19. The impact of circular economy

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1 INTRODUCTION

All organizations have social, environmental and economic impacts that affect people, their communities and the natural environment. Impacts can be positive and negative and include intended as well as unintended effects. While intended effects are related to the activities of an organization and explicitly aimed for, unintended effects are also related to the activities of the organization but are not explicitly aimed for by the organization (Maas, 2009). Intended effects include, for example, the production of products or services. In the case of for-profit organizations they also include profit for the shareholders. These effects are accounted for by the organization and are traditionally included in performance measurement and management decisions. Unintended effects might include effects on the natural environment such as emissions of air pollutants, waste and energy use. Moreover, unintended effects can include adverse impacts on human beings, their property, their welfare and their well-being.

Governments, activists, the media and consumers request organizations to be increasingly accountable for the social and environmental consequences of their organizational activities. This development has contributed to the judgement that most firms operate on business models that are not sustainable (Boons et al., 2013). Innovation – in particular, sustainable innovation connected to new business models – is often positioned as a win–win situation for society and the business (Porter and Kramer, 2011). Consequently, interest in sustainable innovation is rapidly increasing (Boons and Lüdeke-Freund, 2013).

Circular economy (CE) and related circular business models are a recent trend in sustainable innovation. CE is most often defined as 'an economy where finite resources are circulating in a closed-loop system' (Ellen MacArthur Foundation, 2012), although the social dimension is increasingly integrated into the definition as well (for example, Murray, Skene and Haynes, 2017). To do business in a circular way, firm operations need to be adjusted from the linear take-make-use-dispose strategy towards smart and durable design, use and reuse at a resource, component and/or product level (Achterberg, Hinfelaar and Bocken, 2016). The traction that innovations towards a circle economy have reached in the past decade seems to stem from the promise that the underlying business models are expected to deliver high business profits hand in hand with positive ecological (resource and low carbon) and social impacts (Ellen MacArthur Foundation and McKinsey & Company, 2014). Despite this promise, it is often unclear how and whether circular enterprises are aiming to maximize, measure and adjust their strategy based on societal impact (Maas, 2009; Ewen et al., 2017).

We know little about what type of impact circular enterprises expect to make, whether they measure their impact and if they use the results to adjust their strategy where necessary. This leads us to the following research question: what is the expected impact of different types of innovations by firms towards a circular economy, and do firms measure

this impact? To answer this research question, we first explain the concept of impact (Maas and Liket, 2011) and we outline what impact (measurement) is and how to link this to the CE and the potential intended impact (Ellen MacArthur Foundation, 2012) and the potential unintended impact (Geng et al., 2012; Sundararajan, 2014; Guttentag, 2015). Second, we give an overview of different circular business models (Accenture, 2014; Stegeman, 2015; Achterberg et al., 2016; Lewandowski, 2016; Linder and Williander, 2017). We use this to introduce the innovation elements of circular business models developed by Ewen et al. (2017). Third, based on the underlying case studies we link potential circular impact to the five innovation elements identified in our circular innovation model. We analyse what type of impact is expected in which innovation element. We conclude with an overview of the current status of impact measurement for circular innovation.

2 IMPACT AND IMPACT MEASUREMENT

Innovations towards a circular economy have received a lot of attention from researchers and practitioners. In both fields, we find advocates as well as critics. The latter believe innovations towards a circular economy are mainly about enlightened self-interest, PR and green washing and will not provide any value for society (for example, Sauvé, Bernard and Sloan, 2016). Advocates believe that innovations towards a circular economy will provide value for business, society, and ecosystems, and are a source of innovation (for example, Ellen MacArthur Foundation, 2012).

Surprisingly little is known about the actual impact of CE. Academic literature and research on sustainable innovation has tended to neglect the way in which firms need to combine a value proposition, the organization of the value chain and a financial model in order to bring sustainable innovations to the market (Boons and Lüdeke-Freund, 2013). Next to that, existing studies on innovation and even more specifically sustainable innovation, are mostly of a conceptual nature, and the limited amount of empirical work that does exist mainly consists of single case studies (Coccia, 2009). Single case studies can be accurate and specific, but often lack the ability to offer generalizable findings. Finally, innovation literature mainly focuses on drivers for innovation and performance of innovation on output and business levels (for example, competitiveness, financial performance, jobs created) (Fagerberg, Mowery and Nelson, 2005). Despite the interest in sustainable innovation and business models, the larger question about the impact of organizations on society remains largely unexplored (Wood, 1991; Maas and Boons, 2010; Murray et al., 2017).

The public interest in circular innovation and belief in the potential of circularity to contribute to the reduction of worldwide problems require validation (Ghisellini, Cialani and Ulgiati, 2016; Linder and Williander, 2017). Next to that, the firm itself will need to monitor the impact of its activities. This urges firms to assess their value creation (or destruction) across ecological, social and economic dimensions, and to incorporate those impacts in management decisions.

