Developing and implementing circular economy business models in the information and communication technology (ICT) sector

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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-based 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. This is demonstrated through an application of the Backcasting and Eco-design for the Circular Economy (BECE) framework in an ICT firm. BECE, previously developed by the authors 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 a number of sustainable business model innovations for circular economy. The two most promising business model innovations are explored strategically with the aim to design circular economy models consistent with the company's priorities of customer satisfaction and profitability. The research findings confirm that ICT companies have the ability to actively support the deployment of a circular economy in the service sector. Importantly, 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-based organisations.

Keywords:

Backcasting; circular economy; eco-design; service sector; resource efficiency; sustainable business models.

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, a CE model embraces innovative concepts such as the design-out of waste, pursuing eco-effectiveness instead of eco-efficiency (EMF 2012; 2013). Thus, 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 a 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 a CE, depending on their particular circumstances (Lacy and Rutqvist, 2015). Thus, several frameworks have emerged in the literature to guide CE thinking and decision-making within companies in such diverse settings (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 whole 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. 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 (EEA, 2013; JRC, 2015), it is responsible for 13.3% of energy consumption in the EU28 (Eurostat, 2016a). It also had the largest increase in energy consumption (30%) than any other sector over the period 1990-2014, now accounting for 1,642 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-based businesses have the potential to play a significant role in improving resource efficiency and climate change mitigation. In fact, Johannsdottir et al. (2014a) highlight that the development of closed-loop business models in service-based organizations, 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 is 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 and 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 is also much reason for the ICT sector to engage in CE as it relies on scarce materials for manufacture - hence the increase in material recovery from wastes (Ng, 2016). The sector also 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 better maintain products through data monitoring and predictive analysis (EMF, 2016). The ICT industry, therefore, represents an important lens for assessing the potential for the service sector to contribute to a CE.

The above suggests that the development of CE business models in the ICT service sector has the potential to contribute to a CE by utilising the sector's strategic position between manufacturers and customers. The ability of the ICT service sector to contribute to a CE is also evidenced by the fact that one of the instrumental pathways towards a 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 in the ICT support sub-sector. This finding is supported by Johannsdottir (2014c), who states that the redesign of non-manufacturing companies towards sustainable business models has not been covered properly by the literature. Moreover, there is a lack of research on the ability of small organisations to adapt to a 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 gap, this paper aims to explore how ICT service-oriented firms can build CE business models to implement CE principles in everyday business practice. This is demonstrated through an application of the Backcasting and Eco-design for the Circular Economy (BECE) framework (Mendoza et al., 2017). Previously demonstrated for product-oriented applications, BECE 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 a 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 develop CE innovation have emerged in the literature in recent years. A review of such frameworks by Mendoza et al. (2017) found that most have the potential to contribute to building CE business models to some extent. However, many fail to offer guidelines and step-by-step support to embed the concept of CE into corporate decision-making and to implement CE by bringing operational and strategic thinking together. 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., 2016). To overcome these barriers, Mendoza et al. (2017) proposed a participative BECE framework to help 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 (Holmberg and Robert, 2000). 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 Figure 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 a 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; Sanye-Mengual 2014) to characterise the business model and service portfolio in accordance to 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.

INSERT FIGURE 1 HERE

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, 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 used (Osterwalder, 2004). The other side describes how this value is created, that is, 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 visually see 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 a 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 a CE is, and by providing examples of CE solutions in given case settings that could act as inspiration in the development of innovation activities.

2.2 Application of BECE

2.2.1. Overview of the company

The BECE framework (Mendoza et al., 2017) was applied to a small ICT business in the UK to identify and analyse opportunities for building CE business models. 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 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 members of the public representing a small share of their customers. The company's employees spend a significant amount of time on site visits, traveling 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 in the service sector and other businesses receiving ICT support. Secondly, as a small organisation, it presents an opportunity to identify how a CE can be implemented in small business 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 (Bayone 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 (Nooteboom, 1994; Vossen, 1998).

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. Figure 2 illustrates how BECE was applied across the two workshops. Each workshop lasted for three hours to prevent information overload and minimise interruption to the company's daily operations, an important factor for most and particularly small organisations. Having two shorter workshops rather than one longer also provided additional time for reflection by both the company participants and 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 a 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 organisations operations, the types of activities undertaken, the limited level of expertise held within the firm regarding both CE and sustainability. We 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- 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.

INSERT FIGURE 2 HERE

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 a 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 researcher 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 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 a 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 (Easton, 1973), 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). The results 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 circularity: *"To provide profitable zero-waste and zero- emission services to our customers by 2025*".

