by Bocken et al. (2014): maximising material and energy efficiency (‘data monitoring and analysis’ and ‘remote webcam support’), encouraging sufficiency (‘per-use fee’), creating value from waste (‘take-back service’) and adopting a stewardship role (‘upstream engagement’). Although maximising material and energy efficiency can be regarded as incremental organisational changes that are largely compliant with a company’s existing
business model, they do have the potential to significantly reduce the energy demands and emissions (from vehicles) from both the focal firm and its customers (through ICT energy usage).

The holistic nature of the BECE framework ensures that alternative CE business models are commensurate with a firm’s wider objectives and the wider environment in which the company operates. BECE links strategic and operational processes to help to develop CE businesses. As such, using a qualitative evaluation matrix with the participants to assess the CE options and their appropriateness for the company's strategy proved a useful addition to the BECE framework.

Leveraging the ReSOLVE checklist (EMF, 2015a) as part of BECE was valuable in guiding eco-design processes to generate CE business innovations. However, using ReSOLVE for generating CE innovations could potentially have confined the thinking of participants to considering only similar outcomes. It is possible that some solutions may exist that are not captured by ReSOLVE; therefore, exploring the extent to which guiding checklists such as ReSOLVE are beneficial could be an avenue for future research. This paper has demonstrated that the ReSOLVE checklist can be a useful resource in helping businesses to adapt to the CE.

This research also supports the findings from Mendoza et al. (2017) that a limitation of the BECE framework is the complexity that its comprehensiveness entails. For instance, the focal firm would not have been able to apply BECE as described in this paper without the researchers’ assistance. Future research could investigate how BECE and similar CE tools could be made more usable without the need for such assistance.

4.2. The potential for the service-oriented technology sector to contribute to the CE

The findings of this research indicate potential for micro-sized service-oriented technology organisations, of relatively little resource and influence, to adhere to CE principles. Offering services rather than products is one of the key recommendations for the CE and the services sector has a role to play in the move away from linear production systems. The literature often proposes that businesses rooted in linear production systems need to look towards new service-oriented business models to close resource loops (Stahel, 2006). This paper contributes to the literature by suggesting that there is also potential for micro-sized, service-oriented technology businesses to offer services that can contribute to circularity in both companies receiving technology-related support (downstream firms) and companies reliant on the manufacture of products (upstream technology producers). However, further research would be appropriate to corroborate the research findings.

This paper argues that the ICT support sector is an example of a service-oriented technology industry that is able to support the CE, by offering existing services in new ways, or developing entirely new services, to enable their customers to decouple profits from resource consumption. In particular, the findings of this research suggest that the ‘optimise’ action from the ReSOLVE checklist (EMF, 2015b) may hold the greatest potential for the sector to achieve this decoupling. This action is technological in nature and for this reason ICT support companies are well suited to provide such services. Such innovations are consistent with examples detailed in EMF (2016). Whilst not all service-oriented businesses have the same technical expertise as is the case in this study, the ReSOLVE actions offer many examples of how such businesses may be able to contribute to circularity in other ways. For example, retailers could offer business models to leverage the sharing economy, or through optimised production and supply chains.

Of the six ReSOLVE actions, some appear more appropriate than others for service-oriented technology companies, for example the ‘optimise’ action discussed above. Other actions, however, do not lend themselves easily to services, according to this research, and so may be less frequently pursued by those unwilling to consider innovations in new fields. Interestingly, the focal firm has demonstrated that it is already applying many of the ReSOLVE actions to complement its main business model. Such voluntary application of CE principles suggests that, despite many barriers, micro-sized business may already be adapting to the CE. There may also be a business case in doing so, as the implementation of CE principles can reduce operating costs.

The fact that ‘data monitoring and analysis’ and ‘remote web-cam support’ are less disruptive than other generated options may explain why the company advocated them as the two most promising solutions of the five evaluated, despite scoring poorly in the profitability category. The decision by the company not to pursue the ‘data monitoring and analysis’ is a missed opportunity, as this type of data analytics has the potential to improve an organisation’s understanding of their customers and their needs, thereby strengthening the relationship between them and satisfying customer demands for lower energy use. For a business such as the focal firm, whose business model is built on customer satisfaction, this consideration could have contributed not only to realising improvements in material and energy efficiency, but also to growing the company. They could have obtained the required expertise through training courses, or by partnering with academia. However training courses cost time and money, which is a barrier to CE identified by Rizos et al. (2015). Engagement with academia has limited take up by micro-sized organisations for similar reasons (Bayona et al., 2002).

4.3. The potential for CE adoption in micro-sized companies and SMEs

The results of this research indicate that micro-sized companies have the capacity to take initial steps towards the CE. The focal firm understood the complexities of the concept and the need for businesses to adapt their business models to comply with CE principles. Through the use of the BECE framework the company was able to generate 20 potential CE actions.