Conventional performance measurement is often based on the so-called goal-attainment approach and does not usually consider social or environmental questions (for example, Preston, 1988; Clarkson, 1995). The assumption that underlies the goal-attainment

approach is that the goals of an organization are identifiable and unambiguous (Forbes, 1998). An organization's effectiveness is represented by the attainment or progress towards these organizational goals. Attaining organizational goals such as increasing production, increasing profit or reducing costs, can be researched using conventional performance measurement methods. Including impact upon society on various dimensions – economic, environmental, social – in performance measurement complicates the ability to identify, measure and value these impacts (Maas, 2009), however, it contributes greatly to the completeness of the performance measurement (Maas and Liket, 2011). In general, environmental and social impacts are externalized by the market, as they do not have a market value and are therefore often fundamentally ignored by companies (Schaltegger and Burritt, 2010; Maas and Grieco, 2017).

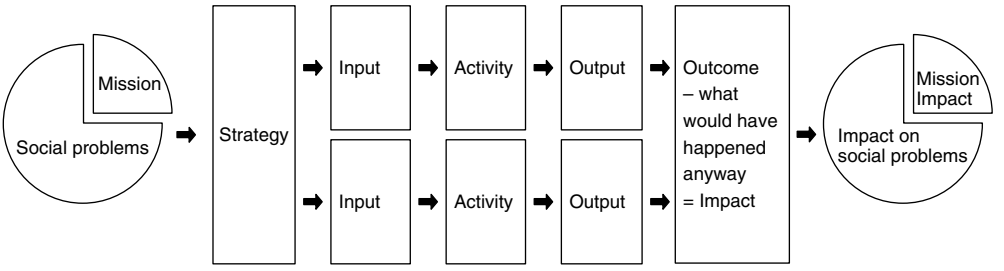
Impact includes intended as well as unintended effects, negative as well as positive effects, and both long-term and short-term effects (Wainwright, 2002). Impact can be assessed at various levels including the individual, organizational, community and policy levels (Yates, 2004). The term social impact is used to capture the impact on society on the economic, environmental and social dimensions. The general interest of organizations to improve their impact on society is not sector specific. In corporate boardrooms and by other stakeholders – for example, government, consumers and suppliers – managers are increasingly being asked to describe, for example, their impacts on resource use, waste or the local economy (Clark et al., 2004). This implies that organizations need to improve the management of their environmental and social impacts and urges organizations to assess their impact across the environmental, social and economic dimensions. Ideally, social impact would be incorporated into management decisions and corporate strategy.

2.1 From Output to Impact

The different terms used by different researchers from business and society studies, management accounting, strategic management, and practitioners to capture performance, results and impact are confusing. The main difference is found between the entrepreneurs' and social scientists' definitions of the words 'impact', 'output', 'effect', 'outcome' and 'social return'. Many different definitions of (social) impact or related terms can be found in the literature (for a good overview of definitions see Maas and Liket, 2011). The term impact is often replaced by terms such as 'social impact' (Latané, 1981; Burdge and Vanclay, 1996), 'social value' (Emerson, Wachowicz and Chun, 2000) and 'social return' (Clark et al., 2004).

In this chapter we build on the so-called impact value chain (Figure 19.1) used to differentiate outputs from outcomes and impact. While outputs and outcomes are related to the provider of the product, activity or service, impacts are associated with the user (Kolodinsky, Stewart and Bullard, 2006) and society at large (Liket, Rey-Garcia and Maas, 2014).

Inputs are the resources provided to the organization in order to achieve the organization's mission. These inputs are used in activities, services or production that will lead to certain outputs. Outputs are the direct and immediate consequences of the activities undertaken. Outcomes are, unlike inputs and outputs, much more comprehensive and are translated to the extent that the goals of the organization are achieved. Outcomes are those benefits or changes for individuals or communities after participating in or being



Source: Based on Liket, Rey-Garcia and Maas (2014).

Figure 19.1 Impact value chain

influenced by the activities of the organization. Impacts are those outcomes minus what would have happened anyway. This refers to the need for a so-called counterfactual, an indication of what might have happened if the activities would not have been undertaken by the organization. The use of a counterfactual, also called a baseline, is also used in cost–benefit analysis. The counterfactual or baseline situation does not necessarily mean that nothing will happen to the current situation over time if the activity is not undertaken. Impacts include intended as well as unintended effects, negative as well as positive effects, and both long-term and short-term effects (Wainwright, 2002).

The difference between outputs, outcomes and impacts can be illustrated hypothetically using the example of a medicine (Maas and Liket, 2011). Outputs can be measured by the amount of medicines produced, outcomes measure the use of the medicines by patients, impacts measure the actual health effects users of the medicine experience compared to a situation where they would have not used the medicines. This example illustrates that impact measurement is a form of performance or effectiveness measurement.

2.2 The Potential Impact of Circular Economy

In contemporary literature on business models, the focus shifted away from the question 'How could innovation in business models lead to more profit?' towards the question of 'How may innovation in business models solve societal problems and hence contribute to a sustainable economy and society?' (Hall and Wagner, 2012; Bocken et al., 2014; Schaltegger, Hansen and Lüdeke-Freund, 2015; Rauter, Jonker and Baumgartner, 2017). Within this literature, innovating by shifting from a 'linear' to a 'circular' business model has received much attention (Boons and Lüdeke-Freund, 2013; Achterberg et al., 2016; Linder and Williander, 2017), in order to help firms strategize how to integrate the principles of circular economy (CE) into the way they do business (Lewandowski, 2016).