Table 1 details potential barriers and drivers to a 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 size and resources.

Table 1: Barriers and drivers to circular economy implementation identified by the participants (BECE step 2).

Barriers	Drivers
Unknown demand	A marketing tool (as a sustainable supplier)
Difficult to influence suppliers alone	Stronger supplier relationships
Financial and time costs and investments	More future proof to policy, resource risks, and costs (proactive vs reactive)
Risk of radical innovation	Potential for a new product offer resulting in new revenue streams
Risk of low profitability of new systems	

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 Figure 3, identifying key priorities across the nine building blocks of the canvas. The numbers against each element within the canvas represents the order in which they were approached in the workshop. These are discussed below, with building blocks denoted in bold.

INSERT FIGURE 3 HERE

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 as 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 it only represented 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 remote support, and that vehicle fuel was identified as a key cost incurred. **Customer relationships (4)** were identified as being intimate and long-term with dedicated personal assistance per client.

Given that physical hardware (leased or sold) contributes to the company's **revenue streams 5)**, circularity could be increased through the way in which customers use and dispose of such equipment, i.e. through product-service systems. Such CE actions could partly overcome the identified barriers of engaging upstream with **key partners (6)** that currently prevent the circularity in product manufacture and delivery.

The canvas and resulting discussion confirmed the findings from the pre-workshop engagement that the majority of the company's **key activities (7)** (80%) included providing servers, broadband, email, data back-up, security, web design and web hosting. The remaining 20% of company activity was related to the provision to customers of ready-built products: typically desktop PCs, laptops and photo-copiers. As a small organisation, the company had no direct upstream influence on the design and manufacture of the products. **Key resources (8)** can be split into two categories of physical and intangible resources. The former relates to equipment, vehicles and stock, whilst the latter refers to capital, knowledge and expertise and 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 (Figure 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. The company believed that on-site support would have the greatest potential for contributing to 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 save energy through the purchase of more efficient equipment, better data management and 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 – 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 ‘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, as this ReSOLVE action 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 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.

Table 2: Actions identified in workshop two to align the company’s business model with CE principles (BECE step 6)

ReSOLVE action	CE actions identified by participants[a]
Regenerate	Supply ICT equipment sourced from reclaimed materials and engage with upstream suppliers to request 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
	Provide a carbon offset offer to customers
Share	***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)
Optimise	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
	Engage with upstream suppliers to reduce product packaging
Loop	***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
Virtualise	Increase the amount of sever-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 resolve issues remotely, thus reducing vehicle travel
	Use remote webcam software/hardware to resolve issues remotely and reduce vehicle travel
Exchange	No actions identified due to the nature of the business

[a] Bold italic font denotes actions taken into the evaluation stage.

Table 3: Evaluation matrix of the proposed alternative business models (BECE step 7).

Criteria	Weight[a]	'Data monitoring and analysis'	Per-use fee (e.g. printers)	Takeback service	Reduce supplier packaging	Remote webcam support
Profitability	5	Low[b]	Medium[b]	Low	Low	Low
Exceeding customer expectations	5	High[b]	Low	Medium	Medium	High
Satisfying supply demands	3	High	Low	Medium	Low	Medium
Evaluation score		**29**	**18**	**21**	**18**	**26**

[a] 1 = least important; 5 = most important.
[b] High =3; medium = 2; low = 1.

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. In so doing this 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 'takeback service', the company would increase its current takeback 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 and thus contributing to achieving zero-waste 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 Figures 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, and reduced miles driven by the company vehicle fleet by using remote webcam support. Additionally, both business models presented in Figure 4 and Figure 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 the analysis of data.

INSERT FIGURE 4 HERE

INSERT FIGURE 5 HERE

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), and had developed 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 the service sector

The application of the BECE framework with the focal firm helped to analyse the 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 business, this study emphasised a user-centric focus, based on the value sought by customers, rather than the products offered to them. 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. Services can, therefore, affect the way in which 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 in the user interaction with existing products.

The user-centric focus was facilitated through the Business Model Canvas (Osterwalder and Pigneur 2010), which expands the scope of eco-design analysis in BECE by considering an organisation's entire business model in detail and the way 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 solves the same requirement for on-site support services, whilst being able to provide that service faster and with lower costs and pollutant emissions, through reduced vehicle emissions, for the service provider.

Whilst the service 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 operating environment in which the company operates. BECE links strategic and operational processes to help develop CE businesses. As such, using a qualitative evaluation matrix together with the participants to assess the CE options and their appropriateness for the company's strategy proved a useful addition to the BECE framework.

