Business decision-making for material demand reduction

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Confirmation of authorship

The candidate confirms that the work submitted is her own, except where work which has formed part of jointly-authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others.

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Abstract

Material demand reduction is a major global challenge that requires actions at individual, organisational and systemic levels. Businesses are considered the key players in making significant contributions towards material demand reduction and sustainability through business model change. Despite increasing research into this area, it remains unclear what factors enable sustainable business model change. This research explores factors at organisational and individual levels influencing business model change for sustainability by using a multiple case study research strategy to answer three research questions.

First, internal factors at the organisational level (e.g. culture, leadership and top management team) and the individual level (e.g. adversity to change and open mindedness) influence business model change. Furthermore, external factors at system level (e.g. governmental affairs and public policies) also influences business model change. However, less is known about factors influencing business model change in the context of sustainability. Therefore, the first research question is *what internal and external factors influence business model change for sustainability?* Second, there is an empirical gap in understanding the role of individuals' cognitive models in decision-making about business model change for sustainability. From here, the second research question is *what sustainability issues influence decision-making for business model change to improve sustainability performance?* Furthermore, the third question is derived: *how do cognitive models of sustainability issues differ in the context of sustainable business models?*

The research questions were addressed using a mixed-methods approach in four case studies. The first one was a pilot project in which a developed cognitive mapping method was tested using an online survey to elicit cognitive models. Resulting cognitive models were validated and adjustments were made to the method. The method was applied to the remaining case studies with additional data collection methods. First, document analysis was used to better understand the background of organisations selected as cases and site visits and observations were carried out. Second, interviews with key informants were used to explore factors influencing business model change for sustainability at the organisational level. Furthermore, participatory cognitive mapping was used to explore sustainability issues driving key informants' decision-making at the individual level.

Findings suggest that resource-based businesses can do more to achieve material demand reduction and improved sustainability performance. However, a number of factors will influence their success; for instance, companies' research and development, sustainability approaches, and the context in which they operate. Cognitive models of sustainability issues can help managers to better understand and manage business model change for sustainability. Significant changes are likely to happen when changes at individual, organisational and systemic level occur simultaneously.

The research findings address the empirical gap regarding factors enabling business model change for sustainability. Specifically, findings across the four cases showed diversity in individuals' cognitive models of sustainability issues in relation to content and structure. These findings give an indication of the type of decision-making stance managers tend to use when considering business model change for sustainability. Links were found between individuals' cognitive models and components in sustainable business models. This research contributes to the current debates in business model change within the contexts of circular economy and sustainability.

This research makes three key contributions. First, it makes an empirical contribution to the research field of sustainable business models, focusing on the business model change for sustainability. More specifically, it provides insights into cognitive models of sustainability while also considering other internal, external and contextual factors influencing business model change for sustainability. Second, it provides a methodological contribution by developing a survey method to explore cognitive models of sustainability. Third, the integrative, conceptual framework designed in this research can be used in further theoretical and practical research to identify paradoxical tensions that could hinder business model change for sustainability.

Table of Contents

List of Tables

List of Figures

List of acronyms

AFPW	agricultural and food processing waste
B2B	business-to-business
B2C	business-to-consumer
CBM	circular business models
CEO	chief executive officer
CPU	central processing units
csv	comma-separated value
EMS	environmental management system
EoL	end of life
EPD	environmental product declarations
FISP	Furniture Industry Sustainability Programme
FRC	flame retardant chemicals
GHG	greenhouse gas
ICT	information and communication technology
IEA	International Energy Agency
IRP	International Resource Panel
LCA	life cycle assessment
LVT	luxury vinyl tiles
PSS	product-service systems
PVB	polyvinyl butyral
R&D	research and development
SME	small and medium enterprises
UNEP	United Nations Environment Programme
VOC	volatile organic compound
WRAP	Waste and Resources Action Programme
WTP	willingness to pay

Chapter 1 – Introduction

Societies around the world rely on industrial transformation of raw materials into end-use products and services such as shelter, mobility, sustenance, and leisure. While different products and services can benefit societies, they can also cause negative environmental impacts if the business models supporting their deployment do not consider sustainability. For instance, business models that rely heavily on the short lifespan of products with a built-in obsolescence and their frequent replacement such as consumer electronics and fast fashion. This combined with the fact that many products require a significant number of finite materials that are not recovered, makes these business models unsustainable which indicates the importance of business model change for sustainability.

Sustainable business models differ from traditional business models in the way they create and deliver economic, environmental and social values to a broad range of stakeholders (Lüdeke-Freund et al., 2016; Høgevold et al., 2014; Boons and Lüdeke-Freund, 2013). Companies developing sustainable business models are using approaches such as shifting from products to services, collaborating in unprecedented partnerships for inclusive business and focusing on stewardship of natural resources (Bocken et al., 2014). Sustainable business models are considered as one solution to achieve sustainable development goals by decoupling economic activities from natural resources use and environmental impacts (Beltramello et al., 2013; European Commission, 2017). However, demand for natural resources is expected to continue growing because of different factors, for instance, growing population and its needs for food, water and space. Therefore, businesses have to accelerate the adoption of approaches that can deliver significant improvements in their sustainability performance such as material demand reduction; where material demand reduction refers to producing products and services with reduced material input to achieve reduction in greenhouse gas emissions (GHG) (Norman et al., 2016).

Past research has focused on identifying and categorising the types of sustainable business models (Bocken et al., 2014; Stubbs and Cocklin, 2008; Lüdeke-Freund et al., 2018). Furthermore, investigating subsets of sustainable business models such as circular business models, differences between them and what level of sustainability performance they deliver (Nußholz, 2017; Urbinati et al., 2017). Researchers have developed different methods and tools for practitioners to help them design innovative, sustainable business models (Lüdeke-Freund et al., 2016). However, business model change for sustainability is a complex process and it is not yet fully understood how it happens and how decision-making drives the necessary organisational change.

Organisations and businesses dealing with sustainability face diverse issues of economic welfare, social prosperity and environmental protection that are connected and interdependent (Bansal, 2002; Maon et al., 2008). Understanding these issues can be challenging for decision-makers, for example, research has shown that they struggle with understanding how sustainability issues relate to each other (Cherrier et al., 2012) and how they link to their business (Bertels et al., 2016). Managers at different organisational levels play an important role in business model change because the sustainability issues they consider important influence their decision-making and action-taking for sustainability improvements.

Decision-makers use cognitive or mental models that enable them to orientate themselves for action in a complex environment inside and outside organisations (Hielscher and Will, 2014). Cognitive models are used to make sense of sustainability and process of sense making influences how decisions are made, which in turn influences whether business model change for sustainability happens.

This study focuses on exploring factors that influence business model change for sustainability in resource-based businesses by specifically focusing on the internal, individual factors such as individuals' cognitive models of sustainability. Before moving on to address the relevance of this research project, I will first define the main concepts used throughout this thesis.

1.1 Defining the main concepts

Sustainability is commonly defined as a development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p.41). To achieve sustainable development, progressive transformation of economy and society is required to preserve ecosystems and natural resources. According to Bansal and DesJardine (2014), the balance at the macro-level between economic, societal and ecological systems can be achieved if resources at the micro-level (businesses) are distributed across time.

Material demand reduction is one way that resources within business can be redistributed. The concept refers to producing and using goods and services with less material input to achieve reduction in GHG emissions associated with production and consumption (Norman et al., 2016). In this thesis I focus on new business models that have the aim of reducing material demand as a way to achieve sustainability.

Existing management literature on business models has provided many definitions of the concept, however, for the purpose of this research I follow definition proposed by Osterwalder and Pigneur (2010) who said that a *business model* describes a rationale of how organisations create, deliver and capture values. This is a commonly accepted definition in research and practice that tends to be the basis for conceptual frameworks in the field of sustainable business models by integrating economic, environmental and social values (e.g. Bocken et al., 2014; Breuer, 2013; Joyce and Paquin, 2016; Upward and Jones, 2016). I also consider this definition useful for my research because it describes a complex phenomenon in a simple and logical manner.

A *business model change* or *transformation* can be considered as a type of business model innovation that refers to a change in an organisation's existing business model (Geissdoerfer et al., 2018b). It is a change in the way an organisation does business; it can range from incremental improvements to transformative changes (Taran et al., 2015). In relation to business model innovation for sustainability, the most transformative change is a business model redesign that involves creation of a new value proposition to deliver sustainability performance (Schaltegger et al., 2012).

Businesses need to change the way they do business in order to conserve natural resources for future generations. In other words, businesses need to shift towards sustainable business models. According to Schaltegger et al. (2016a, p.6) a *sustainable business model* or *business model for sustainability* can be defined as a model that:

> helps describing, analyzing, managing, and communicating (i) a company's sustainable value proposition to its customers, and all other stakeholders, (ii) how it creates and delivers this value, (iii) and how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries (Schaltegger et al., 2016a, p.6).

In addition to examining business models at the organisational level, in this research I also examine the individual factors that can influence business model change. In particular, I focus on *mental or cognitive models* which refer to individuals' internal representations of external reality, while *cognitive maps* are physical constructs that refer to the outcome of researcher's elicitation process to analyse internal, cognitive models (Doyle and Ford, 1999).

In the following section I discuss the relevance of the research project.

1.2 Relevance of the research project

The 20th century was marked by technological advances, economic and demographic growth which led to increased consumption of raw materials such as construction materials, ores and minerals, biomass and fossil fuels (International Resource Panel [IRP], 2017). The economic activities including production and consumption of food, housing and transportation are associated with the negative environmental impacts such as land degradation, groundwater pollution and GHG emissions; the economic activities are the major contributors to global warming (United Nations Environment Programme [UNEP], 2010). The quantity of global demand for raw materials is expected to continue growing, thus the overexploitation of resources has become one of the key environmental concerns at the international level (UNEP, 2011). If the business as usual continues, driving the unsustainable levels of consumption of materials, then the reduction potential of material use is low (Schandl et al., 2016). Therefore, dramatic changes are required across production and consumption systems to achieve resource decoupling, meaning "reducing the rate of use of (primary) resources per unit of economic activity. This 'dematerialization' is based on using less material, energy, water and land resources for the same economic output." (UNEP, 2011, p.4).

A growing demand for materials is a huge challenge for global sustainability. To make products or construct new buildings and infrastructure raw materials are needed to produce stock engineering materials (Allwood et al., 2011). Production of only five key engineering materials (steel, cement, aluminium, plastics, and paper) accounts for more than 50% of global industrial energy consumption (International Energy Agency [IEA], 2015). A focus on material demand is important not only to reduce material consumption (and the associated resource depletion and environmental impact) but also the energy use and emissions associated with material use – which can help reduce the severity of climate change. Material demand is expected to continue growing (IEA, 2015) but material efficiency literature challenges this and proposes ways to avoid it.

Thus, businesses at national and international levels are striving to increase material efficiency (Kazmierczyk et al., 2016). Transition to a sustainable future that requires less material production is needed and businesses are the key players in responding positively to this sustainability challenge (Tukker et al., 2008). To achieve the sustainable future, businesses must continue innovating and developing resource efficient products and services to reduce material consumption. While many incremental changes have been achieved to date, the development of systemic eco-innovations and sustainable business models is crucial to enable a long-term transition and transformation towards a greener, low-carbon economy (Beltramello et al., 2013). To reduce material demand, the focus should be on the interventions showing high potential impacts such as material demand reduction in business-to-business transactions and in delivering products and/or services to final consumers with less material (Norman et al., 2016). Material efficiency strategies, for instance, lean production and industrial symbiosis can help businesses to improve sustainability performance, but to date they have not been adopted widely. Thus, there is a need for more dramatic changes in business models. Businesses have to rethink the way they do business and pursue the resource value-retention potential through innovative, sustainable business models such as product-service systems (PSS), sharing economy and warranty-driven reverse-logistics (IRP, 2018).

In the context of industrial production, material efficiency has improved significantly as a result of light weighting. There are products such as aluminium cans, plastic bottles, and packaging that are much thinner and lighter than few decades ago. On the other hand, products such as cars have grown heavier because of improvements in comfort, performance, safety and style (Allwood et al., 2012). Lighter cars mean improved fuel efficiency, however, customers are more concerned about cars' new features. Therefore, to reduce carbon emissions derived from the car use a legislation promoting production and use of lighter cars is required (Allwood et al., 2012). However, light weighting also has its limits, thus improved recycling and material substitution might be better alternatives to achieve material efficiency (Peck and Chipman, 2007). Even though recycling has a positive effect on the improvements of material efficiency, the total use of resources and waste generation continue to grow because of different factors such as population growth and changing consumption trends (Clay et al., 2007). Therefore, using fewer materials in the first place seems to be a more sustainable option.

Sustainable business models are widely considered as an option to achieve the goals of sustainability. What businesses do is crucial because if their core business is devastating for the environment then a significant change in their business models is needed or they will go out of business (Russell, 2010). In other words, business cannot endure on a dead planet (Lovins et al., 1999). Therefore, businesses need to rethink the way they do business and change their existing business models to improve sustainability performance. We do not yet fully understand how the complex process of business model change for sustainability happens and what cognitive models drive decision-making for business model change for sustainability. I argue that mixed level of analysis at individual and organisational level is required to better understand how decisions taken at the individual level influence changes at the organisational level.

Applying cognitive lens to investigate how individuals in the context of sustainable business models perceive sustainability issues and relationships between them can help identify paradoxical tensions in relation to sustainability issues at different levels that could hinder business model change for sustainability. Furthering understanding about the role of cognitive models in business model change for sustainability creates important theoretical and practical implications.

1.3 Objectives and research questions

Our society is facing the difficult challenge of reaching sustainability in order to provide economic benefits, positive impacts for the natural environment, and social justice (Bansal, 2002). Practitioners and scholars have been increasingly interested in the role of business models in enabling sustainable development (Beltramello et al., 2013), therefore, this study aims to contribute to the literature on business model change for sustainability by addressing the following research questions:

Research Question 1: *What internal and external factors influence business model change for sustainability?*

Research Question 2: *What sustainability issues influence decision-making for business model change to improve sustainability performance?*

Research Question 3: *How do cognitive models of sustainability issues differ in the context of sustainable business models?*

This research makes both empirical and theoretical contributions to extant literature. It makes an empirical contribution to the research field of sustainable business models, focusing on the business model change for sustainability. It provides insights into internal, individual factors, i.e. cognitive models of sustainability while also considering other internal, external and contextual factors influencing business model change for sustainability. The main finding from the pilot case study (Agrimax) suggests that cognitive models of sustainability influence decision-making about what aspects of economic, environmental and social issues, and what scope will be included in the building blocks of the circular business models. One of the main outcomes in the case study of Interface was the importance of ability of staff to translate the new, sustainability mission into a prototype carbon-negative tile. In the case of Silentnight and Techbuyer managers adopted a proactive approach to deal with the paradox of having two competing business models simultaneously. Findings across the four cases showed diversity in individuals' cognitive models of sustainability issues in relation to content and structure.

This research also provides a methodological contribution by developing a survey method to explore cognitive models of sustainability. Finally, the outcome of the research is an integrative, conceptual framework that can be used in further theoretical and practical research to identify paradoxical tensions that could hinder business model change for sustainability.

The thesis is structured as follows. Chapter 2 considers our current understanding of business model change for sustainability and the outcomes in terms of sustainability performance such as material demand reduction. It also analyses cognitive models in the context of sustainability. Chapter 3 describes the rationale for choosing the multiple case study with mixed methods approach to conduct my research. It discusses the philosophical underpinnings of this research investigation and provides details about case selection. It also describes the methods used for data collection and data analysis in this study. Chapter 4 provides details of the pilot case study (Agrimax) where the method to elicit cognitive models through an online survey was developed and tested. Chapters 5-7 provide results and analysis from the main three case studies: Interface (Chapter 5), Techbuyer (Chapter 6) and Silentnight (Chapter 7). Chapter 8 is the final chapter that discusses the main findings and cross-cutting themes that emerged from the case studies. It also reflects on theoretical and practical implications of the thesis. Furthermore, it reflects on the limitations of the present research and highlights potential future research directions, and provides concluding remarks.

Chapter 2 – Literature review

The introduction established that businesses are seen as important players in dealing with sustainability issues such as material demand reduction to achieve global sustainability. However, it is not yet fully understood how they change their business models for sustainability and how decision-making drives necessary organisational change. This chapter provides a critical analysis of the existing literature and debates relevant to business model change for sustainability in relation to material demand reduction and cognitive models of sustainability that led to formation of research questions for this study.

The chapter has two sections. Section 2.1 focuses on analysing the business model change for sustainability. Specifically, it analyses sustainable business models and factors influencing business model change for sustainability. Section 2.2 provides a review of the cognitive models in the context of sustainability.

2.1 Business models and sustainability

Business model is a contested concept that has been defined, interpreted and applied in different research fields. For instance, it has been used to describe business activities designed to create and deliver value proposition to a customer (Amit and Zott, 2012; Demil and Lecocq, 2010). According to Teece (2010), a business model shows the revenues, costs, and profits related to the formation of the value for customers. Furthermore, Osterwalder and Pigneur (2010) suggest that a business model contains nine components that are interconnected and interrelated: key partners, key resources, key activities, value propositions, customer relationships, customer segments, channels, cost structure and revenue streams. Osterwalder and Pigneur's interpretation of a business model contains the key elements that are also reflected in other definitions. Magretta (2002) interprets business models as tools that have a narrative power to tell the story about businesses and what they do, while Chesbrough (2010) argues that business models perform different functions. According to Chesbrough (2010), business models articulate a customer value proposition; identify market segments; define the structure of a value chain; detail the revenue mechanisms; estimate the cost structure and profit potential; describe the position of the company within the value network; and formulate competitive strategy. Recently, Massa et al. (2017) explored existing interpretations of a business model based on its definitions and functions. Results showed that researchers tend to use three different interpretations: business models as attributes of real firms, business models as cognitive/linguistic schema, and business models as formal conceptual representations. Massa's study emphasised that researchers need to be clear about the business model interpretation they adopt in their research. In this research I align my definition of business models with Osterwalder and Pigneur (2010) who said that a business model describes a rationale of how organisations create, deliver and capture values. This is a commonly accepted definition in research and practice that tends to be the basis for conceptual frameworks in the field of sustainable business models by integrating economic, environmental and social values. I also consider this definition useful for my research because it describes a complex phenomenon in a simple and logical manner.

At the heart of a business model is the concept of value. It is expressed in terms of value proposition (products and/or services offered by the firm), value creation and delivery (activities/processes and resources needed to create and deliver a value proposition) and value capture (profit formula) (Richardson, 2008). Different definitions of business models differ in their perception of value. For instance, perspectives focusing on the profit-making function of business models see them as vehicles for generating economic value (Birkinshaw and Goddard, 2009; Hienerth et al., 2011; Sinfield et al., 2012). These definitions are in line with the traditional view of business models based on the linear economic thinking of take-make-use-dispose. However, the concept of value can be explored from other perspectives such as sustainability.

From a sustainability perspective, value is perceived in a more holistic way. Sustainable business models incorporate the triple bottom line approach (economic, social and environmental dimensions of sustainability) and consider the interests of a wider range of stakeholders including society and environment (Bocken et al., 2014; Jonker, 2012; Schaltegger et al., 2012). According to Schaltegger et al. (2016a, p.5) sustainable business models' perspective highlights:

> the value creation logic of an organization and its effects and potentially allows (and calls) for new governance forms such as cooperatives, public private ownerships, or social businesses, thus helping transcend narrow for-profit and profit-maximization models.

This definition indicates that different types of sustainable business models have the potential to go beyond and above profit maximisation. Truly sustainable business models should create multi-values; economic, environmental and social.

Different areas of sustainability research have produced vast conceptual literature on how businesses can deliver sustainability through business models. Researchers have focused on building sustainability business model archetypes (Bocken et al., 2014), analysing the adoption and implementation tactics of new business models (Reim et al., 2015), reporting on business models for eco-innovation (Beltramello et al., 2013), and investigating the financial sustainability of green business models (Gebauer and Saul, 2014). Nevertheless, it seems that business models used in practice get little attention in research (Short et al., 2014) even though they are, along with consumer choice and policy, considered as a means through which sustainability strategies should be deployed (Allwood, 2013; Eco-Innovation Observatory, 2012). Therefore, more empirical research is needed to understand the business model change for sustainability and how companies create, deliver and capture economic, environmental and social values simultaneously.

2.1.1 Business model change for sustainability and material demand reduction

A business model change is a type of organisational change that includes improvements of different components in an existing business model such as key activities and partnerships, furthermore, it includes a development of new business models (Amit and Zott, 2012; Chesbrough, 2007; Teece, 2010; Zollo et al., 2013). The business model change for sustainability helps to create and deliver multiple values, economic, social and environmental, to a broad range of stakeholders (Bocken et al., 2014; Lüdeke-Freund and Dembek, 2017; Schaltegger et al., 2012). Business model change has been increasingly recognised as an important enabler of reduction in resource demand (energy and material) to achieve the goals of sustainability. For instance, business model change based on industrial symbiosis has been shown to reduce material use and CO_2 emissions while also increasing profitability by focusing on collaboration between companies that physically exchange resources such as materials, by-products, energy and water (Chertow and Ehrenfeld, 2012; Lombardi and Laybourn, 2012; Short et al., 2014). Synergistic exchanges of resources divert waste from landfills to replace raw materials to make new products. Reducing material demand is important to preserve natural resources and reduce environmental impacts. Specifically, emissions associated with the energy and material use which can help reduce the severity of climate change.

Material demand is expected to continue growing but material efficiency literature challenges this and proposes ways to avoid it. Material efficiency means to provide the same level of services with less material production and reduce negative impacts linked with the use of those materials (Allwood et al., 2013; Lifset and Eckelman, 2013). To achieve significant reductions in material demand, changes across supply chains are required to improve material efficiency (Norman et al., 2016). Furthermore, promoting more intensive use of existing products among consumers by sharing and maintaining products for a longer use can further reduce material demand (Gutowski et al., 2013).

In the context of industrial production, material efficiency mostly refers to waste reduction and light weighting (Peck and Chipman, 2007). To improve material efficiency within the broader context of production and consumption systems, recycling of materials is strongly encouraged. While recycling attracts attention from the public policy, other material efficiency strategies tend to be overlooked. Meyer et al. (2007) argue that economic and environmental dimensions of sustainability will be hindered if policy changes do not occur regarding material consumption. A report from European Environmental Agency on drivers for material resource efficiency policies in EU shows that environmental concerns about reduced use of resources do not play an important role in the majority of member states (Kazmierczyk et al., 2016). Thus, it seems that it is rather up to businesses to take the responsibility and engage in adopting material efficiency strategies to achieve material demand reduction.

Ideas about material efficiency are not new, but it seems that they have not been implemented widely by businesses in order to reduce global material and energy demand (Gutowski et al., 2013). Halme et al. (2007) argue that businesses do not take advantage of their material saving potential because they do not recognise opportunities or do not act on them when recognised. A survey among EU innovating companies showed that a third of those companies reported improved material efficiency as a result of implemented eco-innovations or material efficiency measures, for example, product, process, or business model change for sustainability (Eco-Innovation Observatory, 2012). Even though this is encouraging, the majority of companies still do not pursue eco-innovations or they achieve low material savings due to eco-innovation efforts.

The reduction of material demand can be achieved through four major strategies (Allwood et al., 2011; Allwood et al., 2013): longer-lasting products, modularisation and remanufacturing, component re-use, and optimal design. However, these strategies have received little attention because of economic, regulatory, social and behavioural barriers (Allwood et al., 2011; Gutowski et al., 2013). To reduce material demand, a more rapid deployment of material efficiency strategies is needed which might require business model change for sustainability. In line with Allwood et al. (2013), Gutowski et al. (2013) and Halme et al. (2007), I argue that business model change for sustainability can potentially deliver material demand reduction by companies adopting more sustainable business models or combinations of them (Bocken et al., 2014). For instance, PSS business models that are based on multi-stakeholder collaboration have the potential to deliver significant sustainability benefits (Evans et al., 2007; Rahimifard et al., 2009; Tukker, 2004; Wells, 2013; Yang et al., 2017). Therefore, it is important to explore existing sustainable business models in practice and their enabling factors.

2.1.2 Sustainable business models

Sustainable business models, also referred to as business models for sustainability, are an emerging, integrative research field (Lüdeke-Freund and Dembek, 2017) that is gaining attention among scholars in the field of organisations and the natural environment. One of the seminal studies in this area was Stubbs and Cocklin’s (2008) conceptualisation of sustainable business model. The authors found that internal organisational, structural and cultural capabilities influence the level of sustainability achieved in creating, delivering and capturing value at the organisation-level. On the other hand, collaboration with key stakeholders is required to achieve sustainability at the system-level. Stubbs and Cocklin’s ideas influenced further development of research within the sustainable business models community. For instance, Schaltegger et al. (2012) explored business cases for sustainability, i.e. situations in which organisations achieve their economic success through planned, mainly voluntary, social and environmental actions. The authors argue that managers create business cases for sustainability by addressing traditional business case drivers such as cost reduction, profit margin, innovative capabilities and reputation. Furthermore, they emphasised that business model change might be needed to systematically manage business case drivers for sustainability.

The basic normative requirements for business model change for sustainability were examined by Boons and Lüdeke-Freund (2013). The authors analysed the literature on business models in the context of technological, organisational and social innovation. They argue that a business model change at the organisational level includes implementation of alternative paradigms that go beyond neoclassical economic thinking and influence organisation’s culture, structure and routines for sustainable development. Boons and Lüdeke-Freund’s (2013) findings formed a basis for the development of sustainable business models archetypes proposed by Bocken et al. (2014). One of the authors’ main arguments was that while organisations could apply proposed sustainable business models in isolation, the most significant sustainability benefits could be achieved by combining different sustainable business model archetypes. For instance, companies could focus on delivering functionality instead of ownership while slowing manufacturing and adopting principles of natural processes such as biomimicry. Recently, Lüdeke-Freund et al. (2018) developed a taxonomy of sustainable business model patterns. The authors used a multi methods approach including a literature review, Delphi survey and card sorting to classify existing sustainable business model patterns. Results showed that sustainable business models could be grouped into 11 pattern groups based on the forms of value creation. For instance, the integrative form of value creation (considering economic, social and environmental dimensions) is associated with a community platform sustainable business model pattern. Lüdeke-Freund et al.'s work aims to enable unified and comparable studies in the field of sustainable business models.

Despite existing sustainable business models, demand for natural resources is increasing because of production and consumption trends. Therefore, businesses need to accelerate their business model change for sustainability to achieve significant material demand reduction. Furthermore, more research is needed to understand how companies change their existing business models towards sustainable business models and which sustainable business models have the potential to deliver substantial resource efficiency such as circular business models (Bocken et al., 2014; Geissdoerfer et al., 2018b).

2.1.3 Circular business models

Circular business models are based on the three principles of circular economy: sustainable design, product life extension and regeneration of natural system (Ellen MacArthur Foundation, 2016). The main challenge of the circular economy is to find new ways of maximising the value of materials and products throughout products’ life cycle to reduce demand for virgin materials by encouraging closed-loop recycling and re-use (European Commission, 2017; Stahel, 2016). To realise the overarching goal of circular economy, preservation of natural resources, changes are needed at different levels from social, technological to industrial (Stahel, 2016). However, businesses are considered as the major player in transition towards circular economy through innovative, circular business models. Therefore, more empirical research is needed in the context of circular business models to better understand how businesses integrate circular economy principles and contribute to sustainability.

To achieve preservation of natural resources, businesses need to change their existing business models towards circular business models which can be challenging. Therefore, researchers have been developing tools to help businesses in the business model change process. For instance, Antikainen and Valkokari (2016) proposed a framework for circular business model innovation suggesting that businesses need to consider a business ecosystem, business model components and sustainability impact for successful business model change. Similarly, Nußholz (2017) conceptualised circular business models from a business model innovation perspective in combination with resource efficiency strategies. The author argues that circular business models focus on adopting resource efficiency strategies such as long-life design and remanufacturing that lead to more transformative and systematic improvements instead of less impactful resource strategies. The importance of long-life design for circular business models has also been addressed by Moreno et al. (2016) and Mestre and Cooper (2017) who provided practical guidance specifically for designers. For instance, Moreno et al. (2016) recommend that designers should design products/services considering the type of circular business model that will support those products/services. The authors mapped circular business models against circular design strategies showing which combinations have the greatest potential to achieve not just material efficiency but resource sufficiency. Recently, Urbinati et al. (2017) developed a taxonomy of circular business models, i.e. linear, upstream circular, downstream circular and full circular business models. The identified circular business models differ in the extent to which companies manage to integrate circular economy principles. For example, the full circular business model is based on a production system that involves the adoption of circular economy throughout a whole supply chain. It seems that companies need to adopt systems perspective and relevant resource efficiency strategies to achieve enhanced circularity of materials.

Companies' ability to build circular business models has been recently explored through empirical research. For instance, Heyes et al. (2018) investigated the potential of service-oriented companies to build circular business models in the information and communication technology (ICT) industrial sector. Results showed, that micro and small businesses could play an important role in the use of circular business models in the ICT. Specifically, if provided with external support such as support from the supply network and government to overcome company-level barriers. Another example is a case study by Whalen et al. (2018) who explored ICT sector in Sweden and its potential to scale up reuse practices to extend products' life-cycle. Results showed that circular business models promoting reuse depend on sufficient supply of used ICT and its quality. Furthermore, the lack of take-back schemes, consumers' misconceptions of reuse, bad reuse practices and labour costs were identified as the main barriers for scaling up reuse practices. Similarly, Veleva and Bodkin (2018) explored drivers and barriers to circular business models across 12 companies of different sizes and from different industrial sectors in the US. The authors highlight the importance of collaboration between entrepreneurs and corporations to reduce time, costs, environmental impact and resources to build circular business models.

While circular business models have been considered as a promising option to achieve material demand reduction and sustainable development (Geissdoerfer et al., 2018a), they have also been critiqued for focusing on environmental and economic benefits and neglecting social dimension (Kirchherr et al., 2017; Murray et al., 2017). Therefore, companies across industries should consider combining circular business models with other types of sustainable business models (Bocken et al., 2014) to increase their potential for a significant contribution to sustainable development.

Thus far, I have analysed sustainable business models that have the potential to positively contribute to the global sustainable development. While there are organisations, of different sizes and from different industries, that have successfully transformed their business models such as Unilever and Nike, more organisations need to follow the suit. Therefore, it is important to understand the factors that influence business model change for sustainability. A better understanding of the driving factors can inform business decision-makers and help them design sustainability strategies to transform their existing business models.

2.1.4 Factors influencing business model change for sustainability

Research has shown that there are different factors that influence business model change for sustainability. For instance, Høgevold et al. (2014) explored corporate reasons and organisational challenges influencing sustainable business models through a multiple case study of eight Norwegian companies. The companies were of different sizes, from small to large, and from different industries such as manufacturing, retail and transportation. Results showed that an individual or small group of individuals acted as change agents for sustainable business models. While environmental issues were found to be the driving factors of sustainable business models, the strong commitment to sustainability was linked to economic reasons. Furthermore, as sustainable business models evolved, the engagement of stakeholders within and outside organisations became more prominent. Similarly, Morioka et al. (2017) investigated factors influencing sustainable business models by adopting a multiple case study involving 11 companies (from manufacturing and service industries and of different sizes) from Brazil and the UK. Results showed that there were three main factors that influenced business model change for sustainability: linkages between the company's purpose and employees' values and beliefs; employees' pro-active engagement in sustainability activities; and system-level changes. In addition, the investigated cases demonstrated the importance of external, context factors such as material supply market, government affairs and public policies, technology, independent associations and collaborative networks of stakeholders for sustainable business models.

Furthermore, Carayannis et al. (2015) conducted a case study of a lightning company in Thailand to explore factors influencing business model change for sustainability. The authors identified organisation design and governance competences that integrate existing resources, strategic entrepreneurship and dynamic capabilities, and collaboration with stakeholders as the main drivers of business model change for sustainability. Similarly, Roome and Louche (2015) also adopted a case study approach to investigate business model change for sustainability in two companies of different sizes, operating in textile and construction industry in Switzerland and the UK. Both companies adopted an approach based on learning, experimentation and innovation for a long-term sustainability. Findings are partially in line with those of Høgevold et al. (2014), Morioka et al. (2017) and Carayannis et al. (2015) that highlighted the importance of collaboration. Furthermore, Roome and Louche (2015) pointed out that collaborative networks and practices are important to bring about new, sustainability-oriented vision. Additionally, redesigning existing network structure was considered as an enabler of sustainable business models.

Another study that focused on factors enabling business model change for sustainability was conducted by Sorescu et al. (2011). The authors identified external factors (e.g. technological development and changing customers' values) and internal factors (e.g. customer-centric orientation, innovation and experimentation) that influence business model change for sustainability in retail. In contrast, Laukkanen and Patala (2014) focused on analysing barriers to sustainable business models through the innovation systems perspective. The authors used a qualitative Delphi study to evaluate structural and cultural barriers. Results showed three groups of barriers to business model change for sustainability: regulatory barriers; market and financial; and behavioural and social. According to the authors, activities from governments, companies and consumers could help overcome the identified barriers.

The aforementioned multiple case studies by Høgevold et al. (2014), Morioka et al. (2017) and Roome and Louche (2015) investigated the business model change for sustainability across different contexts such as industrial sectors and company's size. However, none of them addressed the differences between small and large companies in relation to business model change for sustainability. This gap was addressed by Bohnsack et al. (2014) who used a qualitative analysis of electric vehicle projects to examine the influence of path dependency on the business model change for sustainability in small, entrepreneurial and large companies in the automotive industry. Results demonstrated that large and small entrepreneurial companies differed in their approaches to business model change for sustainability. While the large companies were constrained by path dependencies, following their usual business logic and focusing on efficiency gains, small, entrepreneurial companies were more radical in their innovative approaches to business model change for sustainability.

Business model change for sustainability has also been explored in relation to resource efficiency. For instance, Gauthier and Gilomen (2016) conducted an in-depth qualitative study of two energy efficiency urban projects in France to explore how organisations engaged in collective sustainability projects change their business models to improve sustainability. Results showed that suppliers' push or organisations' intentional search for new markets led to business model change in organisations engaged in collective sustainability projects. Besides energy efficiency, material efficiency has also been explored from the perspective of business model change for sustainability. For instance, Halme et al. (2007) used thematic interviews and focus groups discussions to explore opportunities for material efficiency services in the paper and food industries. The authors argued that businesses use natural resources insufficiently because they lack expertise to identify material and/or energy efficiency opportunities; many businesses stay inactive even when they do identify opportunities for efficiency improvements.

Furthermore, Short et al. (2014) examined how a leading company in the sugar industry in the UK, British Sugar, changed its business model through industrial symbiosis and internal symbiosis. Findings showed that trade agreements and protective agricultural quota, increased low-cost sugar production in developing countries and supply chain risks were the main external factors influencing business model change for sustainability. Furthermore, innovative, sustainability changes were at first initiated and developed internally; over time the company engaged with external, collaborative partnerships to create new products such as liquefied CO_2. The finding related to development of external collaborative partnerships over time compares well with the findings of Høgevold et al. (2014) for business model change for sustainability across companies from different industries.

Collaboration was also identified as the main factor for the business model change for sustainability in a study conducted by Iles and Martin (2013). They used a dynamic capabilities framework to perform a comparative case study of three conventional plastic manufacturers from Germany, the US and Brazil that have adopted bioplastics. The authors found that engagement with societal actors such as advocacy groups, consumers and farming communities was necessary for the manufacturers to understand the values of stakeholders and sustainability issues they consider in relation to chemical products. Thus, collaboration with stakeholders helped the companies to evaluate their sustainable value propositions.

Rauter et al. (2017) used a qualitative study to investigate 10 companies across different industries in Austria. Results showed that companies' leaders played a key role in integrating sustainability practices into business models. Furthermore, managers' personal motivation and engagement with sustainability, organisational culture and strategies proved to be an important internal factor driving sustainable business models. However, a committed leader alone is not enough to bring about fundamental change towards sustainability (Belz, 2012). According to Belz (2012) companies need to have change with environmental knowledge and knowledge about transition processes at all levels of management. Additionally, informed and committed employees are also crucial players for successful business model change for sustainability.

The most recent study at the time of writing was by Long et al. (2018), who investigated the business model change for sustainability in 14 start-ups and small and medium enterprises (SMEs) from food and beverage industries in the

Netherlands. The authors found that collaboration, company's vision, continuous innovation, sustainable foundation, profitability and external events such as changes in regulation and consumer trends positively influenced business model change for sustainability. On the other hand, lack of governmental support and external events such as economic crisis had a negative effect on the business model change for sustainability.

It could be said that in prior literature on business model change for sustainability, the focus has been on identifying external and internal (mostly organisational level) factors. However, there is a lack of literature on individual level factors such as cognition. This research project aims to address this gap by exploring factors influencing business model change for sustainability at both organisational and individual level, specifically focusing on cognitive models that drive individuals' decision-making for sustainability. Therefore, the first research question is *what internal and external factors influence business model change for sustainability?*

2.2 Business decision-making for sustainability

Business decision-makers need to deal with economic, environmental and social issues to contribute to sustainable development. However, research has shown that they struggle to translate the principles of sustainable development into business practices (Bansal, 2002). For example, research on the acceptance of corporate environmentalism and organisational identity has shown that senior executives and board members of a large hospital in Australia struggled to understand how sustainability issues relate to each other (Cherrier et al., 2012).

Similarly, research on decision-making for sustainability among chief executive officers (CEOs) in South Africa has found that CEOs' lack of knowledge about sustainability issues and inability to link sustainability to their business hindered CEOs from prioritising sustainability (Bertels et al., 2016). Therefore, exploring decision-makers' understanding of sustainability issues and their linkages might inform decision-makers to design more transformative changes in existing business models.

The way businesses respond to sustainability issues is influenced by different factors. For instance, a qualitative study on how corporations in Japan and the United Kingdom respond to environmental issues showed that three contextual factors influenced corporate responsiveness: strong networks, individual concern about the natural environment and the perceived importance of environmental issues among business decision-makers (Bansal and Roth, 2000). Furthermore, the study identified three motivations that influenced corporate responsiveness: competitiveness, environmental responsibility and legitimation. These findings are partially in line with findings from Banerjee (2001) who identified regulatory requirements, commitment from executive managers, potential to create competitive advantage and public concerns about environmental issues as important factors for decision-making. Bansal (2003) found that individual concerns aligned with organisational values were more likely to be considered as strategic and therefore acted upon. Similarly, Anderson and Bateman (2000) explored how individuals concerned with environmental issues become sustainability champions that drive organisational change. Anderson and Bateman found that successful sustainability championing was associated with active scanning behaviour, business-like approach in framing sustainability issues and using soft touch tactics such as inspirational appeal. The way businesses respond to sustainability issues depends on decision-makers' capabilities to understand and deal with sustainability issues.

Awareness of sustainability issues plays an important role in business decision-making and consequently action-taking. Gadenne et al. (2009) explored the relationship between awareness and business actions to improve environmental performance among SMEs. Results showed that legislation leads to higher awareness and consequently changes in environmental practices. While stakeholders' pressure was associated with actions to reduce waste, it did not influence the adoption of environmental management systems. The results also showed that SMEs had low awareness about the benefits of their environmental actions. Similarly, Cassells and Lewis (2011) conducted a survey among owner-managers of manufacturing SMEs in New Zealand to explore the relationship between awareness and attitudes towards environmental issues. Results showed that in most cases a positive attitude towards environmental issues did not influence environmental improvements, except in the area of environmental management. Furthermore, most owner-managers expressed scepticism about cost-savings related to environmental practices. While awareness of sustainability issues and positive attitude towards them are important, they do not necessarily lead to action for improved sustainability performance.

Business decision-makers in the context of sustainability are faced with paradoxical tensions stemming from conflicting but interrelated economic, environmental and social goals. Paradoxical tensions can be both inherent within the system or emerging as individual decision-makers make sense of sustainability dimensions (Smith and Lewis, 2011). According to Smith and Lewis (2011) there are four key paradoxical tensions related to the core functions in organisations: learning tensions (issues with knowledge acquisition and interpretation); belonging tensions (identity issues); performing tensions (issues of identifying and implementing adequate processes); and organising tensions (issues related to forming strategies and goal setting). Furthermore, business decision-makers need to manage challenges related to the systems in which their organisations operate, i.e. institutional level; they also need to manage spatial challenges, i.e. demands across different contexts (Hahn et al., 2015). Sustainability management can lead to different paradoxical tensions and their identification is the first step to dealing with them.

Ozanne et al. (2016) adopted a multiple case study approach to explore paradoxical tensions that emerge from sustainability management. Results showed that organisations pursuing sustainability deal with the four types of paradoxical tensions proposed by Smith and Lewis (2011). The authors also emphasised the role of public policy in providing conditions that influence the importance of paradoxical tensions to the organisations and how they respond to them.

Similarly, van Bommel (2018) examined paradoxical tensions in the context of sustainable business model innovations across 30 companies in Germany, Austria and the Netherlands. The author found that managers reported two sources of performing tensions: management of conflicting stakeholders' demands and interests, and tensions related to the value creation function of sustainable business models. Furthermore, organising tensions were related to the issues of metrics to measure sustainability progress and position of sustainability departments within companies. Finally, sustainable business models require cultural changes and changes of mind-set, which can cause belonging tensions. Dealing with paradoxical tensions can be challenging, however, understanding their sources can help managers in resolving them.