The concept of a circular economy is developed as a counterweight to the take-make-break (linear) economy, in which firms use virgin resources, transform them into consumer products, which are sold and disposed of by consumers after use (Ellen MacArthur Foundation, 2012; Achterberg et al., 2016). Such sales-oriented business models incentivize companies to engage in 'planned obsolescence': lowered durability of products to ensure consumers make regular repeat sales (Bulow, 1986; Agrawal, Kavadias and Toktay, 2015). Although perhaps economically sound in the short- to mid-term, at a

macro level this industrial model is unsustainable in the long term from climate, ecosystem and natural resources perspectives (Stern, 2008; Ellen MacArthur Foundation, 2012). The definition of the CE embodies its environmental impact promise (Ellen MacArthur Foundation, 2012):

> A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.

Despite the clear environmental focus of the definition of CE, social and economic impact also play a role in the circular economy. Based on reviewing the key literature on CE we have identified six often-mentioned areas of potential impact, both intended positive impact as well as potential unintended negative impact.

2.2.1 Reduction of waste (including use of toxic materials)

First, and most prominently, circular innovation should be directed towards minimizing the loss of material residuals (Andersen, 2006). In other words, waste should be eliminated (Ellen MacArthur Foundation, 2012). This can be realized by closing, slowing and narrowing resource loops through, amongst other options, recycling on product or resource level, designing products for longevity and using homogeneous materials for a single product (Bocken et al., 2016). To achieve this impact, innovation of materials is needed since the current production systems and materials are not automatically capable of fulfilling those needs. Currently, not all materials are benign for human health and the environment and therefore difficult to recycle. CE has the potential to favour the necessary material innovation to eliminate toxic chemicals from materials to create non-toxic alternatives (Ellen MacArthur Foundation, 2012), but also encourages organizations to create new business models built upon the recycling of challenging waste streams.

2.2.2 Reduction of greenhouse gas emissions

Circular innovation can lead to reduced greenhouse gas emissions, in line with the Paris Accord and the urgent need to keep global warming below 2°C (Stern, 2008; United Nations, 2016). The impact of greenhouse gas emissions on our planet by human activities is a significant driver of climate change.

Global implementation of circular economy principles is claimed to potentially provide up to half the reduction in greenhouse gas emissions needed to stay within the targeted range (Circle Economy and Ecofys, 2016). Since more than half the emissions are related to material management, more efficient use of existing materials and assets can directly lower emissions, even without considering the increased use of renewable energy as part of circular strategies (ibid.). In particular, energy use involved in extracting virgin materials and converting them into a commercially viable form is huge, so longevity and recycling are of interest from an energy perspective as well (Ellen MacArthur Foundation, 2012).

2.2.3 Employment effects

Circular innovation shifts economic activity away from extracting virgin materials and industrial production of low-value consumer goods (arguably very capital intensive)

and towards reuse, refurbishment and recycling of existing goods (arguably more labour intensive). The type of economic activity envisioned in CE should improve employment in these areas; however, it will also lower employment in the more traditional take-make-waste industries if these shrink as a result (Morgan and Mitchell, 2015). Almost half the jobs in the circular economy (in the Netherlands) are in sectors that preserve and extend product life times, but the fastest job growth that enables the circular economy seems to be in the digital sector (Circle Economy, 2017). On the other hand, if CE leads to less production it could overall also lead to less employment (Guttentag, 2015). The net effect is yet undetermined and will also require a worldwide view, since some jurisdictions will find a negative and others a positive impact, depending on current employment options in their region.

2.2.4 Increased quality of life

The total cost of ownership of high-quality, durable goods is expected to decrease through circular innovation, thereby increasing access for individuals to goods but also lowering down time and repair time. Improved access to high-quality, durable goods by, for example, lease contracts, will have a positive impact on quality of life. Also, increased servitization of products will lead to a broader choice set for consumers, since they will be able to choose products and contractual terms and switch between them more easily than in traditional sales-oriented models. Furthermore, health benefits are expected to be part of circular innovation as well, due to elimination of toxic materials and simplicity of design and lowering of environmental costs in general (Ellen MacArthur Foundation, 2012).

2.2.5 Macroeconomic effects

Finally, circular innovation can improve macroeconomic stability by maintaining the natural capital that delivers ecosystem services that provide input to the stable functioning of our economy. Closing material loops should limit the need for extraction of virgin resources (raw materials, forests) that erodes the planet's ability to deliver essential ecosystem services such as agricultural productivity, prevention of diseases, nutrient cycling, flood prevention and soil conservation (Ellen MacArthur Foundation, 2012). From resource depletion to flooding to poverty, instability caused by ecological degradation can be prevented by large-scale circular innovation (Ellen MacArthur Foundation and McKinsey & Company, 2014).

