Circular Supply Chain Management:

Conceptualisation and Empirical Investigation of Performance and Barriers in China

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Abstract

This thesis conceptualises a new frontier in supply chain sustainability research, namely Circular Supply Chain Management (CSCM), which integrates the Circular Economy (CE) concept in Supply Chain Management (SCM). Building on the newly-established CSCM definition, this thesis investigates the performance outcomes of CSCM and its implementation barriers. The thesis comprises three sequential and interrelated studies/manuscripts contributing to the CSCM perspective, as described below.

The first study/manuscript presents a comprehensive, integrated view and a unified definition of CSCM. It conducts a structured literature review of 261 articles and provides a classification of CSCM research into two broad categories, i.e., at SCM and/or value chain level, and at SCM functional level. Future research directions are discussed for advancing this important and emerging research domain. More research is called for in the areas of design for circularity, procurement and CSCM, biodegradable packaging for CSCM, circular supply chain collaboration and coordination, drivers and barriers of CSCM, circular consumption, product liabilities, and producer's responsibility, and technologies and CSCM.

The second study/manuscript examines the impact of CSCM on firm performance, including the contextual role of eco-industrial parks (EIP). A conceptual model is developed, based on the Natural Resource-Based View (NRBV), Contingent NRBV and the literature on CSCM. A statistical analysis of the survey data collected from 255 Chinese manufacturing firms establishes the following results: Firstly, CSCM, when exercised as a unified strategy, has a significant positive effect on environmental, cost, and financial performance. However, quite surprisingly, there is no statistically significant improvement in resource circularity performance, which may be due to the modest progress towards CE in China. Secondly, firms located within EIPs demonstrate higher levels of CSCM adoption when compared to firms located outside EIPs. Thirdly, the contextual factor of being located within an EIP does not moderate the CSCM-to-firm performance relationship, which suggests that performance is driven by practices rather than firms' locations.

The third study/manuscript identifies and systematically analyses the causal-effect relationships among barriers to integrating CE in SCM. For this purpose, the paper develops a theoretical framework grounded in multiple organisational theories. The study uses 105 responses from Chinese food supply chain stakeholders and applies a fuzzy decision-making trial and evaluation laboratory (DEMATEL) method to examine the causal-effect relationships among the identified barriers. Overall, the results reveal two key causal barriers: weak environmental regulations and enforcement, and lack of market preference/pressure. Lack of collaboration/support from supply chain actors is identified as the most prominent barrier. Based on these results, important managerial and policy implications are drawn. A systemic sustainability collaboration among key food supply chain players needs to be established, focusing on increasing economic and environmental gains. Moreover, designing and launching an extensive promotion campaign using a variety of media sources should also be considered, in addition to strengthening CE and environmental education in the schools.

This thesis makes multiple theoretical contributions. It is among the first to define CSCM and map the current state of research, providing a comprehensive, integrated view of the field. This thesis further contributes by developing new constructs, namely CSCM, which consists of four operational practices (i.e., circular product design, circular procurement, cleaner production, and end-of-life product and waste management), and resource circularity performance. These constructs are developed through extensive review, and their measurement items are validated by academic and industry experts. The studies/manuscripts presented in this thesis use and validate several organisational theories in the CSCM research context. Manuscript 2 links CSCM with Natural Resource Based View (NRBV) of the firms and contingent NRBV to develop a conceptual model. Manuscript 3 develops a theoretical framework of barriers to integrating CE in SCM. It contributes by identifying resource dependence theory, institutional theory and stakeholder theory as the most relevant theories that may be focused in the CSCM barriers research.

The practical contributions of this thesis include the provision of a reference point to SCM practitioners on how to implement CE/CSCM at the firm and supply chain level. The positive and significant CSCM-to-performance link provides clarity to SCM practitioners in implementing CSCM. Firms operating inside an EIP demonstrate higher levels of CSCM adoption but being located inside an EIP itself does not moderate the CSCM-to-firm performance relationship, suggesting that performance is driven by practices rather than firm location. Based on the study results, all manufacturing firms, irrespective of their locations, are advised to develop systemic collaboration for CSCM, as its implementation offers numerous opportunities for organisational gains in supply chains. Moreover, the identification of barriers serves an important purpose, that of helping managers and policymakers in developing appropriate strategies and in prioritising relevant barriers in the short and long run. This research suggests developing systemic sustainability collaboration among key food supply chain players in China, with an explicit focus on improving economic and environmental impact outcomes. The Chinese government needs to improve and enforce environmental regulations and to better educate the public on environmental protection.

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Attestation of Authorship[1]

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Also, I declare that I am the principal author of the jointly authored manuscripts listed below and have contributed at least 80% in all three manuscripts presented in this thesis. The contribution of all co-authors in each manuscript and their percentage contributions are described below:

Manuscript 1

Muhammad Farooque: Did the literature review and contributed at least 80% of the published work under the guidance of his primary supervisor and other co-authors.
Abraham Zhang: Contributed the idea of Figure 1, polished the whole article and advised throughout the process being the primary supervisor.
Matthias Thürer: Played an advisory role for the systematic literature review methodology and supported during review/revision cycles.
Ting Qu: Contributed in the technology related section given his expertise in technologies.
Donald Huisingh: Played an advisory role; contributed in future research directions given his expertise in the field.

Percentage contribution (80/10/5/2.5/2.5)

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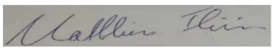
Matthias Thürer	
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[1] Note: At the time when the PhD candidate was enrolled at AUT, the primary supervisor Dr Abraham Zhang was the only researcher at AUT in the relevant discipline of supply chain management. Due to this shortage of AUT based researchers who have expertise on the topic, several external advisors/co-authors were formally or informally involved in the supervision process.

Manuscript 2

Muhammad Farooque: Wrote all sections under the guidance of his supervisors.
Abraham Zhang: Polished the whole article and advised throughout the process being the primary supervisor.
Janet Hartley: Advised on questionnaire development and helped in organizing the flow/structure of the manuscript given her expertise in the field.
Yanping Liu: Advised on the data collection instrument, and organized data collection from China and shared valuable feedback being the secondary supervisor.

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Manuscript 3

***Muhammad Farooque*:** Wrote all sections under the guidance of his supervisors.
Abraham Zhang: Polished the whole article and advised throughout the process being the primary supervisor.
Yanping Liu: Advised on the data collection instrument, potential barriers and organized data collection from China and shared valuable feedback being the secondary supervisor.

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Chapter 1/ Introduction

This thesis defines the new concept of circular supply chain management (CSCM) by integrating circular economy (CE) philosophy into supply chain management (SCM). Building on the newly established CSCM conceptualisation, the overarching theme of this thesis is to analyse the CSCM and firm performance relationship, in addition to identifying the barriers affecting the integration of CE into SCM.

This introduction chapter provides a research background and motivation, and identifies research gaps. After that, it defines research objectives and questions. An overview of research design and methodology is then presented, followed by the intended contributions of the thesis. This thesis includes five chapters including this introduction chapter, three main chapters (chapters 2-4) written in the journal article format, and a conclusion chapter.

1.1 Background

This section provides a short introduction to the two main concepts addressed in this research, i.e. sustainability and the CE. Their definitions and brief descriptions are provided to set the research background.

According to the most commonly accepted definition, sustainability is defined as “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). Given the widespread diffusion of the term, its most contemporary understanding is the so-called triple bottom line, i.e. the three pillars of sustainability: people, profit, and planet (Elkington, 1997, 1998). This triple bottom line approach to sustainability is also referred to as the balanced integration of economic, environmental and social performance. As such, these three spheres are systemically intertwined and they act as interdependent and mutually reinforcing pillars (McKelvey, 2002; United Nations General Assembly, 2005). Given its popularity and efficacy, sustainability has been institutionalised into the agendas of policymakers and organisations quite symmetrically (Hodgson, 2005). In the organisational context, past research suggests that firms that have embraced sustainability as a core operational strategy exhibit strong economic, social and environmental performance (Garetti & Taisch, 2012; Senge et al., 2001).

The extant literature suggests that CE plays a significant role in relation to sustainability and sustainable development (Korhonen et al., 2018; Kristensen & Mosgaard, 2020; Sauvé et al., 2016). It has quickly evolved into an influential driving force behind sustainability, both in the literature and in practice (Hobson, 2016; Stewart & Niero, 2018), and it has begun to be recognised as of great potential to help organisations achieve a breakthrough in sustainability performance.

The circular economy (CE) philosophy has been increasingly recognised as a better alternative to the dominant linear (take, make, and dispose) economic model (Ghisellini et al., 2016; Stahel, 2016). There are many definitions of CE; however, the two most authoritative definitions include that of the Ellen MacArthur Foundation (2020) and another by Kirchherr et al. (2017). According to the Ellen MacArthur Foundation (2020), "A CE is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems." CE represents an industrial system that is restorative and regenerative by design. It aims to keep products, components, and materials at their highest utility and value at all times in both biological and technical cycles. This means biological ingredients or nutrients can be safely returned to the biosphere and enhance natural capital. Similarly, geosphere-derived technical nutrients can be designed for recovery (remanufacturing, refurbishing and recycling); thus, they can be kept within the technosphere by being circulated in and contributing to the economy with minimal wastage (Ellen MacArthur Foundation, 2014). Based on analysis of 114 CE definitions, Kirchherr et al. (2017) defined CE as "an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations" (p. 224–225).