Recent studies focused on exploring paradoxical tensions emerging from the circular economy business case (Daddi et al., 2019) and sustainable supply chain management (Xiao et al., 2019). Daddi et al. (2019) conducted a multiple case study to explore how managers from six organisations in paper, leather and textile industrial sectors in Italy respond to paradoxical tensions. The authors identified a response strategy, which they labelled as escape strategy, i.e. combining defensive strategy with a proactive strategy. Similarly, Xiao et al. (2019) conducted an in-depth case study involving a Western, multinational company that sources its supplies from China to examine how purchasing and sustainability managers deal with paradoxical tensions between cost and sustainability. The authors found that both purchasing and sustainability managers responded to paradoxical tensions mostly from an instrumental perspective, meaning that they prioritised cost reduction above sustainability goals. On the other hand, the authors also found that sustainability managers used a different response strategy, which they labelled as contextualising (referring to managers adapting their sustainability standards to the socio-economic environment of China). From these results it seems that the way managers respond to identified paradoxical tensions influences an organisation's sustainability performance.

This research makes clear that business decision-makers need to understand complex and interrelated sustainability issues to be able to design and implement organisational changes needed to achieve improved sustainability performance. According to Hahn et al. (2014), business decision-makers use different cognitive frames or models to make sense of diverse and ambiguous sustainability issues. Yet, to date very little research has examined business model change for sustainability from the level of cognition. In the following section I review the extent literature and identify research gaps.

2.2.1 Cognitive models in the context of sustainability

The idea that people develop and use cognitive models as internal representations of external reality has been strongly accepted for several decades in cognitive science and psychology literature (Jones et al., 2011). In organisation theory, cognitive models are understood as mental representations that enable individuals and organisations to orientate themselves for action in a complex environment inside and outside organisations (Hielscher and Will, 2014).

Cognitive models consist of three elements: cognitive content, cognitive structure and cognitive style (Finkelstein and Hambrick, 1996). Cognitive content represents beliefs, knowledge and assumptions of decision-makers. Cognitive structure shows how decision-makers arrange, connect and study cognitive content in their mind, while cognitive style refers to the collection and processing of new information. These three elements are interconnected, for instance, cognitive style might hinder or facilitate the decision-maker's ability to perceive new information (Porac and Thomas, 2002). The elements of cognitive models influence how decision-makers frame strategic problems and plan strategic choices (Finkelstein and Hambrick, 1996).

Decision-makers' cognitive models of sustainability can vary in their complexity and the sustainability dimensions they focus on. Hahn et al. (2014) conceptualised two contrasting types of cognitive frames that can be used to understand business decision-making in the context of sustainability: the business case frame and the paradoxical frame. The two frames differ in the content and structure that have an effect on the three stages of sense-making: scanning, interpreting and responding. Decision-makers using the business case frame focus on business attributes following the alignment logic wherein social and environmental aspects of sustainability are considered only when they have the potential to lead to profit maximization. On the other hand, decision-makers following the paradoxical frame will take into consideration all three sustainability aspects and their attributes with different rationales. Hahn et al. furthermore suggest that the structure of a business case frame is simple and contains a low number of elements that have a low degree of connectedness. The implicit goal is to improve economic performance at the organisational level. The paradoxical frame is structured in a more complex way. It consists of a high number of elements among which there is a high degree of connectedness. The implicit goal is to address all three sustainability aspects at the organisational and societal level. However, as Hahn et al. (2014) suggest these are two contrasting types of cognitive models representing two ends of a spectrum and in reality most cognitive models are likely to fall in between the two ends of the spectrum.

Although little empirical research in the area of cognitive models of sustainability in relation to organisational change exist to date, there are a few notable exceptions. For instance, Schlange (2009) adopted a cognitive perspective to explore how sustainability-driven entrepreneurs select and manage their key stakeholders compared to economically-driven, socially-driven and ecologically-driven entrepreneurs. Schlange argues that cognitive models of sustainability-driven entrepreneurs are more comprehensive, meaning they include a broader range of stakeholders and are more future oriented. While results from the study confirmed the first part of the author’s argument, the second part about future orientation was not confirmed. However, this was a pilot case study and Schlange suggests that more theoretical and empirical research is needed on cognitive models to explore how stakeholder management influences sustainability-driven entrepreneurship. Schlange’s study explored cognitive models of sustainability-driven entrepreneurs, however, significant sustainability change at the macro-level is more likely to occur with the co-evolution of sustainable business models among sustainability-driven entrepreneurs and mass market players (Schaltegger et al., 2016b). Therefore, more empirical research is needed to explore differences and similarities between decision-makers’ cognitive models across companies of different sizes that are at different stages of their sustainability journeys.

Bergman et al. (2016) analysed executive managers’ cognitive models of sustainability management across nine companies from the cleantech industry in

Finland to explore cognitive diversity between companies in the same industry. Results showed that economic issues were the most salient issues in the cognitive models, meaning that the corporate sustainability was pursued to achieve more traditional corporate objectives, rather than being a goal in itself. Furthermore, collective cognitive models revealed high level of similarity across managers within the same company, which implies that managers interpret strategic issues in a similar way. Bergman et al.'s study focused on analysing cognitive models of sustainability from the boards of directors within one industrial sector, however, more research is needed to gain insights into cognitive models of sustainability across different industrial sectors. Specifically, the material-intensive industrial sectors such as agriculture, manufacturing and construction. Furthermore, to achieve more substantial organisational change, all levels of management need to be committed to sustainability. Therefore, studies focusing on multi-level analysis are needed to explore how managers at different levels understand sustainability issues and relationships between them which influences their decision-making and action-taking.

Another example is a multiple case study by Hockerts (2015) who analysed individual and collective cognitive models to examine investor relations managers' sense-making in relation to business case for corporate sustainability. The participating investor relations managers came from 12 multinationals that were identified as top performers, runners-up and followers in relation to sustainability performance. Hockerts interviewed managers on different topics: awareness of sustainability, motivations to engage with corporate sustainability and perceived links to competitiveness. Emerging themes from the interviews were then coded and codes used to create individual cognitive maps which were merged to create collective cognitive maps of leaders, runners-up and followers. Results showed that managers from top performing companies had more complex cognitive models compared to the managers from the companies with a lower sustainability performance. While Hockerts' study made valuable contribution to the area of cognitive models of sustainability in relation to organisational change, it only focused on managers whose cognitive models are more likely to be competitive advantage-oriented. Furthermore, the author created cognitive maps based on the interviews without validation from the interviewees. In addition, the evoked cognitive maps only show the links between research issues; they do not consider causation. More empirical research is needed to explore how managers from different functional areas perceive sustainability using participatory cognitive mapping to avoid researcher bias in the creation of cognitive maps.

In line with Hockerts (2015) and Hahn et al. (2014) I argue that managers with complex cognitive models are more likely to consider economic, social and environmental dimensions when making decisions related to business model change for sustainability. Therefore, the second and third research questions are: W*hat sustainability issues influence decision-making for business model change to improve sustainability performance?* (Research Question 2), and *How do cognitive models of sustainability issues differ in the context of sustainable business models*? (Research Question 3).

The literature review has established that there are different external, internal and contextual factors influencing business model change for sustainability. However, less attention was paid to the contextual factors and the internal, individual factors such as cognitive models and their role in the change process. While there have been a few notable empirical studies in the area of cognitive models of sustainability in relation to organisational change, this area seems to be underexplored and merits more attention. In the next chapter I focus on describing and justifying my methodological approach and methods used to answer my research questions.

Chapter 3 – Methodology

This chapter gives an overview of the methodological approach and methods used to address the research questions. Specific methods will be also addressed in each of the case study chapters. First, it provides a short discussion about underlying, philosophical orientation that guided my methodological choices. Second, it explains why a multiple case study was selected as the most appropriate research strategy for the project. Then, it describes and justifies methods used in data collection and analysis to answer the research questions. It also presents relevant ethical issues considered during the research design development. The chapter concludes with a brief summary of the main points.

3.1 The philosophical underpinnings of the research project

The purpose of clarifying philosophical underpinnings of this research project is to demonstrate my engagement in conscientious selection of the most suitable approach to explore project's research questions. Furthermore, to outline the basis for the knowledge claims made in research findings. Figure 3.1 shows how I organised and developed the research design for the present project, using the adapted research onion proposed by Saunders et al. (2012). The outermost layer of the research onion refers to the research philosophy that guided my choices in the inner layers. I adopted an interpretivist research philosophy to gain insights into business model change for sustainability. An interpretivist research philosophy assumes that we use our mind to interpret the world we see around us, therefore, knowing the true nature of the object entails our perception of it (Walliman and Baiche, 2001; Williams and May, 1996).

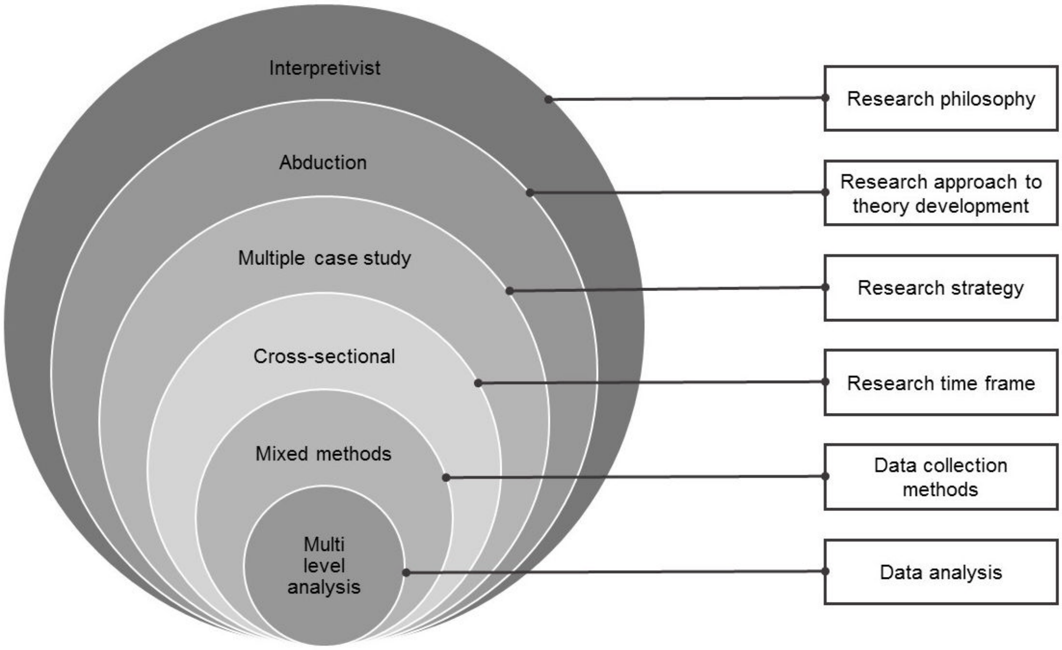

Figure 3.1: The research onion adapted from (Saunders et al., 2012)

I was trying to understand what factors enable sustainable business models by interviewing decision-makers in organisations that were selected as cases. Additionally, I focused on exploring individuals' perceptions of important sustainability issues and relationships between them that drive decision-making for changes in business models. My research interests are in line with subjective ontology, which assumes that reality is made up of perceptions and interactions of living subjects (Saunders et al., 2012). It also emphasises the importance of contexts in understanding reality that is dependent on variable behaviours, attitudes, experiences, and interpretations (Johns, 2006; O'Gorman and MacIntosh, 2016). Furthermore, it tends to be aligned with the interpretivist epistemological approach to knowledge (Saunders et al., 2012), which was also the case in the present project. Therefore, the adoption of the empathetic stance was essential when observing research subjects and trying to understand business model change for sustainability from their point of view (Saunders et al., 2012). Interpretivist research is value bound, which means that I, as a researcher, could not be separated from what was being researched.

My position about the research approach to theory development is in line with the systematic combining approach (Dubois and Gadde, 2002). Systematic combining is an abductive approach to case research that involves constant interplay between deductive and inductive reasoning to achieve deeper understanding of theory and phenomenon of interest. For instance, one of the outcomes of this research project is an integrative, conceptual framework to analyse business model change for sustainability from a cognitive perspective, which was evolving as the research progressed based on findings, analysis and interpretations.

The multiple case study was considered as the most appropriate research strategy to explore external and internal factors enabling business model change for sustainability. Furthermore, it was also used to explore internal, micro-level factors such as cognitive models and their role in business model change for sustainability (Hall, 2003; Blatter and Haverland, 2012). Collecting data with mixed methods enabled me to look holistically at each case and establish different views of business model change for sustainability (Myers, 2013; O'Gorman and MacIntosh, 2016). Data were collected and then analysed at individual and organisational levels. Table 3.1 shows the methods used in data collection and analysis that are explained in more detail in subsection on Mixed methods (Section 3.3).

Table 3.1: Data collection methods and data analysis used in the project

Data collection methods	Data analysis
Document analysis	Analytical strategy of interviewing documents
Site visits and observations	Content analysis of field notes and reflexive diaries
Interviews with participatory cognitive mapping	Content analysis of participants' themes, descriptions and explanations. Content and structural analysis of key informants' cognitive maps.
Online survey	Contents and structural analysis of individual and collective cognitive maps.

The following section focuses on evaluating, justifying and substantiating the methodological choices made in this research project.

3.2 Multiple case study

I decided to conduct the multiple case study to gain better understanding of business model change for sustainability. The multiple case study approach allowed me to preserve holistic characteristics of real-life events, organisational and managerial processes, while examining the business model change for sustainability in different contexts (Gillham, 2000; Pettigrew, 1973; Yin, 2003). Furthermore, it allowed me to use a mix of different methods to gather a more fine-grained empirical evidence compared to large-N studies (Blatter and Haverland, 2012). I argue that the use of multiple cases produces more robust conclusions from the research (Yin, 2003) and deepens existing experience and understanding of research phenomena (Stake, 2009).

To ensure the trustworthiness of the multiple case studies, I addressed the four criteria for rigorous research process: confirmability, internal consistency, transferability and dependability (Gasson, 2003). To meet the criteria of confirmability, I tried to minimise the researcher bias by using the variety of sources of evidence, i.e. overlapping methods of data collection and data analysis. To address internal consistency, I used a strategy of preparing brief reports for participants to validate the outcomes of data collection for each individual case. Participants were able to comment, amend and clarify any ambiguities. This is how I ensured that results were the true reflection of participants' social realities. Transferability of results was addressed by providing the detailed descriptions of particular contexts for each case. Thus, potential readers of my work will be able to evaluate whether its findings can be transferred to their settings and to what extent. To ensure dependability, I practiced reflexivity (Steier, 1991) by writing diaries about how my ideas developed, which helped to describe my research process in sufficient detail to facilitate another researcher to repeat the work. Furthermore, the audit trail of project documentation was also kept.

Case selection was based on criteria proposed by Stake (2006). First, I selected cases that were relevant to the phenomenon of interest, i.e. business model change for sustainability. Thus, I purposefully targeted cases that created variety and opportunities for intensive study of the business model change for sustainability. The selected cases were bound together by the main concept of sustainable business models. According to Bocken et al. (2014), sustainable business models integrate the triple bottom line approach and consider a broad range of stakeholders' interests. Furthermore, sustainable business models drive corporate innovation for sustainability and generate competitive advantage. Second, selected cases provided diversity across contexts in relation to industry, size, resources and sustainability journey[1] (Willard, 2002). Table 3.2 shows the selected cases and their contexts. The diversity of contexts also provided good opportunities to learn about internal and external factors that can enable business model change for sustainability and perceptions of sustainability issues that drive decision-making.

Table 3.2: Selected cases and their multiple contexts

Cases	***Industry***	***Size***	***Main materials***	***Sustainability journey***
Agrimax	Agricultural and food processing	Big	Crops (tomatoes, olives, potatoes and cereals)	Integrated strategy
Interface	Flooring industry	Big	Nylon yarn Recycled and bio-based materials	Passion and purpose
Techbuyer	IT/hardware	Medium	Used data centre equipment	Beyond compliance
Silentnight	Mattress manufacturing	Big	Steel, foams, timber, fabrics	Integrated strategy

[1] Businesses progress towards sustainability through a five-stage sustainability continuum: 1. Pre-compliance, 2. Compliance, 3. Beyond compliance (focus on eco-efficiency), 4. Integrated strategy (enhance company value) and 5. Purpose/passion (sustainability is at the centre of founder's or CEO's value system) (Willard, 2002).

To identify potential cases, I started searching academic and grey literature on sustainable business models. The purpose was to first understand the different types of sustainable business models and how they function, focusing on sustainable business models that can deliver resource efficiency. For instance, I got in touch with the industry bodies such as the National Industrial Symbiosis Programme (International Synergies Limited, 2016) and Leeds Manufacturing Alliance. Furthermore, I searched online sources, for instance, the business model innovation grid (Vlaanderen Circulair, 2016), certified B corporations (B Corps, 2016) and TEDx Talks (e.g. company Vigga). Additionally, academic and business contacts helped to identify potential cases and provide leads.

Finally, four cases met the selection criteria (i.e. cases were relevant to the phenomenon of interest and were bound together by the main concept of sustainable business models, and provided diversity across contexts) and had key informants willing to participate. Case 1, Agrimax, is a collaborative project between different partners from agricultural and food-processing industry, research institutes and end users that aim to build circular business models for resource recovery from agricultural and food processing waste. Case 2, Interface, is a company that is well-known for its sustainability initiatives and is an example of good practice. Case 3, Techbuyer, is a company providing refurbished data centre equipment that is integrating circular economy principles in its business model. Case 4, Silentnight, is a market leader in the mattress manufacturing industry that is focusing on improving its existing resource efficient business model. Each of the four cases will be discussed into detail in the corresponding results section (Chapters 4-7).

3.3 Mixed methods

The multiple case study approach enabled me to collect data using mixed methods to produce fine-grained, empirical evidence. There were three main reasons for adopting the mixed methods approach: data triangulation, instrument development and comprehensive account. First, data triangulation means that the facts of case studies have been supported by multiple sources of evidence (Greene et al., 1989; Yin, 2003). Second, an online survey was developed based on the results gathered through interviews with participatory cognitive mapping and document analysis. Third, mixed methods provide a more comprehensive account of the phenomenon of interest (Bryman, 2016). For example, I combined document analysis, site visits and participant observations, and interviews to deepen the knowledge about sustainable business models and what factors enable them. Furthermore, multiple levels of analysis for different data collection methods were used:

- Individual level (interviews with participatory cognitive mapping and online surveys);
- Group level (participant observation); and
- Organisational level (document analysis, site visits and interviews with key informants).

The following subsections explain how I used each data collection method and the respective analyses in this research project (see Table 3.3).

Table 3.3: Sources of evidence used in the multiple case study

Source of evidence	Case Agrimax	Case Interface	Case Techbuyer	Case Silentnight
Documents	✓	✓	✓	✓
Site visits (filed diary)/observations	✓	X	✓	✓
Interviews with participatory cognitive mapping	✓	✓	✓	✓
Online survey	✓	✓	✓	✓

3.3.1 Document analysis

To understand the background of selected organisations, I analysed publicly available documents. Document analysis is a type of qualitative research method in which researchers follow a systematic procedure of evaluating documents that includes gathering data, interpreting meanings, developing understanding and producing empirical knowledge (Corbin and Strauss, 2008). I used document analysis in combination with other data collection methods as a means of data triangulation to corroborate findings through different sources of evidence (Bowen, 2009). Furthermore, document analysis was used to further my understanding of business model change for sustainability and to strengthen my standpoint by considering different perspectives (Denzin and Lincoln, 2018; Leech and Onwuegbuzie, 2007). Documents contain textual data and images that were “recorded without researcher’s intervention” (Bowen, 2009, p. 27). Texts can cover a broad array of data types derived from an individual, group or organisation and can be grouped into different categories, for example, official data and records, and organisational communication (O'Leary, 2014). To classify types of documents gathered and selected for the analysis of each case organisation, I followed the categorisation proposed by O'Leary (2014). Table 3.4 shows the three categories of documents analysed in each case study.

Table 3.4: Categorisation of the types of documents for the analysis

	Official data and records	**Organisational communication**	**Personal communication**
Case Agrimax	None available because of pre-launch	Dissemination material (brochure, flyer, animation, BBI JU/Agrimax video, partner interviews, journal article, infographics) Project's website Online news about the project's progress Project deliverables (progress reports) Social networking sites (Twitter)	Social networking sites (LinkedIn)
Case Interface	UK industry reports (IBISWorld database) News information (Nexis)	Company's website Corporate videos Press releases Blog entries Annual and sustainability reports Environmental product declarations Grey literature (electronic magazine articles, books) Youtube videos	Social networking sites (LinkedIn)
Case Techbuyer	UK industry reports (IBISWorld database)	Company's website Corporate videos	Social networking sites (LinkedIn)

	Official data and records	Organisational communication	Personal communication
	News information (Nexis)	Company's brochures Press releases Grey literature (electronic magazine articles) Blog entries	
Case Silentnight	UK industry reports (IBISWorld database) News information (Nexis)	Company's website Press releases Annual reports Sustainability award application document PP presentation Corporate videos Infographics Grey literature (electronic magazine articles)	Social networking sites (LinkedIn)

The analytical strategy was based on *interviewing the documents* (O'Leary, 2014). Relevant questions to be asked were designed around my research phenomenon and available documents. Before starting with the document analysis, I defined what I wanted to know and which documents could provide answers to my questions. For instance, to gather information about financial and sustainability performance, annual and sustainability reports and organisations' websites were reviewed. Microsoft Excel was used to organise data for analysis by the type of document being interviewed, authorship, date of creation, relevant parts of the document, notes and reflective comments. Document analysis provided background information about selected organisations that guided the next steps in the data collection process.

3.3.2 Site visits and observation

The main purpose of site visits was to gain better understanding of selected organisations and their core business activities. For instance, the visit of Techbuyer's warehouse provided the opportunity to observe the main processes of IT data equipment refurbishing such as physical inspection of IT equipment and data erasure. Furthermore, I was able to observe relevant sustainability issues, for example, the use of plastic packaging. Similarly, visiting Silentnight's manufacturing facility provided insights into the mattress manufacturing process and specific sustainability issues, for instance, problems related to spring frame recycling and the energy intensive wrapping machine. In the case of Interface (see Table 3.3) I did not do site visits because there was sufficient amount of publicly available documents such as online videos and sustainability reports which provided a good overview of sustainability actions taken across Interface's manufacturing sites.

Participant observation is an appropriate method to explore scholarly problems when little is known about the phenomenon being studied (Jorgensen, 1989). This research technique was used in the case of Agrimax. I was interested to explore how stakeholders of an evolving circular supply chain perceive sustainability issues and relationships between them that could influence decision-making for business model innovation.

Stakeholders were observed at two different events: a general assembly meeting and business model innovation workshop. These events were selected because they offered an opportunity to observe the stakeholders of specific, substantive interest (Becker et al., 2002). First, the general assembly meeting provided information about the progress achieved since the last general assembly meeting and future plans, and the role of different stakeholders, which improved my understanding of Agrimax as a whole. Second, participating at the business model innovation workshop provided the opportunity to observe one group of stakeholders and their interactions and decision-making during different activities. The selection of study events was driven by the research interest into sustainable business models that have the potential to facilitate more efficient use of resources and access. Data were gathered through note taking during both events and the preparation of a reflexive diary immediately afterwards. I used a reflexive diary because it enabled me to integrate reflexive thinking into my research process and record my perceptions of research situations (Nadin and Cassell, 2006). Furthermore, the reflexive diary was used to increase the trustworthiness of data and integrity of research process (Finlay, 2002). It also helped me to better understand my role as a researcher in the research process, i.e. epistemological considerations (Cassell and Symon, 2004).

3.3.3 Interviews with participatory cognitive mapping

I included interviewing in the mix of methods because it allowed me to explore participants' subjective perspectives of organisational reality (Greenfield, 2002) as well as facilitating analysis, validity checks and triangulation. Interviews consisted of two parts that will be addressed separately in this section. The first part had an organisational focus, i.e. past and potential future business model changes that led or could lead to improved sustainability performance in the case organisations and factors enabling or hindering sustainable business models.

The second part was focused on the individual level, exploring sustainability issues that drive decision-making for changes in business models by utilising the participatory cognitive mapping technique (Gray et al., 2014; Özesmi and Özesmi, 2003).

During the preparation stage, I considered different aspects that could play an important role before, during and after the interviews. To ensure the quality of the interview process for both, the interviewer and the interviewees, I tried to understand the interviewees' backgrounds prior to the interviews by reviewing the organisations' websites, professional networking websites (e.g. LinkedIn) and key documents. Before the interview, I created materials for the interviewees, i.e. a project information sheet and a poster explaining what the research was designed to accomplish. Materials were sent to the interviewees prior to the interview and they were able to ask questions to clarify any doubts or to get additional information about the research and interview itself. The project information sheet with a consent form (see Appendix A: Research project information sheet) explained the purpose of the interview, what was expected of the interviewee, the type of information being sought, potential risks and disadvantages related to taking part in the interview as well as potential benefits. Additionally, a research project poster was prepared that included a brief overview of the research study (see Appendix B: Research project poster).

3.3.3.1 *Part 1 – Organisational level interviews*

Interview contexts

I also considered the role of different contexts that could influence the interview process at different stages, i.e. physical context (interview location) and interactional context (interview enacts its context that unfolds through the conversation between the interviewer and interviewee) as well as practical considerations such as issues with the recording devices (Mann, 2016). In the case of conventional face-to-face interviews, the interviews were to be held in the case organisations, i.e. offices where the interviewees worked or the meeting rooms. This was considered the best option because it enabled me to visit the case organisations and to observe some of the main activities (e.g. warehouse operation in the case of Techbuyer and mattress manufacturing process in the case of Silentnight). However, I was aware of the potential issue related to professional identity dominance when conducting interviews in the case organisations (Mann, 2016). (Mann, 2016, p. 66). The views of the interview event, the potential prior experiences and awareness of the norms related to the interview as well as expectations could all influence the interview process (Eggins and Slade, 1997). To avoid practical issues related to recording, two different recording devices were used, the main recorder and a back-up recorder. Additionally, I made sure the batteries in the recording device were fully charged and carried with me spare batteries. Other pragmatic issues that were considered involved planning of trips to arrive on time to the interview location, i.e. checking the interview location using google maps, choosing the most appropriate routes and public transportation options.

Type of interviews

In deciding upon the type of interviews, I considered the research interests and research questions as well as similarities and differences between the case organisations. While the case organisations fit the criteria of a sustainable business model context, they were at different stages of their sustainability journey. For instance, Interface is considered a sustainability leader in their industry (GlobeScan, 2018). Furthermore, the company has been launching sustainability initiatives and projects since the 1990's (Interface, 1997; Interface, 2017e). In contrast, Silentnight received their first Sustainability award in 2017 for improved sustainability performance as a result of changes in business model (The Furniture Makers' Company, 2017). At first, I designed a list of questions and sought opinions from the supervisory team as well as from business experts. The final decision on the type of questions and the structure of the interviews was based on the results from a pilot case study and feedback received at doctoral consortiums. Because case organisations were at different stages of their sustainability journey, I decided not to use a standardised list of questions but tailored questions to each specific case. The interviews were structured around topics related to business model change and sustainability performance and specific situations identified as critical incidents (Butterfield et al., 2005). For instance, Appendix C shows the interview topics and related questions used in the three main cases (Interface, Techbuyer and Silentnight). In line with the exploratory nature of the study, the interviews relied on semi-structured questions to understand the interviewees' perspectives on research phenomenon (Morse, 2012). In the case of Silentnight, the interviewees requested to receive the questions before the interview. I decided to provide the questions because they required a longer thinking time and to avoid cancelling or postponing the interviews because of the interviewees' busy schedules.

This research project included face-to-face interviews and online interviews. Most of the face-to-face interviews were planned to be performed in a dyadic form (one on one), except in the case of Silentnight where a group interview was adopted. The group interview was considered a good option in that particular case because of the interviewees' active involvement and collaboration on sustainability programme. Furthermore, my objective was that the whole group participates in the research project because they could provide complementary answers. Online interviews were synchronous meaning the principles of conventional face-to-face interviewing were followed in an online environment, i.e. participants responded in real time and were highly involved in the interview process (James and Busher, 2012). The Skype software application was used to conduct the online interviews due to its international recognition and because it enables audio and video communication in real time (Deakin and Wakefield, 2014). Furthermore, all of the interviewees and the researcher had previous experiences in using the Skype. Audio and video level of contact was applied which also enabled the screen sharing between the interviewer and the interviewees.

Participants

Interview participants were key informants who had experience and were engaged with sustainability activities in their respective organisations (see Table

3.5). Initial contact was established through emails providing a project information sheet and poster. Then, a conference call was arranged to provide more details about the research project itself, clarify any doubts, and schedule interviews. A slightly different approach was applied in the pilot case study of Agrimax were I interviewed survey respondents who expressed their willingness to participate in further research. Furthermore, the objective of those interviews was different, to validate cognitive maps derived from the online survey. Additionally, I explored reasons behind participants' choices of sustainability issues in their cognitive maps.

Table 3.5: Interview participants in each case study

Case	Participant's code	Role in the organisation	Tenure	Education	Age	Gender
Agrimax	CoM14	Agricultural cooperative	More than six years	PhD	40-49 years	M
Agrimax	CoM1	Food processing	More than six years	PhD	40-49 years	M
Agrimax	CoM11	Project manager	1-3 years	Bachelor's degree	30-39 years	F
Agrimax	CoM3	Research and development (R&D)	More than six years	Master's degree	40-49 years	M
Interface	IF-A	Global manager	More than six years	PhD	30-39 years	M
Techbuyer	TB-A	Senior manager	More than six years	High school level	40-49 years	M
Techbuyer	TB-C	Sustainability communication officer	1-3 years	Bachelor's degree	40-49 years	F

Case	Participant's code	Role in the organisation	Tenure	Education	Age	Gender
Techbuyer	TB-B	Sales director	1-3 years	High school level	40-49 years	M
Silentnight	SN-B	Product development manager	More than six years	High school level	50-59 years	F
Silentnight	SN-A	Senior manager	More than six years	Bachelor's degree	60-69 years	M
Silentnight	SN-C	Director of operations	1-3 years	Bachelor's degree	40-49 years	M

Analysis of the interviews

Shortly after the interviews, I listened to the entire recordings and took notes about the sections that were most pertinent to the research, i.e. data sampling (Saunders et al., 2012). Then, only those pertinent sections were transcribed. Transcribing was an iterative process that required careful and repeated listening of recordings and rewriting of transcription drafts. Final transcriptions were carefully checked for the accuracy and then analysed. Content analysis focused on participants' themes, descriptions and explanations which enabled the mapping of the interviews' content (Schrauf, 2016). Furthermore, where additional information was needed, follow-up questions were addressed.

3.3.3.2 *Part 2 – Individual participatory cognitive mapping*

During the interview method cognitive maps were developed using a participatory cognitive mapping tool. Participatory cognitive mapping was used to explore how individuals perceive important sustainability issues, i.e. economic, environmental, and social issues that drive their decision-making to improve sustainability performance of existing business models. Furthermore, to explore how they understand the causal relationships between the important sustainability issues that could influence achieved sustainability performance. A visual representation of managers' perceptions was created *in situ* with the help of Mental Modeler software that utilises fuzzy-logic cognitive mapping technique (Gray et al., 2014). Fuzzy-logic cognitive mapping is a parameterised semi-quantitative technique that was initially developed to explore experts' knowledge structures (Kosko, 1986) and has since been used in different disciplines "due to its flexibility to model any domain” (Halbrendt et al., 2014, p.54). Mental Modeler software was chosen as an appropriate tool for this study based on the research interests and different applications of fuzzy-logic cognitive mapping technique to explore beliefs, perceptions, and understandings of individuals as well as groups. For instance, to investigate stakeholders’ perceptions of factors influencing large-scale renewable energy projects (Konti and Damigos, 2018); to explore differences between stakeholders’ beliefs and perceived impacts of conservation agriculture (Halbrendt et al., 2014); and to investigate the integration of stakeholders’ knowledge into the governance of socio-ecological systems (Vasslides and Jensen, 2016).

During the participatory cognitive mapping interviews, participants were asked to think about the most important sustainability issues that drive their decision-making. The elicited sustainability issues were inserted in the Mental Modeler interface and participants were able to see and interact with the cognitive map in the process of making it. Participants were also asked to think about the causal relationships between the elicited sustainability issues. When participants identified a relationship between two sustainability issues, an arrow was inserted that indicated the relationship between the two issues as well as the direction of influence. Then, they decided on the type of relationship between the two sustainability issues, i.e. positive or negative that are represented with + and – sign in the Mental Modeler software. Positive relationships meant that an increase in the amount, degree or level of one issue led to an increase in the amount, degree or level of another issue (see Figure 3.2, relationship a). Negative relationships meant that an increase in the amount, degree or level of one issue led to a decrease in the amount, degree or level of another issue (see Figure 3.2, relationship b).

Participants were also asked to indicate the strength of the relationship between the sustainability issues as weak, moderate, strong or very strong. Mental Modeler software provides sliders to select the strength between -1 and +1. For instance, an assigned strength of 0.25 indicated that the relationship between sustainability issues was considered weak. The strength of relationship was also visually presented with the width of the arrow that adjusted automatically once the strength was indicated with a slider. Wider arrows indicate stronger relationships between sustainability issues.

Participants were able to consider one- and two-way relationships between the sustainability issues (see Figure 3.2, relationship c) and to amend sustainability issues in the cognitive map, i.e. by removing, relabelling or merging existing issues, and adding new sustainability issues. If there were no perceived relationships between a specific sustainability issue and other issues in the cognitive map then no directional arrows were added (see the example of bank connections in Figure 3.2). Furthermore, participants provided their reasons for choosing specific sustainability issues which enabled me to gain deeper understanding of their cognitive maps.

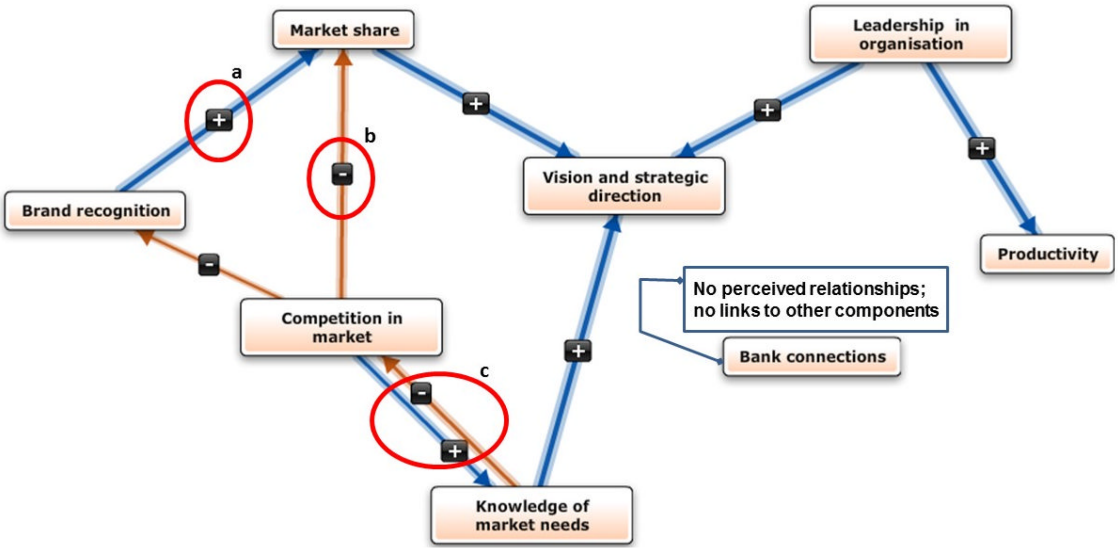

Figure 3.2: Illustrative example of a cognitive map (based on Markóczy and Goldberg, 1995)

Analysis of the cognitive maps

After the cognitive mapping process, content and structural analyses were carried out using the metrics in the Mental Modeler software (Gray et al., 2013). Then, I prepared brief reports that were sent to the participants for validation. During validation, participants were able to clarify any ambiguities or missing information as well as provide answers to follow-up questions. The validation of cognitive maps also ensured the trustworthiness of findings (Gasson, 2003).

3.3.4 Online survey

The purpose of the online survey was to explore the diversity of the cognitive maps within the organisations participating in the research project. A list of important sustainability issues was created for each organisation based on the results obtained in participatory cognitive mapping and document analysis.

Sustainability issues were grouped into three main categories: 1. Economic issues, 2. Environmental issues and 3. Social issues. Then, key informants were asked to review the list for completeness before it was incorporated into the online survey. I sought to have case-specific, sustainability issues because each organisation operates in a different industry; furthermore, all organisations were at different stage of their sustainability journey during the time of research. *Qualtrics* was used to create and distribute the online survey. The online survey covered three blocks of questions:

- Block1: Important economic, environmental and social issues; respondents were asked to select the two most important economic, environmental and social issues for their company.
- Block 2: Relationships between the most important sustainability issues selected in Block 1. Questions in block 2 were designed with a linking logic command, which enabled incorporation of respondents' answers from block 1 into questions in block 2. Figure 3.3 shows instructions and illustrative examples to assist respondents to address questions in Block 2.
- Block 3: Demographics; questions related to the respondents' position and tenure in the company, age, gender and education.

The link to the online survey was provided to one of the key informants who performed the final check before distributing the online survey to the department leaders. Responses were gathered through *Qualtrics* and downloaded in PDF format (see Appendix D: A case example of a full survey) and the comma-separated values format (csv) for the analysis.

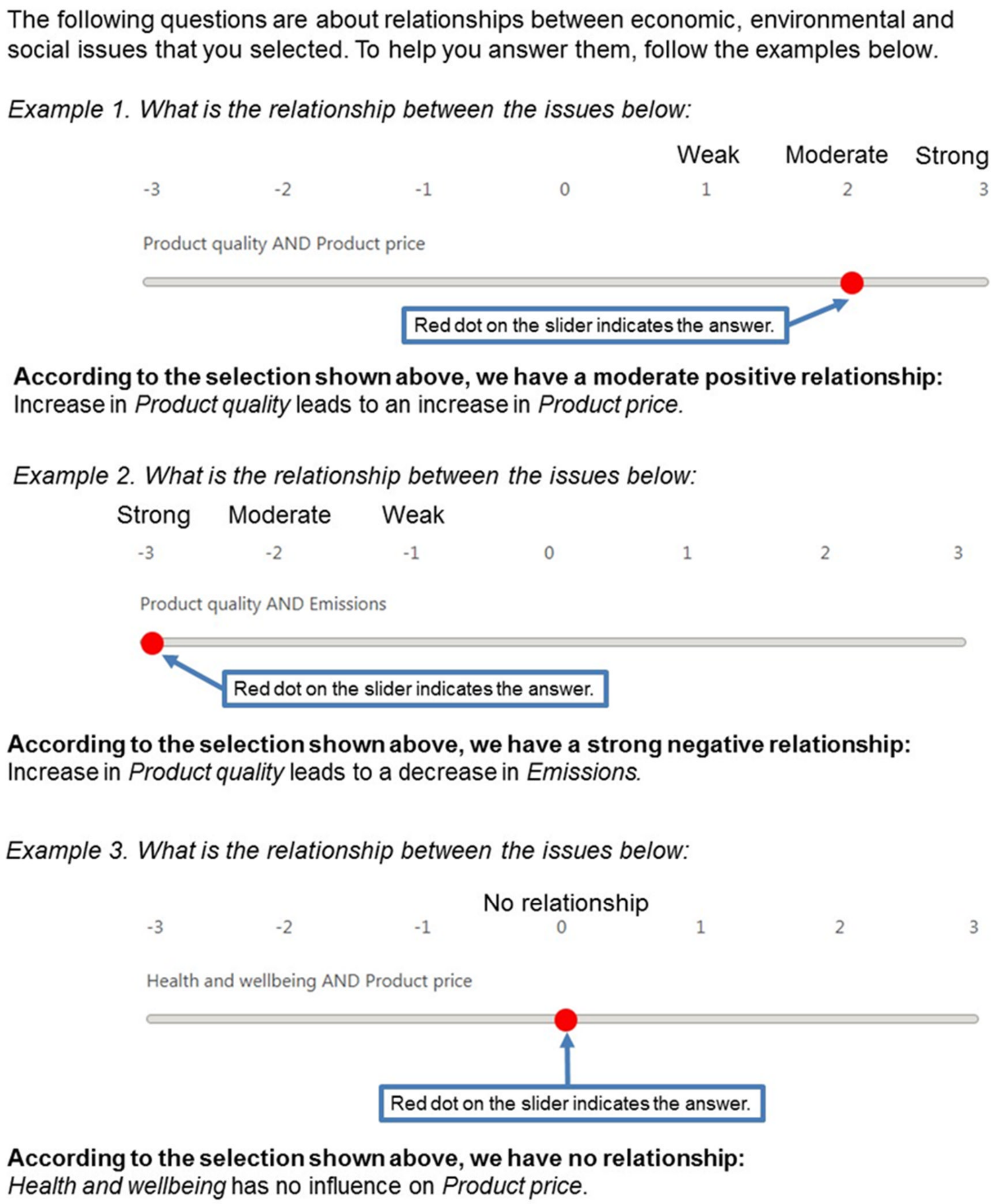

Figure 3.3: Online survey instructions and illustrative examples of relationships between sustainability issues

Respondents were able to select the six most important sustainability issues; two from each sustainability category (economic, environmental, and social).

Limiting the choices to six sustainability issues was pragmatic, i.e. to avoid response fatigue, to minimise the incomplete and erroneous responses, and time constraints. Limiting the selection to six sustainability issues may have affected the possibility to observe additional complexity in the cognitive maps. However, complexity was not the priority when observing the differences between cognitive maps across organisations, rather the priority was about observing the perceived relationships between selected sustainability issues. On the other hand, participatory cognitive mapping posed no restrictions to the number of sustainability issues, which allowed emergence of more complex cognitive maps. Thus, time constraints, elicitation technique, and the purpose of cognitive mapping influenced the choices made about the number of sustainability issues included in the cognitive maps.