Micro-sized enterprises often share similar characteristics with SMEs; for example, limited economic and internal resources, such as managerial expertise regarding factors outside of their core business. Therefore, these findings may have relevance for SMEs. Considering that in the UK SMEs accounted for 99.9% of all private sector businesses at the start of 2015 (FSB, 2016), the potential scope for the sector to contribute to a national CE is significant. However, the literature has identified multiple barriers that limit the potential for micro-sized and small organisations to adapt to the CE (Rizos et al., 2015), consistent with the barriers identified in the case of the focal firm here. For example, potential innovations identified in BECE step 6 were not pursued due to limited support from company suppliers. The size of the focal firm relative to their suppliers, availability of resources and limited networks for closing resource loops, constrained the ability of the firm to enhance the circularity of the products it re-sells. Such barriers are consistent with the types of barriers identified in the literature (for instance, Abrams, 1998; Hillary, 2004, Hillary and Burr, 2011). The company had limited knowledge on the CE prior to the workshop and had no established environmental culture. These findings are consistent with a survey of 300 SMEs in England, France and Belgium conducted by Fusion (2014), which found that the majority of businesses had not heard of the CE, or did not understand what it was. However, when the concept was defined to them, the majority of companies responded that their business, at least in part, complied with CE principles, particularly product reuse and repair (Fusion,
There is a disconnect between the barriers for micro-sized and small companies implementing the CE and how such barriers are overcome. The barriers analysed by Rizos et al. (2015) and identified in this paper are similar, but both are at the micro-economic level. The barriers are related to the ability of individual businesses to adapt to short-term changes in operating environment. Overcoming such barriers, however, requires support at the macro-economic level, including from government (through appropriate legislation and economic pricing mechanisms), universities (through research collaboration), and network organisations; examples of the last in the UK include Grants4Growth and the Scottish Recycling Fund (Technopolis, 2014). This disconnect is potentially a significant obstacle in the move towards the CE and should be subject to further research to identify appropriate policies to bridge the gap.

One of the potential advantages of micro-sized service-oriented technology companies, such as the one studied here, is that they are situated between suppliers and their customers, thereby being able to engage both upstream (suppliers) and downstream (their customers). The focal firm already influences the decision-making of customers by giving specific advice, for instance, on the lifespan of products. The potential for repair, and, additionally, the company’s focus on building long-term customer relationships means that the company often recommends products based on their longevity and life cycle performance, rather than on short-term profitability. The firm could, however, expand this service further, by adopting existing best practice. For instance, Re-Tek (EMF, 2016) is an ICT equipment re-use business that has developed reverse supply chains for the repair and refurbishment of electrical products. As a result, approximately 80% of the products the firm receives are refurbished as a re-usable product, with just 1% of the volume received going to landfill. Such examples demonstrate an opportunity for the focal and similar firms to develop innovative business models requiring collaboration with their customers and other ICT micro businesses and SMEs, perhaps facilitated by a local municipal authority, to collect and reprocess ICT equipment. This could prove a valuable revenue stream and one that would contribute to closing resource loops.

It should be noted that the encouraging results from this research, such as the number of CE actions identified and the willingness to implement them, could be due to the ICT setting rather than the company being micro-sized. ICT is at the heart of many businesses, and technology is a requirement of many CE solutions, for example dematerialisation, more efficient technologies, and big data. Future research could, therefore, look at other service sectors, such as retail, catering, and finance, to assess whether similar opportunities exist elsewhere.

Conclusions

This paper has explored the potential of businesses in the service-oriented technology industry, and specifically in the ICT support sub-sector, to contribute to the CE by using the iterative Backcasting and Eco-design for Circular Economy (BECe) decision-support framework. The focal firm found the entire process valuable and within days began to implement the recommended actions. The focus of BECe on implementation and user-centred eco-design played a key role in this process. With further testing at other businesses, BECe could facilitate the service sector’s move towards the CE. Despite the researchers’ active role throughout the study, the research design, particularly the verification of findings with the participants, supports the validity of the findings.

The application of BECe within the case firm was a valuable exercise, as it helped the company to devise and begin to implement business model innovations. Service-oriented technology companies cumulatively have a high potential to contribute to the CE due to their strategic position between product manufacturers and end users. In this regard, such businesses influence the way in which products are used by customers through innovative business models, designed to slow, close, and narrow resource loops. Thus, service-oriented technology companies can actively engage customers in the design and management of CE business models and product-service solutions. The business models generated fit within the interactions and value drivers of the CE to maximise the utilisation of assets and keep them in the inner loops of their resource-use cycles. For instance, the service of ‘data monitoring and analysis’ can change user behaviour and maximise the performance of the assets that they use, thereby extending the product lifespan.

The following limitations of this paper could be addressed in future research. Firstly, other service sub-sectors may reveal different opportunities to those in the ICT support sector. Additionally, the same study design applied to a large organisation may uncover a different set of barriers and drivers to CE implementation. Finally, a life cycle assessment of the generated business models and CE actions would help to quantify the full environmental implications of different innovation opportunities identified through the application of the BECe framework.

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