Due to its promising vision, the CE concept has gained traction with policymakers, governments and leading organisations and management consultancies across the globe. Several reports, including recent publications by Accenture and McKinsey, suggest that CE has an economic potential as high as trillions of dollars (Accenture, 2020; McKinsey & Company, 2020).

1.2 Research motivation

The challenges posed by global resource scarcity and depletion were one of the main reasons for choosing this topic for PhD research. The rate of natural resource consumption has increased at an alarming pace creating severe resource security issues. According to credible reports and estimates, humanity has been in ecological deficit or overshoot (i.e. annual demand on resources exceeding what Earth can regenerate) since the 1970s (Global Footprint Network, 2020). Today humanity uses the equivalent of 1.75 Earths to provide the resources we use and absorb our waste. If the current trends continue, it is estimated that by the year 2030, we will need two Earth planets to meet human needs (European Commission, 2020b).

As an early career researcher, I was inspired by the well-established supply chain sustainability concepts such as green and sustainable supply chains. The passion and desire to create new knowledge in the supply chain sustainability domain to better serve the sustainability cause has always been a key desire. The CE philosophy seemed to provide that impetus and promising new vision that was clearly lacking in the extant conceptualisations. It was soon realised that the interface between CE and SCM sustainability is still less understood, and thus, there are ample opportunities for developing this promising new perspective for the better future of world and the SCM sustainability domain.

1.3 Research gaps and research questions

The Circular Economy, being widely promoted by the Ellen MacArthur Foundation (2019b), is regarded as an industrial system based on restorative and regenerative design thinking that is far more sustainable than the dominant linear economic model (Ghisellini et al., 2016; Stahel, 2016).

In CE, outputs from one organisation are turned into inputs for another through biological (natural decomposition) and technical (remanufacturing, refurbishing and recycling) cycles, thereby aiming to generate no waste at all (Ellen MacArthur Foundation, 2014; Gartner, 2019; Veleva et al., 2017). Previous research suggests that integrating CE into SCM can provide advantages from a sustainability viewpoint (Agrawal et al., 2019; Genovese et al., 2017; Nasir et al., 2017; Van Wassenhove, 2019). However, SCM research is still at a nascent stage when it comes to conceptualising how to advance supply chain theories and practices to achieve sustainability benefits. Similarly, there are difficulties in linking firms via supply chains to cooperate in turning outputs into inputs (i.e. waste into resources) to help realise the vision of a CE (Mathews & Tan, 2016).

This thesis presents three sequential and interrelated studies contributing to the CSCM perspective. The following subsection presents the knowledge gaps and specific research questions.

Manuscript 1: Circular supply chain management: A definition and structured literature review

The supply chain sustainability domain has remained at the forefront of academic research for more than two decades. Sustainability concepts in the SCM literature have been largely inspired by Elkington (1997) idea of a triple bottom line (TBL), which suggests that organisational sustainability consists of three components: environment, economic and social sustainability (Carter & Dale, 2008). Based on the sustainability premise, a number of key concepts have been introduced and used interchangeably (Gurtu et al., 2015) to express the integration of the sustainability concept and its various components in the SCM literature (Ahi & Searcy, 2015). These concepts include: "sustainable supply chain management" (Anne & Helen, 2015; Craig & Easton, 2011; Seuring & Müller, 2008); "green supply chain management" (Li et al., 2019; Malviya & Ravi, 2015; Schmidt et al., 2017; Srivastava, 2007); "closed loop supply chain" (Govindan, Soleimani, et al., 2015; Guide & Van Wassenhove, 2003; Guide & Van Wassenhove, 2006; Souza, 2013); and "environmental supply chain management" (Darom & Hishamuddin, 2016; Walker et al., 2008; Zhu et al., 2010; Zhu, Geng, et al., 2011). Similarly, in recent years, the CE philosophy has also become an influential driving force behind SCM sustainability both in the literature and in practice, offering new and innovative perspectives in the SCM sustainability domain (Agrawal et al., 2019; Genovese et al., 2017; Van Wassenhove, 2019).

When compared with extant SCM sustainability concepts, CSCM offers a much broader sustainability perspective (Agrawal et al., 2019; Van Wassenhove, 2019). Firstly, CSCM involves restorative (for technical materials) and regenerative (for biological materials) cycles designed based on CE philosophy. It represents a paradigm shift in SCM sustainability research from “cradle-to-grave” to “cradle-to-cradle” (Genovese et al., 2017). This means that materials are no longer seen as a waste management problem, as in the cradle-to-grave system. Rather, CE follows cradle-to-cradle closed-loop nutrient cycles of nature, in which materials designed as biological nutrients follow the biological cycle and provide nourishment for nature after use. Similarly, technical nutrients follow the restorative cycle and circulate through industrial systems in closed-loop cycles of production, recovery and remanufacture (McDonough & Braungart, 2003, 2010).

Secondly, the zero-waste vision of CSCM goes beyond the narrow scope of the traditional SCM sustainability terms. For example, CSCM further extends the boundary of sustainable supply chain management and green supply chain management by encouraging the use of non-virgin materials through a systematic circulation of resources within supply chains systems (Andersen, 2007; Genovese et al., 2017). Similarly, when compared to closed-loop supply chains, CSCM does not restrict the scope of value recovery from end-of-life (EoL) products and/or wastes within the producer’s supply chain only. In contrast, firms in a circular supply chain go further by collaborating with other firms within and/or outside of their industry sector (Weetman, 2017) including secondary supply chains and/or involving new auxiliary channel members (Moula et al., 2017).

While the term “circular supply chain” to link CE with SCM appeared in a number of studies (for example, Canning, 2006; De Angelis et al., 2018; Du et al., 2010; Genovese et al., 2017; Mishra et al., 2018; Nasir et al., 2017), the first working definition of CSCM was presented in a recent study authored by Batista, Bourlakis, et al. (2018). However, their CSCM definition closely mirrors the definition of sustainable supply chain management and fails to account for the new and innovative aspects of CE in its conceptualisation. Hence, there is a need for an accurate and comprehensive definition of CSCM, clarifying its underlining differences from existing SCM sustainability concepts and fostering the further development of the field. Therefore, chapter 2 (manuscript 1), addresses the following research question:

RQ 1: What is circular supply chain management and its current state of research in the light of extant SCM sustainability literature?

Manuscript 2: Relationship between CSCM and firm performance and the role of eco-industrial parks

Firms making a transition towards CE require considerable transformations in business models, supply chain configurations and practices such as product/service design, production, logistics, consumption, waste management, reuse, and recycling (Bicket et al., 2014; Hobson, 2016; Mendoza et al., 2017). Corresponding to these requirements, firms have adopted various micro level (that of organisations' operations and supply chain) CE practices to reflect circular thinking in supply chains (Ghisellini et al., 2016). However, given the dominance of traditional SCM sustainability concepts in the past two decades, the conceptualisation of CE-oriented SCM practices (i.e. CSCM practices) has remained far less known in the extant literature. Therefore, the new innovative perspectives offered by CSCM practices as part of an integrated system and how they lead to performance benefits for firms remains largely unexplored (Agrawal et al., 2019). Although CE is extremely strong, based on the economic, social, and environmental benefits (Mathews et al., 2018, Atasu et al., 2018), due to the lack of conceptualisation of CSCM and its associated practices, some earlier research attempts have reported contradictory results with regard to the economic viability of CSCM. For example, Zhu et al. (2010) and Zhu, Geng, et al. (2011) indicate a positive economic performance outcome, whereas Genovese et al. (2017) and Nasir et al. (2017) suggest that CSCM implementation may be economically challenging. Given the inconsistent research findings and dearth of empirical work to support the economic and environmental benefits of implementing CSCM practices, more studies are needed to guide the transition to CE at a micro level (Bocken, Olivetti, et al., 2017; Franco, 2017; Sousa-Zomer, Magalhães, Zancul, Campos, et al., 2018).

The CE concept is currently being promoted by the European Union (EU) and several national governments including China, Japan, UK, France, Canada, The Netherlands, Sweden and Finland as well as leading businesses around the world (Korhonen et al., 2018). The CE concept was popularised in China in the 1990s in response to increasing environmental degradation and resource depletion challenges as a result of rapid economic development (Winans et al., 2017; Zhu et al., 2010). In 2008, China become the first country in the world to incorporate CE into part of its national development policy (Geng et al., 2012). China's distinctive feature of having more than half of its manufacturing industries operating in industrial parks and export processing zones has been one of the biggest advantages for its CE development (Mathews et al., 2018). As part of its CE strategy, China has been focused on transforming the existing industrial parks into eco-industrial parks (EIPs) intending to form closed-loops of resource flow and loop-linking production systems (also known as industrial symbiosis) in accordance with CE principles (Mathews et al., 2018). EIP development for the purpose of industrial symbiosis is increasingly being considered a useful strategy to support CE implementation; however, there is lack of knowledge on the role of EIP development and industrial symbiosis practices from a supply chain perspective (Herczeg et al., 2018). Specifically, the research concerning the impact of being located in an EIP on the CSCM practices and its performance implications is clearly missing in the extant literature. Hence, chapter 3 (manuscript 2) addresses the following research question:

RQ 2: What is the impact of CSCM practices on firm performance and how does being located in an eco-industrial park (EIP) affect the CSCM to firm performance relationship?