Online survey data analysis

Data analysis was performed in two parts. First, to visualise and analyse individual cognitive maps, the collected responses in *Qualtrics* survey tool were exported as csv files with numeric values. Responses from each individual respondent were transformed into a 6-by-6 adjacency matrix in Excel. Figure 3.4 shows an example of the adjacency matrix. Then, data from each adjacency matrix was incorporated into Mental Modeler software to visualise cognitive maps and use content and structural metrics for analysis. The Mental Modeler software was an appropriate tool for this study because it facilitates analysis of relationships between key concepts into a mental model.

Cognitive map TBCM24	Negative customers' perceptions (perceptions that refurbished products are not as good as new)	Data loss concerns	Waste reduction	Encouraging reuse of material	Technical knowledge (across different product ranges on IBM, HP, DELL...)	Staff expertise
Negative customers' perceptions (perceptions that refurbished products are not as good as new)	0	2	2	1	1	1
Data loss concerns	2	0	2	2	1	1
Waste reduction	0	0	0	2	0	0
Encouraging reuse of material	1	0	2	0	0	0
Technical knowledge (across different product ranges on IBM, HP, DELL...)	-1	-1	-1	-1	0	-1
Staff expertise	2	2	0	2	2	0

Figure 3.4: A cognitive map presented in the form of an adjacency matrix

Second, to analyse and visualise a collective cognitive map, an extended matrix was created. The size of the extended matrix was defined by sustainability issues included in individual adjacency matrices, for example, a 20-by-20 extended matrix was created for Silentnight. Then, each individual adjacency matrix was coded into the extended matrix; all extended matrices (14 in the case of Agrimax, 8 in the case of Interface, 24 in the case of Techbuyer and 11 in the case of Silentnight) were added together (in pairs) using matrix addition operation. The resulting extended matrix was normalised; each value was divided by the total number of adjacency matrices. Finally, data from the resulting extended matrix was incorporated into Mental Modeler software to visualise and analyse the collective cognitive map.

3.4 Case analysis

To analyse each individual case, I used a template analysis. The template analysis is a type of thematic analysis that is used to analyse textual data (Brooks et al., 2015). The focus of the template analysis technique was on a development of a coded template based on the subset of data and then applied to the whole set of data (Brooks et al., 2015). The reason why I decided for this technique is its flexibility that allowed me to adapt the technique to the needs of my research study and the study's philosophical underpinnings (Brooks et al., 2015). Furthermore, this technique enabled me to develop templates in the formats (word tables) that I considered most suitable ways to make sense of data.

I developed three templates that were used as analytical frameworks for business model circularity, factors influencing business model change for sustainability and sustainability performance. In advance, I identified themes that were considered relevant and helpful for the analysis (Brooks et al., 2015). For example, the template to analyse business model circularity included two overarching themes: business model components and the R principles for circular economy. Sub-themes in the R principles for circular economy included:

- recover and recycle (low level of circularity);
- repurpose, remanufacture, refurbish, repair and reuse (medium level of circularity); and
- reduce, rethink and refuse (high level of circularity) (Kirchherr et al., 2017).

The business model circularity template was inspired by the conceptual framework for analysing business models in the circular economy proposed by Ranta et al. (2018). The sub-themes in the business model components were based on a value based view on the sustainability of circular business models, i.e. the value proposition, value creation and delivery, and value capture

(Geissdoerfer et al., 2018a). The developed templates displayed data from the individual cases; templates from each individual case were compared side-by-side to perform a cross-case synthesis. Each case was first treated separately and then findings were aggregated across the collection of four individual studies (Yin, 2003).

3.5 Ethical considerations

I took care to conduct research ethically and in compliance with the University's Research Ethics Policy. Ethical implications of this research were considered during the research design to identify potential risks and the ways to address them. This was done for different data collection and analysis methods used throughout the research project. Awareness of a researcher's obligations and participants' rights led the conduct of this research. I provided an information sheet about the project to the participants and obtained their informed consent prior to the data collection. Participants were informed about the purpose of their participation, the use of audio recordings for data analysis, potential research outputs, benefits, and risks of taking part in the research. Furthermore, participants involved in the participatory cognitive mapping received an illustrative example to facilitate their participation. Participants were able to ask questions if they needed clarifications about any aspects of the research project before deciding to participate as well as during the participation. After the initial data analysis, short reports were provided to the participants for validation.

The research project was reviewed and approved by the Ethics Committee at the University of Leeds; ref. no. LTSEE-049 (see Appendix E: Ethical approval).

Any emerging issues during the research, were consulted with the supervisory team as well as with the Research Ethics department. For example, gathering observational data was not part of the original research design, therefore, I submitted the amendment to the research application for ethical approval prior to implementation.

3.6 Summary

In the present research project, I adopted a multiple case study to collect data through mixed methods that enabled me to investigate my research questions.

Chapter 4 – Case Study 1: Agrimax

In this chapter I present and interpret results derived from a pilot case study of Agrimax. The purpose of this case study was to explore how the European stakeholders involved in the Agrimax perceive the importance of sustainability issues. Such issues could influence decision-making during business model innovation for sustainability and the resulting circular business models (CBMs). I used cognitive models to gain insight into how Agrimax stakeholders understand interrelations and interactions between different sustainability issues in the bio-based industry. This study addresses the research question: *how do stakeholders' cognitive models of sustainability issues influence business model innovation for sustainability?* Specifically, *how do cognitive models of sustainability issues link to CBMs?* The research questions for this pilot case study were different to those that were eventually decided upon for the following case studies and the overall thesis. During the case study, Agrimax stakeholders participated in a business model innovation workshop for their newly evolving, circular supply chain which influenced the formation of specific questions for the study. My assumption was that stakeholders' perceptions of sustainability issues would influence their decisions in developing CBMs to create and deliver multiple sustainability values. I expected to see links between cognitive models of sustainability issues and the main elements in the developed CBMs such as value-added propositions because cognitive models influence decision-making. Therefore, the content of the cognitive models should be reflected in the elements of CBMs.

This chapter is structured as follows. Section 4.1 introduces the Agrimax. Section 4.2 gives an overview of the methods used for data collection and data analysis. Section 4.3 presents and analyses the main findings. Section 4.4 provides an overall discussion of the main findings in relation to the existing literature.

4.1 Background

Agrimax is a four-year EU-funded project which aims to develop the production of multiple bio-based products using agricultural and food processing waste (AFPW) (Agrimax, 2017). Agrimax was launched in 2015 with the goal of building two pilot bio-refinery plants to demonstrate the technical and commercial feasibility for high-value compounds extraction such as proteins and phenolic acids from the AFPW. To achieve this goal, a range of partners from 11 different European countries are involved in Agrimax from industries including:

- Agricultural and food processing industry;
- Co-operatives;
- Waste management agencies;
- Laboratories and research institutes; and
- End-users such as bio-packaging and agricultural manufacturers (Velenturf and Jensen, 2017).

It is estimated that in Europe approximately 90 million tons of food and 700 million tons of crops are wasted each year (Stenmarck et al., 2016). In 2015, the EU set the target to reduce food waste and loss that occur during production and consumption by 50% per capita by 2030 (European Commission, 2016). Agrimax has the potential to close the loop on crops and food waste, and associated GHG emissions. Furthermore, Agrimax aims to help reduce dependence on fossil fuels by providing biogas and reducing the use of raw materials by utilising crops and food processing residues and by-products. Social and economic benefits such as job generation, rural development and new market creation are also expected. Due to the potential sustainability benefits, the EU Commission has high expectations for the Agrimax which could become an example of best practice (Belotti, 2017). During my study, Agrimax was in the final stages of the testing phase for extraction processes and technologies. The pilot bi-refinery plants were planned to be in full operation by September 2018. The project is expected to be completed in 2020 (Bio-based Industries Joint Undertaking, 2017).

4.2 Methodology

The mixed methods approach comprised two phases. Phase one involved the collection of data from online surveys and in-depth interviews. Phase two involved participant observations of a general assembly meeting and a business model innovation workshop with key stakeholders, as well as document analysis. In the following sections the research context is introduced and then each phase of data collection outlined. Table 4.1 gives an overview of the mixed methods multilevel approach used in this case.

Table 4.1: Agrimax methods

Phase	Method	Data collection approach	Level of analysis	Analysis technique
1	Online survey	Qualitative and quantitative	Individual	Content and structural analysis
1	Interviews	Qualitative	Individual	Content analysis, thematic coding
2	Observation	Qualitative	Group	Description as analysis
2	Document analysis	Qualitative	Organisational	Side-by-side comparison

4.2.1 Phase 1: Individual level

Fourteen participants responded to an online survey about sustainability issues related to the bio-based industry and perceived relationships between them. The survey was distributed to the Agrimax network via email and was available in English and Spanish. Translation and editing were done by two native Spanish speakers to ensure appropriate Spanish equivalents to English terms. Participants came from a range of industrial sectors including: food processing (4 participants), agricultural (2), waste management (1), packaging (1), consulting (1) and R&D (5). The average age of stakeholders was 42.5 years, and they held different job roles including CEO, technological group manager, and project manager. Most stakeholders (71%) had more than six years at their respective organisations, and 57% were educated to PhD level. Respondents were Spanish (50%), Italian (36%) and German (14%). A survey was developed by reviewing literature to identify the most frequently mentioned sustainability issues in the bio-based industry. A list was derived grouping those issues into three categories: economic, environmental and social. I then sought an expert's opinion (having more than five years of research experience in the bio-based industry context) for completeness of the list. In total, 28 sustainability issues were selected based on the relevance criteria for bio-based industry within EU context, i.e. consideration in the bio-economy strategy for Europe. I also considered the time constraints of participants, possible response fatigue, and selection difficulties if the list was too long (Markóczy and Goldberg, 1995). Table 4.2 shows the list of sustainability issues used in the survey divided into three categories.

Table 4.2: List of sustainability issues in the survey

Economic	Environmental	Social
• Innovation, R&D • New production processes • Technological development • Innovative bio-based products • Food prices • Demand for bio-based products • Revenue • Profit • Collaboration within supply chain, across industry sectors • Competitiveness	• Water use • Ecosystem services • Recycling • Biodiversity loss • Land use • Greenhouse gas emissions • Waste • Energy use • Pollution • Use of natural resources (biomass)	• Health and well-being • Employment • Product/service safety • Wages and benefits • Training and education • Rural development • Working conditions • Ethical behaviour and human rights

Four survey respondents also participated in Skype interviews. To preserve anonymity respondents' names were replaced with a unique code made up of CoM (cognitive model) and a number (1-14). Respondent CoM1 came from the food processing industrial sector, with a tenure of more than six years, educated to PhD level, aged 40-49 years and was Spanish. Respondent CoM3 was involved in R&D, with a tenure of more than six years, educated to master's degree level, aged 40-49 years, and was German. Respondent CoM11 was involved in R&D, with a tenure of 1-3 years, educated to bachelor's degree level, aged 30-39 years, and was Italian. Respondent CoM14 came from agricultural industrial sector, with a tenure of more than six years, educated to PhD level, aged 40-49 years, and was Spanish. The purpose of the interviews was to validate the cognitive maps generated from the survey and seek additional insight into the perceptions and rationale behind the choices.

Components of the cognitive maps were derived from the most important issues identified by respondents, two from each sustainability category (environmental, social, and economic). A cognitive map example is shown in Figure 4.1. Arrows represent relationships between sustainability issues as identified by respondents. The relationships' strength is represented with weights ranging from -1 to +1. Plus and minus signs indicate the type of relationship between sustainability issues, i.e., positive and negative correlation. For instance, -1 between recycling and GHG emissions means that an increase in recycling leads to a very strong decrease in GHG emissions.

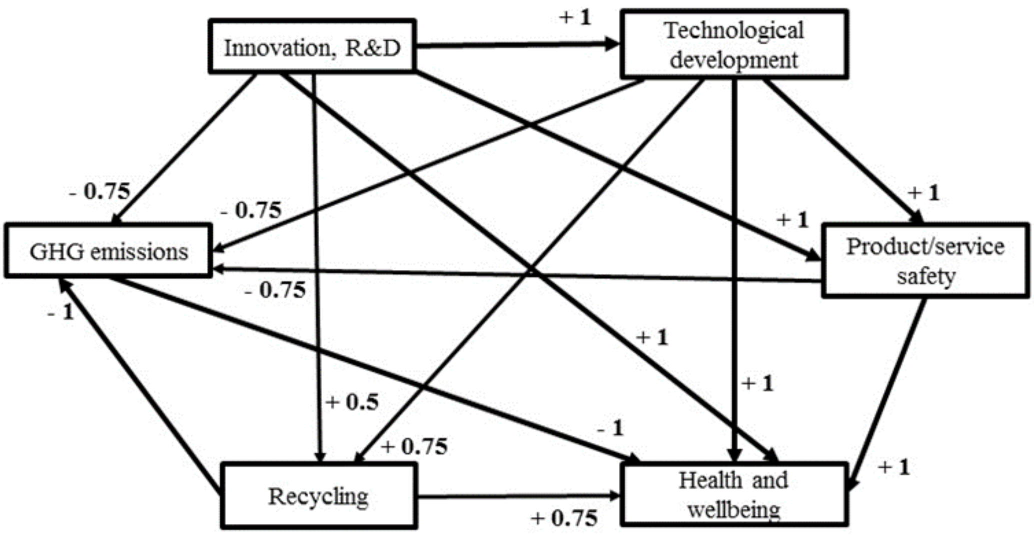

Figure 4.1: Agrimax cognitive map example

NB. Six sustainability issues are represented; arrows represent relationships and numbers represent weights (R&D: Research and development, GHG: Greenhouse gas emissions)

Sustainability issues that influence other issues in the cognitive map and are not being influenced themselves by others are called driver sustainability issues. In contrast, receiver sustainability issues are those that are influenced by other issues in the model and themselves do not influence others. Ordinary sustainability issues can do both, influence other issues in the model and be influenced by others. For instance, the cognitive map in Figure 4.1 has one driver sustainability issue (*Innovation, R&D*), one receiver sustainability issue (*Health and well-being*) and four ordinary sustainability issues (*Recycling*, *GHG emissions*, *Product/service safety*, and *Technological development*). The centrality score of an individual sustainability issue in the cognitive map shows how important is that issue in the map. It is an absolute value obtained by adding all the relationship weights for that issue. For instance, the centrality score of *Innovation, R&D* is $1 + 1 + 1 + 0.5 + |-0.75| = 4.25$. The higher the centrality score, the greater the importance of that issue in the cognitive map. Table 4.3 shows the centrality score of sustainability issues across the elicited cognitive maps.

4.2.2 Phase 2: Group and organisational level

Phase 2 included participant observation based on the principles of ethnography research. Ethnography is an immersive type of fieldwork that allows a researcher to study the phenomenon of interest in its natural environment as an active participant (Van Maanen, 2011). In the current study, I observed and interacted with participants at two events: a general assembly meeting and a business model innovation workshop. Website data and documents relating to the project more generally were also collected in order to triangulate findings (Creswell and Creswell, 2018).

The general assembly meeting involved 55 representatives from the partners involved in the Agrimax and the one-day business model innovation workshop involved 73 stakeholders. During the workshop, stakeholders developed four different circular business models, two for the bio-refinery plants and two for the cooperatives. Data were gathered through note taking during the meeting and workshop, and the preparation of a reflective diary immediately afterwards. During the workshop a detailed observation of a group of six stakeholders was also conducted. Data from participant observation were given unique identifiers describing the data source (participant observation – PO) and a number (1-6). Participants included: a quality manager from agricultural sector (PO1), an R&D manager from food processing industry (PO2), a representative from a waste management agency (PO3), a representative from a wine cooperative (PO4), a CEO from a cooperative (olive oil, dry/citrus fruits) (PO5), and a representative from a food supplements business (PO6).

Documentary data at the organisational level were collected from publicly available documents such as website and project reports, as well as business models developed during the workshop.

4.3 Results and analysis

The main results from Phase 1 show that economic issues were among the most central issues in 10 stakeholders' cognitive models. Twelve cognitive models had one driver sustainability issue and in seven cases that was *Innovation, R&D*. None of the cognitive models included *Demand for the bio-based products*. The main results in Phase 2 show that there exist internal and external issues that could hinder the development of the circular supply chain. For instance, differences in thinking between the co-operatives and businesses, and negative perceptions of products derived from AFPW. Finally, links between the aspects of central sustainability issues in the cognitive models and the elements in the developed CBMs were found. For instance, *Innovation, R&D* was identified as one of the main activities and the key value-added proposition in CBMs.

4.3.1 Stakeholders' cognitive models of sustainability issues in the bio-based industry

Previous research has shown the primacy of long-term profitability as the most central sustainability issue in the cognitive models of managers from the bio-based industry (Bergman et al., 2016). And yet results show this was not the case in the Agrimax. It may, however, be explained because Agrimax is a start-up project and innovation might be considered as more important in this phase of the project's development. Once the technical and commercial feasibility are demonstrated, then we might expect other economic issues to become more salient for the project partners when the project scales up to an industrial level. Therefore, it would be interesting to observe the cognitive models and their potential changes at different stages of the Agrimax.

What was surprising is that none of the cognitive models included demand for bio-based products (Table 4.3). Provision of new, everyday eco-products is one of the main goals in the Agrimax, thus I expected that the demand side would be considered more important. This result suggests that Agrimax network has been set up with a focus on developing circular business models, without due consideration of its customers. Therefore, stakeholders are prioritising the innovative components of the project over and above the new products users' needs. Research has shown that customer demand is one of the key external drivers for organisations to become more sustainability oriented (Lozano, 2015), yet the findings of the present study suggest that Agrimax case differs from this outcome.

In terms of the structure, 12 out of 14 cognitive models had one driver component; in seven cases that was *Innovation, R&D*. Other driver components were *Technological development*, *Innovative bio-based products*, *Health and well-being, Recycling* and *Training and education*. For each cognitive model, a centrality score[2] for each sustainability issue was calculated. Table 4.3 includes the top three centrality scores for each cognitive model. Furthermore, Appendix F shows a couple of examples of how centrality score was calculated.

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[2]A centrality score is an absolute value obtained by adding all the weights (ranging between -1 and +1) that represent the strength of relationships between sustainability issues. Because the centrality score represents an absolute value, in some cases, multiple issues achieved the same centrality score.

Economic issues achieved high centrality scores in 10 out of 14 cognitive models (see Table 4.3). For instance, participant CoM1 commented that *Innovation, R&D* has always been one of the key processes in his organisation that enables profitability. Furthermore, his company is continuously developing new products in collaboration with partners to achieve competitive advantage. Social and environmental issues achieved the highest centrality score in five cognitive models. This is an interesting finding because CBMs tend to be criticised for not considering social issues, however, this seems not to be the case in Agrimax (see Table 4.3).

Table 4.3: Agrimax cognitive models centrality scores

Cognitive model	**Most central sustainability issues**	**Type of issue**	**Centrality score**
CoM1[a]	Collaboration within supply chain, across industry sectors	Economic	2.75
	Food prices	Economic	2.5
	Rural development	Social	2.25
CoM2	Use of natural resources	Environmental	3.5
	Innovation R&D[b]	Economic	3.5
	Innovative bio-based products	Economic	2.75
CoM3	Innovation, R&D	Economic	4.25
	Ecosystem services	Environmental	4
	Competitiveness	Economic	3.25
CoM4	Innovation, R&D	Economic	5
	Innovative bio-based products	Economic	5
	Use of natural resources	Environmental	5
CoM5	Health and well-being	Social	2.5
	Product/service safety	Social	2
	Revenue	Economic	1.75
CoM6	Health and well-being/ Rural development	Social	5
	Water use/ Biodiversity loss	Environmental	5
	Innovation, R&D/ Competitiveness	Economic	5
CoM7	Innovation, R&D	Economic	4.25
	Technological development	Economic	4
	Use of natural resources	Environmental	2

Cognitive model	Most central sustainability issues	Type of issue	Centrality score
CoM8	Technological development Innovation, R&D Recycling	Economic Economic Environmental	3.75 3.75 1.75
CoM9	Rural development Revenue Use of natural resources	Social Economic Environmental	4.75 4.5 4.5
CoM10	Innovation, R&D/Technological development Ecosystem services Employment (job generation)	Economic Environmental Social	4 4 4
CoM11	Health and well-being Technological development Innovation, R&D	Social Economic Economic	4.75 4.5 4.25
CoM12	Product/service safety Recycling Training and education	Social Environmental Social	4 4 3.75
CoM13	Innovation, R&D GHG[c] emissions Health and well-being	Economic Environmental Social	2.75 1.5 1.25
CoM14	Innovation, R&D New production processes Use of natural resources	Economic Economic Environmental	5 4 4

[a] Cognitive model (stakeholder 1 to 14), [b] Research and development, [c] Greenhouse gas emissions

As Table 4.3 shows, *Innovation, R&D* was the sole issue with the highest centrality score in four cognitive models. Furthermore, *Innovation, R&D* was included in five cognitive models that had multiple issues with the highest centrality score. This might imply that innovation is important to the Agrimax stakeholders because of the innovative nature of the project itself. Furthermore, Agrimax stakeholders collaborate in creating a new circular supply chain by utilising innovative extraction technologies and processes. On the other hand, it might imply that *Innovation, R&D* is one of the core activities in the stakeholders' respective organisations. For example, participant

CoM14 commented that *Innovation, R&D* is strongly linked to new product developments from biomass, i.e. hazelnut and almond skins and shells.

4.3.2 Business model innovation for sustainability in Agrimax

This subsection presents the main results derived from ethnographically informed participant observations of the business model innovation workshop. The group (PO1-6) observations revealed that the roles and positions of food processors, cooperatives, and bio-refineries have not been clearly defined. For instance, it was unclear whether cooperatives and bio-refineries should be separate or combined entities; this could have important implications for logistics and related transportation costs as well as associated GHG emissions. Furthermore, it was unclear what type of bio-refineries should be built, the ones that buy waste or the ones that charge for using it. These decisions could influence the environmental impacts and the profit formula of the CBMs, therefore, stakeholders need to establish the most viable solution before scaling up to industrial level.

Participant PO3 had the most difficulty articulating the CBM elements and how her organisation aligns with the Agrimax circular supply chain. This is an interesting finding because, according to the group's facilitator, the waste management agency is the key partner in Agrimax that can help promoting the importance of circular economy principles. Furthermore, the waste management agency gathers information about the amount and type of waste streams and by-products of all the registered industrial sectors in the region. On the other hand, participant PO1 said that previous experience with the circular economy concept and corporate social responsibility enabled her to think about CBMs for the Agrimax more easily. She also commented that EU financial initiatives are important drivers for small and medium enterprises to get involved in sustainability projects and that they need to change their mind-set to shift towards circular economy. All participants commented that there were differences in thinking among cooperatives and businesses because cooperatives tend to think in a more linear way because of the nature of their core activities. This indicates that tensions might occur as the circular supply chain evolves and decision-makers should take this into consideration and design strategies to overcome them. The group also discussed the issue of consumers' perception of products derived from agricultural and food processing waste, and difficulties in getting permissions to make bio-based products for human consumption.

The key finding from the workshop observation is that the role of each stakeholder in the circular supply chain should be clearly defined to avoid unnecessary logistics costs and associated environmental impacts. Furthermore, circular thinking should be promoted across the whole circular supply chain with the emphasis on cooperatives to minimise the potential paradoxical tensions between partners in the Agrimax.

4.3.3 Agrimax central sustainability issues and circular business models

Economic issues that were identified as prioritised by participants and achieved the highest centrality scores in their cognitive models *Innovation, R&D*, *Technological development* and *Collaboration within supply chain, across industrial* *sectors* have clear links to different building blocks in each individual CBM (see Table 4.4). The centrality of economic issues in the cognitive models developed in Phase 1 could mean that they were more easily recalled compared to other issues in the cognitive model which might indicate availability bias (Tversky and Kahneman, 1973). Furthermore, the design of a template used to generate CBMs might have influenced the way participants engaged into thinking about the most important building blocks and sustainability issues relevant to them. Similarly, different aspects of *Use of natural resources (biomass)* issue, for instance, quality and storage of biomass were identified across different building blocks in each individual CBM.

Table 4.4: Agrimax central sustainability issues and circular business models links

Sustainability issues with the highest centrality scores in cognitive models	CBM1[a]	CBM2[b]	CBM3[c]	CBM4[d]
Innovation, R&D[e]	• Activities	• Activities	• Activities • Value added proposition	• Value added proposition
Technological development	• Value added proposition • Key partnerships • Costs	• Value added proposition • Key partnerships • Activities • Benefits • Customer relationships • Customer segments	• Value added proposition • Customer relationships • Channels	• Assets
Collaboration within supply chain, across industrial sectors	• Key partnerships • Customer relationships	• Key partnerships • Value added proposition • Customer relationships	• Key partnerships • Value added proposition • Customer relationships	• Key partnerships • Customer relationships
Health and well-being	• Not identified	• Not identified	• Not identified	• Not identified
Rural development	• Costs and benefits created and shared in the wider circular supply chain	• Not identified	• Not identified	• Not identified
Product/service safety	• Not identified	• Not identified	• Benefit	• Value added proposition
Use of natural resources (biomass)	• Activities • Value added proposition • Key partnerships	• Activities • Value added proposition • Key partnerships	• Activities • Value added proposition • Assets • Benefits	• Key partnerships • Benefits

[a] Circular business model: cooperative for olive and potato waste; [b] Circular business model: cooperative for tomato and cereal waste; [c] Circular business model: bio-refinery for olive and potato waste; [d] Circular business model: bio-refinery for tomato and cereal waste; [e] Research and development

On the other hand, social issues were less likely to be included in the CBMs even though they were quite central in the cognitive models. For instance, CBM3 and CBM4 (see Table 4.4) addressed *Products/service safety* either as a type of benefit for the business or value-added proposition. CBM1 included an aspect of *Rural development* as costs and benefits created and shared in the wider circular supply chain. No links were found between *Health and well-being* and CBMs. I would expect to see aspects of *Product/service safety* to be more prominent across CBMs because of the legal challenges associated with the production of bio-based products for human consumption and consumers' negative perceptions of products derived from AFPW and by-products. The missing links between social issues and CBMs have been addressed in the wider context of circular economy. For example, Murray et al. (2017) critiqued the circular economy approach for not recognising social aspects of human rights, equity and well-being that are otherwise central to the concepts of sustainability and sustainable development. Furthermore, research on CBMs has emphasised the need of including and measuring social performance (Lee et al., 2012) as well as environmental performance (Bakker et al., 2014) to achieve sustainability. The mismatch found between the centrality of social issues in the cognitive models and the building blocks of CBMs indicate that Agrimax might not deliver high social performance, even though stakeholders prioritise social issues.

4.4 Discussion

The results of this study suggest that stakeholders' cognitive models of sustainability issues influenced the business model innovation for sustainability, i.e. aspects of different sustainability issues were included in the resulting CBMs.

Specifically, links between central sustainability issues in the cognitive models and building blocks in the CBMs were identified. For instance, aspects of *Innovation, R&D* were identified in the Activities and Value-added proposition building blocks in the CBMs (see Table 4.4). However, the centrality of sustainability issues alone might not be the most important factor in the business model innovation for sustainability and resulting CBMs. For example, *Health and well-being* and *Rural development* were both central sustainability issues, but only one link associated to Rural development was found in CBM1. No links were identified between *Health and well-being* and CBMs. Therefore, it can be inferred that a combination of centrality and type of sustainability issue play a more important role in the development of CBMs than centrality alone. It is important to emphasise that relationships between sustainability issues in the cognitive models and building blocks in the CBMs make no assumptions about causality due to the type of cross-sectional data. The aspects related to economic and environmental issues were more likely to be identified across different building blocks in the CBMs than social aspects. These findings suggest that even though stakeholders considered relationships between different sustainability issues in their cognitive models, there was a tendency to prioritise aspects of economic and environmental issues in the CBMs. Therefore, they might have overlooked some opportunities for creation and delivery of broader societal benefits when thinking about CBMs. Additionally, the workshop was designed within circular economy context which could have had some limiting influence on the scope of sustainability issues being considered by stakeholders, i.e. focusing on economic and environmental issues. Thus, thinking within a broader context of sustainability might have led to different outcomes in terms of CBMs and their overall sustainability performance potential.

Previous research has used cognitive models to explore stakeholders' perceptions and motives in relation to sustainability. For instance, competitive advantage has been identified as the main driver for businesses to engage with sustainability activities (Hockerts, 2015). However, the current study has shown that other economic issues such as innovation played a more important role in business model innovation for sustainability. Bergman et al. (2016) found that long-term profitability was the most central sustainability issue in the cognitive models of decision-makers in the case companies within bio-based industry. Similarly, in the agricultural context, economic viability of the farm was identified as the most influential issue in the cognitive models (Hoffman et al., 2014). Yet, financial indicators such as profit and revenue were not the most central issues in the stakeholders' cognitive models in the current study. Rather, it was innovation, technological development and collaboration. Furthermore, the centrality of social issues was also noticeable which differs from previous findings.

Business model innovation enables organisations to integrate sustainability into business through creation of new sustainable business models. The Agrimax is trying to achieve this by building CBMs that create value from AFPW and by-products. According to Schaltegger et al. (2012) the degree of business model innovation for sustainability depends on the type of organisation, sustainability strategy, and the business-case drivers for sustainability. In line with Foss and Saebi (2017), I argue that micro-level factors such as perceptions and understanding of sustainability issues also play an important role in the business model innovation for sustainability. The findings of the current study suggest that stakeholders' cognitive models of sustainability issues might influence how the building blocks of the CBMs are shaped. Specifically, cognitive models may influence the aspects of economic, environmental, and social issues that are considered and included in the building blocks of the CBMs. These decisions can affect the level of sustainability performance achieved. The CBMs developed for the Agrimax tackle the problem of crop and food processing waste by collaborative approach. Stakeholders in different parts of the evolving circular supply chain exchange knowledge, information, expertise, and technology to improve sustainability of the whole circular supply chain and create broader societal benefits. However, stakeholders' perceptions of sustainability issues that underpin their cognitive models might limit the scope of identified opportunities for sustainability benefits if important drivers such as consumer demand are not being considered. This will be particularly important as the project leaders begin to scale up the project to the industrial level.

Findings from this study contribute to the debate about business model innovation for sustainability by furthering understanding of the influences of cognitive models on decision-making about business model innovation for sustainability. Specifically, empirical analysis of stakeholders' cognitive models of a circular supply chain found links between perceived important sustainability issues and developed CBMs. This suggests that cognitive models influence decision-making about what aspects of economic, environmental, and social issues, and what scope will be included in the building blocks of the CBMs. This study builds on the literature that applied cognitive perspective to business model innovation (e.g., Aspara et al., 2013; Saebi et al., 2017; Tikkanen et al., 2005) and sustainable business models (e.g., Rauter et al., 2017; Schaltegger et al., 2012). The key contribution of this study is its focus on exploring the influence of stakeholders' perceptions of sustainability issues on business model innovation for sustainability by analysing multiple levels with mixed methods approach. The analysis of individual cognitive models, group level participant observations and the organisational level showed links between them and the challenges in resolving tensions across levels. Collaboration between stakeholders and sustainability performance of CBMs developed for the Agrimax might be hindered if tensions across levels are not reconciled in a timely manner.

Chapter 5 – Case Study 2: Interface

In this chapter I present and interpret results derived from a case study of company Interface, Inc. (Interface). This case study was driven by three research questions and I will address each of them in turn. I start by examining past and future changes in Interface's business model to improve sustainability performance. I also analyse the main barriers and drivers of business model change for sustainability, addressing Research Question 1. I continue this chapter by exploring individuals' perceptions of important sustainability issues for the company through an interview with participatory cognitive mapping and an online survey, addressing Research Question 2 and 3.

This chapter is structured as follows. Section 5.1 introduces the case company Interface. Section 5.2 gives an overview of the methods used for data collection and data analysis. Section 5.3 analyses and interprets results at the organisational and individual levels. Section 5.4 brings together an overall perspective of the main findings for the case study.

5.1 Background

Interface is a global company that manufactures modular flooring systems for different commercial environments such as corporate, healthcare, retail, hospitality and government. The company is well-known for its achievements in environmental practices and sustainable product design, and has been recognised as one of the global corporate sustainability leaders for over 20 years (GlobeScan, 2018; Interface, 2017b). In 2018, the company employed 4,094 employees globally and achieved 18% growth in net sales compared to 2017

(Interface, 2019). According to the 2018 Annual Report, all the products sold through the Carbon Neutral Floors programme in 2018 were carbon neutral across the entire product lifecycle (Interface, 2019).

The company's manufacturing sites are located in the US, the Netherlands, the UK, Australia, China and Thailand (Interface, 2018e). The company also has over 40 showrooms globally. In this study I focused on the UK division of the company, specifically the area of R&D and product development.

5.2 Methodology

I conducted this case study in three phases, using multiple data sources. An overview of mixed methods used in each phase of data collection and data analysis is shown in Table 5.1.

Table 5.1: Mixed methods multilevel approach in the case of Interface

Phase	Method	Data collection approach	Level of analysis	Analysis technique
1	Document analysis	Qualitative	Organisational	Interviewing of documents
2	Interviews with participatory cognitive mapping	Qualitative, semi-quantitative	Individual, Organisational	Content and structural analysis
3	Online survey	Semi-quantitative	Individual	Content and structural analysis, group categorisation, collective cognitive map

Phase 1 involved document analysis to get background information about the company that helped inform the next phases in the research. Phase 2 involved two interviews with the key informant as well as participatory cognitive mapping. To preserve anonymity key informant's name was replaced with a unique code made up of IF (Interface) and a letter (A). The key informant IF-A is a global manager working in the area of R&D and is educated to the doctorate level. Phase 3 included an online survey that was distributed to team leaders across the company. The online survey was fully completed by eight respondents who came from different functional areas; R&D (3), Operations (3) and Sustainability (1). Six respondents held managerial positions. The average age of respondents was 48 years. Two respondents were educated to bachelor's level, four to master's level and two to the doctorate level. To preserve anonymity respondents' names were replaced with a unique code made up of IN (Interface), CM (cognitive map) and a number (1-8).

Data collection and data analysis methods used in the three phases described above are explained into detail in chapter 3 (see 3.3 Mixed methods). In the next section I focus on analysing and interpreting results at the organisational and individual level.

5.3 Interface's business model and key sustainability issues

This section has two parts. In the first part, I present and interpret results about Interface's business model change for sustainability. In the second part, I present and interpret individuals' cognitive maps of sustainability issues.

5.3.1 Results and analysis at the organisational level

5.3.1.1 *Interface's business model change for sustainability*

Interface's sustainability journey was triggered by a critical incident that occurred in the early 1990s. Customers' questions about company's environmental policies led the company's late chairman and founder, Ray Anderson, to start thinking about environmental issues more deeply (Todd, 2006). A realisation that businesses and industries are the leading cause of environmental degradation inspired him to create a new vision: transforming the petroleum-intensive company into restorative business (Anderson, 2010; Dean, 2007). Consequently, a new mission was defined, *Mission Zero*, to eliminate negative, environmental impacts through sustainable design and manufacture of carpet tiles by 2020 (Anderson, 2009).

Mission Zero has been the main driver of Interface's sustainability initiatives and transformative changes across different business model components since 1994. Table 5.2 shows some of the major sustainability improvements and approaches that Interface adopted to achieve the business model change for sustainability. For instance, product designers started to apply biomimicry principles, mimicking organic design of the natural world, to create more sustainable products. In 2000, a carpet tile *Entropy* was introduced into the market (Biomimicry Institute, no date). A non-directional pattern and modular design applied to *Entropy* enabled Interface to reduce production waste and extend life of a floor covering. *Entropy's* commercial success led to the introduction of an entire product line, *i2™ Next Generation Modular Carpet*, in 2003.

Table 5.2: Sustainability improvements and approaches across business model components in Interface

Business model component	Key areas of sustainability improvements	Approach
Value creation and delivery	New partnerships	Eco dream team: collaboration with authors, activists, scientists, and entrepreneurs to design a sustainability framework for the company; began in 1994 (Interface, 2017e) InterfaceRAISE: Interface's sustainability management consulting practice to share knowledge about business sustainability (Trigflor, 2010) Collaboration with the strategy advisor Lavery/Pennell to codify strategies to improve sustainability performance (Interface, no date-e) Partnering with carpet reclamation companies (Interface, no date-f) Partnering with Manufacture 2030, an online community for cross-industry collaboration on resource efficient manufacturing (Interface, 2018h) Net-works: collaboration with the Zoological Society of London and Aquafil to reimagine the company's supply chain with an inclusive business model (Net-Works, 2017; Ellis, 2017)
	Relationships with stakeholders (sensitising stakeholders)	Creating a culture based on sustainability principles to deliver benefits to a broad range of stakeholders: employees, partners, suppliers, customers, investors and communities (Interface, 2017e). Employees' engagement with sustainability projects: *I am Mission Zero* (Interface, 2012d)

Business model component	Key areas of sustainability improvements	Approach
		Knowledge sharing through tailored workshops for suppliers in collaboration with The University of Cambridge (Cambridge Institute for Sustainability Leadership, 2019). Sharing information with customers through *Interface FYI*; using bite-sized videos to explain concepts related to topics such as recycling and carbon (Interface, no date-b) Brand experience and learning centre for customers and partners*, The Awarehouse*, in Scherpenzeel, the Netherlands (Interface, 2016f)
	Eco design	The Natural Step framework and tools to operationalise sustainability; focusing on the product and process (Harel et al., 2013; Interface, 2017e) Biomimicry: mimicking random design with multicolour palette of the forest floor and geckoes' adhesion to the surface applying physical forces to interact with the surface (Interface, 2016i) Biophilia: introducing biophilic design with natural (e.g., light and natural patterns) into the built environment such as workspace to improve health and well-being by reducing stress level and increasing creativity and cognitive functioning (Interface, 2015b; Interface, 2014c)
	Carbon emissions	Cool Fuel™: offsetting programme for the carbon impact associated with daily travel of the company's associates and the company's fleet (Interface, 2006b) Trees for Travel™: programme that helps offsetting carbon emissions associated with business air travel (Interface, 2013b)

Business model component	Key areas of sustainability improvements	Approach
		Cool CO2mmute™: programme inspired by Interface's employees to offset GHG emissions associated with their daily commutes (Interface, 2013b) Cool Carpet™: a zero carbon footprint products helping customers achieve their sustainability goals (Interface, 2013b)
	Renewable energy	In 2017, the global renewable energy use reached 88% (Interface, 2017f). Interface Americas manufacturing sites have achieved 96% renewable energy target in 2016; the same year the global renewable energy use reached 84% (Interface, 2016h). In 2015, Interface joined the climate group of world's most influential companies *RE100* and pledged to 100% renewable electricity at manufacturing sites globally (Interface, 2017f). European manufacturing facility in Scherpenzeel, The Netherlands, has been operating with 100% renewable energy (electricity and gas) since January 2014 (Interface, 2014b).
	Resource efficiency (closing the loop)	ReEntry take-back programme enables closing the loop on fibre and backing; separation of fabric from backing for recycling; materials that cannot be recycled through ReEntry are reused to avoid landfill (Interface, 2018g; Interface, 2018d; Interface, no date-f) Cool Blue™ is a technology for recycling the vinyl backing, enabling increased use of recycled content in the products (Interface, 2013d)

Business model component	Key areas of sustainability improvements	Approach
		Energy efficiency improvements in manufacturing sites: installation of energy monitoring system, efficient lighting system, skylights and solar tubes (Interface, 2017f) In 2017, 91% decrease in total waste to landfills has been achieved across manufacturing sites since 1996 as well as 88% decrease in total water intake intensity (Interface, 2017f). In 2017, 58% of products' content was recycled or bio-based (Interface, 2017f). Microtuft construction process: enabling the manufacture of light-weight carpet tiles (Nicholls, 2015; Waste and Resources Action Programme, no date-a)
	Greening supply chain	Sustainable Carpet Assessment Standard: a certification system based on the life-cycle assessment (LCA) for sustainability progress of the entire supply chain (Fried, 2009; National Sanitation Foundation, 2019)
	Measuring sustainability progress and increased transparency	EcoMetrics™ and SocioMetrics™ (Interface, 2017e) Sustainability reports – the first sustainability report published in 1997 (Interface, 1997; Interface, 2001; Interface, 2002; Interface, 2003; Interface, 2004; Interface, 2005; Interface, 2006a; Interface, 2007; Interface, 2008; Interface, 2009; Interface, 2010; Interface, 2011; Interface, 2012a; Interface, 2013a; Interface, 2014a; Interface, 2015a; Interface, 2016e; Interface, 2017a; Interface, 2018b) Environmental product declarations (EPDs) (Interface, 2016a; Interface, 2016b; Interface, 2016c; Interface, 2016d; Interface, 2016)

Business model component	Key areas of sustainability improvements	Approach
		Leadership in Energy and Environmental Design rating system to certify environmental performance of buildings (Interface, 2018a) Certified by Building Research Establishment Environmental Assessment Method (Interface, no date-a) GreenCircle Certified Environmental Facts (Interface, 2018c)
Value proposition	Sustainable products with recycled and bio-based content	Entropy™, i2™ products (Biomimicry Institute, no date) TacTiles® glue-free installation system reducing volatile organic compound (VOCs) (Interface, 2015c; Interface, 2017j; Interface, 2017k) Biosfera (made from 100% recycled yarn; 50% less yarn than the average carpet tile) (Interface, 2012c) Fotosfera (63% of the material used is bio-based nylon yarn) (Interface, 2012b) Recycled polyvinyl butyral(PVB) reduces the precoat's carbon footprint by 80%; the first product range that incorporated recycled PVB was The Scandinavian Collection (Interface, no date-d; Interface, 2015d) Net-effect collection made with 100% recycled yarn (recycled yarn through Net-Works initiative and reclaimed carpet fluff through ReEntry programme) (Chin, 2013; Interface, 2013c) Proof positive prototype (carbon negative) (Interface, 2017d; Interface, 2017i; Interface, 2017g; Mace, 2017; Sustainable Brands, 2017)
Value capture	New revenue streams	Entering new markets: moving from the corporate office interior market to residential/consumer, government, healthcare, hospitality, education, retail

Business model component	Key areas of sustainability improvements	Approach
		space, and tenant improvement markets (Interface, 1997; Interface, 2001; Interface, 2002; Interface, 2003; Interface, 2004; Interface, 2005; Interface, 2006a; Interface, 2007; Interface, 2008; Interface, 2009; Interface, 2010; Interface, 2011; Interface, 2012a; Interface, 2013a; Interface, 2014a; Interface, 2015a; Interface, 2016e; Interface, 2017a; Interface, 2018b; Interface, 2019) In 2010, microtuft products accounted for 11.5% of sales in Europe Middle East, Africa and India (Waste and Resources Action Programme, no date-a) In 2017, introduction of luxury vinyl tiles (LVT) across Americas, Europe and Asia-Pacific (Interface, 2017c) In 2018, the company acquired nora Holding GmbH; resilient rubber flooring products accounted for approximately 10% of Interface's sales (Interface, 2019). In 2018, the mix of corporate office and non-corporate office modular carpet and LVT sales was 60% and 40%, respectively (Interface, 2019).