Other researchers warn of the destabilizing effects of CE. Based on empirical evidence from China Geng et al. (2012) argue that a circular economy stresses harmonized economic, social, and ecological relationships.

2.2.6 Rebound effects

Sharing platforms like Airbnb or Uber can be thought of as a 'disruptive innovation' (Christensen and Raynor, 2003), due to the companies' innovative internet-based business model and unique appeal to users (Guttentag, 2015). There is potential that those new upcoming firms disrupt an existing sector and is of great concern for the traditional accommodation or taxi sector. Traditional sectors are threatened by the rapid growth of those new firms, while many legal issues like permits, tax issues and consumer rights arise. Unfortunately, there is not a lot of empirical information available about the actual impact and rebound effects of those firms, except for growth rates and discussions related

to safety issues related to the tourism growth for Airbnb and labour right issues related to Uber. Guttentag (2015) and Sundararajan (2014) both plead for more research on empirical effects of disruptive innovations.

3 CIRCULAR BUSINESS MODELS AND CIRCULAR INNOVATION

3.1 Existing Frameworks and Models for Circular Innovation and Business Models

There is a large body of literature dedicated to typologies, frameworks and business models for circular innovation (Bocken et al., 2016). The value hill is a typology that divides circular innovation into three stages: pre-use, use and post-use innovation, often implemented sequentially or partly, depending on the position of a firm in the value chain (Achterberg et al., 2016). Others use a categorization based on different circular business models (Accenture, 2014; Stegeman, 2015; Bocken et al., 2016) or the effect of product–service systems on sustainability, circularity and innovation (Manzini and Vezzoli, 2002; Tukker, 2004).

In general, a business model should be in line with the organization's mission, while a mission reflects what the organization aims to accomplish. In their mission, circular organizations determine their purpose and think about their impact ambitions or opportunities. A company's mission is translated into strategy that helps them to realize their ambitions, if necessary in cooperation with other organizations. A strategy is a fundamental pattern of present and planned objectives, resource deployment, and interactions of an organization with stakeholders and environmental factors (Hart and Milstein, 2003). Various choices can be made to achieve these ambitions and to realize the impact opportunities.

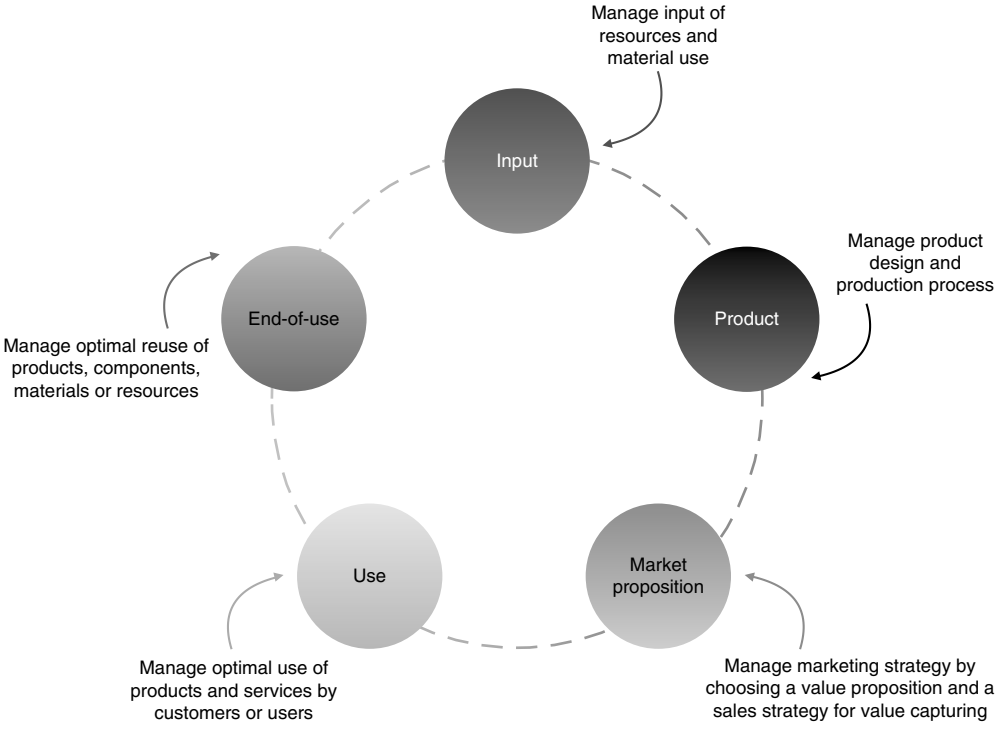
3.2 Five Strategic Elements Towards Circular Economy

Based on both existing literature and interviews with 20 firms engaging with circular innovation in the Netherlands, Ewen et al. (2017) identified five strategic elements that organizations use to attain expected circular impact. These strategic elements were translated into the circular innovation model (Figure 19.2).

Depending on the desired outcome, organizations focus on one, some or all strategic elements. Each element leads to different interventions, successes and challenges. Each element may also lead to distinctive impacts and therefore organizations should make a strategic and conscious decision regarding these elements. We have analysed, based on desk research and interviews, 20 Dutch cases of organizations aiming to have a positive impact on circular economy. In Table 19.1, it is specified which strategic element(s) these firms use.