Manuscript 3: Barriers to integrating CE into SCM

On the other hand, the transformation of an economy from a linear to a circular format is not without challenges. Since making CE part of its national development policy, the Chinese government has adopted various legislations and financial measures to strengthen its CE program (Mathews & Tan, 2016). However, China's modest progress in achieving CE objectives after two decades of extensive promotions has manifested the difficulties in linking firms by circular supply chains to cooperate in turning outputs into inputs (i.e. waste into resources) (Mathews & Tan, 2016). So far the majority of studies have focused on the macro (cities, provinces, and regions) and meso level (eco-industrial parks) implementation of CE in China (Liu & Bai, 2014; Wu et al., 2014). Among them, many studies broadly discussed some challenges and barriers at a macro level (Geng & Doberstein, 2008; Geng et al., 2012; Geng et al., 2009). To date, however, little is known about the barriers affecting the integration of CE in SCM at a micro level. Since CSCM is a new and emerging concept, it is worthwhile to identify barriers that hinder the development of CE practices at a firm and supply chain level. Hence, chapter 4 (manuscript 3) addresses the following question:

RQ 3: What are the key barriers to integration of CE in SCM (CSCM) and how do these barriers interact with each other?

1.4 Research Design

1.4.1 Ontological and epistemological assumptions

This thesis follows the positivist philosophical paradigm. A research paradigm is a belief system with assumptions related to ontology, epistemology, methodology and methods. Ontology is concerned with "what is, with the nature of existence, with the structure of reality as such" (Crotty, 1998, p.19). Positivism assumes that the reality can be observable, measurable and understandable, it exists external to the researcher and must be investigated through the rigorous process of scientific inquiry (Gray, 2013). Epistemology is concerned with "providing a philosophical grounding for deciding what kinds of knowledge are possible and how we can ensure that they are both adequate and legitimate" (Maynard, 1994, p.10). The epistemological position of positivists is that of objectivism (Gray, 2013), which asserts that social phenomena and their meanings have an existence that is independent of social actors (Grix, 2002). In essence, this thesis undertakes research related to organisation systems, practices and performance. The researcher's positivist stance posits CSCM as an organisational system, its performance implications and barriers to its development able be investigated and tested independently of the researcher's viewpoint. Therefore, the only purpose of this thesis is to discover the objective reality that is 'out there' and the researcher does not intend to include their own feelings and values (Gray, 2013).

1.4.2 Research methodology

Ontological and epistemological assumptions lead to decisions about research methodology. Research methodology identifies the ways to answer the research questions (Blaikie, 2009). Quantitative and qualitative researches are the two well-recognised research methodologies. The difference between the two lies in the logic and application of both methodologies. Quantitative methodology mainly uses deductive logic and looks for explanations and predictions that are generalisable to the whole population using concepts, variables, and hypotheses which remain fixed over the period of the study (Leedy & Ormrod, 2005), whereas qualitative methodology uses inductive logic for theory building and strengthening using a fact-finding mechanism (Bryman, 2015). Qualitative research is often depicted as a research methodology with an emphasis on a relatively open-ended approach to the research process, resulting in frequent surprises, changes of direction and new insights (Bryman, 2006). Positivist operations management researchers generally employ quantitative methodologies including optimisation models, simulation modelling and survey methodology to describe or explain research phenomena (Meredith, 1998).

The three studies presented in this thesis use a variety of robust methodologies to achieve a comprehensive understanding of the research problem. Table 1 presents a summary of the research questions and methods used to answer these questions.

Manuscript 1 (chapter 2) offers a literature review on CSCM and, thus, is based on secondary data. A systematic literature review procedure similar to Seuring and Müller (2008), Harland et al. (2006) and Mayring (2003) is used for retrieving, selecting and synthesising the studies in the structured review.

The primary data for manuscript 2 (chapter 3) is collected using a survey methodology. Data is collected as part of a larger study focused on CSCM adoption throughout the Chinese manufacturing sector. A multi-industry viewpoint is justified given the fact that the Chinese government has taken a lead by promoting CE as a part of mainstream national policy for sustainable development for about two decades (Geng et al., 2012). Consequently, many industries have adopted various supply chain practices to demonstrate their transition towards CE.

Also, the country has strategically developed the world's largest network of EIPs to form a large scale network of closed loops of resource flows among firms (Mathews et al., 2018). This provides a research opportunity to investigate the impact of CSCM on firm performance and the role of EIPs in the practice-performance relationship.

A snowball sampling approach, which is a commonly used means of obtaining data from a variety of firms in various industries (Martins et al., 2002), is involved in the survey. In order to obtain quality and reliable data, the questionnaires were distributed using the researchers' own professional network along with some additional support from postgraduate and MBA students at a large state university and local government agencies in northern China to collect data from respondents within their network. An effort was made to collect data from two respondents per organisation, one for the independent variables and one for the dependent variables. Overall, this survey methodology is contextually appropriate and in line with previous studies (Zhu, Geng, et al., 2011; Zhu & Sarkis, 2004) where authors have reported difficulties in obtaining data for organisational practices in the Chinese manufacturing industry. Data analysis for manuscript 2 (chapter 3) involves structural equation modelling (SEM) and rank based non-parametric test (i.e. Kruskal-Wallis H test) using IBM® SPSS® Amos 25 software package to examine the relationship between CSCM and firm performance including the role of eco-industrial parks.

Manuscript 3 also involves a survey method. The data is collected from multiple stakeholders in the Chinese food sector. This study argues that, despite the Chinese government's efforts for CE implementation over the last two decades, the country's progress towards CE has been modest (Mathews & Tan, 2016). This calls for an investigation of the barriers to integrating CE into SCM. However, it is further argued that, for CE implementation, different industries may need different supply chain actors with which to collaborate, along with a diverse range of techniques in waste management and resource recovery procedures. Therefore, it is imperative to identify industry specific barriers in the industries requiring immediate intervention. The severity of adverse environmental impacts of food supply chains and scarcity of research on their sustainability practices makes this issue worth investigating in the Chinese food supply chain context.

A combination of email and postal survey methods is used to collect data from a list of various manufacturing companies provided by the regional Chinese government. The distribution and collection of the survey questionnaires was aided by three branches of a regional government in northern China, namely the Development and Reform Commission, Bureau of Commerce and Food Safety Committee. For data analysis, a multi-criteria decision analysis tool, i.e. decision-making trial and evaluation laboratory (DEMATEL), is used to analyse the interrelationships among barriers. DEMATEL is a suitable technique in barriers studies with significant advantages over competing methods (Venkatesh et al., 2017).

Table 1: Summary of research questions and methods

Manuscript	Focus	Research question	Methodology
Manuscript 1	Definition and structured literature review of circular supply chain management	RQ 1: *What is circular supply chain management and its current state of research in the light of extant SCM sustainability literature?*	*Systematic Literature Review method*
Manuscript 2	Circular supply chain management to firm performance relationship and the role of eco-industrial parks	RQ 2: *What is the impact of CSCM practices on firm performance and how does being located in an eco-industrial park (EIP) affect the CSCM to firm performance relationship?*	*Survey method and data analysis using structural equation modelling and Kruskal-Wallis H test*
Manuscript 3	Barrier to integration of CE in SCM	RQ 3: *What are the key barriers to integration of CE in SCM (CSCM) and how do these barriers interact with each other?*	*Survey method and data analysis using Fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique*

1.5 Overall thesis contribution

The thesis intends to make significant theoretical and practical contributions. Firstly, this thesis offers a multifaceted and holistic perspective of CSCM, which is an emerging concept in the SCM sustainability domain. This includes a comprehensive definition of CSCM, a pioneering structured review of the literature, CSCM practice-performance relationship at the firm level and the role of eco-industrial parks at the supply chain level, as well as identifying barriers to CSCM development. Secondly, this research contributes by developing a new construct, namely CSCM, consisting of four operational practices such as circular product design, circular procurement, EoL and waste management. The CSCM construct and its measurement items were developed through extensive review of the literature and were validated by academic and industry experts. Similarly, this research also broadens the scope of firm performance viewpoint with the addition of a new construct, that is, resource circularity. A similar approach as explained above was adopted to develop the construct and its measurement items. Thirdly, this thesis contextualises several relevant organisational theories for investigating the CSCM practice–performance link and for identifying barriers to integrating CE in SCM. This provides an opportunity to test these theories and shed light on their relevance in the CSCM research context.