As Interface was approaching its net-emission goal, senior managers, the current CEO and chief sustainability officer, started to think about the next stage to move beyond *Mission Zero* (Interface, 2017h). Furthermore, a growing concern of climate change and its detrimental effects on the environment inspired Interface's new mission. In 2016, the company announced its new mission, *Climate Take Back*, with the goal of creating a positive impact on the environment (Makower, 2016). *Climate Take Back* focuses on sustainability actions in four key areas: 1. not emitting more carbon into the atmosphere; 2. using carbon to make raw materials for products; 3. supporting biosphere's ability to control the climate; and 4. leading industrial re-revolution by sharing knowledge, information and innovation to transform the way businesses operate (Interface, 2017h; Interface, 2016g). The ultimate goal of *Climate Take Back* is to reverse the impact of global warming.

One of the main ideas behind *Climate Take Back* is to love carbon. According to the key informant IF-A, the loving carbon concept refers to extracting carbon from the atmosphere, with carbon capture and utilisation technology, to make raw, carbon-sequestered materials for flooring systems. To achieve the reduction of CO_2 in the atmosphere, Interface's chemistry and technical teams first needed to understand the problem of climate change and how *Climate Take Back* translates to products (Key informant IF-A). The teams' efforts resulted in a prototype, a carbon-capturing tile, which was proof positive of an alternative, green flooring system (Interface, 2017d 563). The company hopes to inspire its clients and competitors to follow the suit; as key informant IF-A commented, "if everybody makes carbon-negative materials we would be actively reversing climate change: given that materials are recycled or taken care of in the right way at the end of life".

5.3.1.2 *Barriers of Interface's business model change for sustainability*

According to the Interface's 2018 annual report, the competitive environment represents one of the main challenges for the company's business model in the future (Interface, 2019). For instance, competitors with greater financial resources have been expanding their manufacturing capacities globally, which could affect supply in the floor coverings market and pricing, consequently affecting Interface's profitability. Furthermore, economic cycles in the renovation and construction of commercial and institutional buildings have been affecting and are expected to continue affecting sales of the Interface's key products.

Another challenge is associated with raw materials. While Interface has been increasing the amount of recycled and bio-based content in its products (Interface, 2018f; Waste and Resources Action Programme [WRAP], no date-b) , the company still relies on petroleum-based raw materials. Therefore, large increases in the cost of petroleum-based raw materials would have negative effects on the company's profitability, if cost increases were not transferred to consumers. Similarly, any interruptions of arrangements with suppliers of synthetic fibre would have negative effects on the company's profitability.

Finally, the latest acquisition of Nora systems represents a strategic challenge for Interface. While the acquisition provides new opportunities for the expansion of Interface's product portfolio, the success of merging businesses will depend on the realisation of identified synergies between the companies. It could be said that senior management executives' efforts and abilities will play the crucial role in achieving synergistic goals and future success. Furthermore, the management executive team needs to consider the possibility of Nora systems achieving lower contributions to the revenue and profitability as expected.

5.3.1.3 *Drivers of Interface's business model change for sustainability*

The analysis showed that *Mission Zero* and *Climate Take Back*, are the main driving forces for actions on sustainability. It could be said that success of future sustainability changes depends on the quality of senior management team and its strategic decision-making and action-taking. As key informant IF-A commented, the CEO has a clear way of communicating the key areas of development for the company to achieve economic and environmental benefits simultaneously. The CEO himself made a comment in the video on measuring Interface's progress of *Mission Zero*: "We at Interface believe in the power of *and*. Profits *and* purpose. We don't see those as trade-offs. We see them as symbiotic relationships and how we grow our business" (Interface, 2017h, 2:19-2:31).

Greening products by sustainable design continues to be the focus of Interface's business; therefore, innovation and technology teams' work on projects to realise ambitious goals defined by *Climate Take Back*. It could be argued that staff's ability and efforts to translate the mission's goals into innovative, greener products plays an important role in achieving improved sustainability. Previous research has showed that developed innovation capabilities were one of the main contextual factors at the organisational level that affected the success of Interface's innovative recycling programme Net-

Works (Luqmani et al., 2017). As explained earlier, staff's ability to translate the underpinning philosophy of the *Climate Take Back* has already been proven by the development of the carbon-negative carpet tile prototype.

According to the key informant IF-A, Interface's success depends heavily on collaboration with suppliers. Interface assembles carpet flooring; however, the company does not manufacture any materials and therefore needs to green its supply chain to improve sustainability performance as illustrated by the quote below:

> You internally identify which materials could be and should be changed or replaced or eliminated and then you come up with options, try to fix it yourself, but in the essence… in the end you will always have to go to a new supplier or an existing one and push them. Push them, this is the mantra… we have to give credit to our suppliers who have come the long way and understood what sustainability is. [Key informant IF-A, interview, 2017, 22 June]

Interface has challenged its suppliers to search for more sustainable solutions; all suppliers that collaborate with Interface are encouraged to perform LCA (Interface, no date-c). Key informant IF-A noted that strong bonds and belief in a similar future are at the core of Interface's collaborative relationships with suppliers. While there are other companies that practice collaborative innovation with suppliers such as IBM, they have not managed to integrate collaborative innovation as rigorously as Interface has (The Initiative for Global Environmental Leadership and Knowledge@ Wharton, 2012).

5.3.1.4 *Organisational level summary findings*

Analysis showed that Interface has adopted a broad range of transformative approaches across all business model components to improve its overall sustainability performance (see Table 5.2). Interface's senior management team designed a proactive strategy that led to a full integration of environmental and social objectives into the company's core business, consequently leading to a business model redesign with a new value proposition (Schaltegger et al., 2012). To track sustainability progress, the company uses its metrics (EcoMetrics™ and SocioMetrics™). Furthermore, Interface strives to be completely transparent about materials used in its products by providing EPDs. Additionally, continuous innovation and sustainable design increase the amount of recycled and bio-based content in products. The company is purpose-driven and engages with suppliers, employees and other stakeholders to further improve its overall sustainability performance.

So far, this chapter has focused on the organisational level. The next section will present and interpret results at the individual level, i.e. sustainability issues influencing decision-making. It will also discuss differences between individuals' cognitive maps of important sustainability issues.

5.3.2 Results and analysis at the individual level

In this section I analyse and interpret the complexity of sustainability issues that influence key informant IF-A's decision-making related to improving company's sustainable business model and its overall sustainability performance. Results were obtained through the interview using participatory cognitive mapping which is described into details in chapter 3 (see subsection 3.3.3). Results were used to address the second research question: *What sustainability issues influence decision-making for business model change to improve sustainability performance?*

Furthermore, I present and interpret content and structural differences across cognitive maps of sustainability issues derived from the online survey. I also analyse shared perceptions of important sustainability issues through a collective cognitive map. Results were used to address the third research question: *How do cognitive models of sustainability issues differ in the context of sustainable business models?*

5.3.2.1 *Content of the cognitive maps*

Participatory cognitive mapping

Key informant IF-A identified 18 sustainability issues that drive his decision-making and explained reasons for his choices (see Table 5.3). Environmental issues were the most salient in his cognitive map which reflect his main job responsibility of reducing environmental impact of the flooring products. On the other hand, economic issues were excluded from the cognitive map. While supply chain costs were considered important for reducing carbon footprint of products, the key informant noted that “that’s a step forward” in decision-making. In relation to social issues, well-being was considered important, specifically when related to the use of chemicals in the flooring products.

Table 5.3: Important sustainability issues driving key informant IF-A's decision-making

Key informant IF-A	
Sustainability issue	*Reasons for selection*
Mission Zero	Mission Zero has been the main driver of sustainability, achieving zero emissions by 2020. While Mission Zero still drives the company's sustainability efforts, a new mission, Climate take Back, has already been put into place. As key informant explained, this is the next step for the company "not doing harm is not enough anymore, we need to do good and this mantra is what drives the decision-makers and technical teams".
Lower impact materials compared to currently used ones	The goal is to continue increasing the content of low impact materials in the flooring products.
Carbon neutral/negative materials	"A carbon footprint-wise you want something that is lower carbon footprint or carbon neutral, carbon-negative".
Recycle	Some compounds of materials need and can be replaced with recycled or bio-based materials. To make sustainable materials related decisions, managers quantify the percentage of sustainability improvement per project and its regional and global effect.
Reuse	Reuse connects to reverse logistics.
Discard	Ideally, less than 20% of materials are discarded; percentage varies across regions.

Key informant IF-A	
Sustainability issue	*Reasons for selection*
Well-being	Actively working on reducing the amount of potentially concerning chemistries, but also adding well-being enhancing chemistries. For instance, functional materials that make the working/living environment more comfortable, rooms brighter and air cleaner.
Red lists	Consumers' forbidden chemistries.
Governmental lists of chemistry likely to become more regulated	To be considered for product improvements and new product developments.
Bio materials	The global goal is to replace virgin petrochemicals with 100% recycled or bio-based materials.
Post-consumer and post-industrial non-carpet derived material	From the feedstock perspective, the waste recycled material does not have to be carpets; post-consumer or post-industrial material is used as input for Interface's products.
LCA	Interface "lives and breathes" by LCA. It is the main tool that provides information about sustainability progress.
Recycled and bio-content	From a sustainability perspective, bio-content does not necessarily have a lower carbon footprint compared to virgin petrochemicals; however, oftentimes that is the case.

Key informant IF-A	
Sustainability issue	*Reasons for selection*
Carbon footprint	At the beginning, the carbon footprint of Interface's products was over 20 kg of CO_2 emissions per m^2 of product. The best product to date, emits 3.5kg CO_2/m^2 of a carpet. The new prototype project is carbon negative, -2kg of CO2/m2 of a carpet. The company uses LCA analysis to calculate the carbon footprint of its products.
Materials/chemistries of concern	These are the materials and chemistries that Interface does not want to use in the manufacturing process.
Recycle and reuse (ReEntry)	A take-back programme, ReEntry, is a prerequisite for recycling.
Sorting	Rigorous selection process by reverse logistics provides sourcing of good quality materials. Materials' quality is important because it influences the outcome of the sorting process, i.e. the amount of materials for reuse, recycle and discard.
Reverse logistics	To ensure ReEntry programme, a logistics challenge needs to be overcome.

Sustainability issues identified by the key informant IF-A were the basis for the online survey to explore individual cognitive maps across the company. The final list of sustainability issues was generated based on the consultation with the key informant (some issues were merged, added or deleted) and document analysis.

5.3.2.2 *Structure of the cognitive maps*

Participatory cognitive mapping

Results showed that the key informant IF-A identified 19 one-way, positive relationships between 18 sustainability issues (see Figure 5.1). Most of sustainability issues in the map were receiver issues, meaning that they are influenced by other issues, while they themselves do not influence any issues. *Mission Zero* was the driver sustainability issue that influenced *LCA*. It could be said that strong environmental mission, set in the 1990s, influenced a comprehensive analysis of the products' environmental impact to achieve the zero emissions goal by 2020. *LCA* was described as the main tool that the company uses to measure its sustainability progress and was linked to four other sustainability issues. The key informant identified that a more comprehensive *LCA* contributes to an increase in *Recycled and bio content* in the flooring products and *Recycle and reuse (ReEntry)* of waste materials. *LCA* was also perceived as the most central sustainability issue in the map, meaning that this is the area of great concern to the key informant.

It seems that some linkages between *LCA* and other issues were inaccurate. For instance, I would expect to see a negative relationship between *LCA* and *Carbon footprint*. The comprehensive *LCA* should ideally lead to a decrease in

Carbon footprint; however, the key informant identified a positive relationship, meaning that he expected the opposite to occur, i.e., an LCA would increase the carbon footprint. Similarly, the relationship between *LCA* and *Materials/chemistry of concern* was perceived as positive. There are different reasons why inaccuracies may have occurred. For instance, the mapping process may have been perceived as confusing, which led to misinterpretation of linkages, even though I provided example with instructions prior to the interview and guidance during the interview. Daily tasks and priorities could have influenced key informant's attention during the mapping process, consequently, affecting the accuracy of the cognitive map. The cognitive map was validated with the key informant after the interview; however, he made no changes to the map, thus suggesting this accurately represented his perceptions.

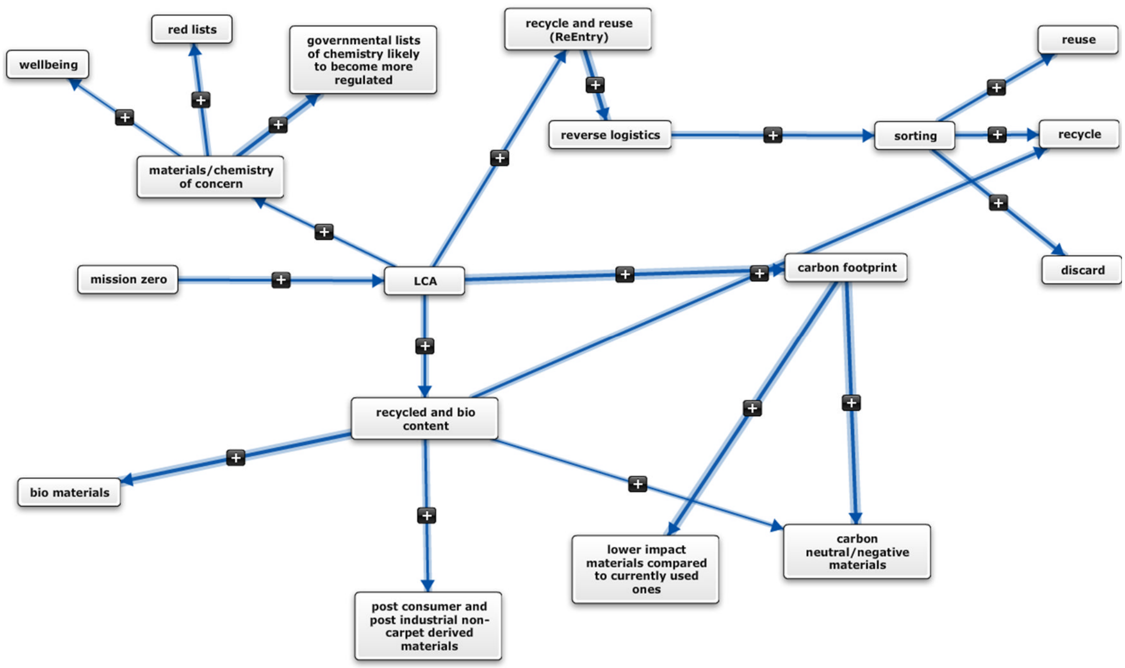

Figure 5.1: Key informant IF-A's cognitive map

Online survey

In relation to online survey respondents' cognitive maps, a group categorisation showed differences across cognitive maps in perceptions of relationships between specific sustainability issues. For instance, relationships between *Product quality and performance* and *Recycle and reuse (ReEntry programme)* (see Table 5.4). To preserve anonymity key respondents' names were replaced with a unique code made up of IF (Interface), CM (cognitive map) and a number (1-8). The respondent IFCM7 identified a very strong positive two-way relationship between *Product quality and performance* and *Recycle and reuse (ReEntry programme)*, while respondent IFCM5 identified no relationship between issues. Similar to respondent IFCM7, respondent IFCM3 also identified a two-way relationship between the issues; however, the strength of relationship and the type of influence were different.

Table 5.4: Relationships between *Product quality and performance* and *Recycle and reuse (ReEntry)*

Cognitive map	No relationship	Product quality and performance → Recycle and reuse (ReEntry)	Recycle and reuse (ReEntry)→ Product quality and performance
IFCM3		-1	+2
IFCM5	0		
IFCM7		+3	+3

Similarly, differences were found in respondents' perceptions of relationships between *Health and well-being* and *Recycle and reuse (ReEntry programme)*.

Respondents IFCM2 and IFCM5 considered that no relationship exists between the issues, while IFCM7 and IFCM8 perceived two-way relationships between the issues (see Table 5.5).

Table 5.5: Relationships between *Recycle and reuse (ReEntry)* and *Health and well-being*

Cognitive map	No relationship	Recycle and reuse (ReEntry)→ Health and well-being	Health and well-being→ Recycle and reuse (ReEntry)
IFCM2	0		
IFCM5	0		
IFCM7		+3	+3
IFCM8		+1	+2

It could be said that the existing differences across the online survey respondents' cognitive maps in perceptions of relationships between specific sustainability issues described above indicate a potential for paradoxical tensions between staff. Furthermore, the paradoxical tensions could hinder decision-making and action-taking in relation to sustainability at the individual and group level, consequently influencing changes in existing business model at the organisational level. While strategic decision-making regarding sustainability is part of top management team, achievement of significant sustainability improvements requires commitment to sustainability at all management levels and employees (Morioka et al., 2017). Therefore, it is important to resolve any paradoxical tensions to enable good understanding of sustainability issues, which might consequently lead to adoption of new, transformative approaches for sustainability.

This section analysed linkages between sustainability issues in the cognitive maps at the individual level. In the next section I focus on analysing the centrality of sustainability issues in the cognitive maps.

5.3.2.3 *Centrality of sustainability issues in the cognitive maps*

Participatory cognitive mapping

A centrality score of individual sustainability issues represents a degree of relative importance of each sustainability issue in the cognitive map (Gray et al., 2014; Özesmi and Özesmi, 2004). Comparing central sustainability issues in cognitive maps helps to ascertain what areas are of concern to individual interviewee (Eden and Ackermann, 1998). Table 5.6 shows the centrality score of sustainability issues included in the key informant's cognitive map. *LCA* achieved the highest centrality score which suggests that this is the area of great concern to the key informant. On the other hand, *Well-being* achieved the lowest centrality score which could imply that interventions are needed in this area. As key informant explained, use of chemicals in the flooring products links to well-being, therefore, further approaches to reduce or eliminate the use of harmful chemicals would be required.

Table 5.6: Interface key informant (IF-A) centrality scores

Sustainability issue	Centrality score
LCA	3.7
Recycled and bio content	3.4

Sustainability issue	Centrality score
Sorting	3.07
Carbon footprint	2.91
Materials/chemistries of concern	2.34
Recycle	1.64
Recycle and reuse (ReEntry)	1.6
Reverse logistics	1.54
Carbon neutral/negative materials	1.2
Governmental lists of chemistry likely to become more regulated	1
Lower impact materials compared to currently used ones	1
Bio materials	0.91
Discard	0.78
Reuse	0.78
Mission Zero	0.69
Red lists	0.63
Post-consumer and post-industrial non-carpet derived material	0.6
Well-being	0.23

Online survey

A collective cognitive map was created based on eight individual cognitive maps to represent the shared perceptions of sustainability issues. The collective cognitive map revealed that *Health and well-being* (social issue) was the most central sustainability issue followed by *Recycle and reuse (ReEntry programme)* (environmental issue) and *Product quality and performance* (economic issue).

Health and well-being was the busiest issue in the map with 14 outward and inward links respectively. It could be said that ensuring health and well-being is one of the core values for Interface. Table 5.7 shows the centrality scores of sustainability issues in the collective cognitive map.

Table 5.7: Interface centrality scores

Sustainability issue	Centrality score
Health and well-being	3.16
Recycle and reuse (ReEntry programme)	3.06
Product quality and performance	2.23
Employees' engagement in sustainability projects	1.96
Use of recycled and bio-based materials	1.59
Renewable energy	1.48
Profitability	1.47
Employees' satisfaction	1.42
Product innovation and design	1.38
Quality of management team	1.3
Greening/ redesigning supply chain	1.17
Established brands	1.16
GHG emissions	1.01
Safe working environment	0.95
Costs	0.9
Ethical behaviour	0.82
Mission (Mission Zero, Climate Take Back)	0.8

A particularly interesting finding was that company's mission achieved the lowest centrality score. This was surprising because of mission's criticality at the organisational level, however, collectively participants considered other issues more important. Interestingly, *Product quality and performance* achieved higher centrality score than *Profitability*. Profit is traditionally considered as the most important economic issue for business, yet this seems not to be the case for Interface. Furthermore, respondents considered specific social and environmental issues to be more central in relation to the company's sustainability than profit.

This section has analysed centrality of sustainability issues in the cognitive maps. Before I move on to discussing the main findings in this case study, let me briefly summarise the main findings at the individual level of analysis.

5.3.2.4 *Individual level summary of findings*

Results showed that the key informant IF-A perceived *LCA* as the most central issue in his cognitive map that is driven by *Mission Zero*. In contrast, *Health and well-being* achieved the highest centrality score in the collective cognitive map, while *Mission (Mission Zero, Climate Take Back)* achieved the lowest centrality score.

5.4 Discussion

The purpose of this chapter was threefold: (1) to understand internal and external factors that influence Interface's business model change for sustainability; (2) to understand individuals' cognitive models of sustainability issues that influence decision-making for business model change for sustainability; and (3) to understand shared perceptions about sustainability issues across Interface. The case study was addressing three research questions that form the basis for this discussion.

Research Question 1: What internal and external factors influence business model change for sustainability?

Results suggest that different internal and external factors play an important role in Interface's business model change for sustainability. An important internal driver is the senior management team's commitment and passion to explore and adopt new approaches to sustainability. Interface's sustainability journey started with its late founder, Ray Anderson, whose vision led the company through transformative process. According to Willard's (2002) five-stage sustainability continuum, Interface has reached the fifth stage; sustainability is driven by purpose and passion. Interface's management team launched a new mission, Climate Take Back, with an ambitious goal of reversing the impact of global warming by adopting carbon capture and storage principles to make carbon-negative products. Furthermore, the company aims to share their knowledge to promote sustainability across industries.

Interface has adopted a broad range of transformative approaches across all business model components to improve its overall sustainability performance (see Table 5.2). It could be said that Interface's senior management team designed a proactive strategy that led to a full integration of environmental and social objectives into the company's core business, consequently leading to a business model redesign with a new value proposition (Schaltegger et al., 2012).

To track sustainability progress, the company uses its metrics (EcoMetrics™ and SocioMetrics™). Furthermore, Interface strives to be transparent about materials used in its products by providing EPDs. Additionally, continuous innovation and sustainable design increase the amount of recycled and bio-based content in products. The company is purpose-driven and engages with suppliers, employees and other stakeholders to further improve its overall sustainability performance. The results of this study are in line with the findings from Stubbs and Cocklin (2008) and Luqmani et al. (2017) who found that internal organisational, structural and cultural capabilities influence sustainability performance at the organisation-level. However, the results of the present study also point out the importance of the technical and chemistry teams' ability to translate the new mission, Climate Take Back, into innovative products. For instance, the teams' efforts resulted in a prototype, a carbon-capturing tile, which was proof positive of an alternative, green flooring system (Interface, 2017i; Interface, 2017g).

The analysis shows that Interface's business model change for sustainability was influenced by a combination of external and internal factors. These findings are in line with previous research on the influence of external and internal, organisation-level factors and individual-level factors on business model change (Carayannis et al., 2015; Morioka et al., 2017; Roome and Louche, 2015; Sorescu et al., 2011). However, less is known about the internal, micro-level factors such as managerial cognition in relation to changes in business models (Foss and Saebi, 2017). Furthermore, there is a lack of empirical research in the area of cognitive models that play an important role in decision-making and action-taking related to business model change for sustainability. In order to contribute to this area of knowledge I explored the cognitive models of sustainability issues in Interface. Results obtained through the interviews with participatory cognitive mapping and the online survey were used to address the second and third research question:

Research Question 2: What sustainability issues influence decision-making for business model change to improve sustainability performance?

Research Question 3: How do cognitive models of sustainability issues differ in the context of sustainable business models?

This case study found evidence that predominantly environmental issues influence key informant IF-A's decision-making. Specifically, *LCA* was found to be the most central issue indicating that this is the area of great concern to the key informant. Environmental issues related to the use of materials and carbon footprint are at the forefront of the company's sustainability agenda, therefore, the high importance of environmental issues to the key informant was not surprising. Findings from this study are in line with previous research on drivers of business model change for sustainability that highlighted the importance of environmental and social issues (Bocken et al., 2014; Lüdeke-Freund et al., 2018; Schaltegger et al., 2012; Stubbs, 2017). Furthermore, the collective cognitive map also showed that social and environmental issues are considered more important than economic issues; *Health and well-being* was considered as the most central sustainability issue for the company.

My findings show that key informant IF-A's cognitive map falls between the spectrum of the two contrasting types of cognitive frames proposed by Hahn et al. (2014), i.e. the business case frame and the paradoxical frame. Furthermore, there are signs of inaccurate linkages between some sustainability issues. For instance, a positive relationship between *LCA* and *Carbon footprint*, meaning that the key informant IF-A expected LCA to increase the carbon footprint. Accuracy of cognitive maps was found to play an important role in the understanding of a domain (Gary et al., 2012). Therefore, inaccuracies found in the key informant's cognitive map in relation to linkages between *LCA* and *Carbon footprint*, and *LCA* and *Materials/chemistry of concern* could negatively influence his decision-making for sustainability.

My findings on cognitive models hint that there are also paradoxical tensions in perceptions of linkages between specific sustainability issues at the individual level across the company. For instance, group categorisation revealed differences in linkages between *Product quality and performance* and *Recycle and reuse (ReEntry programme)*; differences were found in directionality, the type of relationships and strength of relationships between those sustainability issues (see Table 5.4). Furthermore, differences were also identified in perceptions of linkages between *Health and well-being* and *Recycle and reuse (ReEntry programme)*. While two cognitive maps contained no relationships between the issues, two other cognitive maps contained two-way relationships with different strengths (see Table 5.5). It could be said that the existing differences across the online survey respondents' cognitive maps indicate a potential for paradoxical tensions at two levels: within one person and between staff. It is likely that paradoxical tensions could hinder decision-making and action-taking for sustainability at the individual level, consequently influencing changes in existing business model at the organisational level. My findings imply that there is a potential to improve understanding of ReEntry recycling and reuse programme and its links to other sustainability issues to moderate paradoxical tensions at individual level. I argue in line with Vilanova et al. (2009) that identifying existing paradoxes can benefit managers in interpreting sustainability issues and relationships between them to improve decision-making and action-taking for business model change.

The analysis at the individual and organisational level revealed that there is a mismatch between perceptions of sustainability mission. While *Mission Zero* and *Climate Take Back* are considered as two main drivers of sustainability at the organisational level, they achieved the lowest centrality score in the collective cognitive map (see Table 5.7). This is a surprising finding because at the organisational level *Mission Zero* has influenced the main sustainability initiatives and actions undertaken since early 1990s to achieve business model change for sustainability. Furthermore, *Climate Take Back* is the next step that goes beyond *Mission Zero's* goals to reverse the impact of global warming. A possible explanation for this result is that the new mission has not yet been fully embraced and understood at the individual level. As the key informant IF-A commented, the technical and chemistry teams needed to understand the global change first to be able to translate the new mission into products. It could be said that individuals are still in the process of learning and translating the abstract concept of mission *Climate Take Back*; they need to understand how the new mission relates to their role and how can they realise the mission's goals. Another possible explanation is that there is a paradoxical tension between the old and the new mission, at the individual level. Research on paradoxical tensions and organisational change has highlighted leaders' role in supporting individuals' sense-making in organisational change (Lüscher and Lewis, 2008; Maitlis and Sonenshein, 2010; Smith and Lewis, 2011). Even though the key informant commented that the current CEO has a good way of communicating the new vision and mission, it seems that more could be done to help individuals moderate this tension to ensure successful business model change for sustainability.

In this case study I have investigated factors that influence business model change for sustainability and perceptions of key sustainability issues driving decision-making to achieve that change. Furthermore, I explored cognitive models of sustainability issues and how they differ across individuals in the company. My study has led me to the conclusion that there is a broad range of internal and external factors that enable business model change for sustainability. Furthermore, Interface is in the change process that is led by the new mission *Climate Take Back*. This change process builds on the preceded achievements of *Mission Zero*, going beyond eco-efficiency to reverse the impact of global warming. As my study suggests, there are some paradoxical tensions in perceptions of linkages between sustainability issues at the individual level. Furthermore, some of those paradoxical tensions appear to exist between the individual and organisational level.

Chapter 6 – Case Study 3: Techbuyer

In this chapter I present and interpret results derived from a case study of Techbuyer. This study was driven by three research questions and I will address each of them in turn, providing the line of evidence used to address them. I start by examining the past and future sustainability changes in Techbuyer's business model as well as the barriers and drivers for business model change, addressing Research Question 1. Results were obtained through document analysis, site visits and interviews with participatory cognitive mapping (see chapter 3, subsection 3.3).

I continue this chapter by exploring individuals' perceptions of important sustainability issues for the company. First, three key informants were interviewed with participatory cognitive mapping to explore what sustainability issues influence their decision-making at the individual level. Second, an online survey was distributed to examine how cognitive models of sustainability issues differ among individuals across the company. The survey was also used to examine the current shared perceptions of important sustainability issues that might help to inform the company's decision-makers about designing future sustainability strategies. Results were used to address the Research Question 2 and 3.

This chapter is structured as follows. Section 6.1 introduces the case company Techbuyer. Section 6.2 gives an overview of the methods used for data collection and data analysis. Section 6.3 and its subsections present results at the organisational level, Techbuyer's business model change, and results at the individual level in relation to key sustainability issues. Section 6.4 brings together an overall perspective of the main findings for the case study at the organisational and individual level.

6.1 Background

Techbuyer is a business-to-business (B2B), medium-sized company that specialises in buying, refurbishing and selling of data centre equipment such as servers, storage systems, and memory and networking systems to the global market. For the sake of simplicity, all types of equipment will be referred to as IT equipment. The company's turnover for the 2017-2018 financial period was £30,322,502 which represented a 35% increase compared to a previous financial period (Techbuyer Limited, 2017; Techbuyer Limited, 2018a). In 2017, the number of staff increased from 52 to 102 (Wynne, 2018b). In the same year, the company increased the stock of a global inventory from 150,000 to 225,000 IT components, i.e. physical parts of a computer system such as hard disk drive (Wynne, 2018b; Techbuyer Limited, no date-b). As an example of a growing business, the company joined the Great British Business campaign that promotes and showcases the growing SMEs across the UK (The Telegraph, 2017).

Techbuyer's main office is located in Harrogate, UK. The company also has global offices in the US (2), Germany (1), France (1), Australia (1) and New Zealand (1) (Techbuyer, 2018). This study was focused on the British operations.

6.2 Methodology

I conducted this case study in three phases, using multiple data sources. Table 6.1 gives an overview of the mixed methods used in each phase of data collection and data analysis.

Table 6.1: Mixed methods multilevel approach used in the case of Techbuyer

Phase	Method	Data collection approach	Level of analysis	Analysis technique
1	Document analysis	Qualitative	Organisational	Interviewing of documents
2	Site visit	Qualitative	Organisational	Description as analysis
2	Interviews with participatory cognitive mapping	Qualitative, semi-quantitative	Individual, Organisational	Content and structural analysis
3	Online survey	Semi-quantitative	Individual	Content and structural analysis, group categorisation, collective cognitive map

Phase 1 involved document analysis to get background information about Techbuyer that helped inform the next phases in the research. Phase 2 involved site visits and interviews with participatory cognitive mapping. I visited Techbuyer on two occasions. To preserve anonymity key informants' name was replaced with a unique code made up of TB (Techbuyer) and a letter (A-C). During the first visit, I met three key informants (TB-A, TB-B and TB-C) who came from different functional areas in the company: management, sales and communications. The average age of key informants was 42 years, two of them were educated to high school level or equivalent and one was educated to bachelor's level.

Key informant TB-C showed me the warehouse where I observed some of the main activities, i.e. physical inspection of the used IT equipment and data erasure. I was also able to see first-hand what the sustainability issues are that the organisation is faced with, for example, the use of plastic packaging and bubble wrap. Key informant TB-B explained the refurbishing process to me, specifically how Configure-to-Order service works. After that, I interviewed key informant TB-A about the past and future business model changes as well as about the important sustainability issues driving his decision-making. During the second visit, I conducted two additional interviews using the participatory cognitive mapping technique with key informants TB-B and TB-C. Analysis techniques employed in Phase 2 are outlined in Table 6.1., analysis procedures are explained into detail in chapter 3 (see subsections 3.3.2 and 3.3.3). Brief reports were prepared and sent to key informants for validation.

Phase 3 included an online survey that was distributed across the company, i.e. team leaders and their team members. Online survey was completed by 24 respondents who came from different functional areas: Sales/Marketing (14 respondents), IT (4), Administration (1), Finance/Accounting (1), Operations (1), Product pricing and return merchandise authorisation (1), and Purchasing (2). The majority of respondents, 54.2% held managerial positions. The average age of respondents was 28 years and 54% were educated to high school level or equivalent, 42% were educated to bachelor's level and 4% to the master's level. To preserve anonymity respondents' names were replaced with a unique code made up of TB (Techbuyer), CM (cognitive map) and a number (1-24).

Each individual cognitive map derived from the online survey was visualised and analysed using structural metrics provided by Mental Modeler software. Then, I focused on the cognitive maps that contained the most important sustainability issues from each category (economic, environmental and social). For instance, *Staff expertise* was perceived as the most important social issue by 16 out of 24 respondents and included in their cognitive maps. Then, I looked at how *Staff expertise* related to other sustainability issues in each of those 16 cognitive maps. Groups of cognitive maps that contained the same combinations of sustainability issues emerged. I decided to further analyse groups that had a minimum of three cognitive maps with the same combinations of sustainability issues. Group categorisation focused on analysing differences and similarities in relationships between *Staff expertise* and other sustainability issues. I specifically looked at directionality (one and two-way), type of relationship (positive or negative), and the strength of relationships (weak, moderate or strong).

Finally, a collective cognitive map was created by aggregating the individual cognitive maps to represent a shared view of important sustainability issues for the company and to reveal the embedded company's value system.

6.3 Techbuyer's business model and key sustainability issues

6.3.1 Results and analysis at the organisational level

Results and analysis at the organisational level were obtained through mixed methods outlined in section 6.2 and described into detail in chapter 3 (see Mixed methods 3.3). Results were used to address the first research question: *What internal and external factors influence business model change for sustainability?*

6.3.1.1 *Techbuyer's business model change for sustainability*

The analysis showed that there have been two critical incidents since the inception of the company in 2005 that led to a business model change. The two critical incidents were the economic crisis of 2007-2008 and the recent realisation of the company's alignment with the circular economy. Figure 6.1 shows the timeline of critical incidents and related business model changes.

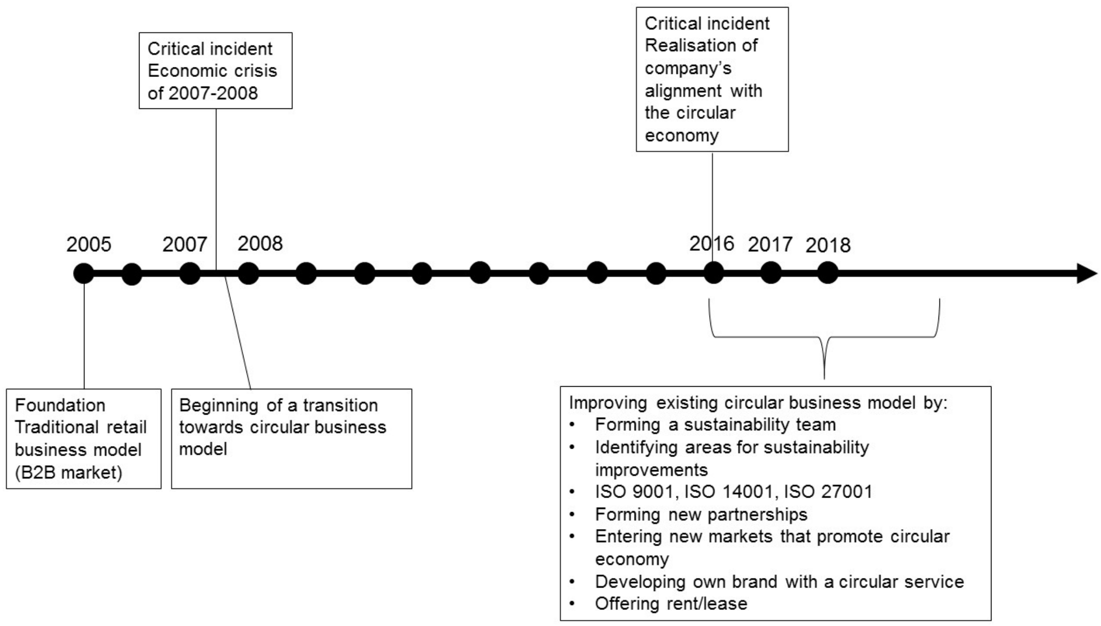

Figure 6.1: Techbuyer's timeline of critical incidents and business model change for sustainability

The company first adopted a traditional retail business model for B2B market as commented by key informant TB-A, "when we first started out was to sell new equipment to corporate businesses (…) and as a little side line of what we did, we used to buy back old equipment". Then, the economic crisis of 2007-2008 influenced transition from the traditional retail business model to a circular business model. The economic crisis negatively affected productivity within businesses in the UK and globally which reduced financial resources for the acquisition of new IT equipment. Consequently, a new market for low-cost IT equipment emerged. The data show that the company recognised a new business opportunity and shifted its core business activity to providing refurbished IT equipment which was a transformative change. A shift towards refurbishing required a design of different processes to make the same or similar IT equipment to the new products manufactured from raw materials. Additionally, the business model change was customer-driven and led to a creation of a new customer value proposition. As key informant TB-A noted, “we just found that it must be a much more interesting proposition for people, the idea of us buying back their old equipment as oppose to them maybe paying someone to take it away”. He added that this was a critical moment for the company, focusing on rehousing of used IT equipment.

A business model change for sustainability that involves a new value proposition and a different underlying business logic is the most advanced stage of business model change, i.e. a business model redesign (Schaltegger et al., 2012). It is probable that the company’s environmental contribution associated with refurbishing of IT equipment (i.e., waste reduction due to the extension of the products life span) was a consequence of the business case improvement. Another likely explanation is that the company’s managers were aware of the positive environmental impact of refurbishing since the beginning, however, the environmental aspect was not the main driver of the business model change.

After refocusing on refurbishing, the company implemented a broad range of incremental changes to further improve its business model, for instance, broadening the scope of IT equipment in terms of the type of products and brands. Furthermore, the company focused on changing the business unit processes such as quality control to achieve high-quality standards that led to the ISO 9001 certification in 2018 (Techbuyer Limited, 2018b). The company also focused on providing training to develop and extend the technical competence of staff that is able to configure complex IT systems. The company invested in new technologies and developed a bespoke testing and data wiping software in collaboration with the industry software development providers. Additionally, an internal marketing system to keep the records of the IT components was developed. These incremental changes have helped the company to achieve business growth that is now perceived as an important enabler of sustainability improvements. Key informant TB-A commented that people in the company are becoming more aware of the actual issues such as depletion of natural resources, therefore, sustainability is the company's growing focus. He added that the company started small with the main focus to remain in business. He further noted, "now we're of a certain size and we're able to look at how we can develop more sustainable system and do more to help with that issue".

Techbuyer's recent realisation of its alignment with the circular economy has become the main driver for further business model changes for sustainability. Key informant TB-A pointed out that their business has always been sustainable or circular, however, they have not considered themselves as part of the circular economy until recently. Additionally, key informant TB-B noted that this new realisation motivated them to deploy the circular economy throughout Techbuyer.

Table 6.2 shows the identified areas for sustainability improvements that are linked to the overarching business model components, and to the approaches that the company is exploring to adopt. The company has identified incremental change approaches, i.e. efficiency as well as more transformational change approaches such as forming new partnerships and collaborative projects.