3.2.1 Input: manage input of resources and materials

Product-oriented organizations have the ability to manage the input of resources and materials. Organizations have several options when choosing this strategic element, including: (1) input of resources and materials that are completely circular: renewable,



Source: Based on Ewen et al. (2017).

Figure 19.2 Circular innovation model – strategic elements

biodegradable or recyclable; or (2) input of resources and materials that are excavated from waste streams. Organizations managing material and resource input could achieve reduction of waste and reduction of greenhouse gas emissions. These organizations avoid loss of materials, innovate to create superior materials, use renewable energy and/or lower environmental impact using a low-emission recycling process instead of extracting virgin materials. Examples can be found in the CO_2-efficient processes used to produce closed-loop carbon black (Black Bear) and no use of water in Niaga® technology (DSM).

Resource and material science has shown that renewable resources are more accessible and applicable, but also that unexpected resources and materials are able to perform equally effectively compared to materials made from fossil resources. Not all resources and materials have a circular equivalent yet, although applications are rapidly evolving.

Both technological and biological innovations are of interest in the circular economy. Examples are bioplastics, biodegradable paper and cardboard made of agricultural waste or elephant grass. Case study research amongst 120 organizations identified circular supplies as one of the important opportunities within a circular economy (Accenture, 2014, p. 12). Quality is an important requirement for input innovation, because the circular alternative should have equal or superior quality compared to the virgin material. This requires entrepreneurship within companies to stimulate new input innovations if there

Table 19.1 Use of the strategic elements of CE by 20 case companies

	Input	Product	Market Proposition	Use	End-of-use
BlaBlaCar			x		
Bundles			x	x	x
Canon	x		x	x	x
Closing the Loop	x		x		x
Coolrec					x
DESKO			x		x
Desso	x	x	x		x
DSM	x	x	x		
Fairphone	x	x	x	x	x
Finch	x	x	x	x	
Gispen	x	x	x	x	x
Greenwheels			x		
Gyproc	x		x		x
HVC				x	x
Interface	x	x	x		x
Moonen	x		x	x	
OV-fiets	x	x	x		x
Philips	x	x	x	x	x
Rockwool	x	x	x		x
Waternet					x

is no alternative available. There are opportunities to achieve an increased quality of life by development of superior materials. Companies should be willing to invest in research and development (R&D) and partner with innovative companies and universities to explore alternative input. This strategic element may affect supply chains, product design departments and R&D.

3.2.2 Product: manage product design and production

Some products are designed and constructed with glued and/or welded parts. These products may be less valuable in a circular economy because product design has not taken disassembly or recycling at the end-of-use stage into account. Organizations producing such products should assess whether redesigning products contribute to the impact opportunities. Management of product design and production: (1) increases resource and/or material life-cycle; or (2) decreases resource and/or material usage in production process. Research by Bocken et al. (2016) shows that there are several product design strategies. Examples of product design and production management are modular product design, design for durability and dematerialization.

Organizations managing products could achieve reduction of greenhouse gas emissions and increased employment. These organizations typically use existing materials and assets efficiently, shift away from production of low-value customer goods, and increase activity in service and repair activities. Examples can be found in modular phones by Fairphone, energy and labour-efficient recycling of DSM-Niaga® carpet, modular products by Gispen and Interface and robust design by Dutch Railway bikes (OV-fiets).

Product design and production efficiency have the potential to lead to cost efficiency. Companies may combine modular design and manage end-of-use at the same time to assure access to the product after usage. This creates opportunities to upgrade old models and lower resource and/or material costs to produce new products. This strategic element affects product design departments and production process.

3.2.3 Market proposition: manage value proposition and sales strategy

Previous strategic elements affect the internal organization, but some organizations choose to change their customer relations and market approach. These organizations use a specific market proposition to manage their value proposition and sales strategy. Organizations position themselves or a product (line) by choosing: (1) value proposition and/or (2) value capturing. Research by Bocken et al. (2016) also defines different strategies for business models in CE built on value proposition and value capturing. Organizations managing their market proposition could achieve reduction of greenhouse gas emissions, increased employment and increased quality of life (Ewen et al., 2017). These organizations typically use existing materials and assets efficiently, shift away from production of low-value customer goods, increase activity in service and repair and decrease the total cost of ownership for high-quality and durable goods. Organizations using a service or platform model potentially increase accessibility of high-value goods for a wider range of customers. Examples can be found in high-quality M-Use® elevators by Mitsubishi Elevator Europe, Diamond Select products by Philips Healthcare and accessibility of high-quality home appliances by Bundles.

Case study research shows that, while some organizations choose a circular value proposition, others do not want to position their organization or product (lines) actively as being circular (Ewen et al., 2017). The organizations should also consider the appropriate market offering: sales models, service models or platform models. Some researchers state that service models are ideal to accelerate the circular economy (Tukker, 2015). A product–service system (PSS) will not automatically result in a circular economy, but the so-called function-oriented PSS has potential to have a positive impact on the environment (Tukker, 2004).