The practical implications of this research are manifold. The results will help organisations to determine whether implementing CSCM is worth the effort in terms of firm performance across various performance measures. As such, it provides guidance in terms of how to implement CE/CSCM at a firm and supply chain level. In addition, it sheds light on the role of contingency factors such as eco-industrial parks in fostering CSCM development. The identified barriers and their interplay will help policymakers and other involved stakeholders (e.g. businesses and customers) to gain more insights and devise appropriate circumventing strategies.

1.6 Thesis structure

This thesis comprises three manuscripts (i.e. chapters 2-4). Chapter 2 (manuscript 1) offers a structured literature review on CSCM. Chapter 3 (manuscript 2) analyses the CSCM practices-performance relationship including a contextual role of eco-industrial parks (EIPs) in the stated relationship within Chinese manufacturing industries. Chapter 4 (manuscript 3) identifies and systematically analyses the causal-effect relationships among barriers to circular food supply chains in China. The thesis is concluded in Chapter 5. Abstracts of the three manuscripts are presented below.

Chapter 2

Title: Circular supply chain management: A definition and structured literature review

The Circular Economy is increasingly recognised as a better alternative to the dominant linear (take, make, and dispose) economic model. Circular Supply Chain Management (CSCM), which integrates the philosophy of the circular economy into supply chain management, offers a new and compelling perspective to the supply chain sustainability domain. Consequently, there is increasing research interest. However, a review of the extant literature shows that a comprehensive integrated view of CSCM is still absent in the extant literature. This prohibits a clear distinction compared to other supply chain sustainability concepts and hinders further progress of the field. In response, this research first classifies various terminologies related to supply chain sustainability and conceptualises a unifying definition of CSCM. Using this definition as a base, it then conducts a structured literature review of 261 research articles on the current state of CSCM research. Based on the review results, the researchers call for further studies in the following directions that are important but have received little or no attention: design for circularity, procurement and CSCM, biodegradable packaging, circular supply chain collaboration and coordination, drivers and barriers of CSCM, circular consumption, product liabilities and producer's responsibility, and technologies and CSCM.

An early version of this paper was presented at the 15th ANZAM Operations, Supply Chain and Services Management Symposium, Queenstown, New Zealand, in June 2017. This current version presented in the thesis is a substantially revised version that has been published in the *Journal of Cleaner Production* (ABDC ‘A’ ranked).

Chapter 3

Title: Circular supply chain management: Performance outcomes and the role of eco-industrial parks in China

The Circular Economy (CE) is increasingly being recognised as a new sustainability frontier throughout the globe. Circular supply chain management (CSCM), which integrates CE in supply chain management (SCM) offers great promise and breakthroughs in the sustainability performance. Firms have adopted a number of supply chain practices in their transition towards CE; however, there is a lack of evidence on how these practices form a unified CSCM strategy and lead firms to higher levels of performance. China has made great efforts to promote CE over the last decade. The country has strategically developed the world's largest network of eco-industrial parks (EIPs) to form a large scale network of closed loops of resource flows among firms. However, the contextual role of being located within an EIP on the adoption of CSCM and their performance implications has not been empirically explored. For this purpose, we combine a Natural Resource-Based View (NRBV), Contingent NRBV and the literature on CSCM to develop a conceptual model. Using statistical analysis of the data collected from 255 Chinese manufacturing firms, we establish the following results. Firstly, CSCM, when exercised as a unified strategy, has a significant positive effect on environmental, cost and financial performance. However, quite surprisingly, our results do not show significant improvements in resource circularity performance, potentially due to the modest progress towards CE. Secondly, firms located within EIPs adopt CSCM at higher levels as compared to firms located outside EIPs. Thirdly, the contextual factor of being located within an EIP does not moderate the CSCM practice-performance relationship, suggesting that performance is driven by practices rather than firms' locations. Our findings contribute to the supply chain sustainability literature by offering new constructs and measurement items relevant to CSCM and resource circularity performance, and provide insights to guide managers in adopting CSCM more effectively.

This manuscript has been prepared for submission to the *Journal of Operations Management* (ABDC 'A*' ranked).

Chapter 4

Title: Barriers to circular food supply chains in China

This paper aims to identify and systematically analyse the causal-effect relationships among barriers to circular food supply chains in China. Grounded in multiple organisational theories, this paper develops a theoretical framework for identifying relevant barriers to integrating circular economy philosophy in food supply chain management. The study uses 105 responses from Chinese food supply chain stakeholders, including food processors, sales and distribution channels, consumers and government officials. It applies a fuzzy decision-making trial and evaluation laboratory (DEMATEL) method to examine the causal-effect relationships among the identified barriers. Overall, the results suggest two key cause barriers: firstly, weak environmental regulations and enforcement, and secondly, lack of market preference/pressure. Meanwhile, lack of collaboration/support from supply chain actors is the most prominent barrier. The key cause and prominent barriers are also identified for each of the supply chain stakeholders involved. The study offers practical insights for overcoming barriers to integrating circular economy philosophy in the management of supply chains in the Chinese food sector, as well as in other contexts where similar challenges are faced. It also sheds light on which organisational theories are most suitable for guiding similar studies. To the best of the authors' knowledge, this is the first barrier study on circular food supply chains. The use of multiple organisational theories for the development of the theoretical framework is unique in barrier studies. The study offers insights from multiple stakeholders in the Chinese food supply chains.

An early version of this paper was presented in the 48th International Conference on Computers & Industrial Engineering, Auckland, New Zealand, in December 2018. This current version presented in the thesis is a substantially revised version that has been published in the S*upply Chain Management: An International Journal* (ABDC 'A' ranked).

Chapter 2/ Manuscript 1 – Circular Supply Chain Management: A Definition and Structured Literature Review

Prelude

This chapter/manuscript offers the conceptualisation of a new frontier in the supply chain sustainability research domain, namely, circular supply chain management, which integrates CE concept in SCM. A unified definition and a comprehensive integrated view of CSCM is presented in this manuscript. Using the newly proposed definition, a structured literature review of 261 articles is conducted to gain an in-depth understanding of the current status of CSCM research. Further it aims to provide insights into what has been done and what research needs to be done in the future for the further development of this promising research field.

This manuscript has been published in the *Journal of cleaner production.* The spelling in this manuscript is in accordance with the publisher's requirements and may slightly differ from the other chapters. Moreover, the original numbering of captions for tables and figures is also retained from the published version.

1. Introduction

Sustainability has provoked a multitude of discussions and debates in the academic literature, including the Supply Chain Management (SCM) literature (Morali & Searcy, 2013; Seuring & Müller, 2008). However, global patterns of production, consumption and trade still remain dangerously unsustainable (Preston, 2012). At its current level of consumption, the world will deplete many natural resources in the foreseeable future if there is no change in the way products are sourced, produced, delivered, used, reclaimed and regenerated (Hazen et al., 2017).

One important philosophy that may bring about this change is the circular economy (CE), a philosophy that has been increasingly recognized as a better alternative to the dominant linear (take, make, and dispose) economic model (Ghisellini et al., 2016). The CE philosophy is evolving into an influential driving force behind sustainability, both in the literature and in practice (Hobson, 2016; Stewart & Niero, 2018), and it has begun to be recognized as of great potential to help organizations achieve a breakthrough in sustainability performance.

CE was promoted by the Ellen MacArthur Foundation (EMF) (2014) as an industrial system that is restorative and regenerative by design. CE aims to keep products, components and materials at their highest utility and value at all times in both biological and technical cycles. This means biological ingredients or nutrients can be safely returned to the biosphere and enhance natural capital. Similarly, geosphere-derived technical nutrients can be designed for recovery (remanufacturing, refurbishing, and recycling); thus, they can be kept within the technosphere by being circulated in and contributing to the economy with minimal wastage (EMF 2012b; 2014).

Integrating CE into SCM can provide advantages from a sustainability viewpoint (Genovese et al., 2017; Nasir et al., 2017). Consequently, there is enthusiasm and a growing interest in SCM for CE (Aminoff & Kettunen, 2016; Batista, Bourlakis, et al., 2018; Batista, Gong, et al., 2018; Bressanelli, Perona, et al., 2018; Darom & Hishamuddin, 2016; De Angelis et al., 2018; Govindan & Hasanagic, 2018; Howard et al., 2018; Kazancoglu et al., 2018; Liu et al., 2018; Ying & Li-jun, 2012). However, SCM research is still at a nascent stage when it comes to conceptualizing how to advance supply chain theories and practices to help realize the vision and potential of a CE.

In the SCM literature on sustainability, a number of concepts, such as sustainable supply chains, green supply chains, environmental supply chains, and closed-loop supply chains, have been introduced and used interchangeably (Gurtu et al., 2015) to express the integration of sustainability concepts in SCM (Ahi & Searcy, 2015). While these concepts represent different degrees of integrating sustainable thinking into supply chains, none of them have systematically integrated circular thinking - i.e. the essence of the CE philosophy – into SCM. Some recent reviews on integrating CE into SCM have a rather narrow scope (Batista, Bourlakis, et al., 2018; Govindan & Hasanagic, 2018). Meanwhile, the extant literature on CE and SCM sustainability remains fragmented where some key principles of CE are reflected at a strategic level and others around SCM functions such as design, procurement, production, etc.