Table 6.2: Identified areas for sustainability improvements and approaches

Business model component	Key areas of potential for improvement	Approach
Value creation and delivery	Energy and material efficiency	Installing solar panels (Key informant TB-A 2018, interview, 20 March). Engaging with Leeds Enterprise Partnership (Key informant TB-A 2018, interview, 20 March) Collaborating with other businesses within the industrial park to reduce the plastic waste through industrial symbiosis approach (Key informant TB-A 2018, interview, 20 March)
	Reducing plastic packaging used in the warehouse Reducing GHG emissions related to transportation	Using sustainable packaging options, i.e. bio-based plastic packaging (Key informant TB-C 2018, company visit, 20 March). Using green couriers (Key informant TB-C 2018, company visit, 20 March).
	Leveraging knowledge capabilities through new collaborations and partnerships Sharing best practices	Collaborating with universities and research institutes (Key informant TB-C 2018, company visit, 20 March). For instance, joint knowledge transfer partnership with the University of East London to collaborate on an innovative project of green data centre modelling that drives circular economy (Fiddes and Kenny, 2018).

Business model component	Key areas of potential for improvement	Approach
		Collaborating with new retailers to help them design new value propositions around circular services, i.e. buy-back service (Key informant TB-A 2018, interview, 20 March) Exploring approaches for resource recovery from waste and how that applies to Techbuyer's business (Key informant TB-C 2018, company visit, 20 March) Contributing to academic research by joining knowledge sharing platforms such as EURECA project and WRAP's platform for developing circular economy, i.e. Electrical and Electronic Equipment Sustainability Action Plan 2025 (Wynne, 2018a)
Value proposition	New offerings	Offering rentals and leasing options, i.e. shifting to a Product-Service System (Wynne, 2018c) Broadening portfolio by including PCs, laptops and other commercial electronics for refurbishing (Key informant TB-A 2018, interview, 20 March) Developing and offering IT equipment under Techbuyer's own brand (Key informant TB-A 2018, interview, 20 March)
Value capture	New revenue streams	Entering new Asia Pacific markets that foster circular economy (Pooley, 2018a; Pooley, 2018b)

The case study analysis indicates that Techbuyer started its transformational change through organisational learning to better understand sustainability issues in relation to its business to improve the overall sustainability performance. For instance, participative management and their commitment to sustainability, i.e. environmental policy statement and adopted environmental management system (EMS) based on the ISO 14001 standards (Towers, 2018; Wynne, 2018c). However, the company did not want to disclose information about environmental procedures internal to its business, therefore, I was not able to assess the depth and breadth of the company's approach to EMS. Furthermore, the company has identified internal change agents that also include a senior manager which is important because it indicates top management's commitment and leadership. Additionally, Techbuyer is focusing on building employee knowledge and commitment. The company is also forming collaborations with new stakeholders, for example, knowledge transfer partnerships with universities to work on innovative projects for sustainability (Fiddes and Kenny, 2018). Finally, the company has identified new business opportunities in foreign markets that show increasing support for the circular economy and rank high in the ease of doing business and transparency such as New Zealand (Pooley, 2018a; Pooley, 2018b).

6.3.1.2 *Barriers of Techbuyer's business model change for sustainability*

The analysis identified two main challenges for the company's circular business model and its overall sustainability performance: customers' negative perception and a speculative nature of refurbishing business. Additionally, an identified paradox between selling new IT equipment versus refurbished IT equipment could potentially impede the future business model changes for sustainability.

Negative customer perception

This case study results show that B2B customers' misconception of refurbishing process and refurbished IT equipment is the key barrier influencing Techbuyer's circular business model. As key informant TB-B noted, "if we're to take this company to the next level, we need to be changing people's perception of refurbished hardware". This finding is in line with previous research showing that negative customer perception of refurbished products influences the acceptance of such products (Harms and Linton, 2016; van Weelden et al., 2016). For example, willingness to pay (WTP) for the products including refurbished components, across different product categories, was found to be lower compared to the WTP for the new products (Harms and Linton, 2016). However, the same study also showed that eco-certification of refurbished products increased the level of WTP for refurbished products. The private consumers' unfamiliarity with refurbished mobile phones and the refurbishing process itself were identified as important factors influencing the low consumer acceptance (van Weelden et al., 2016).

Another aspect of negative customer perception that was identified as important in this case study was the products' reliability that is likely linked to the customers' misconceptions of refurbishing process. Reliability was identified as an important factor that influences the purchasing rates of reused mobile phones within business-to-consumer (B2C) market (Ylä-Mella et al., 2015). The finding of the present case study suggests that similar concern affects customers' decision-making for using refurbished IT equipment in the B2B market.

Key informant TB-A and TB-B emphasised the importance of big, credible companies advocating the use of refurbished IT equipment in overcoming the barrier of negative customer perception. They both pointed out Google's recent public statement about the percentage of refurbished equipment that they use; Techbuyer's position is that smaller businesses could learn from the Google's model and replicate it on a small scale.

Refurbishing is a gamble

This case study results also show that quality of used equipment for refurbishment represents a risk for Techbuyer. In key informant TB-A's view, Techbuyer is taking a gamble when buying used IT equipment for refurbishment because of incomplete knowledge of what they are buying which represents a risk. The risk does not relate just to the quality of used IT equipment but also to its price. Key informant TB-A commented that price in the market fluctuates, "so, there's a bit of a risk, it's not a traditional distribution type model, it's quite speculative I suppose".

A similar finding was found by Ongondo and Williams (2011) who showed that quality of used products such as mobile phones influences their reuse. The speculative nature of the refurbishing business currently inhibits the circularity of Techbuyer's business model considering the R strategies such as reduce and rethink in the context of circular economy (Kirchherr et al., 2017). For instance, when used IT equipment is unsuitable for refurbishing and gets disassembled for recycling instead.

The new versus refurbished paradox

While the company's primary goal is to provide refurbished IT equipment to their customers, there are occasions when refurbished IT equipment is not the optimal solution. For instance, key informant TB-B commented that the criticality of IT infrastructure in different environments, i.e. test environment, back-up environment or disaster occurrence environment can influence customers' decisions to choose new IT equipment over refurbished. In such cases, Techbuyer sells new IT equipment which indicates that there exist two business models simultaneously, i.e. the circular business model and a more traditional business model. It could be said that the identified paradox might be a hindering factor for the company's future sustainability efforts and the question is whether providing a 100% refurbished IT equipment would be a commercially viable option.

6.3.1.3 *Drivers of Techbuyer's business model change for sustainability*

Educating customers

Key informants TB-A and TB-B considered customers negative perceptions of refurbished products as one of the main barriers that the business is faced with, however, it also represents an opportunity for future sustainability improvements. Specifically, educating customers about advantages and benefits of using refurbished products could lead to further improvements of the existing circular business model. Key informant TB-B commented that he is very passionate about changing negative perceptions about refurbishing and he considers active education of customers a central activity of the sales department.

The increased consumers' awareness of refurbishing and its environmental benefits were found to have a positive influence on consumers' purchase intention in the case of smartphones (Mugge et al., 2017). Therefore, it is likely that the proactive strategy of educating B2B customers might influence their decision-making for acquiring refurbished IT equipment, consequently improving the company's circular business model and its sustainability performance.

Improving resource efficiency

Techbuyer's managers have started to explore the options to improve energy and material efficiency in collaboration with an organisation providing support to small and medium sized businesses, Leeds City Region Enterprise Partnership. Another area that company's managers are interested to learn more about is resource recovery. The resource recovery is not one of the company's business activities; however, managers are learning about the enabling technologies and whether resource recovery could be applied to data centre servers. For instance, key informant TB-C commented on a robot used by Apple to disassemble its products and wondered how an invention like that functions and whether it could be applied to data centre servers.

The company is also exploring an engineering dimension of IT equipment, for instance, how a lean manufacturing strategy applies to their refurbishing business. Furthermore, Techbuyer is learning about micro engineering related to the central processing units (CPUs) that have a high-power usage, specifically looking at the possibility of disassembling CPUs in the same manner as data centre servers. Data centre servers are based on a modular design which makes disassembly process easy and thus refurbishment possible. If the same refurbishment process could be applied to CPUs, then the company could further improve the existing circular business model.

Sustainability team formation

The analysis of interviews identified that Techbuyer has a sustainability team to proactively search for options to improve the company's existing circular business model. Key informant TB-B mentioned the team's role when talking about the future sustainability changes as illustrated by the quote below:

> By creating this team, this team has only been in existence for two years and I think certainly Kevin [referring to the company's CEO] realised that there's an opportunity to take our proposition to end users, to universities, and councils and banks as well. So, that's quite transformative certainly for us as a business anyway. We're going into new markets telling them about the virtues and the benefits of refurbished and selling on the environmental aspect as oppose the economic as well which is very positive.

This section has focused on analysing the drivers that influence Techbuyer's business model change for sustainability. The next section summarises the main findings at the organisational level of analysis.

6.3.1.4 *Organisational level summary of findings*

At its inception, the company adopted a traditional retailer business model that has later shifted to a circular business model based on refurbishing. Circular economy principles have been the main driver of recent sustainability initiatives and planned changes to further improve circularity and the overall sustainability performance of the current business model. Additionally, educating customers about the benefits of refurbished IT equipment, improving resource efficiency, and sustainability team formation are factors that influence business model change for sustainability. On the other hand, negative customer perception, speculative nature of refurbishing business, and the new versus refurbished paradox represent the main barriers to sustainable business model.

So far, this chapter has focused on the organisational level. The next section will focus on presenting and interpreting results at the individual level, i.e. sustainability issues influencing decision-making and key informants' cognitive maps of sustainability issues. I will also present and interpret differences and similarities between individuals' cognitive maps across the company and their shared perceptions of important sustainability issues will also be discussed.

6.3.2 Results and analysis at the individual level

In the following sections I analyse and interpret the complexity of sustainability issues that influence key informants' decision-making related to improving company's circular business model and its overall sustainability performance. These results were obtained through the interviews with key informants TB-A, TB-B and TB-C using participatory cognitive mapping as outlined in section 6.2 and described into details in chapter 3 (see subsection 3.3.3.2). Results were used to address the second research question: *What sustainability issues influence decision-making for business model change to improve sustainability performance?*

Furthermore, I present and interpret the differences between cognitive maps of sustainability issues derived from the interviews with participatory cognitive mapping and online survey. The online survey was completed by 24 respondents across the company. I also present shared perceptions of important sustainability issues through a collective cognitive map. Results were used to address the third research question: *How do cognitive models of sustainability issues differ in the context of sustainable business models?*

6.3.2.1 *Content of the cognitive maps*

Sustainability issues driving key informants' decision-making

Three key informants (TB-A, TB-B and TB-C) identified important sustainability issues that drive their decision-making and explained reasons for their choices (see Table 6.3). Identified sustainability issues were the basis to create individual cognitive maps and explore relationships between sustainability issues. Analysis revealed differences in content, i.e. number of sustainability issues considered and types of sustainability issues (economic, environmental and social) across key informants. While key informant TB-A mostly chose economic issues (8 out of 10), key informant TB-C focused on environmental issues (7 out of 12). The key informant TB-B highlighted importance of all types of sustainability issues, however, economic (7 out of 13) and environmental issues (5 out of 13) were the dominant issues in his cognitive map. Furthermore, the key informant TB-B was uncertain how the social aspect fits with Techbuyer's business.

Differences in content of cognitive maps are important because they influence responses to sustainability issues considered by the individual decision-maker. For instance, key informant TB-A's cognitive map is in line with a business-case frame conceptualised by Hahn et al. (2014). This means that key informant TB-A might tend to adopt a more pragmatic decision-making stance (i.e. predisposition to action), considering a narrow scope of existing routines that were successful in addressing issues in the past to act quickly while minimising the risk. On the other hand, the cognitive map of key informant TB-C has characteristics of a paradoxical frame such as complexity (Hahn et al., 2014). This means that key informant TB-C might tend to adopt a prudent decision-making stance, considering a broad scope of new alternative approaches to address sustainability issues in a comprehensive way. However, awareness that new approaches involve higher risk and resulting contradictory effects might hinder the action-taking process (Hahn et al., 2014).

Table 6.3: Important sustainability issues for key informants' decision-making

Key informant TB-A		Key informant TB-B		Key informant TB-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
Product price	Being able to buy used products at a price upon which the company can make a profit.	Profitability	Being a commercial business.	Design	Increasingly important because existing models are unsustainable. Impossible to recover all raw materials from IT equipment. Need for redesign to make IT equipment truly recyclable.
Market	Buoyancy of the market.	Economic for customers	Savings	Emissions	CO2 emissions are high in the manufacture and destruction phase of IT equipment. Carcinogens as by-products of both mining for materials and material recovery at end of life.

Key informant TB-A		Key informant TB-B		Key informant TB-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
Availability	No guaranteed supply of the product (difference compared to the traditional retailer model). Company proactively searches for primary equipment.	Extending life of equipment	Three-year and lifetime warranty ensures equipment in circulation for as long as possible. Can be upgraded over time.	Impact on land	Toxic emissions have an effect on land quality. Destruction phase uses toxic chemicals which leech into the surrounding land and damage soil quality.
Staff expertise	Not easy to find people with the right set of skills. Training, development and retention of young people that feel the company's culture is very important.	Reducing the amount of new equipment required	New equipment is still manufactured but less of it is required.	Social responsibility	Increasingly important because existing/old models are breaking. UK historically based on welfare which proved unsustainable; there is a need for companies that create social value.
Logistics expense	Sometimes goods on offer are too bulky or the value is too low – makes no commercial sense.	Environmental impact of using for longer	Keeping the equipment in circulation and closing the loops. It is company's new proposition.	Job creation and retention	Use of AI in the future; changing job landscape. Economic perspective – creating and maintaining high

Key informant TB-A		Key informant TB-B		Key informant TB-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
	When refurbishing is not financially viable then the company offers recycling service to suppliers.				quality useful jobs to society. Providing social value (e.g. engaging with people, employing and training young people, encouraging curiosity).
Data loss concerns	Even though company offers data wiping according to military standards, some organisations do not want to risk losing data and prefer to scrap their equipment and thus losing the value of materials.	Reducing scrap and wastage	Bring equipment back into the use cycle that would otherwise go for recycling. Disassembly and triage ensures all working parts are salvaged, broken parts sent for recycling.	Remanufacturing	When reusing materials, the manufacturing becomes replaced with remanufacturing (alternate system).
Encourage reuse	Promoting reuse as much as possible; it makes business and environmental sense. Company developed its own brand and portfolio of products that will be turned into a circular business model with	Customers' budget	Budget constrains force customers to go down the refurbishing route. Customers realizing that less can be spent on non-critical	Closed loop system	Ideally we need to move towards a system that is more modular by design, allowing disassembly and reassembly of component parts.

Key informant TB-A		Key informant TB-B		Key informant TB-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
	guaranteed buy-back programme. Aligning with providers of new electronic equipment to help them develop circular models.		infrastructure and that older equipment is sufficient to fulfil their needs.		We need to look at reusing waste for positive by-products, e.g. food waste to create bio-gas; water based data centre cooling to feed hot water supply.
Marketing efforts	Promoting the idea that refurbished is a sensible and sustainable choice.	Market for refurbished products	Economic and financial benefits. Creating positive impact on the environment.	Use of finite resources	Critical raw materials present in IT equipment such as tungsten have been identified as risky in terms of supply.
Perception of refurbished products as viable option	One of the main barriers is the perception that 'refurbished is not as good as new' although this is changing due to sustainability commitments from companies such as Google and their use of refurbished equipment.	Negative customers' perceptions	Main concern is reliability; perception that refurbished products are not of a good enough quality to use them in the primary environment. Unawareness of the full and complex process of refurbishing;	Material wastage (finite materials) End of Life	Recyclers forced to make a choice on which material to recover from IT equipment, e.g. decision depends on quantity and market price. Critical raw materials present in small

Key informant TB-A		Key informant TB-B		Key informant TB-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
			nervousness about trying out refurbished products.		amounts in IT equipment that are often obliterated by recycling process.
Take-back programme	As an industry 'buying stuff back' is a concern and logistics expense can be a prohibitive factor.	Positive customers' perceptions	Good experience with the company and refurbished products lead to positive changes in customers' perceptions and savings by increasing the life of a budget.	Manufacturing	Involves chemical reactions, therefore gas emissions; generates large amount of CO_2. In general, not powered by renewable energy.
/	/	Quality of refurbished products	It is important to change the negative customers' perceptions into positive.	Destruction (of component materials to recover precious materials)	Recovery process for one component material often destroys the other raw materials present in the equipment, especially on smaller components and composite parts like circuit boards.

Key informant TB-A		Key informant TB-B		Key informant TB-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
/	/	Reducing/ delaying unnecessary wastage	Company is delaying wastage by three to four years because equipment will eventually become obsolete.	Reusing of material	Many server parts are hardwearing and can be used again in their entirety; many older systems are still fit for purpose for smaller organisations.
/	/	Social aspect (training)	It is important, however, there is no clear direct link between what company does and areas of social responsibility.	/	/

Analysis also showed similarities across key informants and identified sustainability issues, for instance, key informants TB-A and TB-B both chose customer perception and market for refurbished products as important economic issues. Key informants TB-A and TB-C chose social issues related to human capital, i.e. staff expertise (TB-A) and job creation and retention (TB-C). Key informants TB-B and TB-C both identified environmental issues related to waste, and key informants TB-A and TB-C both identified reuse as an important sustainability issue for decision-making.

Even though similarities were found across key informants' perceptions of important sustainability issues for decision-making, there exist substantial differences in their cognitive maps. There are several possible explanations for this result. For instance, current job role and functional background could have an effect on key informants' cognitive maps. Another possible explanation is that key informants are at different stages of the learning process to better understand the relevance of sustainability issues and how to deal with them at the individual and organisational level. Furthermore, it is probable that contextual factors such as the refurbishing business and circular economy influence the way key informants think about sustainability issues and how they relate to each other.

Another interesting finding about key sustainability issues for decision-making is that some issues were identified during the interview but were not included in cognitive maps. For instance, key informant TB-C considered importance of efficiency gains linked to design, however, it was unclear to her how efficiency gains fit into the cognitive map. The cognitive map reflected key informant TB-C's view of how existing system should change into a more sustainable system which is in line with the results from the analysis at the organisational level. Furthermore, efficiency improvements were identified as one of the key areas for sustainability improvement at the organisational level (see Table 6.2), yet it seems that there is uncertainty at the individual level of how efficiency gains actually link to other important sustainability issues. It could be said that there is a paradoxical tension between individual and organisational level in understanding how efficiency gains link to other sustainability issues to achieve a more sustainable system, i.e. improved circular business model.

Key informant TB-A highlighted increasing awareness of issues such as depletion of natural resources and company's culture, however, these issues were not considered in the cognitive map. This observation was pointed out during the validation process, however, key informant TB-A made no changes to his list of sustainability issues and cognitive map. A possible explanation is that TB-A was in the early stages of awareness development regarding sustainability issues such as resource depletion, trying to understand how this specific issue links to Techbuyer's business and its operations. For instance, TB-A commented that the company wants to ensure that components with high production costs such as microchips do not end up in a landfill. Key informant TB-A described culture as something that "keeps everything together, keeps the customers and suppliers coming back", yet it was not considered in the cognitive map. A possible explanation for the exclusion might be that it is difficult to evaluate how culture contributes to sustainability. Furthermore, it is possible that links between culture and other sustainability issues in the cognitive map were unclear as was the case in TB-C's thinking about efficiency gains and other sustainability issues. It may be said that there is a paradoxical tension between the individual and organisational level in understanding how culture and other sustainability issues relate to each other in order to achieve a more sustainable system, i.e. an improved circular business model.

According to the key informants, Techbuyer is in the process of deploying circular economy processes throughout the company and managers are addressing different sustainability issues. For instance, end of life (EoL) equipment (environmentally friendly disposal and collaboration with specialised recyclers), packaging (constant monitoring to find ways for improvements), and energy efficiency (renewable energy solutions for energy-intensive warehouse). However, key informant TB-B commented that these sustainability issues link to Techbuyer as a business and are separate from the actual IT equipment. It could be said that this is a sign of a business model versus business model components paradox, which could potentially cause problems when designing and implementing future sustainability changes in existing circular business model. Refurbished IT equipment is at the heart of Techbuyer's circular business model that is supported by other business model components to create, deliver and capture sustainability values. Therefore, better understanding of interconnectedness between business model components as well as how they link to sustainability issues could lead to more transformative business model changes in the future.

Sustainability issues identified by key informants (see Table 6.3) were the basis for the online survey to explore perceptions of the most important sustainability issues and relationships between them across the company. The final list of sustainability issues was generated based on the consultation with the key informant (some issues were merged, added or deleted) and document analysis.

6.3.2.2 *Structure of the cognitive maps*

Participatory cognitive mapping

Analysis showed that key informant TB-A identified nine one-way relationships between ten sustainability issues, five negative and four positive relationships (see Figure 6.2). Five sustainability issues (*Availability*, *Logistics expense*, *Encourage reuse*, *Data loss concerns* and *Staff expertise*) were driver issues influencing other issues in the cognitive map. Three sustainability issues (*Perception of refurbished products as viable option*, *Take-back* and *Market*) were receiver issues (being influenced by other issues) and two sustainability issues (*Product price* and *Marketing efforts*) were ordinary issues (having characteristics of both, driver and receiver issues). A cluster of sustainability issues with very strong linkages emerged around *Perception of refurbished products as viable option*.

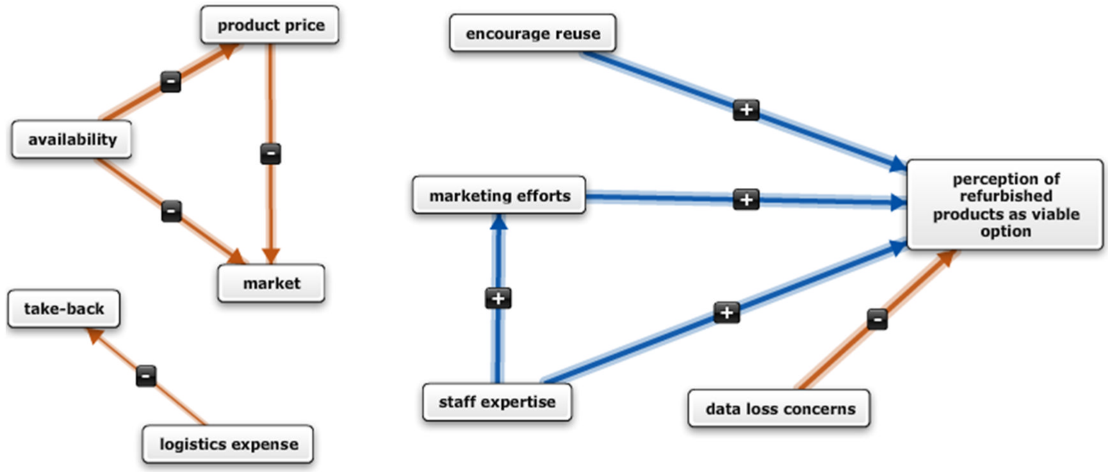

Figure 6.2: Key informant TB-A's cognitive map

There was a low level of interconnectedness or complexity among sustainability issues in the TB-A's cognitive map. Furthermore, TB-A's cognitive map consists of three disconnected clusters, for instance, a pair of issues *Take-back* and *Logistics expense* is disconnected from other sustainability issues in the cognitive map. This low level of interconnectedness might imply that there are paradoxical tensions (either inherent or socially constructed or both) hindering the linkages (Eden and Ackermann, 1998). Another possible explanation might be that key informant TB-A tends to use simplified cognitive models to make sense of the complex sustainability issues relevant to Techbuyer. Furthermore, it seems that TB-A's personal characteristics play an important role in decision-making for sustainability as he commented, "I think I can't tell you more than I just told you about the thing cos I think I'm *quite simple*, *straightforward sort of person*, but the general idea is just to encourage reuse and really promote reuse as much as we possibly can".

In contrast to key informant TB-A, key informant TB-C created the most complex cognitive map that included 35 relationships (15 one-way and 10 two-way) between 12 sustainability issues (see Figure 6.3). Furthermore, most of sustainability issues (11 out of 12) in the cognitive map were ordinary issues, having properties of receiver and driver issues. High complexity of TB-C's cognitive map indicates a deeper consideration of interconnectedness between sustainability issues. Furthermore, it seems that TB-C considers a broader context for decision-making that goes beyond her specific job role including organisational as well as institutional context. Additionally, environmental and social issues were more prevalent than economic issues, therefore, it is likely that transformative sustainability strategies might be considered in advancing the company's circular business model. However, considering new alternative sustainability strategies might not necessarily lead to actual action-taking in the case of paradoxical cognitive frame (Hahn et al., 2014).

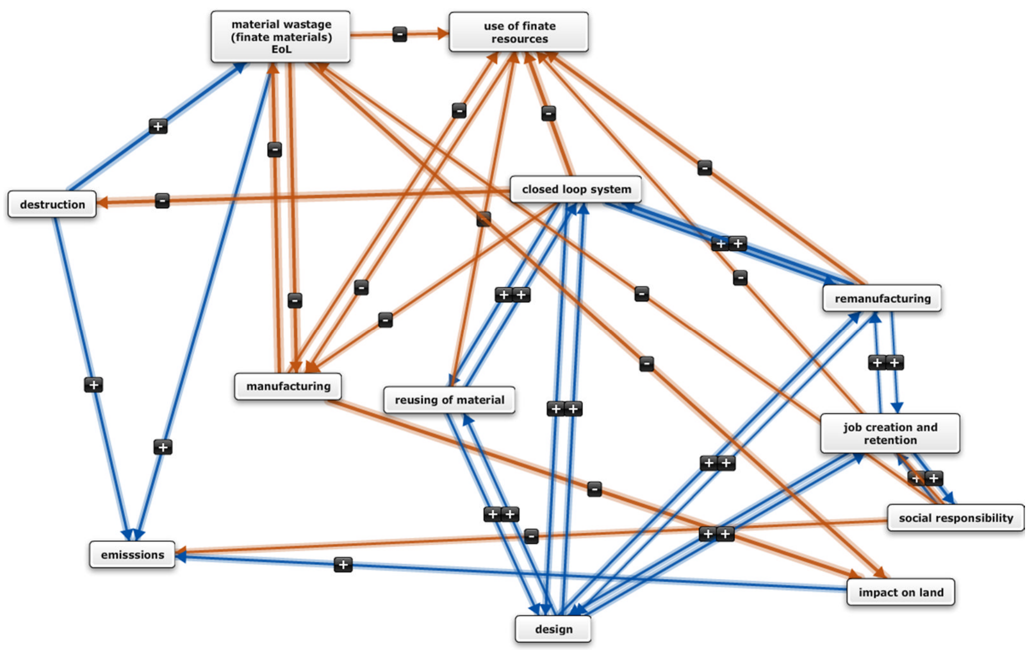

Figure 6.3: Key informant TB-C's cognitive map

TB-C's cognitive map reflects her view on an ideal system shift for Techbuyer's business, a shift that is modular by design allowing assembly and reassembly of modular parts. In TB-C's view, an improved modular design would lead to an increase in the reuse of material and remanufacturing which would replace manufacturing (see Figure 6.3). Furthermore, an improved modular design would have a positive effect on the closed loop system and creation and retention of new jobs.

Key informant TB-B identified 20 relationships between 13 sustainability issues, most of the relationships (16) were one-way relationships (see Figure 6.4). Similar to TB-A's cognitive map, most of the relationships (16 out of 18) were perceived as strong or very strong. Most of sustainability issues (6 out of 13) in the cognitive map were ordinary issue.

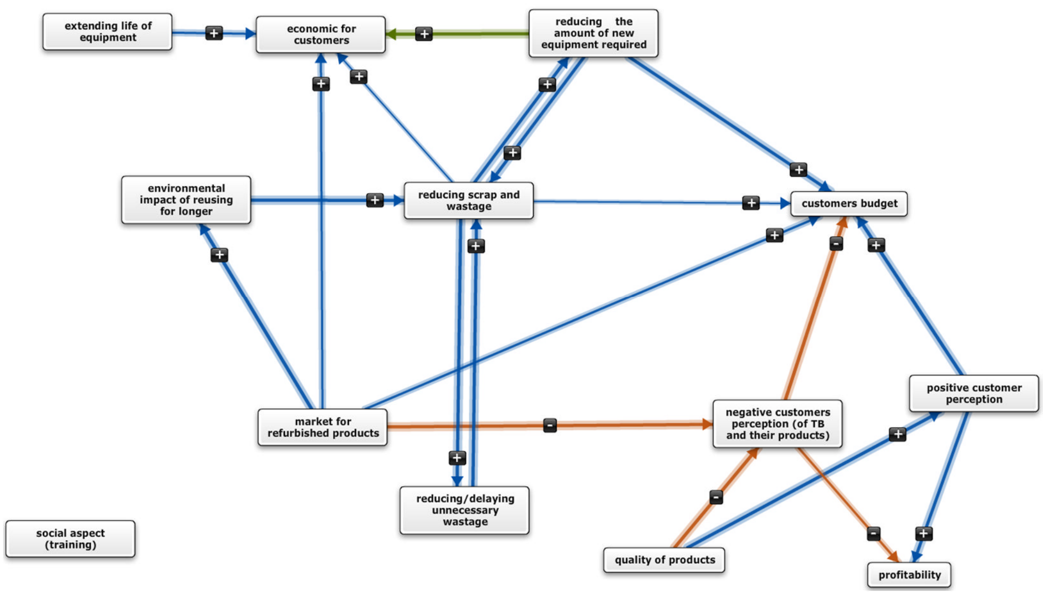

Figure 6.4: Key informant TB-B's cognitive map

An interesting finding is that profitability was linked to customer perception, a positive customer perception leading to an increase in profitability and a negative customer perception leading to a decrease in profitability. However, there were no links between profitability and other economic and environmental issues in the cognitive map. Another interesting finding is that the social aspect was included in the cognitive map but remained disconnected from other sustainability issues because of uncertainty. As key informant TB-B said, “I still think there is a social aspect, but I don’t know what that is just yet. Yes, we train our people but that’s no different to any other organisation”. This provides evidence that there is a paradoxical tension between individual and organisational level in relation to social issues. Specifically, what social benefits the company creates and how social issues link to other sustainability issues to achieve a more sustainable system, i.e. an improved circular business model.

Online survey

In the online survey each respondent selected two most important economic, environmental and social issues for their company, six issues in total. Then, they answered questions about relationships between the pairs of identified important issues, 15 in total. Analysis showed that respondents on average identified 2.5 one-way relationships and 11.04 two-way relationships between sustainability issues (in total, 30 relationships were possible in each cognitive map). Respondents mostly identified positive relationships between sustainability issues (on average 22.17 positive correlations) and all the identified issues across 24 cognitive maps were ordinary, having the function of a receiver and driver issue.

A group categorisation showed that 10 cognitive maps included combination of *Staff expertise* and *Encouraging reuse of material* (see Table 6.4). Three out of 10 respondents identified that the two issues were not related (result 0). On the other hand, four respondents identified positive two-way relationships with the strength ranging from weak (1) to strong (3). Two respondents identified one-way relationships, an increase in *Staff expertise* contributes to an increase in *Encouraging reuse of material*. Differences in perceived relationships between *Staff expertise* and *Encouraging reuse of material* indicate potential for paradoxical tensions within individuals and between staff.

Table 6.4: Relationships between *Staff expertise* and *Encouraging reuse of material*

Cognitive map	**No relationship**	**Staff expertise' → 'Encourage reuse of material'**	**Encourage reuse of material' → 'Staff expertise'**
TBCM3	0		
TBCM6	0		
TBCM7	0		
TBCM10		-3	+3
TBCM12		+2	+3
TBCM15		+2	+2
TBCM19		+3	+1
TBCM21		+2	+2
TBCM23		+1	
TBCM24		+2	

This is an important finding because reuse of material is one of the core values in the company and company's staff is one of the main assets in the existing circular business model that enables creation and delivery of sustainability values. The identified paradoxical tension could represent a hindering factor in company's efforts to further improve the existing circular business model.

Group categorisation also revealed similarities in relationships between sustainability issues across respondents' cognitive maps. Specifically, cognitive maps that included *Profitability* as the most important economic issue and other sustainability issues such as *Staff expertise*, *Technical knowledge, Encouraging reuse of material*, and *Training and development*. Similarities were found in directionality and type of relationships as well as the strength of relationships between those sustainability issues. A likely explanation is that there were no perceived paradoxical tensions between those specific sustainability issues and that linkages were clear. However, differences were found across respondents' cognitive maps in relationships between *Profitability* and *Recycling*. Analysis of a group of six respondents showed that four respondents identified two-way relationships, while one respondent identified one-way relationship and another respondent considered that *Profitability* and *Recycling* are not related. It seems that there was a paradoxical tension at individual level that led to differences in cognitive maps.

This section analysed the linkages between sustainability issues in the cognitive maps at the individual level. Analysis showed that there are paradoxical tensions at the individual level that could cause problems at the organisational level to further improve the existing circular business model.

6.3.2.3 *Centrality of sustainability issues in the cognitive maps*

Participatory cognitive mapping

A centrality score of individual sustainability issues represents a degree of relative importance of a sustainability issue in the cognitive map (Gray et al., 2014). Comparing central sustainability issues in the cognitive maps helps to ascertain what areas are of concern to individual interviewee (Eden and Ackermann, 1998). Table 6.5 shows the centrality score of sustainability issues included in key informants' cognitive maps. For instance, *Perception of refurbished products as viable option* achieved the highest centrality score in key informant TB-A's cognitive map. It could be said that *Perception of refurbished products as viable option* affects decision-making for sustainability more strongly than other sustainability issues with lower centrality scores. In other words, *Perception of refurbished products as viable option* is the area of highest concern to TB-A. Other sustainability issues with the highest centrality score were *Reducing scrap and wastage* (Key informant TB-B) and *Closed loop system* (Key informant TB-C).

Table 6.5: Techbuyer key informants centrality scores

Key informant	Sustainability issue	Centrality score
TB-A	Perception of refurbished products as viable option	4
	Staff expertise	2
	Marketing efforts	2
	Product price	1.7
	Availability	1.7
	Market	1.4
	Data loss concern	1
	Encourage reuse	1
	Logistics expense	0.45
	Take-back programme	0.45
TB-B	Reducing scrap and wastage	5.3

Key informant	Sustainability issue	Centrality score
	Reducing the amount of new equipment required	4
	Customers budget	3.9
	Negative customer perception	3.4
	Market for refurbished products	3.3
	Positive customer perception	2.9
	Economic for customers	2.5
	Reducing/delaying unnecessary wastage	2
	Environmental impact of using for longer	1.9
	Profitability	1.8
	Quality of products	1.7
	Extending life of equipment	0.6
	Social aspect (training)	0
TB-C	Closed loop system	6.8
	Material wastage (finite materials) at the end of life	5.8
	Design	5.6
	Use of finite resources	5.5
	Manufacturing	4.8
	Remanufacturing	4.6
	Job creation and retention	4
	Social responsibility	3.9
	Reusing of material	3.8
	Emissions	3
	Impact on land	2.64
	Destruction	2.61

Key informant TB-C highlighted importance of *Social responsibility* and *Job creation and retention* for Techbuyer, however, both issues achieved lower centrality scores than six other sustainability issues in TB-C's cognitive map. Even though social issues were identified as important, they did not achieve high centrality scores in the cognitive maps, apart from *Staff expertise* in key informant TB-A's cognitive map. In TB-B's cognitive map the *Social aspect* remained disconnected from other issues which resulted in a zero score, which indicates that there is a potential for interventions at the organisational level to improve creation and delivery of social values for stakeholders, i.e. employees, customers and local community.

Online survey

Analysis of the cognitive maps obtained through the online survey identified four groups that included a minimum of three cognitive maps with the same central sustainability issues: 1. *Profitability* (four cognitive maps), 2. *Encouraging reuse of material* (three cognitive maps), 3. *Staff expertise* (four cognitive maps) and 4. *Market for refurbished products* (three cognitive maps). There is a sizeable difference in relation to perceived central sustainability issues across 24 cognitive maps.

A surprising finding is that *Recycling* achieved the lowest centrality score in six out of 24 cognitive maps. Recycling is an important issue for Techbuyer particularly given that they recycle cardboard and plastic packaging waste using balers that were installed in 2017 and 2018 (Wynne, 2018c). In 2018, the company also adopted a new system for domestic waste recycling. Furthermore, amount for recycling for EoL equipment has been 100% through partners in the recycling industry.

A collective cognitive map was created based on the 24 cognitive maps to represent the shared perceptions of sustainability issues. The collective cognitive map revealed that *Staff expertise* (social issue) was the most central sustainability issue followed by *Profitability* and *Technical Knowledge*. It could be said that taking care of human capital is one of the core values in the company. Other economic issues that achieved high centrality score besides profitability were *Quality of refurbished products* and *Quality service*. The environmental issue with the highest centrality score was *Encouraging reuse of material*, followed by *Extending life of equipment* which reflects another company's core value: conservation of resources. The results from the collective cognitive map resonate with the company's business model based on quality customer service. As key informant TB-A noted, "I suppose is taking care really, not just taking care of the people also taking care of the equipment that we deal with (…) and as I said, we take a very focused quality approach to everything we do, I suppose".

A surprising finding was a low centrality score of *Negative customers' perceptions*. I expected a higher centrality score because this sustainability issue is one of the main barriers for Techbuyer's business. As key informants TB-A and TB-B pointed, the company needs to educate customers about advantages and benefits of using refurbished products in order to further improve the existing circular business model. Another sustainability issue with a low centrality score was *GHG emissions*. The company is planning to install solar panels which would have positive effects in terms of emissions reduction. Furthermore, planned collaborations with green couriers will help further reduce carbon emissions related to Techbuyer's business. However, it seems that there is a potential for interventions at the individual level as well. Table 6.6 shows the centrality scores of sustainability issues in the collective cognitive map.

Table 6.6: Techbuyer centrality scores

Sustainability issue	Centrality score
Staff expertise	3.59
Profitability	2.68
Technical knowledge	2.67
Encouraging reuse of material	2.46
Quality of refurbished products	2.13
Extending life of equipment	2.08
Recycling	1.99
Quality service	1.90
Training and development	1.70
Market for refurbished products	1.63
Social responsibility	1.44
Environmental impact of saving resources	1.17
Job creation and retention	1.12
Waste reduction	1.11
Product price	0.96
Relationships with suppliers	0.89
Negative customers' perceptions	0.76
Reducing the amount of new equipment required	0.71
Technology	0.31

Sustainability issue	Centrality score
GHG emissions	0.30
Data loss concerns	0.18

6.3.2.4 *Individual level summary of findings*

Analysis at the individual level showed sizeable differences between key informants' cognitive maps, furthermore, paradoxical tensions were found between individual and organisational level:

- efficiency gains and how they link to other sustainability issues to achieve a more sustainable system (Key informant TB-C)
- culture and how it links to other sustainability issues to achieve a more sustainable system (Key informant TB-A)
- business model versus business model components and how they link to other sustainability issues to achieve a more sustainable system (Key informant TB-B)
- social aspect and how it links to other sustainability issues to achieve a more sustainable system (Key informant TB-B)

In relation to complexity, key informant TB-C created the most complex cognitive map that resonates with the characteristics of a paradoxical cognitive frame. On the other hand, key informant TB-A'S cognitive map had the lowest level of interconnectedness between sustainability issues. Furthermore, TB-A's cognitive map revealed characteristics of a business-case cognitive frame. Key informant TB-B was uncertain how social aspect of sustainability aligns with the company's business and its activities. The most central sustainability issues in key informants' cognitive maps were: *Perception of refurbished products as viable option* (Key informant TB-A), *Reducing scrap and wastage* (Key informant TB-B) and *Closed loop system* (Key informant TB-C).

Differences across online survey respondents' cognitive maps also revealed potential underlying paradoxical tensions at the individual level. In particular, paradoxical tension in perception of relationships between *Staff expertise* and *Encouraging reuse of material*. Furthermore, the collective cognitive map revealed some of the company's core values such as taking care of human capital, conservation of resources and high-quality products and services.

6.4 Discussion

The purpose of this chapter was threefold: (1) to understand factors that influence Techbuyer's sustainable business model; (2) to understand sustainability issues that influence decision-making at the individual level; and (3) to understand shared perceptions about sustainability issues across the company. The case study was driven by three research questions that will be addressed in turn.

Research Question 1: What internal and external factors influence business model change for sustainability?

Results from the organisational level analysis suggest that external and internal factors played an important role in Techbuyer's business model change for sustainability. A change in customers' demands from new to low-cost IT equipment due to budget restrictions was an external economic factor that led to the first transformative business model change for Techbuyer, shifting towards a circular business model for refurbished IT equipment. The results confirmed the findings about changing demands of stakeholders such as customers and their effect on business model change (Ferreira et al., 2013). Techbuyer's ability to change its business model for sustainability in response to changes in the external environment represents the company's key dynamic capability (Teece, 2007; Zott et al., 2011). Techbuyer's key dynamic capability is an internal factor that drives business model change for sustainability and might play an important role in company's future efforts to further advance its existing circular business model.

Another important internal factor that influenced Techbuyer's business model change for sustainability was the realisation of the company's alignment with the growing trend of the circular economy (Ellen MacArthur Foundation, 2016). Key decision-makers have realised that there is a potential to advance the existing circular business model. Similar to Techbuyer's first transformative business model change, managers have sensed and seized the new business opportunity, utilising the company's key dynamic capability. However, the awareness of environmental benefits related to refurbished IT products is higher than it was during the first business model change. Furthermore, managers are actively engaged in the process of learning and understanding how different circular economy principles apply to Techbuyer's business and what approaches could be adopted to achieve improved sustainability performance.

This case study has found that negative customer perception is one of the main barriers hindering the business model change for sustainability in B2B markets. Similarly, studies in the B2C markets, mostly consumer electronics, have also found that the negative customer perception of refurbished products influences the acceptance rate of such products (Harms and Linton, 2016; van Weelden et al., 2016; Ylä-Mella et al., 2015). The negative customer perception was found to be a challenge as well as driver for the future changes in the circular business model. The negative customer perception drives the company to encourage reuse and to educate customers about sustainability benefits of refurbished IT equipment. Educating customers is an internal change driver that combined with external change drivers, such as big businesses advocating the refurbished IT equipment, is perceived as having a positive influence on customer perception of refurbishing.