The market proposition affects commercial and financial departments. It may also affect maintenance departments when additional services are required to operationalize the market proposition.

3.2.4 Use: manage user optimization

It is increasingly important for organizations to build a good customer relationship. This customer relationship gives organizations the opportunity to manage user optimization by (1) stimulating less product usage (quantity) and/or (2) stimulating longer product usage (time). Research by the Ellen MacArthur Foundation (2012) and Bocken et al. (2016) also distinguish quantity and time as variables to slow and narrow loops within a circular system. Organizations can inform, stimulate and offer services to their customers during the user period. Organizations managing user optimization could reduce greenhouse gas emissions by more efficient use of existing materials and assets and could contribute to increased employment by offering services to repair, upgrade or maintain products. These organizations typically create low-maintenance, dismountable modular products (for example, Fairphone, Interface) and add advisory services and information to maximize

product effectivity (for example, Moonen Packaging, Canon). However, Tukker (2004, p. 256) states that 'the fact that the user no longer owns the product could even lead to negative effects, such as a careless use shortening its useful life span'. Information may lead to more awareness about optimal use or knowledge about self-servicing a product (for example, repair or maintenance). Stimulation may encourage users to treat the product more sustainably, especially when users do not own products. Product–service systems are a relatively easy way for organizations to manage relationships with customers and stimulate less product use and longer product use.

Strategic element use affects commercial and maintenance departments. Managing user optimization has an impact on account management and customer service. This element depends on changes in behaviour and mind set.

3.2.5 End-of-use: manage output of resources and materials

A perfect circular model implies that non-renewable materials should be reused for an indefinite period of time, while a linear model replaces materials with new materials. Organizations have opportunities to optimize output of materials at the end-of-use stage by reusing products, components or (raw) materials. There are opportunities to lower material costs (for example, replace new production materials with waste materials) or higher revenues (for example, sell waste materials to third parties). Organizations managing end-of-use could have a positive effect on reduction of waste and greenhouse gas emissions, increased employment and increased quality of life. These organizations focus on preserving access to materials (in a circular system seen as 'waste') and products (Philips Diamond Select) and avoiding health dangers in recycling or landfill (Closing the Loop, Black Bear). Furthermore, circular materials must demonstrate their effectiveness compared to virgin materials through long-term material testing periods, which opens opportunities for superior, toxin-free materials. Moreover, innovative recycling technologies may have less environmental impact – for example, Black Bear's tyre recycling plant.

A perfect circular model eliminates waste, which can be achieved by waste prevention. Organizations can stimulate waste prevention by actively managing previous strategy elements. Products or components may be reused or redistributed for reuse to prevent waste sanitation. As an alternative, products or components may be refurbished or remanufactured for second-life use. Upcycling and recycling are solid alternatives when products or components are dismissed. Strategic element end-of-use affects supply chain, such as logistics and production departments. This element depends on partnerships, supplier relations and material management to collect products, components or materials.

4 IMPACT MEASUREMENT OF CIRCULAR INNOVATION

From the 1990s onwards, several methods have been developed to measure social impact. Maas and Liket (2011) provided an interesting, although non-exhaustive overview of 30 social impact measurement methods. Their analysis of those methods illustrates the diversity in purpose, orientation, time frame, perspective and approach. As we focus on the social impact of circular innovation on a macro level, methods that adopt a macro perspective could be useful. Based on our 20 case studies of CE organizations we have

investigated which promised impacts are related to the strategic elements, whether the organizations measure their impact and if so, which methods they use.

4.1 Defining the Impact of Different Circular Innovation Elements

In the previous paragraphs, the potential impacts and the strategic elements of CE have been described. We have already seen from the 20 case studies that most of the companies use a combination of different strategic elements (see Table 19.1). If a company has a single focus it often focuses on market proposition. Those companies are often part of the sharing economy, and offer the use of durable goods like cars or office furniture.

In Table 19.2 we have specified the promised impacts in relation to the five strategic elements based on our empirical case study results. We see that all strategic elements are expected to have a positive impact on the reduction of waste and greenhouse gas emissions. We do not find any expected impact on increased quality of life by differences in 'product' or 'use'. An exception might be when a product as such already has an impact on the quality of life. In that case, product life improvement could have an impact in the quality of life. Employment effects might be positive or negative. Potential negative effects relate to 'market proposition' and 'use'. We only find a potential impact on macro-economic stability from innovations in 'input' and 'end-of-use'. Finally, CE innovations could potentially lead to disruptive effects related to all strategic elements with exception of 'product', as this mainly relates to product optimization.

During the case study research we also investigated whether the companies already *measure* their impact on environmental and social dimension and what method they use (Table 19.3).

It is interesting to see that eight of the 20 companies do not measure their impact at all. This is quite surprising as the main focus of CE is to have a positive impact on society. Also interesting is that almost all other companies mainly focus on environmental issues by using instruments like life-cycle analysis (LCA), BREEAM, Energy Index, Environmental Product Declaration and Cradle2Cradle certification.