While the term "circular supply chain" was used in some studies to link CE with SCM (Canning, 2006; De Angelis et al., 2018; Du et al., 2010; Genovese et al., 2017; Mishra et al., 2018; Nasir et al., 2017) it is only very recently that a working definition of circular supply chain management (CSCM) appeared in the literature. CSCM has been defined as:

"the coordinated forward and reverse supply chains via purposeful business ecosystem integration for value creation from products/services, by-products and useful waste flows through prolonged life cycles that improve the economic, social and environmental sustainability of organizations" (Batista, Bourlakis, et al., 2018, p. 446).

Apparently, this closely mirrors the definition of sustainable supply chain management:

"the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, into account which are derived from customer and stakeholder requirements" (Seuring & Müller, 2008, p.1700).

It does not sufficiently reflect the two aspects that make CSCM unique: 1) its restorative and regenerative cycles designed based on circular thinking; 2) the vision of a zero-waste economy that is inherent in the CE philosophy. Therefore, this definition is likely to lead to confusion with existing sustainability concepts in the context of SCM and consequently may hinder the development of CSCM. In response, the current study aims to achieve the following objectives:

1. To conceptualize a new definition of CSCM;
2. To map the current state of research on all the aspects and facets of CSCM by use of a structured review of literature; and
3. To identify important directions for future research in CSCM.

The remainder of this paper is organized as follows: section 2 classifies the supply chain sustainability concepts and defines CSCM; section 3 then describes how the structured literature review on CSCM has been conducted; and section 4 then presents the results of our review.

Section 5 discusses important future research directions that emerged from the review. Finally, section 6 concludes this study.

2. **Supply Chain Sustainability Terms and CSCM**

To the best of our knowledge, this is one of the few early attempts to conceptualize and define a comprehensive integrated view of CSCM, to appropriately distinguish it from other sustainability concepts presented in the supply chain literature. To do so, this section first classifies existing supply chain sustainability concepts and discusses their relation to the CE philosophy in Section 2.1. Section 2.2 then presents a working definition for CSCM.

2.1 Classification of Supply Chain Sustainability Terms

Sustainability concepts in the SCM literature have been largely inspired by Elkington's (2004) idea of a triple bottom line (TBL) which suggest that organizational sustainability consists of three components: the natural environment, society, and economic performance at a broader level (Carter & Dale, 2008). Based on these three components, different terminologies emerged from the literature, for example, "sustainable supply chain management" (Anne & Helen, 2015; Craig & Easton, 2011; Leszczynska & Maryniak, 2017; Seuring & Müller, 2008), "green supply chains" (Chakraborty, 2010; Malviya & Ravi, 2015; Seman et al., 2012; Srivastava, 2007), "closed loop supply chains" (Govindan, Soleimani, et al., 2015; Souza, 2013), and "environmental supply chains" (Darom & Hishamuddin, 2016). Each of these concepts gave different weight to the three components. For example, Ahi and Searcy (2013) performed a comparative analysis of 12 unique definitions of sustainable supply chain management (SSCM) from 56 articles and 22 unique definitions of green supply chain management (GSCM) from 124 articles. They found that most definitions for SSCM explicitly addressed all three dimensions of the TBL. In contrast, none of the published definitions on GSCM explicitly mentioned social issues.

EMF (2017) defined the CE philosophy as *"Looking beyond the current take, make and dispose extractive industrial model, the circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out,* *while minimizing negative impacts. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural and social capital"*. The CE philosophy makes a clear distinction between products' biological (regenerative) and technical (restorative) cycles. The biological materials or nutrients become part of the biosphere as natural capital and can be reused as production inputs, whereas the technical materials or nutrients (polymers, alloys and other man-made compounds) are designed for material recovery through repair, refurbishing, remanufacturing, and recycling (Weetman, 2017). Thus, CE may, if actualized, operate in ways where product design, usage, and re-usage based economic activities mimic the natural ecosystem; i.e. natural resources transformed into manufactured products and the manufactured by-products are used as resources for other industries (Zhu et al., 2010).

Integrating CE in SCM would begin to extend the boundary of SSCM and GSCM by reducing the need for virgin materials, which could increase the circulation of resources within supply chains systems (Andersen, 2007; Genovese et al., 2017). However, based on our analysis of the literature on CE, there is a knowledge gap in terms of how to integrate CE into SCM (see also Aminoff and Kettunen (2016)). As presented in Table 1, the sustainability discussion in SCM has mainly addressed restoration options (repair, refurbishing, remanufacturing and recycling) while the regeneration concept has not been discussed in the SCM sustainability context. So there is a need to enhance the existing sustainability concepts in SCM towards a CSCM.

Table 1: Sustainability in SCM and CE

Sustainability in SCM (Terms)	**Definition Source**	**Sustainability Dimension**			**Integration of CE**	
		Environmental	**Economic**	**Social**	**Restorative***	**Regenerative***
Sustainable Supply Chain Management	Seuring and Müller (2008)	■	■	■	■	
Green Supply Chain Management	Srivastava (2007)	■	■		■	
Environmental Supply Chain Management	Zsidisin and Siferd (2001)	■	■		■	
Closed Loop Supply Chains	Guide and Van Wassenhove (2006)	■	■		■	

* ***Restorative:*** Ability of end of life products/materials to become technical nutrients through repair, refurbishing, remanufacturing, and recycling (Ellen MacArthur Foundation, 2017)
* ***Regenerative:*** Ability of end of life products/materials to become biological nutrients and become part of the biosphere as natural capital for reuse (Ellen MacArthur Foundation, 2017)

2.2 Circular Supply Chain Management Definition

The integration of CE into SCM has been termed "circular supply chain" in the literature (Canning, 2006; Du et al., 2010; Genovese et al., 2017; Nasir et al., 2017). However, there is no comprehensive definition of CSCM. Therefore, we2 propose the following definition:

Circular supply chain management is the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems. It systematically restores technical materials and regenerates biological materials toward a zero-waste vision through system-wide innovation in business models and supply chain functions from product/service design to end-of-life and waste management, involving all stakeholder in a product/service lifecycle including parts/product manufacturers, service providers, consumers, and users.

CSCM significantly enhances SSCM and GSCM by a regenerative dimension. It advances sustainability thinking by systematically applying CE's circular thinking in all supply chain stages and functions. As with the CE philosophy, CSCM is applicable to manufactured products as well as to service products. In CSCM, organizations collaborate with others within and outside of the sector to maximize the utility of goods/materials. It offers a promising vision to guide supply chain managers to achieve a breakthrough performance in resource efficiency, and consequently, profitability. Simultaneously, it minimizes the negative environmental, social, and economic impacts.

The purpose of CSCM is to lead towards circular supply chains as illustrated in Figure 1. Figure 1 contrasts a circular supply chain (Figure 1c) with a traditional (linear) supply chain (Figure 1a) and a closed-loop supply chain (Figure 1b). A linear supply chain extracts resources from the geosphere and the biosphere and disposes of EoL products, packaging materials, and wastes from multiple supply chain stages. The unwanted items are often deposited in landfills. A closed loop supply chain improves environmental performance by bringing back goods and packaging materials to the producer to recover value (Guide & Van Wassenhove, 2006). For example, closed

[2] This manuscript adopts the 'we' form as it was published as a jointly authored paper with supervisors/advisors.

loop remanufacturing of photocopiers can conserve 20–70% of materials, labour and energy, and reduce waste by 35–50% as compared to conventional manufacturing (Toffel, 2004). However, the extent of value recovery in a closed loop supply chain is often limited because the efforts are restricted within the original supply chain (producer's supply chain) and do not include secondary supply chains and/or involve new auxiliary channel members (Moula et al., 2017). A closed loop supply chain still generates substantial amounts of waste as it is rarely feasible to reuse/recycle all unwanted items within the same supply chain. A circular supply chain goes further by recovering value from waste by collaborating with other organizations within the industrial sector (open loop, same sector), or with different industrial sectors (open loop, cross-sector) (Weetman, 2017).