Another barrier found in this case study was the speculative nature of refurbishing related to incomplete knowledge about the quality of used IT equipment being bought and changing prices of used IT equipment. Low quality used IT equipment negatively influences the level of refurbishing because such equipment usually gets recycled which in turn negatively influences the circularity of Techbuyer's business model. This finding is partly in agreement with Ongondo and Williams (2011) who showed that low quality of mobile phones entering takeback schemes influences mobile phones reuse, consequently reducing the role of takeback schemes in waste prevention . Additionally, concerns over data loss inhibit collection of used IT equipment for refurbishing because companies prefer to scrap their IT equipment than risk losing data. Reliability and concerns over data loss were reported as important factors that influence reuse and recycling rates of mobile phones within B2C market (Ongondo and Williams, 2011; Ylä-Mella et al., 2015). Findings of the present case study suggests that similar concerns affect decision-making for refurbishing in the B2B market.

In contrast to earlier findings, a paradox was found in this case study between selling new IT equipment versus refurbished IT equipment. The two conflicting business models, the linear and circular business model, co-exist simultaneously. Running two business models simultaneously can be a source of tensions in the transition phase to a more sustainable business model and between different business model components such as value creation and value capture (Chesbrough, 2007). However, a pluralistic perspective suggests that having dual or multiple business models can have a positive effect on the competitive advantage of companies that employ them (Benson-Rea et al., 2013; Casadesus-Masanell and Tarziján, 2012). Dual or multiple business models are usually complements that create a greater value together than apart (Casadesus-Masanell and Tarziján, 2012). Complementary business models share to a great extent the most important physical assets, resources and capabilities, which seems to be the case in Techbuyer. Thus, Techbuyer employs paradoxical strategies (Benson-Rea et al., 2013) to manage its dual business model; however, it remains unclear to what degree the circular business model creates value compared to the traditional business model.

While Techbuyer focuses on promoting refurbished IT equipment, there are cases when new IT equipment is a better solution for the customers, for instance, high criticality of IT infrastructure in a back-up environment. Key informant TB-B acknowledged the contradiction, however, he commented that it rarely happens that refurbished IT equipment is not a suitable solution as illustrated by the quote below:

> Ninety-five percent of our business is refurbished, so we're not deviating too far from that model. It's very rare where refurbished isn't a fit, you know nine times out of 10 it is a fit with the customers. [Key informant TB-B 2018, interview, 23 April]

The observation that Techbuyer manages two co-existing conflicting business models and that the trade-off between selling new vs refurbished IT equipment is perceived as acceptable raises two questions:

- What does having two conflicting business models mean for future sustainability improvements?
- Is transition to a 100% circular business model possible and commercially viable?

Proponents of a sustainable business model perspective suggest that adopting complementary sustainability strategies can improve the strength of sustainable business models (Geissdoerfer et al., 2017; Bocken et al., 2014). In relation to circular economy, there are subsets of business models focusing on dematerialising, narrowing, intensifying, slowing and closing loops that could complement each other (Geissdoerfer et al., 2018a). Considering pluralistic and sustainable business model perspective, complementary sustainable business models can create a greater sustainability value than apart. Techbuyer has started exploring strategies and approaches such as leasing/rental models and industrial symbiosis (see Table 6.2). Furthermore, sustainability team formation and improving resource efficiency are two of the main drivers for changes in existing circular business model; therefore, it is likely that sustainability performance improves. However, it is unclear whether the linear business model will be abandoned.

The analysis shows that Techbuyer's business model change for sustainability was influenced by a combination of external and internal factors. These findings are in line with previous research on the influence of macro-level factors and organisation-level factors on business model change (Bock et al., 2012; Doz and Kosonen, 2010; Ocasio and Radoynovska, 2016; Schaltegger et al., 2012). However, less is known about the internal factors, specifically micro-level factors such as managerial cognition in relation to changes in business models (Foss and Saebi, 2017). Furthermore, there is a lack of empirical research in the area of cognitive models that play an important role in decision-making and action-taking related to business model change for sustainability. In order to contribute to this area of knowledge I explored the cognitive models of sustainability issues in Techbuyer. Results obtained through the interviews with participatory cognitive mapping and the online survey were used to address the second and third research question:

Research Question 2: What sustainability issues influence decision-making for business model change to improve sustainability performance?

Research Question 3: How do cognitive models of sustainability issues differ in the context of sustainable business models?

Results from the individual level of analysis suggest that there is significant cognitive diversity across key informants' perceptions of important sustainability issues for decision-making. Cognitive diversity has been found to be associated with strategic change and organisational performance in the case of healthcare organisations (Van de Ven et al., 2008). Furthermore, the link between cognitive diversity and organisational performance was found to be stronger when organisations considered integration processes (i.e. mechanisms to foster debate and dialogue between different perspectives) to manage cognitive diversity. Cognitive diversity is a critical factor for sense-making and coping with complex environments (Weick, 1995) and issues such as sustainability. The cognitive diversity of Techbuyer's key informants has the potential to positively influence decision-making and action-taking in relation to business model change for sustainability and sustainability performance.

This case study found evidence that key informants use different cognitive models to deal with the complex sustainability issues. Elicited cognitive maps differed in content, i.e. sustainability issues included in the cognitive map, and structure, i.e. relationships between those issues. To analyse the elicited cognitive maps I used a conceptual framework of cognitive frames in corporate sustainability proposed by Hahn et al. (2014). My findings demonstrate two things. First, key informants' cognitive maps fall between the spectrum of the two ideal types of cognitive frames, the business case frame and the paradoxical frame. Second, there are signs of paradoxical tensions in TB-A's cognitive map (i.e. disconnected clusters of sustainability issues) and TB-B's cognitive map (i.e. disconnected social aspect, business model as a whole vs business model components). Similarly, in key informant TB-C's view there was uncertainty how energy efficiency fit into the cognitive map that represented transition towards a more sustainable system. The evidence from this case study suggests that moderating factors such as personal characteristics, for instance, straightforwardness are likely to influence decision-making which is in accordance with ideas proposed by (Hahn et al., 2014).

My findings on cognitive models hint that there are also paradoxical tensions in perceptions of linkages between specific sustainability issues at the individual level across the company. For instance, the paradoxical tension in perceptions of relationships between *Staff expertise* and *Encouraging reuse of material*. This finding indicates that there is a potential to further improve understanding of reuse and to build on staff expertise which could have a positive effect on individual and organisational level of understanding of sustainability, consequently leading to further business model changes. Paradoxical tensions between sustainability issues at individual and organisational level can be understood as the critical points for change (Hahn et al., 2015). I argue in line with Vilanova et al. (2009), that identifying existing paradoxes can benefit managers in interpreting sustainability issues and relationships between them to improve decision-making and action-taking for business model change.

The evidence from the analysis of key informants' cognitive maps suggests that *Perception of refurbished as viable option* (TB-A), *Reducing scrap and wastage* (TB-B), and *Closed loop system* (TB-C) are seen as the most salient sustainability issues for decision-making. Furthermore, it is likely that these salient sustainability issues indicate areas where change should come about to improve existing circular business model. On the other hand, sustainability issues with the lowest centrality score might also indicate areas for interventions, for instance, interventions to reduce GHG emissions as well as concerns about data loss.

The analysis at the individual and organisational levels revealed links between results at both levels. For instance, *Staff expertise* and *Encouraging reuse of material* achieved high centrality scores across online survey respondents' cognitive maps (see Table 6.6). These sustainability issues underlie two of the core values in the company's value system, i.e. taking care of human capital and conservation of resources. Furthermore, *Staff expertise* is reflected in the business model component of value creation and delivery (see Table 6.2), leveraging knowledge capabilities through new collaborations and partnerships, and sharing best practices. Furthermore, *Encouraging reuse of material* is reflected in the business model component of value proposition (see Table 6.2), providing new offerings based on the reuse perspective such as rental and leasing of IT equipment. The results from this case show that *Encouraging reuse of material* was a fundamental issue that drives value creation in the business model through new revenue streams generated by entering new markets that foster circular economy.

In this case study I have investigated factors that influence business model change for sustainability and perceptions of key sustainability issues driving decision-making to achieve that change. Furthermore, I explored cognitive models of sustainability issues and how they differ across individuals in the company. My study has led me to the conclusion that Techbuyer has the key dynamic capability that enables the company to change its business model towards a more sustainable business model, mangers ability to sense and seize new business opportunities and act upon them. Key decision-makers are actively involved in learning about sustainability issues and approaches that could be adopted to deal with those issues successfully.

Techbuyer is in the process of transitioning towards more sustainable business practices to develop a stronger circular business model. As my study suggests, there are paradoxical tensions in perceptions of linkages between sustainability issues at the individual level. Furthermore, some of those paradoxical tensions appear to exist between the individual and organisational level.

Chapter 7 – Case Study 4: Silentnight

In this chapter I present and interpret results derived from a case study of Silentnight. The purpose of this chapter is threefold: (1) to understand internal and external factors that influence business model change for sustainability (2) to understand sustainability issues that influence decision-making for business model change for sustainability at the individual level; and (3) to understand shared perceptions about sustainability issues across Silentnight.

This chapter is structured as follows. Section 7.1 introduces the case company Silentnight. Section 7.2 gives an overview of the methods used for data collection and analysis. Section 7.3 analyses and interprets results at the organisational and individual level. Section 7.4 brings together an overall perspective of the main findings for the case study.

7.1 Background

Silentnight Group Ltd is a large mattress manufacturer in the UK and it is a leader in the industry with an estimated 14.6% market share (Shamsuddin, 2018). Every year, Silentnight Group Ltd produces more than 500,000 beds across its brand portfolio (Silentnight Group Ltd, 2018d). Since 2014, the company has been producing Eco Comfort 1200 mattresses that contain fibres made from recyclable plastic bottles (Silentnight Group Ltd., 2018). To help reduce plastic waste accumulation in the ocean, Silentnight formed a new partnership with Marine Conservation in May 2018 (Fischer, 2018). The company's commitment to sustainability led to full membership of the Furniture Industry Sustainability Programme (FISP) in 2017 (Superbrands UK Ltd, 2017). In the same year, Silentnight received a Sustainability Award by The Furniture Makers' Company that recognises Silentnight's efforts and achieved improvements in sustainability (The Furniture Makers' Company, 2017). Silentnight's offices are located in Barnoldswick, Aspatria and Manchester in the UK (Silentnight Group Ltd, 2018b). This study focused on Silentnight's main office and manufacturing site in Barnoldswick.

7.2 Methodology

I conducted this case study in three phases, using multiple data sources. An overview of the mixed methods used in each phase of data collection and analysis is shown in (Table 7.1). Detailed descriptions of the methods used are presented in Chapter 3 (see subsection 3.3).

Table 7.1: Mixed methods multilevel approach used in the case of Silentnight

Phase	Method	Data collection approach	Level of analysis	Analysis technique
1	Document analysis	Qualitative	Organisational	Interviewing of documents
2	Site visit	Qualitative	Organisational	Description as analysis
2	Interviews with participatory cognitive mapping	Qualitative, semi-quantitative	Individual, Organisational	Content and structural analysis
3	Online survey	Semi-quantitative	Individual	Content and structural analysis, group categorisation, collective cognitive map

Phase 1 involved document analysis to get background information about Silentnight that helped inform the next phases in the research. Phase 2 involved site visits of the manufacturing facility and interviews with participatory cognitive mapping. To preserve anonymity key informants' name was replaced with a unique code made up of SN (Silentnight) and a letter (A-C). I interviewed three key informants (SN-A, SN-B and SN-C) who came from different functional areas in the company: senior management, product development and operations. The average age of key informants was 52 years, two of them were educated to the bachelor's level and one to the high school level. Phase 3 included an online survey that was distributed to team leaders. The online survey was fully completed by 12 respondents, however, one survey was excluded from the analysis due to erroneous responses. Respondents came from different functional areas: Sales/Marketing (2 respondents), Operations (5), Human Resources (1), Finance/Accounting (1) and Administration (2). The majority of respondents, nine out of 11, held managerial positions. The average age of respondents was 49 years. Three respondents were educated to high school level or equivalent, seven respondents were educated to bachelor's level and one respondent was educated to the doctorate level. To preserve anonymity respondents' names were replaced with a unique code made up of Silentnight (Silentnight), CM (cognitive map) and a number (1-11).

In the next section I focus on analysing and interpreting results at the organisational and individual level.

7.3 Silentnight's business model and key sustainability issues

This section has two parts. In the first part I present and interpret results about the company's business model as well as barriers and drivers for business model change for sustainability. In the second part I focus on important sustainability issues for decision-making and individuals' perceptions of those issues and relationships between them.

7.3.1 Results and analysis at the organisational level

7.3.1.1 *Silentnight's business model change for sustainability*

According to key informants SN-A, SN-B and SN-C, sustainability has always been part of Silentnight's business, however, managers have only recently decided to go public about company's sustainability efforts. It seems that

Silentnight is still developing the confidence in its environmental story, trying to avoid any unsubstantiated sustainability claims as pointed out by key informants. It is unclear at what point in time the first sustainability initiatives took place, however, Silentnight joined the FISP in 2008 and achieved full membership in 2017. FISP is an independently certified sustainability programme for businesses in the UK furniture industry supply chain (FISP, 2018). Furthermore, the company became sustainability award winner by The Furniture Makers’ Company for two consecutive years, in 2017 and 2018 (The Furniture Makers' Company, 2017; The Furniture Makers' Company, 2018). The sustainability award by The Furniture Makers’ Company recognises improvements in sustainability of manufacturing of furniture and furnishings.

Results showed that there have been two critical incidents that led to ongoing business model change for sustainability. The first critical incident was the realisation that sustainable modern materials could be applied to Silentnight’s bedding products. Key informant SN-A noted that he had his “light-bulb moment” when key informants SN-B and SN-C discussed the sustainability journey of Patagonia involving the use of modern materials. According to key informant SN-B, there is a link between Silentnight and sustainability leaders such as Nike and Adidas. They all use similar materials such as foams and polyesters to provide high performance and comfort. Furthermore, she noted that Silentnight strives to achieve the same goal as them, to convey the messages of sustainability and performance simultaneously.

The second critical incident was the growing awareness of ocean plastic pollution and its negative effects on marine ecosystems. Managers have realised that there is a potential to use recyclable plastic bottles for innovative, eco-friendly product development preventing plastic bottles ending up in the oceans. Consequently, a new range of eco mattresses has been developed. Eco mattresses contain layers that are made from polyester micro fibres manufactured from recyclable plastic bottles (Silentnightbeds, 2018). Key informant SN-C commented that reuse of materials for bedding products is challenging. Silentnight tries to reuse polyesters by bringing them back into its own production system or other production systems where they are used for sound proofing or underlying carpets for cars.

Silentnight's focus on material reuse led to a growth in product take-back, consequently influencing the need to accommodate a circular business model (Moran, 2017). As a result, a different supply chain was designed to collect, transport and process the used bedding products such as beds and mattresses. The new, circular supply chain needs to be managed well to avoid poor practices leading to reputational risks. Implementing the circular supply chain required changes in relationships with key partners such as home delivery partners and recyclers.

A particularly interesting finding was that Silentnight's managers decided not to promote closed-loop recycling into the company's products because of the uncertainties related to the existing technologies, standards and protocols to achieve closed-loop recycling. However, a procurement policy based on the circular economy principles will require future revisions because of the company's plan to adopt a similar risk management approach for all of its inbound procurement systems.

Silentnight's goal is to achieve a resource efficient business model by benchmarking itself against sustainability leaders such as Unilever (Silentnight Group Ltd, 2018c). To achieve resource efficiency, Silentnight has put in place a programme of continuous improvements, however, the company has a range of products that are not sustainable. Key informant SN-A interpreted the current situation by analogy with Toyota's business model. He commented that like Toyota's Prius, Silentnight has its eco products along with other unsustainable products that might not be profitable in long-term. While more sustainable, practical alternatives exist in relation to materials, they tend to be expensive and Silentnight's goal is to bring sustainable products into the mainstream not just the luxury end of the market.

The results show that Silentnight's managers are aware of sustainability gaps, however, they need to deal with tensions to keep the business profitable. Table 7.2 shows the identified areas with sustainability improvements that are linked to the overarching business model components, and to the adopted approaches in the past as well as the new approaches being explored for the future changes. The company implemented a range of incremental change approaches, i.e. efficiency as well as more transformational change approaches such as forming new partnerships and collaborative projects, i.e. industrial symbiosis.

Table 7.2: Identified past sustainability improvements and sustainability approaches adopted in the future

Business model component	Key areas of sustainability improvements	Approach
Value creation and delivery	Energy and material efficiency	Collaborating with suppliers (i.e. John Cotton and Spencer) through industrial symbiosis approach (Key informant SN-B 2018, interview, 11 April)
		Collaborating with external consultant that audits waste work on an annual basis (Moran, 2017)
		Adopting energy saving opportunity scheme led to investments into smart systems and technologies (i.e. Ecogate system and Vickers Energy Management System) at organisational level. It also led to encourage changes at the individual level through behaviour change programme 'Switch Off' (Moran, 2017)
		Increasing % of electricity supplied by renewable sources (Key informant SN-A 2018, interview, 11 April)
		Measuring material efficiency by comparing standard usage versus actual usage, the data is used to target areas for improvement (Key informant SN-B 2018, interview, 11 April)
	Reducing GHG emissions related to transportation	Between 2012-2017 the company improved average miles per gallon by 14.5% through implementing bonus-related driver efficiency app and camera system (Moran, 2017)
	Waste reduction	Reduction in landfill disposal (i.e. 9% in 2016 compared to 32% in 2013) (Moran, 2017)

Business model component	Key areas of sustainability improvements	Approach
	Use of recycled and recyclable materials	Increasing the use of sustainable technically advanced materials. (Moran, 2017) Investing in product research by forming partnerships with universities and research institutes as well as collaborating with suppliers (Moran, 2017)
	Green procurement	Operating a timber procurement policy, using FSC-certified sources (Silentnight Group Ltd, 2018a)
	EoL products management	Increasing the number of end of life products for disassembly through suppliers; auditing of suppliers to manage the risk of reputation and to better understand how materials from old mattresses are being reused. (Moran, 2017) Future: Designing changes for EoL products management, considering an extended producer responsibility scheme for mattresses (Moran, 2017)
	Increased transparency	Future: Adoption of EPDs (Moran, 2017)
Value proposition	New offerings	Past: Eco-comfort range (mattress filling made of recycled plastic bottles) Foam and chemical treatment free cot bed mattresses

Business model component	**Key areas of sustainability improvements**	**Approach**
		Future: Offering leasing options, i.e. shifting to a Product-Service (Key informant SN-B 2018, interview, 11 April) Modular business model, selling synthetic components (Key informant SN-A 2018, interview, 11 April) New products made of sustainable technology textiles for mass market (Key informant SN-A 2018, interview, 11 April)
Value capture	New revenue streams	Focusing on new market segments, i.e. millennials with a high level of environmental awareness (Key informant SN-A 2018, interview, 11 April)

Having discussed Silentnight's business model, past and future sustainability changes, I will now move on to the main barriers and drivers influencing company's business model change for sustainability.

7.3.1.2 *Barriers of Silentnight's business model change for sustainability*

Results showed that there exist three main barriers influencing company's business model change for sustainability. First, flame retardant chemicals (FRCs) in bedding products and related paradox between compliance with the UK flammability law and use of FRCs that are harmful for the environment and human health. Second, commercial reality defined by consumers' needs and competitive environment. Third, challenges related to managing a traditional and circular business model simultaneously. Each of the barriers will be addressed in turn.

Flame retardant chemical treatments in foam and legislative inertia

Analysis showed that FRCs in bedding products represent the crucial sustainability issue for the company. Specifically, the use of FRCs in foam for mattress application. While foam has positive characteristics that make it a good sleep surface such as flexibility and durability, it can be used safely for mattress application only if it is appropriately fire-retarded (Hirschler, 2008). The company uses foam with added FRCs to comply with the fire safety legislation, however, FRCs can be harmful and pose a risk to human health and environment. For instance, different human health effects were found to be associated with FRCs exposure such as asthma and allergies (Araki et al., 2014) and increased risk of developing papillary thyroid cancer (Mughal and Demeneix, 2017). Recent research on flame retardants in UK furniture has shown that FRCs increase smoke toxicity and suggests that fire toxicity should be included in the fire safety regulations (McKenna et al., 2018).

The data suggest that Silentnight's managers have to deal with the paradox between compliance with the UK flammability law (based on rules designed in the early 1970s) and use of FRCs in bedding products that are harmful for the environment and human health. Key informant SN-B commented that the company is capable to deal with the FRCs in most of their products with the exception of foam. Awareness of the problems related to FRCs drives managers' decision-making for healthier and environmentally friendlier products. Consequently, programmes have been launched to explore and analyse fabrics to remove FRC treatments where possible. While changes at the organisation-level are currently ongoing, a broader system-level change in relation to FRCs is also needed to achieve significant sustainability improvements. Key informant SN-A commented that legislative change is required, which is beyond their individual company's resources, and that trade federation, or European federation should be involved to achieve that.

Suppliers of materials, specifically foam, are important players in the company's sustainability journey. For instance, the foam supplier has been developing a sustainable alternative, however, Silentnight's managers are uncertain about the final outcome and expressed scepticism towards green labelling. Furthermore, key informant SN-A said that alternatives exist such as geltex (using natural oils instead of chemicals), however, the issue is how to balance comfort and safety of bedding products.

FRCs in foam for mattress application represent a complex problem for the company because of the health and environmental issues associated with FRCs. Furthermore, there is a concern whether non-FR treated products are safe against fire. According to key informants, risks need to be balanced against rewards when making decisions about sustainable materials used in bedding products. Additionally, the use of FRC treatments is associated with other inhibiting factors such as commercial reality on which I focus next.

Commercial reality

Doing the right thing is an idiom that was often used by key informants throughout the interview to justify the company’s sustainability efforts. According to key informants, Silentnight tries to promote corporate and personal sustainability. However, as stated by key informant SN-A, there is “no use in bankrupting business by trying to be perfect, so we have to move in step with what we can do within commercial reality”. An important aspect of commercial reality that influences Silentnight’s managers decision-making and action-taking related to sustainability is consumers’ needs. Key informant SN-C commented that using open coil mattresses would be the best option because they are easily recycled. However, he noted that consumers prefer other types of mattresses, therefore, the company tries to use the existing materials as efficiently as possible. Key informant SN-B added that Silentnight’s goal is to have a broad range of products to satisfy diverse consumers’ needs and to distinguish themselves from competitors that follow *one size fits all* strategy.

Another challenging aspect of commercial reality is the competitive environment. Silentnight needs to consider competitors that do not comply with legislation and make the same products at a lower price, easier and faster because “there’s no policing” as noted by key informant SN-A. On the other hand, there are competitors that deliver corporate greenwash while Silentnight is committed to ethical business, therefore, trying to avoid any unsubstantiated claims. For instance, key informants expressed their scepticism about companies claiming zero to landfill status. Silentnight cannot currently achieve this goal, as key informant SN-C explained, “we contacted all of our recycling partners and not one of them could actually commit to a 100% landfill avoidance”.

The managers demonstrate their ability to deal with a paradox between organisation-level recycling goals and system-level recycling infrastructure capacity. Managers understand that zero to landfill could reduce the company’s environmental impact, however, this is currently not achievable because of the limited capacity of recycling infrastructure. Furthermore, managers reported striving to be responsible and prevent greenwashing while balancing the need to sustain their business against companies that are making false sustainability claims.

Challenges of managing a traditional and circular business model simultaneously

Key informants commented that there are different challenges in managing the traditional business model and the circular business model simultaneously. As discussed above, the high level of greenwash in the bedding industry influences the context in which Silentnight operates and needs to be considered in decision-making about business model change for sustainability. Another challenge influencing circular business model is consumers’ concerns about comfort and overheating. The first eco range was launched in 2014 and consumers' needs influenced further developments to improve the comfort and breathability of the eco products. Key informant SN-B commented that these developments required new working relationships with suppliers that provided technology. For instance, collaboration with John Cotton allowed Silentnight to create eco mattresses with a soft and silky feel. Furthermore, Silentnight collaborated with a research institute to look at how fibres transport heat and moisture to prevent overheating. As a result of this collaboration, a three-layer system was developed based on a nappy principle that provides a dry and healthy sleeping environment. The goal of continuous improvements is to design products that deliver environmental benefits, i.e. products made of easily recyclable materials that are chemical free and at the same time provide comfort and breathability.

Another sustainability aspect that influences the circular business model is EoL products. Key informants explained that Silentnight aims to be a responsible recycler, however, there is a limited capacity for recycling in the UK and exporting for recycling is not a sustainable solution. Furthermore, deconstruction is a labour-intensive process and a technological solution for mattress disassembly does not exist. While recycling of mattresses creates positive environmental effects, approximately 30.000 old mattresses are being recycled each week in the UK (Slater et al., 2014; Bell et al., 2017), it also causes concerns. For instance, the inappropriate and unethical reuse of materials obtained through mattress deconstruction.

It seems that while reuse and recycling are behaviours to be encouraged, there are businesses in the bedding industry using poor practices, taking advantage of the desire to recycle and pushing consumers to buy substandard products in relation to health and environmental aspects. Such poor business practices could even be considered fraudulent, consequently having negative effects on the bedding industry and its sustainability efforts. Key informant SN-B cited the reuse of mattress springs and how not all of them are fit for repurposing. While this informant agreed with the practice of repurposing she noted that this should be communicated to the consumer. Key informant SN-C noted that being transparent about reused materials is not something that all manufacturers do and repurposed materials are often sold as new.

Having analysed and interpreted the main barriers for Silentnight's sustainable business model, the next section addresses the main drivers.

7.3.1.3 *Drivers of Silentnight's business model change for sustainability*

Results showed that three main drivers influence company's business model change for sustainability: vision, new markets and the sustainability programme with top management engagement. Each of the drivers will be addressed in turn.

Vision

Vision is an enabler of Silentnight's business model change for sustainability. Managers' decision-making is driven by the *bed for life* concept; they see the future business model as a type of PSS or modular business model. Key informant SN-A envisages the business model based on selling synthetic components rather than selling mattresses. As described in the previous section about barriers, commercial reality plays an important role in the business model change for sustainability. The envisaged modular business model could potentially become viable in the next 10 years if the costs of production are low.

Furthermore, such a business model could potentially change the structure of the whole bedding industry.

Entering market segments with strong sustainability orientation

Managers see new business opportunity in the growing market segment, millennials. Key informants commented that recently new companies such as Eve and Casper have entered the bed market, specifically targeting millennials living in London. These new entrants offer *one mattress fits all sizes* and invest heavily in advertising, trying to gain their market share. While Silentnight's managers describe millennials as "people too cool to shop" and "too cool to be asked to pick anything", they also consider them as probably most environmentally aware segment of consumers.

According to key informant SN-A, the company could seize the opportunity "once we have got confidence in our environmental story, by the way, once our marketing team understands that statement at all". This implies that the marketing team has not yet managed to successfully translate environmental efforts into a strong marketing message to enhance sustainability by encouraging consumers to buy sustainable products.

Sustainability programme and top management involvement

Results showed that the group board set the objective to create an environmental statement which led to an internal audit of sustainability initiatives across departments, resulting in two consecutive sustainability awards. Managers aim to continue improving sustainability performance, however, as illustrated in the analogy with Toyota's business model, Silentnight still offers unsustainable products because they help the company to remain in business.

Thus, managers deal with tensions between environmental, social and economic sustainability by focusing on continuous innovation and considering commercial reality.

7.3.1.4 *Organisational level summary of findings*

Results showed that while drivers such as vision and top management involvement influence business model change for sustainability, barriers related to the use of FRCs and legislative inertia are undermining Silentnight's sustainability efforts. Changes at the individual, organisational and systemic level are required to enable significant business model change for sustainability.

7.3.2 Results and analysis at the individual level

This section analyses and interprets the complexity of sustainability issues that influence key informants' decision-making for improving company's resource efficient business model and its overall sustainability performance. Results were obtained through the interviews with key informants SN-A, SN-B and SN-C using participatory cognitive mapping (see Chapter 3, subsection 3.3.3.2). Results were used to address the second research question: *What sustainability issues influence decision-making for changes in business model to improve sustainability performance?*

Furthermore, I interpret content and structural differences across cognitive maps of sustainability issues derived from the participatory cognitive mapping and online survey. A collective cognitive map was created to provide an overall picture of what sustainability issues are perceived as important across company. Results were used to address the third research question: *How do cognitive* *models of sustainability issues differ in the context of sustainable business models?*

7.3.2.1 *Content of the cognitive maps*

Content of the cognitive maps refers to the type of sustainability issues (economic, environmental and social) and number of sustainability issues included in the cognitive maps.

Sustainability issues driving key informants' decision-making

Exploring sustainability issues that drive managers' decision-making provided insights into why changes in business model occur. Key informants SN-A, SN-B and SN-C identified important sustainability issues that drive their decision-making and explained reasons for their choices (see Table 7.3).

Table 7.3: Important sustainability issues for key informants' decision-making in Silentnight

Key informant SN-A		Key informant SN-B		Key informant SN-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
Difficult recycling at the EoL	Products in the bedding industry are difficult to deconstruct and therefore difficult to recycle.	Seek specialised knowledge	Collaboration, i.e. materials lab; interdisciplinary approach to find modern material solutions.	Environmental impact of materials	Company uses different materials such as timber, fabrics and cotton. For example, the company's aim is to move further away from cotton and to use more of recyclable materials such as polyester and what they call Technical textiles that are manmade fibres. Metal can be recycled, however, production is energy intensive.
Designing products with the EoL in mind	To ensure easier recycling at the EoL. There are still products in the company's portfolio that are not acceptable	Commercial range of sleep solutions to suit all the family	Challenges of delivering sustainable products to the mass market at volume prices.	Recyclable materials (timber)	Current situation with recycled materials is that many businesses are not willing to pay premium price.

Key informant SN-A		Key informant SN-B		Key informant SN-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
	from a sustainability point of view but are acceptable either from a price and/or practical point of view (i.e. produce a nice feel).		Products need to be commercial - that means having wide appeal and offering a range of sleeping solutions.		Silentnight purchases sustainable materials based on the moral principles.
Reducing environmental impact	Consistently reducing environmental impact by focusing on different areas at the same time and getting the message across to the consumers.	Health and well-being	Public Health England's message needs expanding to include sleep as a priority in terms of public health. Sleeping products should deliver health and good night sleep by giving people the correct support for their spine (enabling rehydration and elongation of spine, importance of ergonomics); using comfort materials for different heights and weights; and providing suitable microclimate in the mattresses to prevent overheating and ensure long-term performance of fibres.	High use of steel	Recycle and reuse of steel is a positive thing to do. Manufacturing methods make it very difficult to deconstruct the mattress which influences high costs of recycling process. Infinitely recyclable.

Key informant SN-A		Key informant SN-B		Key informant SN-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
			Issue of using FRs in the products to comply with flammability regulations; FRs have negative impacts on human health and environment		
Legal compliance	Works against sustainability in some areas. FR issues are particularly relevant for the bedding industry.	Resource efficient business	Regenerating process waste into new materials or avoiding waste completely. Take-back service, responsible deconstruction (reuse of materials). Make to order; sufficiency of stock.	Consumers' perceptions	Influence the purchasing decisions. Consumers' perceptions drive the high use of materials, e.g. foam and steel. Example of foam - not necessarily consumers' fault because they are being force-fed foam-based products that are rolled up and come in a box. The industry has a job to change consumers' perceptions.

Key informant SN-A		Key informant SN-B		Key informant SN-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
Commercial viability	Creating demand for commercially viable products that meet the short- and long-term aspirations. Offering products for the mass market at affordable prices. New materials – examples of materials that are uncommercial at the moment but might lead to a major shift in the market dynamic in 10 years' time. Product comfortability and attractiveness.	Vision (contemporary corporate views)	It underlies everything that company does. Sustainability is becoming the fourth pillar of company's vision along with the quality, service and continuous innovation. Changing the thinking of the board group members about sustainability.	Chemical treatments	Compliance with the UK flammability regulations (chemicals added to the materials). Anti-allergens; adding anti-dust mite treatment to a fabric requires adding an additional chemical to get the fire retardancy. Toxins emitted by chemicals added to a fabric might be worse than toxins emitted from the smoke in the case of fire. This is why company invests in testing to reduce the amount of chemicals used. Results of these efforts is a new range of products 'Eco Breeze' that has no additional chemicals.

Key informant SN-A		Key informant SN-B		Key informant SN-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
					For years consumers have been sold the idea of anti-allergy, hypoallergenic and more extreme chemical applications that reduce dust mites and even make you sleep better. These have been sold to entice the consumer and give the retailers a selling point, the truth is that any additional chemicals have an adverse effect on health.
Marketing	Getting the message across - to ‘shout out’ that the products do not contain FR and dangerous chemicals, that they are recyclable and partially made from recycled materials.	Challenging legislation	FR legislation.	High use of foam	It is one of the main issues for the company. It is one of the materials that is difficult to recycle and reuse.

Key informant SN-A		Key informant SN-B		Key informant SN-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
					Transitioning to an eco-foam model but the problem is that eco-foam is not actually a more sustainable option.
Avoid unsubstantiated claims	Not making greenwashed statements.	Marketing	Challenge of how to get the messages across to consumers about all the sustainability efforts involved into making and delivering mattresses.	Logistics	Fabric and timber that is manufactured abroad.
Recycled materials in our new products	Making products that are recyclable and that come from recycled materials; to make acceptable finished products in this context. Increasing the amount of recycled materials in the products.	Greening supply chain	Considerations about how the products and the whole supply chain impact environment; mapping out the impact (e.g. in the case of foam this is challenging because there is no complete information available about what goes into the foam, so the company is trying to get more detailed information based on the foam analysis).	Recycling	Small volume of PET bottles recycled in the UK; localization of recycling will save a lot of the impact. Conversations with local MPs and business partners to search for collaborative solutions.

Key informant SN-A		Key informant SN-B		Key informant SN-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
			It is not a trust issue but currently the suppliers are not sharing all the information. Following REACH and OEKO-TEX guidelines to avoid using questionable chemicals. Working with responsible suppliers.		
/	/	Use of modern materials	Focus on innovation to bring more environmentally friendly materials and processes as per circular economy concept.	High energy consumption	It is a high energy usage business – lack of automated machines in the operations.
/	/	Product development	As above.	Reuse	Negative perceptions of reuse in the bedding industry (the issue of cleanliness and not wanting reused and recycled materials).

Key informant SN-A		Key informant SN-B		Key informant SN-C	
Issue	*Reasons for selection*	*Issue*	*Reasons for selection*	*Issue*	*Reasons for selection*
/	/	Consumers' mind-set	Knowing what people think is the key. Company does not want to make products, give stories that people are not interested in. Consumers' mind-set is changing (e.g. they are reaching out about information on the provenance of the materials which would not have happened five years ago).	Costs of UK manufacture	High costs lead to increase in importing from abroad.

Analysis showed that economic and environmental issues were the most salient issues. A surprising finding was that key informants SN-A and SN-C did not consider any social issues while key informant SN-B considered one social issue, *Health and well-being*. I expected to see health related issues in all cognitive maps since they are important to design healthy, bedding products. The importance of health issues was also highlighted during the organisational level interviews.

Differences in content of cognitive maps are important because they influence responses to sustainability issues considered by the individual decision-maker (Hahn et al., 2014). Considering a spectrum of cognitive frames proposed by Hahn et al. (2014), key informant SN-A's and SN-C's cognitive maps had characteristics that place them close to a business-case frame end of the spectrum. In contrast, key informant SN-B's cognitive map had characteristics that correspond more with the paradoxical frame at the other end of the spectrum. It is likely that SN-A and SN-C might tend to adopt a more pragmatic decision-making stance in relation to sustainability compared to SN-B (Hahn et al., 2014).

Content analysis also showed similarities across key informants' cognitive maps. For instance, key informants SN-A and SN-C both chose environmental impact as an important sustainability issue that drives their decision-making. Similarly, key informants SN-A and SN-B both chose economic issues related to marketing and legislation. Even though similarities were found across key informants' perceptions of important sustainability issues, there exist sizeable differences in their cognitive maps. There are several possible explanations for this result. For instance, current job role and functional background could have had an effect on key informants' cognitive maps. It is probable that contextual factors such as traditional linear business model and accommodation of circular economy influence the way key informants think about sustainability issues and how they relate to each other.

Sustainability issues identified by key informants (see Table 7.3) were the basis for the online survey to explore cognitive maps of sustainability issues across the company. Having analysed and interpreted content differences in cognitive maps, the next section of this chapter addresses structural differences.

7.3.2.2 *Structure of the cognitive maps*

Participatory cognitive mapping

The structure of the cognitive maps refers to the relationships between sustainability issues included in the cognitive maps. Analysis showed that the key informant SN-A identified six one-way and three two-way relationships between eight sustainability issues; seven positive, four negative and one neutral relationship (see Figure 7.1).

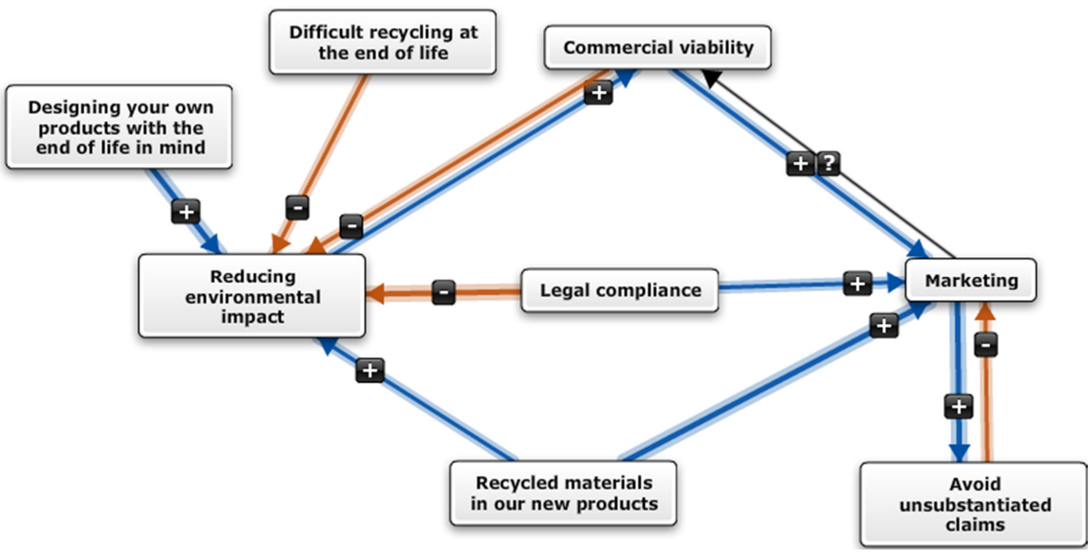

Figure 7.1: Key informant SN-A's cognitive map

The sustainability issue with the highest centrality score was *Reducing environmental impact* around which a cluster of sustainability issues formed with links ranging from moderate to very strong. A surprising finding was the negative relationship between *Commercial viability* and *Reducing environmental impact*, meaning that an increase in *Commercial viability* leads to a decrease in *Reducing environmental impact*. The key informant SN-A commented that it is difficult to decide whether the relationship is negative or positive. Currently, reducing environmental impact can be seen as a commercial disadvantage when considered purely from a cost perspective. Furthermore, if the company manages to communicate their environmental message to customers successfully then Silentnight's products would become more desirable. However, the question is whether customers would be willing to pay a premium price for sustainable products.

Key informant SN-C identified 14 one-way relationships (six positive and nine negative) between 11 sustainability issues (see Figure 7.2).

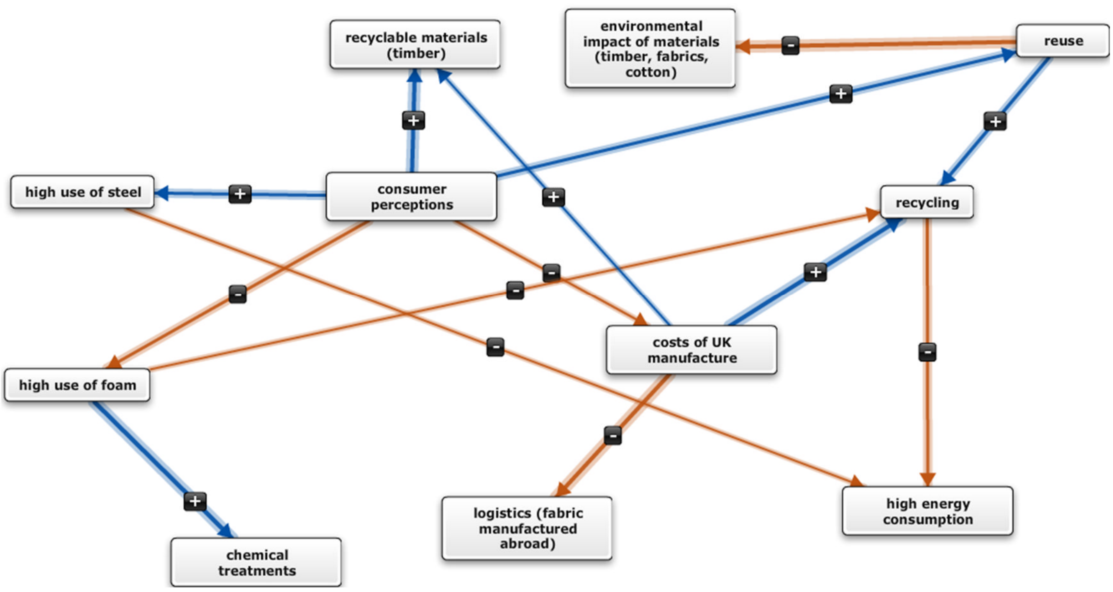

Figure 7.2: Key informant SN-C's cognitive map

In relation to materials' use, high use of steel and high use of foam are the two important sustainability issues. High use of steel, specifically virgin steel, is linked to high energy consumption, however, according to key informant SN-C the infinite use of recycled steel might offset this. Furthermore, steel is a more sustainable option compared to foam; high use of foam increases the use of chemicals because all types of foam require additional FRCs. The increased reuse of materials was linked to the decreased environmental impact. Furthermore, a positive change in consumers' perceptions towards reuse was linked to the increased reuse. As key informant SN-B pointed out, "if the consumer can understand that recycled/reuse materials are still hygienic and clean the reuse would be far greater – especially when manufacturing a mattress and sleeping surface".