Life-cycle analysis or assessment, LCA, analyses the environmental impacts associated with products, or product systems. LCA has its origins in the early 1970s. The method had its roots in energy and waste management, and the products given greatest attention in this initial period were beverage containers and diapers. In the period 1980–2000, the main focus of LCA was solely on environmental aspects. During the last decennia, partnerships of academia and practitioners have developed an approach to incorporate social aspects in LCAs.[1] In the Netherlands, DSM is using social LCA extensively.

BREEAM is the world's leading sustainability assessment method for master-planning projects, infrastructure and buildings. BREEAM does this through third party certification of the assessment of an asset's environmental, social and economic sustainability performance using standards developed by BREEAM. This means BREEAM-rated developments are more sustainable environments that enhance the well-being of the people who live and work in them, help protect natural resources and make for more attractive property investments.[2] The Energy Index is another voluntary instrument to calculate the energy consumption of housing. Environmental Product Declaration (EPD®) is a verified and registered document that communicates transparent and comparable

Table 19.2 Potential impacts of circular innovations

Impact	Strategic Element				
	Input	Product	Market proposition	Use	End-of-use
Reduction of waste	Prevent material loss Innovative superior, toxin-free materials	Prevent waste by modular products	Sharing products leads to less products needed	Life-time extension, less products needed	Prevent material loss Avoid health dangers in recycling or landfill Innovative superior, toxin-free materials
Reduction of greenhouse gas emissions	Use of renewable energy Reduce environmental impact in extracting virgin materials	More efficient use of existing materials and assets Use of renewable energy	More efficient use of existing materials and assets	More efficient use of existing materials and assets	Use of renewable energy Reduce environmental impact in extracting virgin materials
Employment effects	Shift away from extracting virgin materials	Shift away from production of low-value customer goods Increase employment in maintenance and product-related services	Shift away from production of low-value customer goods Increase employment in maintenance and product-related services but decreased employment due to less production	Increase employment in maintenance and product-related services but decreased employment due to less production	Shift away from extracting virgin materials
Increased quality of life	Increased health benefits of superior, toxin-free materials	No impact	Increased accessibility for high-quality durable goods	No impact	Increased health benefits of superior, toxin-free recycled materials
Macroeconomic stability	Keep pace in natural capital Not extracting virgin materials	No impact	No impact	No impact	Keep pace in natural capital
Rebound effects	Disruption of traditional sectors	No impact	Disruption of traditional sectors, labour issues and legal issues	Disruption of traditional sectors	Disruption of traditional sectors

Table 19.3 Use of the strategic elements of CE by 20 case companies.

	Input	Product	Market Proposition	Use	End-of-Use	Output/Impact Measurement
BlaBlaCar			x			No measurement
Bundles			x	x	x	No measurement
Canon	x		x	x	x	Life-cycle analysis
Closing the Loop	x		x		x	No measurement
Coolrec					x	Environmental impact measurement
DESKO			x		x	Internal measurement model
Desso	x	x	x		x	BREEAM
DSM	x	x	x			Life-cycle analysis, social life-cycle analysis
Fairphone	x	x	x	x	x	Internal measurement model
Finch	x	x	x	x		Energy Index
Gispen	x	x	x	x	x	No measurement
Greenwheels			x			No measurement
Gyproc	x		x		x	BREEAM, Cradle2cradle certification
HVC				x	x	No measurement
Interface	x	x	x		x	Social cost–benefit analysis Environmental Product Declaration
Moonen	x		x	x		Life-cycle analysis
OV-fiets	x	x	x		x	No measurement
Philips	x	x	x	x	x	Internal measurement model
Rockwool	x	x	x		x	Life-cycle analysis, environmental product declaration Social cost–benefit analysis
Waternet					x	No measurement

information about the life-cycle environmental impacts of products.[3] Cradle2Cradle (C2C) certification[4] shows that designers and manufacturers went through a continual improvement process that looks at a product through five quality categories – material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness.

Three companies used an internally developed measurement method. Two companies report using a social cost–benefit analysis (SCBA), a general economic tool for performance measurement. Since the 1990s the traditional cost–benefit analysis has been extended to include impacts upon the society. SCBA is a type of economic analysis in which the costs and social impacts of an investment are expressed in monetary or non-monetary terms. The level of analysis is on the macro level. The SCBA approach is able to capture environmental as well as social impacts.

Based on the methods used it becomes clear that more than half the companies do

measure their impact. The main focus of the measurement methods is on environmental impacts, specifically geared towards reduction of waste and greenhouse gas emissions. Only a few of the companies use methods capable of capturing the social impacts as promised by CE supporters – employment, improved quality of life and macroeconomic stability. The latter two indicators in particular were hardly mentioned during the case study interviews.

4.2 From Impact Measurement to Impact Management: A Proposed Solution

The promises that circular innovations bring are high business profits that go hand in hand with positive ecological (resource and low carbon) and social impact. Based on 20 case studies we have shown that potential impacts of circular innovation depend upon the strategic elements of the business models chosen by companies. But how do we know whether we actually achieve those impacts without measuring those impacts?