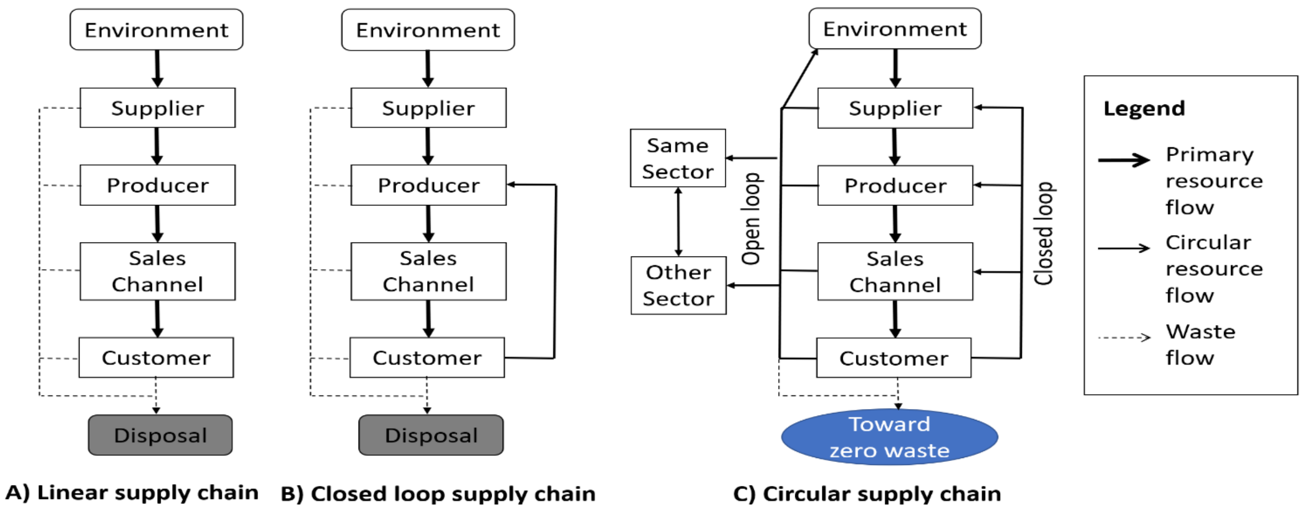

Figure 1. Linear, closed loop and circular supply chains

Ideally, a circular supply chain will generate zero waste because it is designed to systematically restore and regenerate resources in the industrial and natural ecosystem in which it is embedded. Circular supply chains have two types of resource flows: primary resource flows and circular resource flows, as illustrated in Figure 1c. The primary resource flows are identified with the forward flow of goods in the linear and closed loop supply chains. The circular resource flows represent the "re-" type flows of goods/materials/energy that are recycled, retained, reused, repaired, remanufactured, refurbished, recovered, etc.

In practice, CSCM endeavours to produce zero waste through system-wide innovations to recover value from what was traditionally called "waste". For example, recycled PET bottles may be used for construction; light concrete is added to the bottles, creating isolated walls for houses (Scheel & Vasquez, 2013; Scheel & Vazquez, 2011). Similarly, a manufacturer may recycle textile materials to produce insulation products for the construction industry (Nasir et al., 2017) while a food supply chain's waste cooking oil may be refined and utilized to produce biodiesel (Genovese et al., 2017). Food wastes can be minimized at their sources and the remaining food wastes can be composted or anaerobically digested to produce methane as a renewable energy source and fermentate, which can be used as a fertilizer in agriculture/horticulture.

Based on the CSCM conceptualization presented above, we have developed one of the earliest literature reviews in this emerging field. We hope that this significantly furthers the development of CSCM and provides a new dimension for sustainability researchers in SCM, offering significant managerial, policy, human health, and eco-system health implications.

3 Methodology

A structured review of the literature was conducted to summarize the current state of academic research on CSCM. A procedure similar to Seuring and Müller (2008); Harland et al. (2006) and Mayring (2003) was used for retrieving and selecting the articles. The following subsections outline the approach adopted for sourcing, screening and analyzing the articles and sample characteristics.

3.1 Sourcing the Articles

There are, arguably, three major abstract and citation databases: Google Scholar, Scopus and the Web of Science. We excluded Google Scholar because of its low data quality, which raises questions about its suitability for research (Meho & Yang, 2007; Mongeon & Paul-Hus, 2016). Meanwhile, Scopus has a broader coverage than the Web of Science, but the latter provides access to older sources. Since we are investigating a recent phenomenon, the access to older sources offered by the Web of Science database is not an advantage. We, therefore, focused on Scopus. In general, the number of journals in the Web of Science not covered by Scopus is about 5%, and the number of Scopus articles not covered by the Web of Science is about 50% (Mongeon & Paul-

Hus, 2016). Meanwhile, we did not use a full-text database (such as EBSCO, Elsevier, ProQuest, Sage, Springer, Taylor & Francis, or Wilson) in a bid to avoid excluding any particular publisher from the search. All articles published until 2018 were considered.

To maintain the quality of content and to keep the selected articles to a manageable number, the search was restricted to "Articles", "Articles in press" and "Review articles" published in peer-reviewed journals. Although representing a limitation, only English language sources were included in our review given the language limitations of the author team. Scopus was queried using the keywords summarized in Table 2. This step retrieved 2987 publications. After removing duplicates, 1748 articles remained.

Table 2: Keywords used for search and number of papers retrieved

1st step		
No.	**Keywords used for search**	**Papers retrieved**
1	circular economy AND supply chain	152
2	circular economy AND value chain	59
3	circular economy AND operations management	5
4	circular economy AND sustainable supply chain	16
5	circular economy AND green supply chain	14
6	circular economy AND closed loop supply chain	22
7	circular economy AND environmental supply chain	1
8	circular economy AND reverse logistics	25
9	circular economy AND logistics	47
10	circular economy AND design	297
11	circular economy AND procurement	15
12	circular economy AND manufacturing	175
13	circular economy AND production	611
14	circular economy AND end of life	116
15	circular economy AND remanufacturing	68
16	circular economy AND refurbish	20
17	circular economy AND repair	25
18	circular economy AND reuse	222
19	circular economy AND recycle	64
20	circular economy AND reduce	204
21	circular economy AND restore	5
22	circular economy AND regenerate	7
24	circular economy AND consumption	292
25	circular economy AND product service systems	33
26	circular economy AND PSS	16
27	circular economy AND business model	137
28	circular economy AND waste management	339
Total number of papers retrieved		**2987**
2nd step		
1	Circular economy	**1748**

3.2 Screening the Articles

At the screening stage, articles were included/excluded based on the abstract, which was retrieved from the database. All abstracts of the original sample of 1748 articles were read. Any article that covered aspects of CE in an SCM context were retained. Most of the analysis was executed by two researchers/authors. The abstracts were read by both researchers independently and the results were compared. Any inconsistencies of interpretation were resolved through discussion until consensus was reached. All articles for which no clear decision could be reached were put in a backlog. The backlog was then cleared by both researchers through in-depth discussion, with a bias towards including the article if there was any doubt. This rather subjective procedure based on the judgement was required since the literature on CSCM is very broad and covers many different areas. Hence, no specific inclusion/exclusion criteria could be applied beyond whether or not a paper appeared to be incorporating a focus on CE in a SCM context at the micro level (firm or supply chain level).

The screening reduced the relevant articles to 270. The high number of unrelated articles is justified given our broad search terms, which included many articles that did not explicitly integrate the CE philosophy into SCM (i.e. with an exclusive focus on CE or supply chain sustainability). Focusing on articles that explicitly focus on the integration of CE into SCM differentiates our literature review work from reviews in SSCM (Ansari & Kant, 2017; Dubey, Gunasekaran, Childe, Papadopoulos, & Fosso Wamba, 2017; Seuring & Müller, 2008), GSCM (Fahimnia et al., 2015; Malviya & Ravi, 2015; Srivastava, 2007), closed loop supply chain (Govindan & Soleimani, 2017; Govindan, Soleimani, et al., 2015; Souza, 2013) and CE (Ghisellini et al., 2016; Lieder & Rashid, 2016; Su et al., 2013). Using several channels for retrieving the full articles, i.e. database subscription/access available to the authors, a total of 261 articles were obtained and evaluated as the final sample. Figure 2 summarizes the structured literature review process.

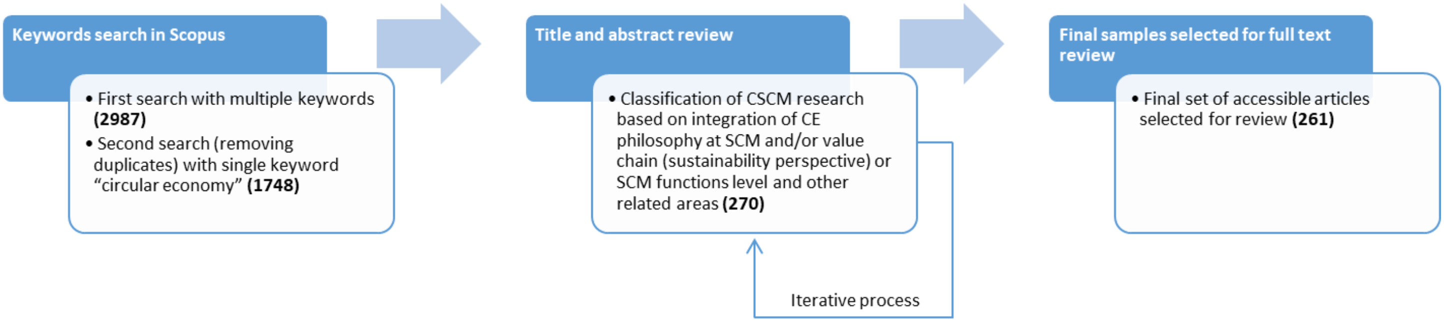

Figure 2: Structured literature review process

3.3 Analyzing the Articles

This stage involved extracting and documenting information from the 261 articles. To minimize subjectivity, the authors: (i) cross-checked results; and (ii) conducted regular meetings between themselves to resolve any emerging inconsistencies in interpreting the results. Our major research vehicle was content analysis (see, Krippendorff (2004)). To ensure that we did not miss relevant information, we held regular meetings to discuss issues and to clarify ambiguities. As a template for data collection, a simple matrix was used where, for each paper (row), we asked (column) the following questions:

- What part(s) of CE were integrated into SCM or value chain (from a sustainability viewpoint)?
- What part(s) of CE were integrated into SCM functions?
- Which circular business models were discussed in the publication?
- What role did technology play in integrating CE in SCM?
- Which industrial sector did it focus upon?
- Which country was the context of the research?
- What was the research/analysis methodology?
- What were the key findings, lessons, recommendations for the short and long-term future?