Likewise, leveraging the ReSOLVE checklist (EMF 2015a) as part of BECE was useful 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 whether guiding checklists such as ReSOLVE are beneficial could be an avenue for future research.

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 company considered in this research would not have been able to apply BECE as described in this paper without researchers' assistance. Thus, future research could investigate how BECE and similar CE tools could be made more usable without the need for such an assistance. The potential for the service industry to contribute to a CE

The findings of this research indicate potential for small service-based organisations of relatively little resources and influence to adhere to CE principles. Offering services rather than products is one of the key recommendations for a 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-based business models to close resource loops (Stahel, 2006). This paper contributes to the literature by suggesting that there is also potential for small businesses in the service sector to offer services that can contribute to circularity in other businesses reliant on the manufacture of products. 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 industry that is able to support a CE, by offering existing services in new ways or developing entirely new services, which enable their customers to decouple profits from resource consumption. The sector can be defined by innovation and technological progress (Cambini, 2013), requiring ICT support firms to adapt to new developments quickly. In particular, the findings of this research suggest that the 'optimise' action from ReSOLVE (EMF, 2015b) may hold the greatest potential for the service 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. These innovations are consistent with examples detailed in EMF (2016). For example, OnFarm Systems (2016) synthesise agricultural data to inform agricultural management decision-making (similar to the 'data monitoring and analysis' idea developed in this research). Similarly, Libelium (2016) uses remote technologies to allow farmers to observe, measure, and respond to environmental conditions. Whilst not all businesses based in the service sector have the same technical expertise as is the case in this study, the ReSOLVE actions offer many examples of ways in which businesses in the service sector may be able to contribute to circularity in other ways. For example, retailers may be able to offer business models that are able to leverage the sharing economy, or through optimised production and supply chains.

Of the six ReSOLVE actions, some appear more appropriate than others for the service sector, 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 company in this research 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, small business may already be adapting to a 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 webcam 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 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. (2016). Moreover, engagement with academia has limited take up by small organisations for similar and other reasons (Bayone et al., 2002).

4.2 The potential for CE adoption in small organisations

The results of this research indicate that small organisations have the capacity to take initial steps towards a CE. The focal firm was able to understand 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.

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 small organisations to adapt to a 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, 2014), again consistent with the findings in this research.

There is a disconnect between the barriers for small organisations implementing CE and how such barriers are overcome. The barriers analysed by Rizos et al. (2015) and identified in this paper are similar but are both at the micro-economic level. They regard 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 latter in the UK include Grants4Growth and the Scottish Recycling fund (Technopolis, 2014). This disconnect is potentially a significant obstacle in the move towards a CE and should be subject to further research to identify appropriate policies to bridge the gap.

One of the potential advantages of service-based small organisations, such is the one studied here, is that they are situated between suppliers and their customers, thus being able to engage both upstream (to suppliers) and downstream (to their customers). The firm in this study already influences the decision-making of customers by giving specific advice, for instance, on the lifespan of hardware and the potential for repair. 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 by following the example of others. 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 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 a small organisation. 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 should, therefore, look at other service sectors, such as retail, catering and finance, to assess whether similar opportunities exist elsewhere.

5 Conclusions

This research has aimed to understand the potential of businesses in the service industry, and specifically in the ICT support sub-sector, to contribute to a 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 had begun to implement the recommended actions. The implementation and user-centred eco-design focus of BECE played a key role in this process. With further testing at other businesses, BECE could facilitate the service sector’s move towards a CE.

Although this paper has focused on one illustrative company, some of the findings apply to the service sector as a whole. This research has identified that service-oriented companies cumulatively have a high potential to contribute to a CE due to its strategic position between product manufactures 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-based organisations 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.

Further research would prove fruitful in extending and validating the findings of this paper. Firstly, other service sub-sectors may reveal different opportunities to those in the ICT support. Secondly, the same study with 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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Captions

Figure 1: The BECE framework for service-oriented applications, combining backcasting and eco-design approaches, including the Business Model Canvas and the ReSOLVE checklist (adapted from Mendoza et al. (2017)).
[ReSOLVE: regenerate, share, optimise, loop, virtualise, exchange (EMF, 2015). Business Canvas Model from Osterwalder and Pigneur (2010)].

Figure 2: The application of BECE with the focal firm over the two workshops.

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

Figure 4: The 'data monitoring and analysis' business model developed by the participants in workshop 2.

Figure 5: The 'remote webcam support' business model developed by the participants in workshop 2.