Although we see that some companies have methods available to measure their (mainly environmental) impact, they are not always used for strategic purposes. If CE is the basis of the business model and is a strategic activity, the company itself will have a need to monitor the impact of its activities. This urges firms to assess their value creation (or destruction) across ecological, social and economic dimensions, and to incorporate those impacts into management decisions. In other words, if CE firms want to live up to the promised impacts of CE, they should measure their actual impact, not only to prove their performance (measurement for reporting purposes) but specifically to improve their performance (measurement for learning purposes).

5 CONCLUSION AND NEXT STEPS

In the current chapter, we provide an impact perspective on sustainable innovation by scrutinizing the potential impact of circular innovation specifically. We use existing literature on circular business model innovation and circular economy as well as case study interviews. We identified the main categories of expected impact of the circular economy and link those to different strategic elements of circular innovation that each embody part of the shift to a circular economy. We use this analysis to assess based on 20 case studies whether organizations that use specific strategic elements of circular innovation and are thereby expected to have a specific impact also measure this impact.

The five elements of circular innovation as identified are: input, product (design), market proposition, use and end-of-use. The main impact areas are reduction of waste, reduction of greenhouse gas emissions, employment effects, increased quality of life, macroeconomic stability and rebound effects. By plotting the main impact areas against the elements where businesses can innovate for circularity we come to our main conclusions. Input and end-of-use are the elements that overall impact the most areas as described in paragraph 1. These elements focus on both material input and output and therefore have the most obvious link to the circular economy and its promised impact. The other elements have the potential to generate a positive impact and it is likely that these elements are more effective when combined with the input and/or end-of-use elements. For example, a company can increase positive impact by creating a modular product (element: product) and disassemble and reuse parts when the product is at the end-of-use.

In addition, the loops of products made from biodegradable materials (element: input) could be slowed by increasing product lifespan (element: use).

The easiest measurable impact of circular innovation is reduction of waste, since this can be partly measured at firm level. The ability to guard the value of materials throughout the chain by employing service models can improve the ability to track waste levels, even after consumer use. Even here though, having full view of secondary effects is difficult because other firms may have used certain waste streams before and could revert back to virgin raw materials. The reduction of waste is most likely to be affected by the input and end-of-use elements, because these elements have direct effect on material use and reuse.

Impact of greenhouse gas emissions is a significant driver for climate change. Organizations may have a positive impact by using renewable energy, reducing extraction of virgin materials and using existing materials and assets more efficiently. Transferring to renewable energy seems the most straightforward choice for organizations who are willing to make a positive impact without altering the business model. However, managing elements such as product, market proposition and/or use provides business opportunities to use existing materials and assets more efficiently.

Circular innovation has the potential to lead to increased employment. Companies and their suppliers can increase employment by shifting away from extracting virgin materials, investing in innovative superior materials and innovative recycling. This is most likely to be achieved by managing the input and/or end-of-use elements, while the other elements are beneficial to increased employment as well. The product, market proposition and use elements can be used to shift away from production of low-value customer goods and increase employment in maintenance and product-related services.

Increased quality of life can be achieved by producing superior, toxin-free materials and decreased cost of ownership and accessibility for high-quality durable goods. Although individual impact on quality of life is difficult to measure, there are opportunities to report on health (toxin-free materials, emissions) and wealth (product accessibility, labour conditions, fair wages). Companies could work together to optimize quality of life within the overall supply chain.

Macroeconomic stability and rebound effects cannot be measured at individual level and are therefore more difficult to assign to individual firm activities. It would require sector-level analysis. Organizations are most likely to have a positive impact on macroeconomic stability by not extracting virgin materials and by keeping pace in natural capital by compensating extracted materials with new materials (for example, planting new trees when using wood). Organizations managing the input and/or end-of-use elements are most likely to have a positive effect on macroeconomic stability, while rebound effects might be most harmful in the case of new market propositions like the sharing economy.

More generally, we find that measuring impact is often difficult in an innovation stage, since effects are often still on a very small scale and secondary effects are yet unclear. Also, in particular for impact of circular innovation, impacts are delivered in an interplay between different chain players and sector shifts can be positive at a sublevel (that is, for employment) but negative at a macro level (loss of jobs elsewhere).

This difficulty in measuring impact of circular innovation leads us to propose two practical policy implications. First, data on circular impact goals should be collected at a global or at least national scale, to be able to understand the interrelated effects of circular innovation. Second, in a similar way to global financial accounting, material usage, waste

and greenhouse gas emissions should be tracked to allow firms to increase their ability to gauge their own impact and adjust their strategies accordingly.

NOTES

1. For more information on LCA, see Hauschild, M.Z., R.K. Rosenbaum and S.I. Olsen (eds) (2017), *Life-Cycle Assessment: Theory and Practice*, Dordrecht: Springer.
2. For more information on BREEAM, please see http://www.breeam.com, accessed 12 April 2019.
3. For more information on EPD®, please see http://www.environdec.com, accessed 12 April 2019.
4. For more information on C2C certification please see http://www.c2ccertified.org, accessed 12 April 2019.

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