Before presenting the results, Section 3.4 summarizes the basic sample characteristics.

3.4 Sample Characteristics

The distributions of publications by the year of publication are presented in Figure 3. The discussion of CE elements in supply chain sustainability literature started in the late 2000s and continued at a modest rate until 2015. There has been an increase of papers on this topic since the beginning of 2016, which indicates a growing research interest in this field, further supporting the need for our comprehensive review (see Figure 3).

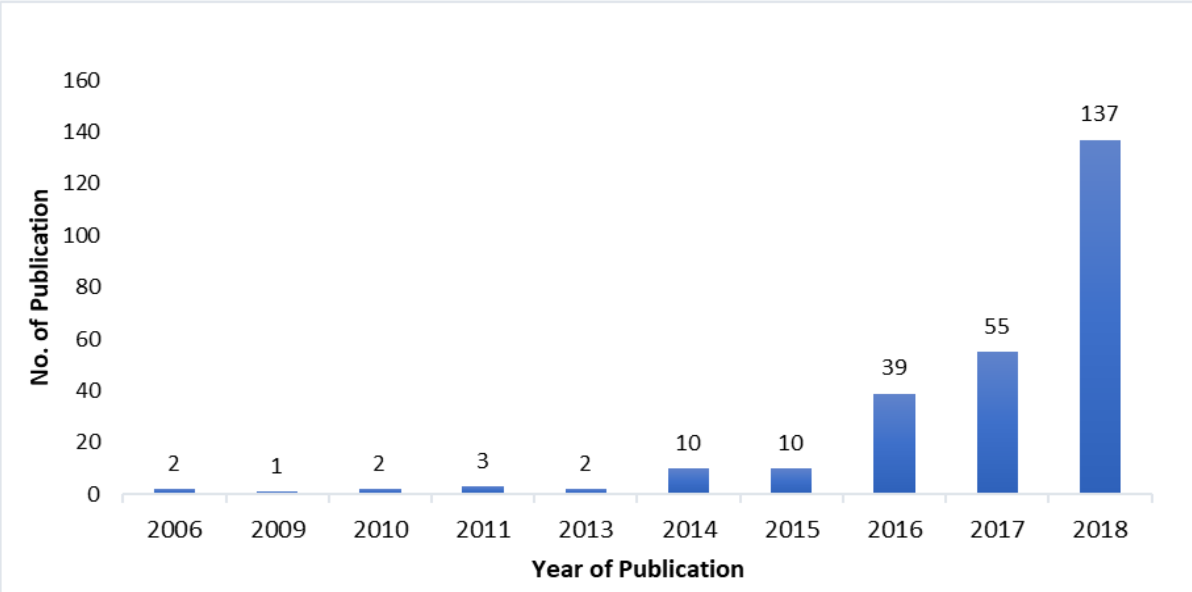

Figure 3: Distribution of articles per year

Table 3 presents the distribution of journals across which the articles were published. The sample contains articles from a broad set of journals. It was found that 51 journals have published just one paper on the topic. Moreover, as anticipated, the leading journals in the field head the list, with the highest contribution of relevant articles in the *Journal of Cleaner Production* (64) in the emerging field of CSCM research.

Meanwhile, Figure 4 presents the distribution of the research context by country. The results indicate a leading role for China in accelerating CSCM research. Moreover, substantial research in the CSCM has also been conducted in the United Kingdom (UK), The Netherlands, the United States of America (USA), and Sweden, in addition to other European countries. The European Union's (EU) growing interest in CSCM is evident in Figure 4. However, these statistics exclude the publications where the research context was unclear or unspecified.

Table 3: Distribution of reviewed articles by journal

Journal Name	No. of papers	%
Journal of Cleaner Production	63	24.14
Sustainability (Switzerland)	32	12.26
Resources, Conservation and Recycling	26	9.96
Journal of Industrial Ecology	12	4.60
International Journal of Production Research	10	3.83
Production Planning and Control	10	3.83
Waste Management	7	2.68
Business Strategy and the Environment	7	2.68
California Management Review	5	1.92
Resources	5	1.92
Management Decision	5	1.92
Environmental Innovation and Societal Transitions	4	1.53
Thunderbird International Business Review	4	1.53
Journal of Remanufacturing	3	1.15
Procedia Manufacturing	3	1.15
Journal of Manufacturing Technology Management	3	1.15
International Journal of Production Economics	2	0.77
Waste Management and Research	2	0.77
Journal of Environmental Management	2	0.77
CIRP Journal of Manufacturing Science and Technology	2	0.77
Technological Forecasting and Social Change	2	0.77
Science of the Total Environment	2	0.77
Others	50	19.16
Total	**261**	**100%**

Figure 5 presents the distribution of articles by industrial sector. The International Standard Industrial Classification (ISIC), a United Nations system for classifying economic data, was used for classification purposes following Gao et al. (2017). The results indicate that the manufacturing sector (including publications where multiple manufacturing industries were indicated) has been the primary research field along with waste management and remediation activities for the relevant papers for this literature review. Wholesale and retail also play an active role in CSCM. Note that these statistics excluded many publications that did not specify any industrial sector.