In contrast to key informants SN-A and SN-C, key informant SN-B developed the most complex cognitive map with 40 relationships (10 one-way and 15 two-way relationships) between 11 sustainability issues (see Figure 7.3). Most of the relationships (38 out of 40) were identified as positive, strong or very strong. All the identified sustainability issues were ordinary issues, meaning they influence other issues and are themselves influenced by other issues in the cognitive map.

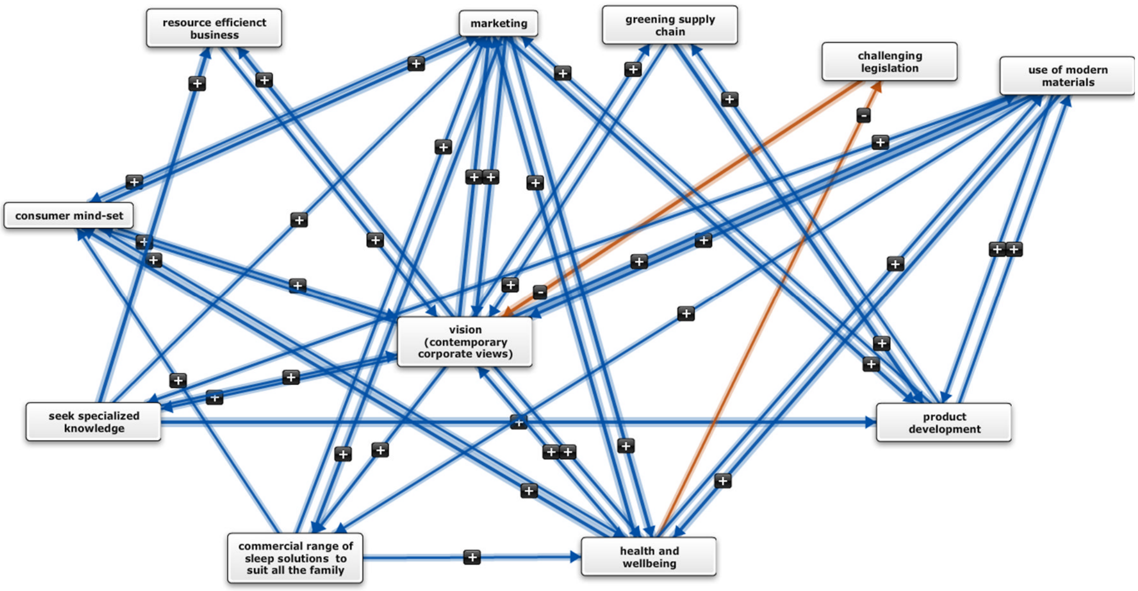

Figure 7.3: Key informant SN-B's cognitive map

The key informant SN-B compared to SN-A and SN-C considers a higher level of complexity of sustainability issues, which might lead to adoption of a prudent decision-making stance, considering a broad scope of new alternative approaches to address sustainability issues in a comprehensive way. However, awareness that new approaches involve higher risk and resulting contradictory effects might hinder the action-taking process (Hahn et al., 2014).

Online survey

A group categorisation of cognitive maps derived from the online survey showed significant differences across respondents' perceptions of relationships between specific sustainability issues. For instance, the relationship between *Commercial viability* and *Employee engagement* was identified by five respondents. Two respondents identified a positive two-way relationship, while a negative two-way relationship, a positive one-way relationship and no relationship were each identified by one respondent. The identified strength of relationship also varied from weak (1) to strong (3). Similar results were found in relationships between *Employee engagement* and *Designing with the end of life in mind* (see Table 7.4) and *Reducing environmental impact* and *Working conditions and rights* (see Table 7.5). Relationships differed in their directionality, type and strength.

Table 7.4: Relationship between *Employee engagement* and *Designing with the end of life in mind*

Cognitive map	No relationship	Employee engagement → Designing with EoL in mind	Designing with EoL in mind → Employee engagement
SNCM2			-1
SNCM6		-3	+1
SNCM7		+3	+1
SNCM9	0		
SNCM11			+1

Table 7.5: Relationship between *Reducing environmental impact* and *Working conditions and rights*

Cognitive map	No relationship	Reducing environmental impact → Working conditions and rights	Working conditions and rights → Reducing environmental impact
SNCM1		+3	+2
SNCM2		+1	
SNCM3		-3	-3
SNCM6		+3	-1
SNCM9		+1	+1

A particularly interesting finding was that a group of four respondents considered relationship between *Commercial viability* and *Reducing environmental impact* as positive, while the key informant SN-A considered the same relationship as negative. Furthermore, he explained that while it is difficult to assess whether the relationship is positive or negative, currently reducing environmental impact is seen as a commercial disadvantage. Existing differences in perceptions of relationships between specific sustainability issues indicate a potential for paradoxical tensions which could hinder decision-making about sustainability at the individual, group and organisational level.

7.3.2.3 *Centrality of sustainability issues in the cognitive maps*

Participatory cognitive mapping

A centrality score of an individual sustainability issue represents a degree of relative importance of that sustainability issue in a cognitive map (Gray et al., 2013). Comparing centrality scores of sustainability issues in cognitive maps helps to ascertain what areas are of concern to individual interviewee (Eden and Ackermann, 1998). Table 7.6 shows centrality scores of sustainability issues included in key informants' cognitive maps. For instance, sustainability issue labelled as *Vision (contemporary corporate views)* achieved the highest centrality score in the key informant SN-B's cognitive map (see Figure 7.3). The key informant commented that vision underlies everything the company does, and that sustainability has become the fourth pillar of business along with quality, service and continuous innovation. It seems that members of the board of directors are changing their thinking and understanding of sustainability which consequently drives new sustainability initiatives at the organisational as well as individual level. For instance, the change in thinking about sustainability was reflected in adoption of FISP sustainability programme. On the other hand, *Challenging legislation* achieved the lowest centrality score. It could be said that this reflects the complexity of the situation in which Silentnight operates, corporate position to reduce the use of FRCs versus flammability legislation that promotes the use of FRCs. While there is a need for intervention at the organisational level, significant changes are also required at the system level.

Table 7.6: Silentnight key informants centrality scores

Key informant	Sustainability issue	Centrality score
SN-A	Reducing environmental impact	4.3
	Marketing	3.6
	Recycled materials in our new products	1.7
	Commercial viability	1.6
	Avoiding unsubstantiated claims	1.5

Key informant	Sustainability issue	Centrality score
	Legal compliance	1.5
	Designing products with the ned of life in mind	1.5
	Difficult recycling at the EoL	0.6
SN-B	Vision (contemporary corporate views)	13.4
	Marketing	9.8
	Health and well-being	8.5
	Use of modern materials	6.8
	Consumer mind-set	5.8
	Product development	5.7
	Seek specialised knowledge	4.9
	Commercial range of sleep solutions to suit all the family	4.6
	Greening supply chain	3.2
	Resource efficiency business	2.7
	Challenging legislation	1.6
SN-C	Consumers' perceptions	3.1
	Costs of UK manufacture	2.9
	Recycling	2.4
	Reuse	2.1
	High use of foam	1.9
	Recyclable materials (timber)	1.5
	High energy consumption	1
	High use of steel	1
	Logistics (fabric manufactured abroad)	1

Key informant	Sustainability issue	Centrality score
	Environmental impact of materials (timber, fabrics, cotton)	1
	Chemical treatments	0.9

Reducing environmental impact was perceived as the most central issue by key informant SN-A. It could be said that this issue drives decision-making in relation to sustainability and represents one of the core values. *Difficult recycling at the end of life* was identified as one of the main barriers affecting business model change for sustainability and it is likely that there is a potential for intervention at different levels. For instance, designing strategies that would encourage behavioural change on the consumers' side, appropriate maintenance of mattresses and disposal that would help more effective recycling. Furthermore, company could help in development of an industry level strategy that would push for a system-level change to provide sufficient recycling facilities for mattresses.

The key informant SN-C perceived *Consumers' perceptions* as the most central issue. Consumers' needs were identified as one of the most important factors influencing business model change for sustainability, specifically, the use and reuse of materials such as steel. It seems that there is a potential to change relationships with consumers, by educating them about sustainability and engaging them in development of sustainable bedding products.

Online survey

A collective cognitive map was created based on 11 individual cognitive maps to represent shared perceptions of sustainability issues. The collective cognitive map revealed that *Reducing environmental impact* (environmental issue) was the most central sustainability issue followed by *Commercial viability* (economic issue) and *Designing products with the end of life in mind* (environmental issue). It could be said that environmental impact reduction is one of the core values for Silentnight. Table 7.7 shows centrality scores of sustainability issues in the collective cognitive map.

Table 7.7: Silentnight centrality scores

Sustainability issue	Centrality score
Reducing environmental impact	2.05
Commercial viability	1.58
Designing products with the end of life in mind	1.54
Cost of UK manufacturing	1.53
Employee engagement	1.44
Working conditions and rights	1.37
Business ethics	1.21
Difficult recycling at the end of life	0.84
Health and well-being	0.77
Vision	0.67
Use of recycled and modern materials in new products	0.66
Legal compliance	0.63
Chemical treatments	0.61
Resource efficient business	0.6
Product development	0.45
Positive consumers' perceptions/mind-set	0.39
Apprenticeships	0.36

Sustainability issue	Centrality score
Innovation	0.36
High use of foam and steel	0.3
Relationships with suppliers	0.3

Issues that achieved the lowest centrality score represent areas where interventions might be needed such as relationships with suppliers, and high use of foam and steel. Interestingly, innovation also achieved a low centrality score even though continuous innovation is considered one of the four pillars of business.

7.3.2.4 *Individual level summary of findings*

Cognitive maps derived from the online survey showed the overall picture of what sustainability issues are perceived as the most important for the company. It seems that the reduction of the environmental impact is considered a priority, followed by commercial viability and product design. On the other hand, key informants' cognitive maps revealed more details about why managers consider specific sustainability issues for decision-making to further improve the existing sustainable business model. It may be argued that changes at the individual, organisational and system level are required to achieve a truly significant business model change for sustainability.

7.4 Discussion

The purpose of this chapter was threefold: (1) to understand internal and external factors that influence the company's business model change for sustainability; (2) to understand individuals' cognitive models of sustainability issues that influence decision-making for business model change for sustainability; and (3) to understand shared perceptions about sustainability issues across Silentnight. The case study was addressing three research questions that form the basis for this discussion.

Research Question 1: What internal and external factors influence business model change for sustainability?

Results suggest that different internal and external factors play an important role in Silentnight's business model change for sustainability. For instance, Silentnight's managers have been inspired by sustainability-driven innovations from fashion brands such as Patagonia, Nike and Adidas, and decided to follow the suit. As a result, they adopted eco-design to create a product range with mattress layers made from recycled plastic bottles. Managers aspire to increase the use of recycled and recyclable materials in products, and bring more sustainable products into the mainstream.

In this case study I found that Silentnight uses steel, polyester, felt, foams, polythene, fabric and traceable timber as main materials in its bedding products. From a sustainability perspective, foam is the worst material that the company deals with. First, foam is a petroleum-based material. Second, foam is extremely flammable material which means that FRCs are added to ensure products safety. Third, foam releases VOCs and human exposure to VOCs might lead to negative health outcomes. Finally, foam does not decompose easily. On the other hand, foam is a cheap, flexible, durable and lightweight material that is also a good sleep surface. While Silentnight's managers have found solutions to reduce the use of FRCs across different bedding products, foam continues to be the most challenging material. Managers have to deal with tensions when they simultaneously pursue sustainability and quality performance objectives embedded in the main pillars of their business. It seems that FRCs used to fireproof foam-based mattresses are undermining the company's sustainability objectives, which raises two questions:

- Is reduction of FRCs in materials that are essentially bad, from a sustainability perspective, a good solution?
- Could foam be completely phased out from mattresses (Silentnight has already developed a cot mattress collection free from foam and chemical treatments, and is ultimately aiming to stop using foam completely) and replaced by more sustainable alternatives?

Currently, more sustainable solutions exist such as foams made with natural oils (polyols), however, performance, cost and the established infrastructure around petroleum-based materials remain the main barriers to significant market penetration (Neff and Gajewski, 2018). Furthermore, there are new developments in bio-based materials such as sugar-derived raw materials that could potentially shift the balance between cost and performance, however, these developments are still in early stages (Neff and Gajewski, 2018). Scepticism about new green developments and their sustainability performance as well as the cost were issues expressed by key informants in this case study. Additionally, the use of such sustainable solutions for mattress application would entail high price for consumers. Therefore, WTP should be taken into consideration when making decisions about sustainable materials to increase the overall business model sustainability performance. Furthermore, managers should also consider the willingness of potential consumers to buy eco products. For instance, willingness to buy a carbon-derived foam mattress was shown to be low or even negative across consumers that reported a high level of ecologically conscious behaviour (Arning et al., 2018). Considering that Silentnight's managers see their opportunity with millennials as environmentally most conscious consumer segment, a good understanding of factors influencing millennials' willingness to buy seems to be crucial for commercial success. Furthermore, collaboration with millennials to co-design products could positively influence their willingness to buy.

Silentnight's total costs for raw materials are approximately £50 million per year and material efficiency is measured by comparing standard usage versus actual usage to target areas for improvement. While the company's aim is to increase the use of recycled and recyclable materials, the scale at which the company operates, and the amount of materials input needed might impede a significant shift towards sustainability. It was a surprising finding that Silentnight has not performed LCA of their bedding products as it could provide detailed information about the environmental impacts at different stages of their products' lives. For instance, environmental impacts of foam and pocket-spring mattresses occur mostly in the manufacturing process, specifically the polyurethane foam block moulding process and the pocket spring nucleus process (Lanoë et al., 2013). Using LCA at the design stage could help improve environmental performance of bedding products and inform manager's decision-making about further sustainability improvements. It should be noted here that managers are considering to adopt EPD based on the LCA in the future.

Another important factor that influences Silentnight's business model change for sustainability is the circularity of materials used to make bedding products. Besides focusing on eco-design, the company has increased the amount of EoL products for disassembly and sale of materials for recycling and reuse. For instance, steel springs are used to make car panels. The company has also adopted the circular supply chain along with the supporting circular business model that required changes in relationships with key partners such as recyclers. However, achieving the zero to landfill goal seems to be challenging because of the limited recycling capacity at the system-level. Furthermore, the variable quality of used mattresses that come back into supply chain through take-back programme influences the level of circularity of materials and the overall business model sustainability performance. Additionally, managers have decided not to promote the closed-loop recycling because they are uncertain about the existing technologies and standards to achieve it.

A high level of circularity of materials can bring about sustainable, competitive advantage. For instance, Patagonia, Inc. has achieved that through sustainability-driven innovation focusing on circular supplies, resource recovery and product life extension, and continuous circular initiatives (Rattalino, 2018). It seems that Silentnight has chosen to follow a similar path, however, to increase the circularity of materials for mattresses, changes at different levels are required. For instance, consumer-level changes in relation to use and maintenance of mattresses to ensure good quality at the point of take-back. Furthermore, organisation-level and system-level changes to increase recycling capacity as well as technology which would enable closed-loop recycling.

This case study has shown that commercial reality, specifically consumers' needs influences managers' decision-making about sustainability changes in the business model. Furthermore, Silentnight's managers want to bring sustainable products into mainstream with a strong environmental story, avoiding any unsubstantiated claims. It could be said that there is disconnect between what Silentnight does in relation to sustainability and marketing efforts of getting the environmental message across to the consumers to increase sustainability performance. For instance, sustainability leaders such as Patagonia, Inc. have successfully adopted communication strategies of green demarketing advertising, encouraging avoidance of buying unneeded products that led to increased sustainability performance (Kim et al., 2018; Reich and Soule, 2016). However, Silentnight might have to design different communication strategies or mix of strategies to address its mass market.

Thus far, the analysis shows that Silentnight's business model change for sustainability was influenced by a combination of external and internal factors. These findings are in line with previous research on the influence of macro-level factors and organisation-level factors on business model change (Bock et al., 2012; Doz and Kosonen, 2010; Ocasio and Radoynovska, 2016; Schaltegger et al., 2012). However, less is known about the micro-level factors such as managerial cognition in relation to changes in business models (Foss and Saebi, 2017). Furthermore, there is a lack of empirical research in the area of cognitive models that play an important role in decision-making and action-taking related to business model change for sustainability. In order to contribute to this area of knowledge I explored the cognitive models of sustainability issues in Silentnight. Results obtained through the interviews with participatory cognitive mapping and the online survey were used to address the second and third research question:

Research Question 2: What sustainability issues influence decision-making for business model change to improve sustainability performance?

Research Question 3: How do cognitive models of sustainability issues differ in the context of sustainable business models?

This case study found evidence that the reduction of environmental impact is perceived as the most central sustainability issue followed by commercial viability. A group of four respondents in the online survey considered the relationship between *Commercial viability* and *Reducing environmental impact* as positive, while the key informant SN-A considered the same relationship as negative. Furthermore, he explained that while it is difficult to assess whether the relationship is positive or negative, currently reducing environmental impact is seen as a commercial disadvantage. Differences in perceptions of the type of relationship between *Commercial viability* and *Reducing environmental impact* could cause tensions, impeding decision-making about sustainability at the individual and organisational level. Commercial reality, specifically competitive environment and consumers’ needs, is considered as one of the main barriers for the business model change for sustainability. While reduction of the environmental impact is considered a priority, sustainable solutions need to align with the commercial reality; this is a paradoxical tension that managers deal with.

Results revealed substantial cognitive diversity across key informants' perceptions of important sustainability issues for decision-making. Cognitive diversity was found to be associated with strategic change and organisational performance in the case of healthcare organisations (Van de Ven et al., 2008). Furthermore, the link between cognitive diversity and organisational performance was found to be stronger when organisations considered integration processes, i.e. mechanisms to foster debate and dialogue between different perspectives to manage cognitive diversity. Cognitive diversity is a critical factor for sense-making and coping with complex environments (Weick, 1995) and issues such as sustainability. Key informants' cognitive diversity in Silentnight has a potential to positively influence decision-making and action-taking in business model change for sustainability. However, managers should consider cognitive diversity and design strategies to resolve any tensions between perspectives.

This case study suggests that resource efficient business model can be achieved through continuous innovation, adoption of best practices and top management engagement with long-term vision. However, Silentnight's business model change for sustainability seems to be also highly customer-driven, therefore, the company's future sustainability efforts are likely to depend on customers' needs and changing habits.

Chapter 8 – Discussion and Conclusion

This thesis set out to explore the underpinnings of business model change for sustainability in resource-based businesses. A review of existing literature on business model change for sustainability demonstrated that scholars have focused on investigating external and internal factors influencing business model change for sustainability. However, there is a gap in understanding how internal, individual factors influence business model change for sustainability. More specifically, how individuals' cognitive models of sustainability drive decision-making for business model change for sustainability, considering other internal, external and contextual factors. This thesis is comprised of empirical research in the form of four studies that explore business model change for sustainability from an organisational and cognitive perspective.

In this chapter I revisit the three research questions and discuss cross-cutting themes that emerged from the case studies. First, I discuss business model change for sustainability and the cross-cutting theme of circularity (section 8.1). Then, I discuss sustainability issues driving business decision-making and paradoxical tensions that emerged from participatory cognitive mapping and online surveys (section 8.2). Section 8.3 summarises the practical and theoretical contributions of this thesis. Section 8.4 discusses the limitations of the findings and provides future research directions. Finally, section 8.5 summarises the overall conclusions of the thesis.

8.1 Business model change for sustainability

In this section I first revisit Research Question 1: *What internal and external factors influence business model change for sustainability?* The first research question applied to the main three case studies, i.e. Interface, Techbuyer and Silentnight. Then, I move on to discuss the cross-cutting theme of circularity that emerged from the case studies, including the pilot case study of Agrimax. Specifically, I discuss how organisations achieved or are planning to achieve different levels of circularity through business model change for sustainability (see an example of the analysis process in Appendix G **Error! Reference source not found.**).

8.1.1 External and internal factors influencing business model change for sustainability

The findings of this thesis showed that different external and internal factors act as drivers and barriers to business model change for sustainability in the case of Interface, Techbuyer and Silentnight. For instance, organisational mission and vision were identified as the main drivers of business model change for sustainability in the case of Interface and Silentnight. A particularly interesting finding was the importance of ability of staff to translate the sustainability mission into tangible products in the case of Interface. Another important driver for business model change in the case of Interface, Silentnight and Techbuyer was top management commitment to sustainability. This is in line with findings from Rauter et al. (2017) who emphasised the importance of managers' commitment and leadership for sustainability in companies of different sizes and ages. However, as Belz (2012) pointed out, commitment at the top management level is not sufficient to achieve sustainability; knowledge about the environmental issues and transition processes towards enhanced sustainability is required at all levels of management. Furthermore, Morioka et al. (2017) emphasised the importance of committed employees in business model change for sustainability, which was also demonstrated in the case studies of this thesis. For instance, Interface's programme *I am mission Zero* demonstrated employees' strong commitment to sustainability and how they create positive impact within and outside the company. Similarly, as noted by key informant SN-B, Silentnight's employees are more engaged with sustainability issues and proposing solutions, which indicates the embeddedness of sustainability within the organisation. On the other hand, Techbuyer is in the process of learning and deploying circular economy throughout organisation, which could lead to more substantial business model change for sustainability in the future. As Roome and Louche (2015) suggested, learning along with experimentation and innovation, positively influences long-term sustainability.

Another factor that was identified in the main case studies was the role of individuals and small groups as change agents. For instance, Interface's CEO and chief of sustainability designed the new mission *Climate Take Back* with the ultimate goal to reverse the impact of global warming. In the case of Techbuyer, a small sustainability team proactively searches for options to improve the company's existing circular business model. Similarly, Silentnight has a small team dedicated to sustainability and ideas to improve sustainability performance are encouraged at all levels or organisation. For example, key informant SN-C commented that a canteen staff member championed the change in using plastic-free cutlery. These findings are partially in line with Høgevold et al. (2014) who emphasised the role of individual and small group change agents for business model change. Høgevold et al.'s found that environmental issues were important drivers for business model change, however, a strong commitment to sustainability was linked to economic reasons. In contrast, my findings suggest that environmental issues were the primary reason for commitment towards business model change for sustainability.

Another factor that was identified in both Techbuyer and Silentnight cases, was related to customers. While Techbuyer's managers identified negative customer perception of refurbished products as one of the main barriers to business model change for sustainability, it was also identified as a driver for business model change. Managers perceive it as an opportunity to educate customers about the benefits of refurbishing, which could positively affect the company's overall sustainability performance. Similarly, Silentnight's managers highlighted the importance of customers' needs for business model change for sustainability. For instance, customers prefer to buy types of mattresses that are not easily recycled, therefore, the company needs to use materials more efficiently and effectively. However, customers' needs seem to hinder more substantial business model change for sustainability. On the other hand, Silentnight's managers identified a new market segment, millennials, that is more environmentally conscious and values sustainable products, therefore, it might be more likely to achieve improved sustainability performance by targeting this specific segment. This is in line with study from Sorescu et al. (2011) who proposed customers' values and organisation's customer-centric orientation as a potential driver for business model change. While Sorescu et al.'s study made a theoretical contribution to the field of business model change, my findings made an empirical contribution which confirmed the importance of customers in relation to business model change for sustainability.

The present research project also found that legislative inertia and fire safety regulations play an important role in business model change for sustainability in the case of Silentnight. This finding is consistent with previous findings that highlighted importance of external factors such as regulation and legislation (Laukkanen and Patala, 2014; Long et al., 2018; Short et al., 2014) to business model change for sustainability. However, the finding from the Silentnight's case refers to manufacturing of bedding products. Furthermore, in this case managers have to deal with the paradox between compliance with the UK flammability law (system level) and use of FRCs in bedding products (organisational level) that are harmful for the environment and human health. Managers have been responding to the paradoxical tension by proactively searching for sustainable solutions to reduce the use of FRCs in their products. So far, Silentnight has managed to develop a cot mattress collection free from chemical treatments, however, the question remains whether FRCs can be eventually removed from all the products in their portfolio. An interesting finding was that corporate's external position has not changed (compliance with the law), while internally managers are changing the way company is doing business (exploring and experimenting with new materials such as foams made with natural oils and bio-based materials). My findings expand the findings of Laukkanen and Patala

(2014), Long et al. (2018) and Short et al. (2014) by showing how regulation can be an inhibitor but working around it has led to innovation for Silentnight.

Another factor influencing business model change for sustainability is a paradox of having two different business models concurrently. This paradox was present in two cases, Silentnight and Techbuyer. Silentnight is having its circular business model for eco line and traditional business model for regular mattresses. On the other hand, Techbuyer deals with the paradox between selling new versus refurbished IT equipment. In both cases managers adopted an active approach to dealing with the paradox. For instance, Silentnight started new collaborations to develop its eco range and is focused on continuous sustainability improvements in product design. Furthermore, they are searching for sustainable solutions to deal with the EoL products. On the other hand, Techbuyer is encouraging customers to choose refurbished IT equipment and searching for new markets that foster circular economy. Techbuyer has also started exploring complementary sustainability approaches such as leasing/rental models and industrial symbiosis to create greater sustainability value. Holding two competing business models simultaneously can be a source of tensions that can hinder business model change (Chesbrough, 2007). However, my results show how innovative focus of the managers and their proactive encouragement to shift customers towards new, sustainable business model help managers in overcoming this paradox.

The findings of this thesis have shown the importance of internal and external factors in business mode change for sustainability, which supports previous literature (e.g. Høgevold and Svensson, 2012; Laukkanen and Patala, 2014;

Roome and Louche, 2015; Sorescu et al., 2011). This thesis extends previous literature by showing the importance of contextual factors such as the interaction between the regulation and the business managers' cognition. Furthermore, my findings add an explanation of how managers deal with the paradox of holding two concurrent business models and the associated challenges. This is in line with Johnson and Clark (2006) who argued that research should consider the impact of context because it influences the occurrence and meaning of behaviour at different levels from individual to organisational.

8.1.2 Circularity achieved through business model change for sustainability

One of the cross-cutting themes is the circularity of resources that was achieved or is planned to be achieved through business model change for sustainability. Different levels of circularity can be achieved by adopting R strategies (Kirchherr et al., 2017) across different components in business models, i.e. value creation/delivery, value proposition and value capture (Osterwalder and Pigneur, 2010; Richardson, 2008). For instance, working in collaboration with local companies, Silentnight adopted industrial symbiosis approach to reuse waste as feedstock to make new products. Thus, reuse of waste led to changes in value creation/delivery (new collaborations) and value proposition (new products). Consequently, Silentnight achieved a medium level of circularity. The highest level of circularity has been achieved by Interface, which was not surprising because of the company's focus on resource efficiency since the early 1990s (Interface, 2017e). Furthermore, the company has implemented different sustainability approaches across all main components in its business model (see Table 5.2). Some of the approaches that the company adopted are associated with different sustainable business models proposed by Bocken et al. (2014). For instance, take-back management for reuse and recycling (create value from waste sustainable business model archetype), and zero emissions incentives, biomimicry and the natural step (substitute with renewables and natural processes sustainable business model archetype). Furthermore, the company adopted approaches linked to deliver functionality rather than ownership sustainable business model archetype and has developed an inclusive business model in collaboration with a non-governmental organisation and local community to recycle discarded fishing nets. As Bocken et al. (2014) suggested, more transformative business model changes for sustainability could be achieved through the combination of approaches from different sustainable business models, which seems to be in line with the findings from Interface case.

From the R strategies perspective (Kirchherr et al., 2017), Interface and Silentnight have focused their efforts mostly on the strategies that deliver high level of circularity such as reduce and rethink. Furthermore, the majority of R strategies were utilised to change value proposition and the way companies create and deliver value. This finding supports Schaltegger et al.'s (2012) view that most transformational changes in business models involve redesign of the value proposition. Recently, Interface has developed a prototype carbon-negative tile as a result of its new mission and overarching sustainability goal to reverse the negative impact of global warming. This is an example of a highly transformative change in value proposition that might further improve company's circularity and overall sustainability performance if the carbon-negative tile concept translates into mainstream.

While Techbuyer has mostly utilised R strategies such as reuse and refurbish for medium level of circularity, Agrimax is aiming to reduce food waste and associated GHG emissions which would lead to high level of circularity. Techbuyer has mostly implemented changes in the value creation and delivery of its circular business model through different approaches, for example, through enhancing product knowledge and experience, capability of testing, repairing and refurbishing IT equipment (Atkinson, 2017). Furthermore, through marketing and sales of refurbished IT equipment by offering configure-to-order server service (Techbuyer Limited, no date-a). On the other hand, Agrimax is a collaborative project that requires changes in business models of partners across the whole supply chain to deploy circular economy principles and align with the new, circular business models for bio-refineries and cooperatives.

As shown in the cases of Interface and Silentnight, adoption of R strategies such as reduce and rethink across multiple business model components, led to substantial business model change for sustainability, especially when value proposition was changed.

8.1.3 Cognitive models and the circular economy approach

The findings across the four case studies showed similarities and differences of cognitive models on decision-making on the circular economy approach. One of the main principles of the circular economy is sustainable product design (Ellen MacArthur Foundation, 2016). Silentnight and Interface are trying to embed this principle in their business which was reflected in the key informants' cognitive models that drive decision-making for business model change. For instance, key informants identified issues related to sustainable product design such as the content of bio-based and recycled materials in products, use of modern, lower impact materials (carbon neutral/negative) and chemical treatments. Inclusion of these issues in cognitive models and how they link to other issues indicate the extent to which managers might integrate circular economy principle of sustainable product design in their company's business models. For instance, companies can develop full circular business models when they manage to integrate circular economy principles throughout the entire supply chain (Urbinati et al., 2017).

Another principle of the circular economy is product life extension (Ellen MacArthur Foundation, 2016; Stahel, 2016), which can be achieved through different strategies such as reuse. Reuse of materials and products have been identified as important issues for decision-making in the key informants' cognitive models in Techbuyer, Silentnight and Interface. At Interface and Techbuyer, a take-back programme was identified as a prerequisite to reuse and recycle (see Figure 5.1). Challenges to implement such a programme include the need to come to grips with reverse logistics (key informant IF-A) and logistic expense (key informant TB-A). Furthermore, at Techbuyer, closing the loops on products was identified as a way of keeping materials in circulation for longer and thus reducing environmental impacts. Closing the loops on products is Techbuyer's new proposition (key informant TB-B) and modular design is a prerequisite to achieve it (key informant TB-C). Additionally, negative customers' perceptions of reused and refurbished were identified as one of the main barriers for product life extension. The main customers' concerns that need to be overcome are related to the performance (key informant TB-A) and reliability of refurbished products (key informant TB-B). Similarly, managers at Silentnight, also need to deal with the negative customers' perceptions of reuse in bedding industry, which influence environmental impact of materials because consumers' perceptions drive high use of materials such as steel and foam (key informant SN-C). To achieve product life extension, managers need to understand what sustainability issues and relationships between them influence product life extension. It is likely that better understanding of important issues will lead to more transformative business model changes based on the circular economy principles.

The principles of the circular economy are also the basis for Agrimax project that is developing CBMs for resource recovery from agricultural and food processing waste. The analysis of cognitive models identified links between sustainability issues in the cognitive models and building blocks in the CBMs. This finding suggests that cognitive models of sustainability issues influence decision-making about what aspects of sustainability issues and to what extent will be included in the building blocks of CBMs. For instance, the use of natural resources (biomass) is an important environmental issue and aspects related to it are quality and storage of biomass, which were found across different building blocks in each CBM in the case of Agrimax (see Table 4.4).

8.2 Sustainability issues driving business decision-making

In this section I first revisit my second and third research questions that applied to the main three case studies, i.e. Interface, Techbuyer and Silentnight:

Research Question 2: What sustainability issues influence decision-making for business model change to improve sustainability performance?

Research Question 3: How do cognitive models of sustainability issues differ in the context of sustainable business models?

Then, I move on to discuss the cross-cutting theme of paradoxical tensions that emerged from the case studies.

8.2.1 Economic, environmental and social issues driving business model change for sustainability

This thesis has shown that different sustainability issues influence key informants' decision-making for business model change for sustainability. For instance, the key informant from Interface considered environmental issues above and beyond social and economic issues. This finding is in line with the findings from Bansal and Roth (2000) who highlighted the perceived importance of environmental issues among decision-makers as one of the main factors influencing responsiveness. However, my finding refers to the product level decision-making for resource efficiency to improve the overall sustainability performance of the business model. My research extends Bansal and Roth's findings by showing that importance of environmental issues among decision-makers at the product level leads to transformative changes in value proposition through creation of innovative, sustainable products. For instance, Interface has launched a negative-carbon tile prototype.

On the other hand, key informants from Silentnight and Techbuyer identified environmental and economic issues as the most important issues for their decision-making, and both cases lacked recognition of social issues. While Techbuyer's key informants all mentioned at least one social issue, two of Silentnight's key informants did not identify any, which was surprising considering the importance of health and well-being in bedding products identified in the organisational level analysis. Furthermore, key informant TB-B from Techbuyer identified training as an important social aspect, however, he was uncertain how it aligns with other identified sustainability issues. He also questioned its contribution to the company's sustainability strategy; he noted that this is an activity that organisations do in general.

Not recognising the importance of social issues could hinder business model change for sustainability, thus leading to a less impactful contribution to sustainable development. In line with Lee et al. (2012), I argue that companies pursuing business model change for sustainability should also measure their social performance. While Interface has developed its metric system to measure environmental and social performance, Techbuyer and Silentnight are lagging behind in this area. However, there is a potential for improvement and realisation that social issues should be given more consideration might be the first step towards designing new strategies to better understand social issues and respond to them.

8.2.2 Key informants' cognitive models in the context of sustainable business models

Results from participatory cognitive mapping found sizeable differences across key informants' cognitive maps in relation to content and structure. Using Hahn et al.'s (2014) analytical framework, my analysis showed that key informants' cognitive models fall between the two ends of contrasting frames, i.e. the business case frame and the paradoxical frame. A cognitive model with a strong economic-orientation that could be described as a business case frame was linked to key informant TB-A from Techbuyer (see Figure 6.2). Key informant TB-A tended to use simplified cognitive models to make sense of complex issues; he described himself as a simple, straightforward decision-maker. On the other hand, none of the elicited cognitive models could be described as a truly paradoxical frame. While three of the elicited cognitive models prioritised environmental issues (see Figure 5.1, Figure 6.3 and Figure 7.2) over economic issues, they barely considered social issues or even excluded them completely. This implies that key informants might not pursue creation of substantial social values through business model change for sustainability.

My findings differ from those of Bergman et al. (2016) who found a high level of similarity across managers' cognitive models within the same company, implying that managers interpret strategic issues in a similar way. Furthermore, Bergman et al.'s study demonstrated that economic issues were the most salient issues in the managers' cognitive models of sustainability. In contrast, my findings demonstrated sizeable differences across managers' cognitive models and in most cases economic issues were not the most salient issues in the cognitive models.

In relation to complexity, two of the cognitive maps (see Figure 6.3 and Figure 7.3) contained highly interconnected sustainability issues. They also included more two-way relationships compared to other cognitive maps. According to Hahn et al. (2014), high complexity between sustainability issues might lead to adoption of a prudent decision-making stance, considering a broad scope of new alternative approaches to address sustainability issues in a comprehensive way. However, awareness that new approaches involve higher risk and resulting contradictory effects might hinder the action-taking process. An interesting observation is that both complex cognitive maps belonged to female participants, which could potentially be an interesting future research orientation, i.e. cognitive models of sustainability in the case of female business decision-makers and the type of response strategies they use to improve sustainability performance of business models.

8.2.3 Paradoxical tensions emerging from the individual cognitive models

This research has identified some paradoxical tensions across key informants' cognitive maps. For instance, TB-A's cognitive map (see Figure 6.2) revealed a low level of interconnectedness between sustainability issues which might be an indication of paradoxical tensions (either inherent or socially constructed or both) hindering the linkages (Eden and Ackermann, 1998). Techbuyer's managers at different levels are in the process of learning about circular economy and sustainability more broadly, therefore, it is likely that there is a paradoxical tension between the existing and new knowledge about the concepts. On the other hand, sustainability issues are inherently paradoxical (contradictory and interrelated). This is important because more comprehensive and connected cognitive models might lead to more transformative sustainability actions. Because cognitive models are dynamic, it could be expected that over-time key informant TB-A will develop a more comprehensive cognitive model.

Additionally, key informant TB-A highlighted organisational increasing awareness of issues such as depletion of natural resources and company's culture during the interview on business model change for sustainability, however, these issues were not considered in the cognitive map. This finding is in line with previous research on managers' understanding of sustainability issues showing that managers struggle to understand links between sustainability issues and their business (Bansal, 2002; Bertels et al., 2016; Cherrier et al., 2012). However, a better understanding of sustainability issues such as resource depletion might encourage reflective managerial strategies (Huxham and Beech, 2003) to enable further learning about sustainability issues and their linkages to company's business. Consequently, better understanding of sustainability issues could improve managers' decision-making and action-taking related to the current circular business model and its overall sustainability performance.

Another indication of paradoxical tensions was identified in key informant TB-B's cognitive map (see Figure 6.4). The identified paradoxical tension could be described as organising tension (Lewis, 2000; Smith and Lewis, 2011). Key informant TB-B was uncertain about company's social performance and how social aspect links to economic and environmental issues to achieve a more sustainable system, i.e. improved circular business model.

Indications of paradoxical tensions at the individual level and between staff have been identified in all the main three case studies. Specifically, there were differences across cognitive maps in perceptions of relationships between sustainability issues. For instance, ten respondents in Techbuyer perceived *Staff expertise* and *Encouraging reuse of material* as either non-existent, one- or two-way relationships (see Table 6.4). The differences between perceived relationships could indicate a learning paradox (knowledge acquisition and interpretation of sustainability issues) at the individual level. Encouraging reuse is a key strategy driving Techbuyer's business, and staff expertise are one of the company's key assets for value creation and delivery. It is important that staff have a good understanding of how they contribute to sustainability performance through encouraging reuse. In general, a good understanding of sustainability issues at the individual level could positively influence decisions at the group and organisational levels to improve company's circular business model and its overall sustainability performance.

In the case of Silentnight, differences were found in perceived relationships between *Employee engagement* and *Designing with the end of life in mind* see (see Table 7.4) and *Reducing environmental impact* and *Working conditions and rights* (see Table 7.5). Similarly, differences were found across respondents' maps from the Interface (see Table 5.4 and Table 5.5). These indications of paradoxical tensions within each individual and between staff could potentially hinder business model change for sustainability at the organisational level. While senior managers are responsible for strategic decisions in relation to sustainability, achievement of substantial sustainability improvements requires commitment to sustainability across all managerial levels (Belz, 2012) and from employees (Morioka et al., 2017). Therefore, it is important to resolve any paradoxical tensions to enable good understanding of sustainability issues, which might consequently lead to adoption of more transformative approaches for sustainability.

8.3 Towards a conceptual framework for business model change for sustainability from the cognitive perspective

The outcome of the thesis is an integrative, conceptual framework to analyse business model change for sustainability from a cognitive perspective (see Figure 8.1). The framework integrates the findings from the case studies, the conceptual work from Foss and Saebi (2017) on business model innovation and Hahn et al.'s (2014) conceptualisation of cognitive frames. Previous research has shown that managers struggle with understanding sustainability and how it links to their business (Bertels et al., 2016; Cherrier et al., 2012). According to Anderson and Bateman (2000), the way businesses respond to sustainability issues depends on decision-makers' capabilities to understand and deal with sustainability issues. Therefore, it is important to explore how individuals understand sustainability issues in the context of sustainable business models.

Individuals concerned with sustainability issues use cognitive models to deal with the complexity and paradoxes inherent in sustainability issues (Hahn et al., 2014). The way individuals perceive the importance of sustainability issues and relationships between them will affect the content and structure of their cognitive models. As Hahn et al. (2014) suggest, more comprehensive cognitive models including economic, social and environmental aspects might indicate a prudent decision-making stance, considering a broad scope of new alternative approaches to address sustainability issues in a comprehensive way. In contrast, cognitive models aligned with the business case frame, prioritising economic aspects are more likely to influence a pragmatic decision-making stance. Additionally, centrality of sustainability issues in the cognitive models indicate areas of great concern for the individual decision maker (Eden and Ackermann, 1998), which in turn influence decisions on business model change for sustainability. In line with Hahn et al. (2014) and Hockerts (2015), I argue that more comprehensive understanding of sustainability issues and relationships between them is likely to influence consideration of transformative approaches to achieve business model change for sustainability.

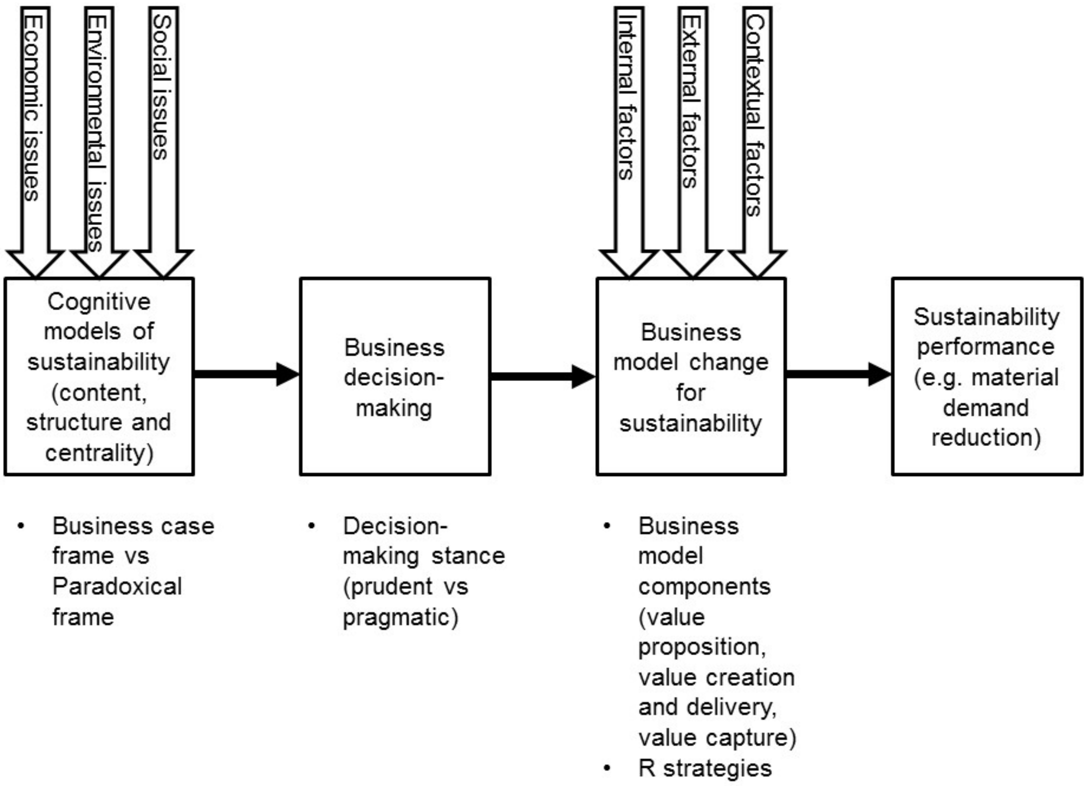

Figure 8.1: Conceptual framework to analyse business model change for sustainability from a cognitive perspective based on Foss and Saebi (2017) and Hahn et al. (2014)

The key business decision-makers, executive managers, are responsible for decisions about business model change for sustainability. However, the business model change for sustainability is a type of organisational change that requires commitment to sustainability at all levels of management and employees to achieve significant sustainability performance. Therefore, it is important to explore cognitive models of sustainability across all levels of management and employees to analyse differences that could hint paradoxical tensions in the understanding of sustainability.

Cognitive models of sustainability are internal, individual factors that have been underexplored in the field of business model change (Foss and Saebi, 2017), therefore, it is important to provide more empirical research in this area. However, cognitive models of sustainability should be considered along with other internal factors, external factors and contextual factors that influence business model change for sustainability. Consequently, the interplay between all the factors will influence the level of the overall sustainability performance. Additionally, changes across all business model components, specifically value proposition (Schaltegger et al., 2012) are more likely to lead to significant improvements in sustainability performance such as material demand reduction. Furthermore, a significant material demand reduction is more likely to happen if businesses pursue R strategies leading to the high value circularity (Kirchherr et al., 2017).

This conceptual framework draws together the work from Foss and Saebi (2017) and Hahn et al. (2014) as well as the findings from this research to suggest that cognitive models are of primary importance in informing business decision-making for business model change for sustainability. While previous literature focused on exploring external and internal factors driving business model change for sustainability, less attention was paid to internal, individual level factors such as cognitive models. Therefore, I have applied a cognitive perspective to explore business model change for sustainability. Furthermore, I have also considered the importance of contextual factors which has been neglected in previous research. The developed integrated, conceptual framework is a substantial advance on existing literature and could be used in future empirical research to further the understanding on the role of cognitive models in the business model change for sustainability.

8.4 Implications for theory and practice

The purpose of this thesis was to make an empirical contribution to the research field of sustainable business models, specifically focusing on business model change for sustainability. Previous literature exploring business models has mostly focused on definitions, applications and functions of business models. As Zollo et al. (2013) pointed out, research in the context of sustainability should focus on the process of business model change, therefore, I conducted a multiple case study to explore how companies changed their existing business models to improve sustainability performance. I found that different critical incidents led to the adoption of sustainability approaches across different business model components. Furthermore, drivers and barriers to business model change for sustainability were examined. Literature that explored factors influencing business model change for sustainability has mostly emphasised the role of internal (organisation-level) factors and external factors (Carayannis et al., 2015; Laukkanen and Patala, 2014; Long et al., 2018; Roome and Louche, 2015). However, less is known about the role of contextual factors in the business model change for sustainability. While some authors also considered internal, individual-level factors such as beliefs, values and commitment (e.g. Morioka et al., 2017; Rauter et al., 2017), cognitive models are under-researched. By focusing on the cognitive models of sustainability while also considering other internal, external and contextual factors my thesis contributes to this body of literature. Furthermore, the designed integrative, conceptual framework could inform future empirical research in the field of sustainable business models from the cognitive perspective.

With this thesis I have also made a methodological contribution by developing a survey method to explore cognitive models of sustainability. While surveys have been used in previous management research as a cognitive mapping tool (Swan, 1997; Wood et al., 2012), my method's focus is on exploring relationships between sustainability issues in the context of business model change for sustainability. The method combined the cognitive mapping approach developed by Markóczy and Goldberg (1995) and participatory cognitive mapping software Mental Modeler designed by Gray et al. (2013). Markóczy and Goldberg (1995) provided the steps for the elicitation method and comparison of cognitive maps. Similar to Markóczy and Goldberg's (1995, p.309) method, I developed a list of sustainability issues which aligns with their development of "pool of constructs", the respondents had to select a fixed number of sustainability issues and identify relationships between them. What I did differently is that I developed a list of sustainability issues by incorporating issues from the participatory cognitive mapping with key informants. Furthermore, I used the Mental Modeler software to visualise and analyse the cognitive maps using the content and structural metrics provided by the software. Thus, my method provides a simple way to capture cognitive models in relation to sustainability.

The findings of this thesis also have practical implications for business decision makers who want to accelerate transition towards sustainability. By shedding new light on the process of business model change for sustainability, business decision makers may be encouraged to pursue more transformative changes leading to significant improvements in sustainability performance. More specifically, business decision makers could focus on developing new value propositions by incorporating the R strategies (Kirchherr et al., 2017) to achieve higher levels of circularity, i.e. reduce, rethink and refuse. Business decision makers could also consider different learning approaches such as interactive workshops in collaboration with universities and research institutes to enhance the understanding of sustainability, consequently developing more connected and accurate cognitive models. Enhanced understanding of sustainability would likely lead to more comprehensive and accurate cognitive models influencing more transformative business model change for sustainability. Furthermore, the integrative, conceptual framework (see Figure 8.1) designed in this thesis could be used to provide insights into cognitive models of sustainability. More specifically, to identify paradoxical tensions at the individual, group and organisational level that could hinder progress towards sustainable business models. For example, paradoxical tensions in relation to acquiring new knowledge about approaches to reduce material demand and how they fit with business model components could lead to the adoption of less transformative approaches. Identification of paradoxical tensions could help managers to design strategies to resolve tensions, which could accelerate business model change for sustainability.

Finally, the findings of this thesis have theoretical and practical implications for development of the R strategies perspective and the circular economy for mainstream companies. Linking to existing CBM literature (Bocken et al., 2016; Geissdoerfer et al., 2018a; Ranta et al., 2018), the findings of this thesis explain how mainstream companies change their current business models towards more CBMs by integrating R strategies across different components in business models. Most transformative business model changes involve redesign of the value (Schaltegger et al., 2012), which was achieved in the case of Interface through the integration of reduce and rethink strategy. For instance, to reduce GHG emissions and improve company's circularity of resources, a new value proposition was designed, i.e. a carbon-negative tile. Interface found a way to create a durable material that stores carbon; material can be recycled and thus carbon kept in a closed technical loop (Interface, 2017d). The case study of Interface showed the importance of technical and chemistry teams' ability to translate the company's new mission, reversing the impact of global warming, into innovative products. Furthermore, Interface has adopted sustainability approaches that are associated with different sustainable business models, not just CBMs. By combining approaches from different sustainable business models, Interface has achieved a more transformative business model changes and a high level circularity of resources.

The case of Silentnight showed that a focus on a reuse strategy led them to growth in product take-back and consequently implementation of CBM, which required changes in relationships with key partners such as home delivery partners and recyclers. Interestingly, Silentnight's managers decided not to promote closed-loop recycling because of uncertainties related to the existing technologies, standards and protocols to achieve closed-loop recycling. Furthermore, reduce and rethink strategies led Silentnight to create and deliver new value propositions, i.e. new products made of sustainable technology textiles and recycled material. By integrating reduce and rethink strategies, Silentnight's managers see new opportunities to shift towards PSS and a modular business model in the future. Additionally, the case of Silentnight showed that high level circularity of resources for mattresses can be achieved through changes at different levels. At the consumer-level, changes are required in relation to use and maintenance of mattresses to ensure good quality at the point of take-back. To increase the recycling capacity and develop technology for closed-loop recycling, organisation-level and system-level changes are needed. By integrating different R strategies (reuse, reduce and rethink) into their existing business model, Silentnight has achieved medium to high circularity of resources. Despite challenges such as legislative inertia and flame retardant chemicals treatments, Silentnight managers continue to focus on improving the company's overall sustainability performance through continuous innovation and collaboration with different stakeholders.

The findings of this thesis showed that different drivers and barriers influence what R strategies will be adopted by mainstream companies to integrate the circular economy principles into their existing business models. Future research could test how mainstream companies in other industrial sectors with high environmental impact such as construction and transportation adopt R strategies to shift towards CBMs. Furthermore, future research could focus on quantitative methods to assess the level of circularity of resources achieved through business model change across industrial sectors that are material and energy intensive.

My findings also suggest practical managerial implications. Managers of mainstream companies integrating the circular economy principles should consider R strategies that lead to high level circularity of resources to create and deliver innovative value propositions. Furthermore, managers should identify paradoxes between organisation-level sustainability goals and system-level barriers that inhibit transformative business model change, and design strategies to overcome them.

8.5 Limitations and future research

While every effort was made to bring quality and rigour into this research, it is not without its limitations. In this section I identify the limitations of the research and highlight future research opportunities that may overcome these limitations. In this thesis I developed an integrative, conceptual framework to analyse business model change for sustainability from a cognitive perspective. The conceptual framework was developed from the multiple case analysis that is yet to be tested in practice. Thus, I would recommend that future research tests the conceptual framework on additional cases to evaluate the role of cognitive models in business model change for sustainability. I would specifically encourage studies focusing on businesses operating in the resource-intensive industries and supply chains with significant environmental and social impacts, for instance, construction and agriculture.

This thesis adopted a cross-sectional study design which means that findings are bounded to a specific point in time. Cognitive models are considered to be dynamic structures that can change (Jones et al., 2011), therefore, elicitation of cognitive models before, during and after business model change for sustainability might have shown different results. Longitudinal analysis would therefore be beneficial to examine how cognitive models change over time and if those changes reflect in sustainable business models.

8.6 Conclusion

This thesis explored the influencing factors on business model change for sustainability in resource-based businesses by specifically focusing on the internal, individual factors such as individuals' cognitive models of sustainability. The findings from the main case studies showed that different critical incidents triggered companies' sustainability journeys that led to adoption of sustainability approaches across business model components. Furthermore, drivers of business model change for sustainability such as the ability of staff to translate the sustainability mission into tangible products (Interface), sustainability team formation and learning (Techbuyer) and focus on continuous innovation and experimentation (Silentnight) have the potential to further improve sustainable business models. However, to achieve substantial improvements, companies also need to overcome different barriers. For instance, negative customer perceptions of refurbishing (Techbuyer), the use of FRCs in bedding products and legislative inertia (Silentnight) and the competitive environment (Interface). The companies' capabilities to adopt transformative changes (e.g. Interface's new mission to reverse the negative impact of climate change, Silentnight's focus on modern materials to reduce the use of foam and FRCs) and bring them to mainstream are likely to lead to more significant sustainability performance such as material demand reduction.

This thesis also suggests that individuals' cognitive models of sustainability play an important role in the business model change for sustainability because they can help reveal paradoxical tensions at different levels (individual, group and organisational). Identification of paradoxical tensions can help business decision-makers design strategies to resolve them which could have a positive effect on the business model change for sustainability.

Chapter 9 – References

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Appendices

The following is the supplementary material to this research project.

Appendix A: Research project information sheet

School of Earth and Environment

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Information sheet

1. **The title of the research project**

   Business decision-making for material demand reduction

2. **Invitation**

   You have been invited to participate in an interview about changes in business models for sustainability because your company has a strong sustainability focus with a business model that is based on the circular economy principles.

3. **What is the purpose of the interview?**

   The aim of this interview is to explore your company's business model to understand the core logic of your business. This is to see how your business creates different values for the customers and other stakeholders. Furthermore, changes that happened in business model elements such as resources, processes, partnerships, customer relationships, revenue streams and products/services or could happen in the future to further improve sustainability performance. The process of change, main drivers and potential barriers and how you measure progress. Additionally, to explore which environmental, social and economic sustainability attributes or issues are important for your company and drive decision-making processes.

4. **Do I have to take part?**

   Your participation in this project is voluntary and you will be given this information sheet to keep (and be asked to sign a consent form). You can still withdraw at any time.

5. **What do I have to do?**

   You will be asked to answer questions related to your company's business model. For example, changes that occurred or will occur to improve sustainability performance, drivers and barriers to implement changes. We are also going to build a concept/cognitive map about sustainability attributes or issues (economic, social and environmental) that are important for your company and drive decision-making processes. A software programme will be used to build the map as we go along with the interview. Please see the illustrative example of a concept/cognitive map in the ConceptMapExample document.

6. **What are the possible disadvantages and risks of taking part?**

   There are no foreseeable discomforts, disadvantages and risks of taking part in this research.

7. **What are the possible benefits in taking part?**

   Whilst there are no immediate benefits for those people participating in the project, it is hoped that this work will be beneficial to decision-makers who are involved in sustainability initiatives in their businesses and organizations. Participants will find this project valuable for rethinking their business model to improve sustainability and profitability. Participants will also receive a project report at the end of the research study.

8. **Will my taking part in this project be kept confidential?**

   All the information that we collect about you during the course of the research will be kept strictly confidential. However, it is likely that the results of this research will be published in the academic journals. Furthermore, it is likely that they will be used in conference presentations and research groups' presentations. Your data will be anonymised for the purpose of disseminating activities of the research outcomes.

12/03/2018

9. What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?

We are interested in what you think are the important elements in the company's business model. Furthermore, how those elements influence each other and how changes in business model affect sustainability performance.

The collection of this information is relevant for achieving the overarching research project's objective to investigate how and why companies change their business models to improve sustainability performance. Furthermore, to analyse the drivers that can facilitate this change process as well as the barriers that might hinder it. While there are many theoretical examples of business models for sustainability there is a lack of practical examples and this project aims to fill this gap.

10. Who is organising/ funding the research?

The project is conducted by Suzana Matoh, a PhD student at the Sustainability Research Institute, School of Earth and Environment, University of Leeds. The Postgraduate Researcher is conducting this research under the supervision of Dr Sally Russell, Associate Professor: Business, Organizations and Sustainability and Dr Katy Roelich, Senior Research Fellow in Climate Change and Energy Policy.

Funding for this project was received from the Research Councils UK under the Centre for Industrial Energy, Materials and Products (CIE-MAP): EP/N022645/1.

This research has been reviewed according to University of Leeds Ethical procedures for research involving human subjects and received ethical approval reference number LTSEE-049.

11. Will I be recorded, and how will the recorded media be used?

The audio recordings of your activities made during this research will be used only for analysis. No other use will be made of them without your written permission, and no one outside the project will be allowed access to the original recordings.

12. Contact for further information

Suzana Matoh, Postgraduate Researcher; E-mail address: eesm@leeds.ac.uk

Mobile: 07476348844

The participant will be given a copy of the information sheet and a signed consent form to keep. Thank you for taking the time to read through the information.

School of Earth and Environment

UNIVERSITY OF LEEDS

Consent to take part in "Business decision-making for material demand reduction" research project

	Add your initials next to the statements you agree with
I confirm that I have read and understand the information sheet dated 12/03/2018 explaining the above research project and I have had the opportunity to ask questions about the project.	
I agree for the data collected from me to be stored and used in relevant future research.	
I understand that relevant sections of the data collected during the study, may be looked at by auditors from the University of Leeds or from regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.	
I agree to take part in the above research project and will inform the lead researcher should my contact details change.	

Name of participant	
Participant's signature	
Date	
Name of lead researcher	
Signature	
Date*	

*To be signed and dated in the presence of the participant.

Once this has been signed by all parties the participant should receive a copy of the signed and dated participant consent form, the letter/ pre-written script/ information sheet and any other written information provided to the participants. A copy of the signed and dated consent form should be kept with the project's main documents which must be kept in a secure location.

Appendix B: Research project poster

Appendix C: Research topics for the interview

	Case Study: Interface
Topic	*Questions*
Business model change for sustainability	Company's business model - what does it represent to you? What are the most important elements? What are the main drivers of business model change? How do you measure sustainability performance?
Sustainability mission Climate Take Back	What are the main elements of the new mission? How does the new mission translate to products? How does the idea of Climate Take Back flow through the organisation? How do different parts of organisation make decisions and how they work together?
Material efficiency	What are the main drivers of material efficiency in your company? Where do the initiatives for material efficiency usually come from; the top management, other parts of the company or outside the company? How do you explore different material efficiency approaches or strategies?

	Case Study: Techbuyer
Topic	*Questions*
Business model	How do you understand a business model concept? What are the main elements that help to create and deliver value to your customers and other stakeholders? Have you implemented any changes in your company's business model? Could you give some examples?
Past changes in business model	What do you think was the most transformational change in the business model in terms of sustainability? What were the main drivers and barriers for business model change? Could you take me through the change process – how it happened? How did you measure the progress (sustainability performance)?
Future changes in business model	What do you think could be changed in the future to further improve your sustainability performance?

Case Study: Silentnight	
Topic	*Questions*
Business model	Company's business model - what does it represent to you? What are the most important elements?
Circular economy business model	Could you take me through the process of adopting circular economy business model? What factors influenced decision-making and collaboration with supply chain? What are the challenges of managing both business models simultaneously?
Sustainability programme	Where did the initiative come from to start a sustainability programme? What were the main stages in developing and implementing the programme? Which sustainability change do you consider to be the most transformative for your company? Could you take me through the process of how the change happened?
Industrial symbiosis	Could you take me through the process of adopting industrial symbiosis approach? What were the key factors for successful implementation? What were the key decision-making moments? Were there any obstacles/barriers in the process that you needed to overcome? Are there other sustainability approaches that you have been testing or are thinking of testing in the future?
Innovation and collaboration	What were the key factors for successful collaboration on co-development of Eco-comfort 1200 product with suppliers? What drives your decision-making for sustainability innovation?
Sustainability performance	What metrics do you use to measure sustainability performance? Where does the biggest environmental impact lie? What is the carbon footprint of your products? What % of recycled content is used in the products? What % of renewable energy?
Future plans	Extended Producer Responsibility Scheme?

Appendix D: A case example of a full survey

Q1.
Welcome to the Business Sustainability survey!

This survey is part of a research project about business decision making and sustainability that is being conducted by a postgraduate researcher Suzana Matoh at the University of Leeds.

Below are the survey topics we will cover:

- **Important economic**, **environmental** and **social** issues for your company
- **Relationships** between the selected issues above
- **Demographics**

The survey will take approximately *15 minutes*.

Q2. Your participation in this research study is voluntary. Your responses will be **confidential** and we will not collect any identifying information. The results of this study will be used for **scholarly purposes only** and may be shared with University of Leeds representatives.

This research has received **ethical approval** reference number **LTSEE-049**. If you have any questions about the research study, please contact Suzana Matoh at **eesm@leeds.ac.uk**.

Q3. Please select 'Yes' below to indicate that you have read the above information and that you agree to participate.

◉ Yes

Q4. Before continuing with the survey, please read the following instructions to ensure that we receive your responses.

- Always click the 'next' button at the bottom of each page after answering the question(s) on that page.
- 'Back' button gives you the option to check your answers to previous questions.

Q5. Which is the most important **economic** issue for your company? Negative customers' perceptions (perceptions that refurbished products are not as good as new)

◉ Negative customers' perceptions (perceptions that refurbished products are not as good as new)
○ Recertification process
○ Profitability
○ Quality service
○ Market for refurbished products
○ Availability (of products for refurbishing)
○ Relationships with suppliers
○ Quality of refurbished products (performance, reliability and efficiency, warranty)
○ Product price (economic for customers, 20%-80% off the RRP)
○ Technology (bespoke testing and data wiping system, internal marketing system)
○ Data loss concerns
○ Buy-back programme (decommissioning service)

Q6. Which is the second most important **economic** issue for your company? Relationships with suppliers

- ○ Recertification process
- ○ Profitability
- ○ Quality service
- ○ Market for refurbished products
- ○ Availability (of products for refurbishing)
- ◉ Relationships with suppliers
- ○ Quality of refurbished products (performance, reliability and efficiency, warranty)
- ○ Product price (economic for customers, 20%-80% off the RRP)
- ○ Technology (bespoke testing and data wiping system, internal marketing system)
- ○ Data loss concerns
- ○ Buy-back programme (decommissioning service)

Q7. Which is the most important **environmental** issue for your company?Recycling (failed equipment, packaging, office waste)

- ○ Extending life of equipment
- ○ Environmental impact of saving resources
- ◉ Recycling (failed equipment, packaging, office waste)
- ○ Energy efficiency
- ○ Waste reduction
- ○ Greenhouse gas emissions (for example, carbon dioxide)
- ○ Encouraging reuse of material
- ○ Reducing the amount of new equipment required

Q8. Which is the second most important **environmental** issue for your company?Waste reduction

- ○ Extending life of equipment
- ○ Environmental impact of saving resources
- ○ Energy efficiency
- ◉ Waste reduction
- ○ Greenhouse gas emissions (for example, carbon dioxide)
- ○ Encouraging reuse of material
- ○ Reducing the amount of new equipment required

Q9. Which do you think is the most important **social** issue for your company?Staff expertise

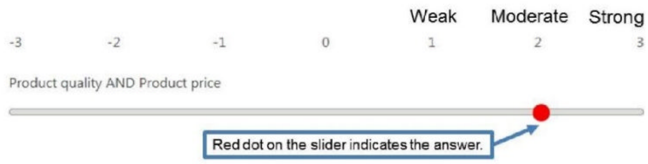
- ○ Training and development (HPE accreditation, qualifications)
- ○ Technical knowledge (across different product ranges on IBM, HP, DELL...)
- ○ Job creation and retention
- ◉ Staff expertise
- ○ Social responsibility

Q10. Which is the second most important **social** issue for your company?Training and development (HPE accreditation, qualifications)

- (selected) Training and development (HPE accreditation, qualifications)
- Technical knowledge (across different product ranges on IBM, HP, DELL...)
- Job creation and retention
- Social responsibility

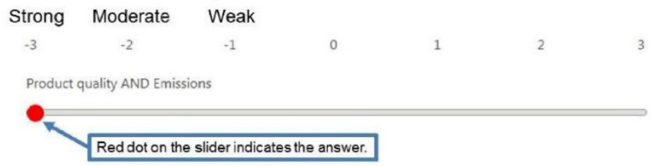
The following questions are about relationships between economic, environmental and social issues that you selected. To help you answer them, follow the examples below.

Example 1. What is the relationship between the issues below:



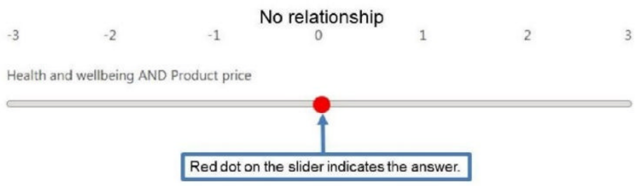
According to the selection shown above, we have a moderate positive relationship:
Increase in *Product quality* leads to an increase in *Product price.*

Example 2. What is the relationship between the issues below:



According to the selection shown above, we have a strong negative relationship:
Increase in *Product quality* leads to a decrease in *Emissions.*

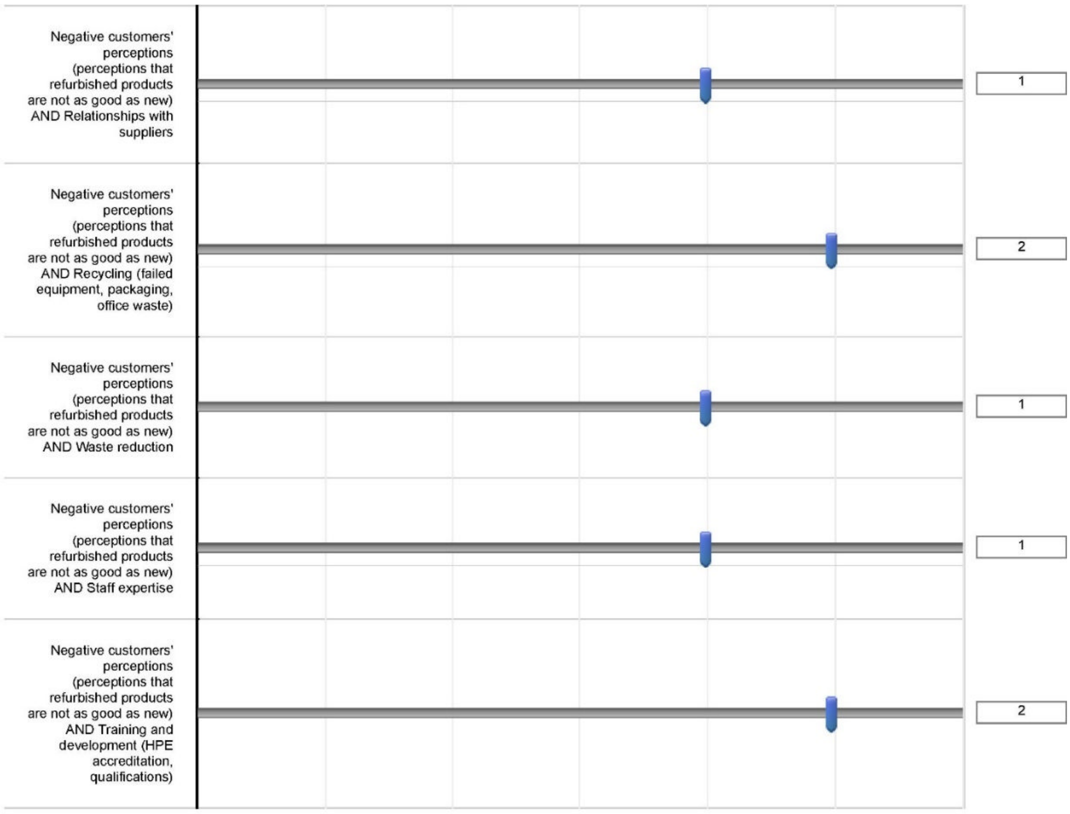
Example 3. What is the relationship between the issues below:



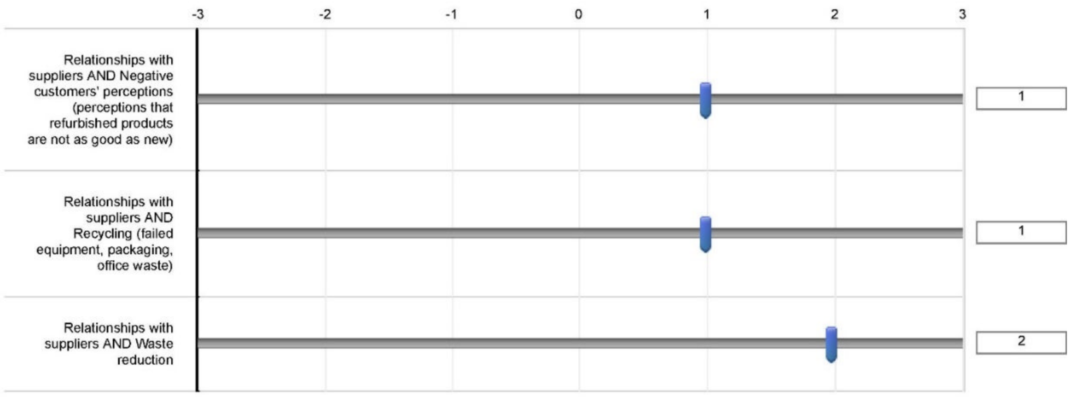
According to the selection shown above, we have no relationship:
Health and wellbeing has no influence on *Product price.*

Q12. What is the relationship between the pairs of issues below?
Please make sure to click on the red dot on the slider and move it to indicate your answer (a number between -3 and 3).

-3	-2	-1	0	1	2	3



Q13. What is the relationship between the pairs of issues below?
Please make sure to click on the red dot on the slider and move it to indicate your answer (a number between -3 and 3).



Relationships with suppliers AND Staff expertise	3
Relationships with suppliers AND Training and development (HPE accreditation, qualifications)	1

Q14. What is the relationship between the pairs of issues below?
Please make sure to click on the red dot on the slider and move it to indicate your answer (a number between -3 and 3).

	-3 -2 -1 0 1 2 3	
Recycling (failed equipment, packaging, office waste) AND Negative customers' perceptions (perceptions that refurbished products are not as good as new)		1
Recycling (failed equipment, packaging, office waste) AND Relationships with suppliers		2
Recycling (failed equipment, packaging, office waste) AND Waste reduction		1
Recycling (failed equipment, packaging, office waste) AND Staff expertise		2
Recycling (failed equipment, packaging, office waste) AND Training and development (HPE accreditation, qualifications)		2

Q15. What is the relationship between the pairs of issues below?
Please make sure to click on the red dot on the slider and move it to indicate your answer (a number between -3 and 3).

	-3 -2 -1 0 1 2 3	
Waste reduction AND Negative customers' perceptions (perceptions that refurbished products are not as good as new)		2

Waste reduction AND Relationships with suppliers	3
Waste reduction AND Recycling (failed equipment, packaging, office waste)	3
Waste reduction AND Staff expertise	2
Waste reduction AND Training and development (HPE accreditation, qualifications)	0

Q16. What is the relationship between the pairs of issues below?
Please make sure to click on the red dot on the slider and move it to indicate your answer (a number between -3 and 3).

-3 -2 -1 0 1 2 3

Staff expertise AND Negative customers' perceptions (perceptions that refurbished products are not as good as new)	3
Staff expertise AND Relationships with suppliers	3
Staff expertise AND Recycling (failed equipment, packaging, office waste)	1
Staff expertise AND Waste reduction	1
Staff expertise AND Training and development (HPE accreditation, qualifications)	3

Q17. What is the relationship between the pairs of issues below?
Please make sure to click on the red dot on the slider and move it to indicate your answer (a number between -3 and 3).

-3 -2 -1 0 1 2 3

Training and development (HPE accreditation, qualifications) AND Negative customers' perceptions (perceptions that refurbished products are not as good as new)	3
Training and development (HPE accreditation, qualifications) AND Relationships with suppliers	2
Training and development (HPE accreditation, qualifications) AND Recycling (failed equipment, packaging, office waste)	0
Training and development (HPE accreditation, qualifications) AND Waste reduction	-1
Training and development (HPE accreditation, qualifications) AND Staff expertise	3

Q18. Please indicate which of the following best describes the department you work in.

- ○ Production
- ○ Research and Development
- ○ IT
- ○ Operations
- ○ Logistics
- ○ Human Resources
- ○ Customer service
- ◉ Sales/Marketing
- ○ Purchasing
- ○ Finance/Accounting
- ○ Administration
- ○ Other (please specify) ____

Q19. Please indicate which of the following best describes your position/role in the company.

- ○ Clerical
- ○ Technician
- ○ Managerial
- ○ Accounting

- ( ) Project Management
- (•) Other (please specify) Account management

Q20. Please indicate how long have you worked at the company.

- (•) Less than 1 year
- ( ) 1-3 years
- ( ) 4-6 years
- ( ) More than 6 years

Q21. Please tick the highest level of your educational qualifications.

- (•) High school qualification or equivalent
- ( ) Bachelor's degree or Professional degree (e.g. BA, BS)
- ( ) Master's degree (e.g. MA, MS)
- ( ) Doctorate (e.g. PhD)
- ( ) Other (please specify)

Q22. Please indicate your age range.

- ( ) 16-19 years old
- (•) 20-29 years old
- ( ) 30-39 years old
- ( ) 40-49 years old
- ( ) 50-59 years old
- ( ) 60+ years old

Q23. Please indicate your gender.

- ( ) Female
- (•) Male
- ( ) Other
- ( ) Prefer not to say

Appendix E: Ethical approval

Performance, Governance and Operations
Research & Innovation Service
Charles Thackrah Building
101 Clarendon Road
Leeds LS2 9LJ Tel: 0113 343 4873
Email: ResearchEthics@leeds.ac.uk

UNIVERSITY OF LEEDS

Suzana Matoh
Sustainability Research Institute
School of Earth and Environment
University of Leeds
Leeds, LS2 9JT

ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee
University of Leeds

19 August 2016

Dear Suzana

Title of study: **Business decision-making for material demand reduction**
Ethics reference: **LTSEE-049**
Grant reference: **EP/K011774/1**

I am pleased to inform you that the above application for light touch ethical review has been reviewed by a delegate of the ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee and I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	Version	Date
LTSEE-049 LightTouchEthicsForm_Suzana M.doc	1	11/08/16
LTSEE-049 Fieldwork_Assessment_Form_low_risk_final_protected_nov_15_ethical_approval_ Suzana M.docx	1	11/08/16

Please notify the committee if you intend to make any amendments to the original research as submitted at date of this approval, including changes to recruitment methodology. All changes must receive ethical approval prior to implementation. The amendment form is available at http://ris.leeds.ac.uk/EthicsAmendment.

Please note: You are expected to keep a record of all your approved documentation, as well as documents such as sample consent forms, and other documents relating to the study. This should be kept in your study file, which should be readily available for audit purposes. You will be given a two week notice period if your project is to be audited. There is a checklist listing examples of documents to be kept which is available at http://ris.leeds.ac.uk/EthicsAudits.

We welcome feedback on your experience of the ethical review process and suggestions for improvement. Please email any comments to ResearchEthics@leeds.ac.uk.

Yours sincerely

JBlaikie

Jennifer Blaikie
Senior Research Ethics Administrator, Research & Innovation Service
On behalf of Dr Kahryn Hughes, Chair, AREA Faculty Research Ethics Committee
CC: Student's supervisor(s)

Appendix F: Centrality score calculation

In CoM3, the respondent identified 11 relationships between sustainability issues: 10 positive weights (blue arrows) and one negative weight (red arrow) (see Figure F.1).

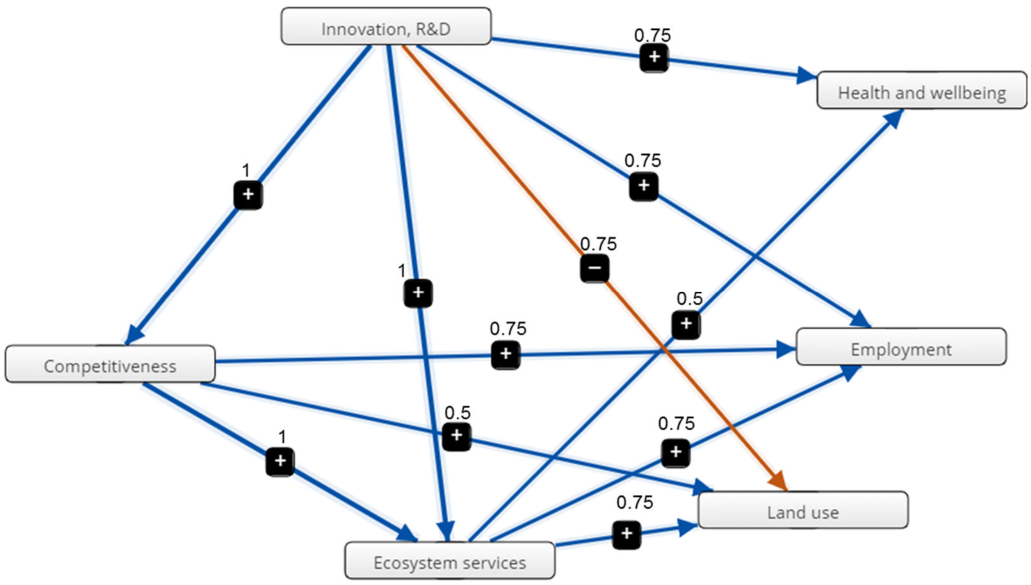


Figure F.1: Relationships between sustainability issues in CoM3

The centrality score of each issue is obtained by adding all the weights' absolute values of the arrows coming in and out of that issue. For instance, the issue *Innovation, R&D* achieved the highest centrality score of 4.25, which was calculated by adding 1+1+|-0.75|+0.75+0.75. The issue *Health and well-being* achieved the lowest centrality score of 1.25, which was obtained by adding 0.5+0.75.

Table F.1: Centrality scores for individual sustainability issue in CoM3

Component	Indegree	Outdegree	Centrality
Innovation, R&D	0	4.25	4.25
Ecosystem services	2	2	4
Competitiveness	1	2.25	3.25
Employment	2.25	0	2.25
Land use	2	0	2
Health and wellbeing	1.25	0	1.25

In Table F.1 the column *Indegree* refers to in-arrows in a cognitive model (see Figure F.1). For instance, *Ecosystem services* has an *indegree* value of 2 because in Figure F.1 that issue has two in-arrows each with a value of 1. The column *Outdegree* refers to out-arrows in a cognitive model (see Figure F.1). For instance, *Land use* has an *outdegree* value of 0 because in Figure F.1 there are no out-arrows for that issue.

There were seven cognitive models in which more than one sustainability issue achieved the same centrality score. This occurred because the centrality score is calculated adding all the weights' absolute values of the arrows coming in and out of an issue. For instance, in column *Centrality* in Table F.2, *Use of natural resources (biomass)* and *Innovation, R&D* achieved the centrality score of 3.5. Similarly, *Product/service safety* and *Waste* achieved the same centrality score of 1.75.

Table F.2: Centrality scores for individual sustainability issue in CoM2

Component	Indegree	Outdegree	Centrality
Use of natural resources (biomass)	1	2.5	3.5
Innovation, R&D	0.75	2.75	3.5
Innovative bio-based products	1.5	1.25	2.75
Training and education	1	1.25	2.25
Product/service safety	1.75	0	1.75
Waste	1.75	0	1.75

Appendix G: Analytical framework for the analysis of circularity

Table G.1: Analytical framework based on business model components and R principles of the circular economy

		R principles of CE		
		Recover and Recycle *(Low level of circularity)*	*Repurpose, Remanufacture, Refurbish, Repair and Reuse* *(Medium level of circularity)*	*Reduce, Rethink and Refuse* *(High level of circularity)*
Business model components	*Value proposition*	Design changes to improve recylability. Used products are disassembled and materials sold for recycling (Moran, 2017). Product take-back programme offering trade-in (Moran, 2017).	Adoption of industrial symbiosis model to reuse waste as feedstock to make new products (Moran, 2017). Adoption of reusable packaging (Moran, 2017). Repurpose of materials from the end-of-life products. For example, steel springs are made to manufacture car panels; foam is crumbled and manufactured into synthetic horse gallops; fabrics are used to make horse blankets and polyester is used to make pet beds (Moran, 2017) and PP.	Product design that uses recycled materials (filling in eco-mattresses made from recycled PET water bottles) (Moran, 2017; Silentnight Group Ltd, 2018a; Silentnightbeds, 2018). New product development through industrial symbiosis model (polyester waste is re-fiberised into insulator pads which are used in-house) (Moran, 2017). New packaging system (non-boxed format for rolled mattresses) (Moran, 2017) and PP. Cot mattresses free from foam and chemical treatments (Silentnight Group Ltd, 2018d). Reducing energy demand through LED lighting, Ecogate installation, Vickers Energy Management System and 'Switch Off' behaviour change programme (Moran, 2017). Reducing CO2 emissions caused by transportation; implementation of bonus-related driver efficiency app and camera system (Moran, 2017).
	Value creation and delivery	Reverse logistics to collect, transport and process used beds and mattresses for recycling. Collaboration with suppliers (TFRG, Colts and Matt UK) to disassemble products that come back through take-back programme (Moran, 2017). Auditing suppliers to manage risk to reputation for managing end-of-life products (PP). Customer segments for buying recyclables (Moran, 2017).	New collaborations with local companies (John Cotton and Spencer) to adopt industrial symbiosis system (Moran, 2017).	Innovative technical textiles (PP). Material testing device, technical staff and laboratory (PP). Distributors and retail partners that support the non-boxed format for rolled mattresses (Moran, 2017). Customer segments for buying eco-products collection.
	Value capture	Sale of recyclables (Moran, 2017).		Sale of Eco-Comfort mattresses (Silentnight Group Ltd, 2018).