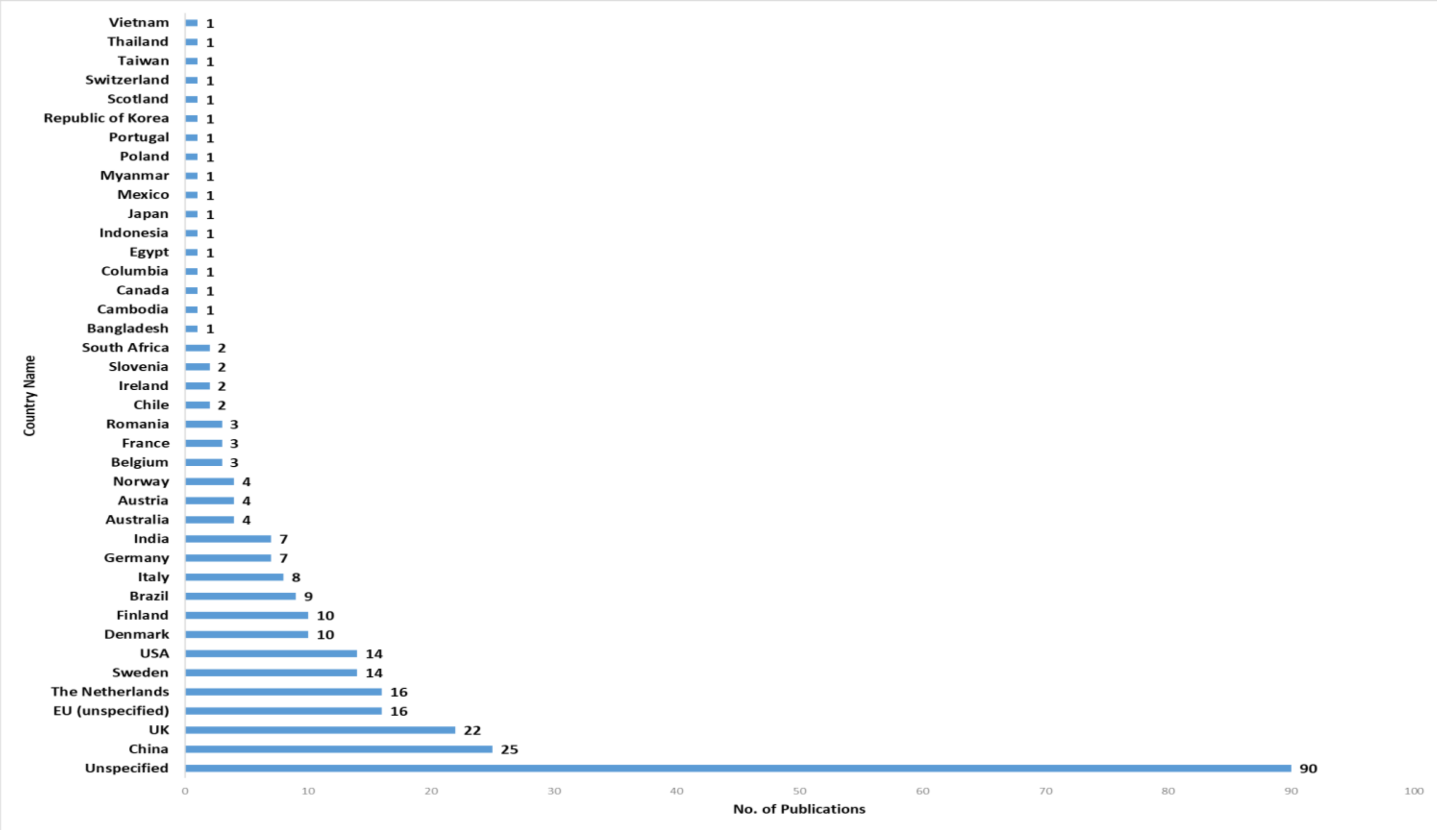

Figure 4: Distribution of reviewed articles by country

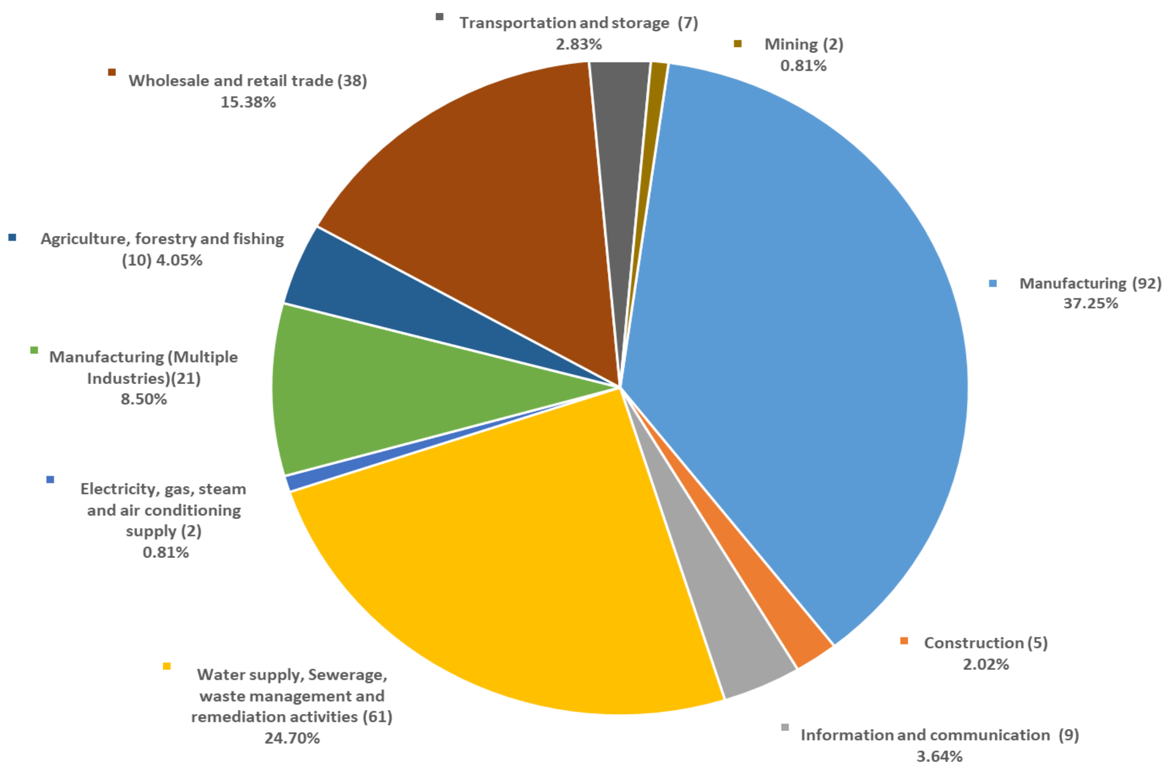

Figure 5: Distribution of reviewed articles by industry

Table 4 summarizes the frequency of research methods after analyzing the articles in detail. Empirical research (148) shows that research in the field of CSCM has mostly been driven by direct observation (case studies, surveys, etc.). Case study (110 papers) has been the most common methodology employed in the studies. Given that CSCM research is still in the early stage of development, it is of no surprise to see a large number of case studies conducted to identify the critical issues and to develop a clearer understanding of the topics. Conceptual/Theoretical model (43 papers) and Literature review (38) are the second and third most frequently used methods in different studies, respectively. These papers serve as the foundation to synthesize the existing knowledge and to develop important guidelines for future research in CSCM. Articles where quantitative approaches (Modeling) have been used for decision-making contribute to 19 papers. Other methods include experimental studies (7), and in a few cases, the researchers used a combination of different methods.

Table 4: Distribution of reviewed articles based on research method

Research Method	**No. of papers**	**%**
Empirical	148	56.70%
- *Case study (110)*		
- *Survey (26)*		
- *Interview (10)*		
- *Mixed method (2)*		
- *Others (2)*		
Conceptual/Theoretical	43	16.48%
Literature review	38	14.56%
Modelling	19	7.28%
- *Simulation (6)*		
- *Optimisation (9)*		
- *Others (4)*		
Experimental	7	2.68%
Literature review + Case study	4	1.53%
Literature review + Interview + Case study	2	0.77%
Total	**261**	**100%**

4 Review Results:

Overall, the CSCM research is classified in two broad categories. The first category classifies the integration of CE philosophy at a broad SCM and/or value chain (sustainability perspective) level. This classification category includes 60 papers representing approximately 30% of the total papers reviewed. The second major category classifies the extant literature concerning the integration of CE philosophy at SCM functional level. A total of 121 papers across various functional areas included in this category represents nearly 46% of the reviewed article. Moreover, the business model and the role of technology represent the other two subcategories of CSCM classification. These subcategories include 67 and 13 papers, representing 26% and 5% of the reviewed papers respectively. Figure 6 presents the classification of CSCM research.

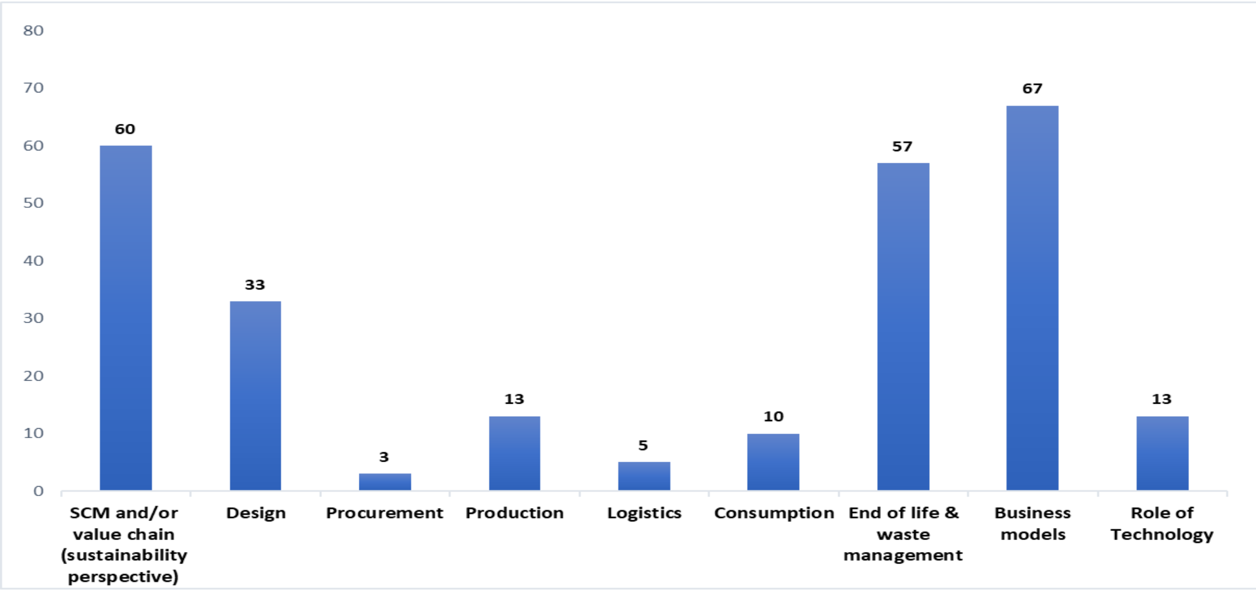

Figure 6. Classification of CSCM research

CSCM classification as presented in Figure 6 has been used to structure the remainder of this section. Note that the most relevant category was chosen when a publication was relevant to more than one category.

4.1 Supply chain-wide integration of CE

4.1.1 Supply chain management/value chain (Sustainability perspective)

A recent review paper (Masi et al., 2017) clustered the circular supply chain research into three supply chain configurations: Eco-industrial parks (EIPs), environmental, sustainable, green systems, and closed-loop supply chains. While EIPs refer to a meso level CE implementation (which is beyond the scope of this paper), the other two clusters represent the SCM sustainability domain, which is currently active in CSCM research. Recent examples include De Angelis et al. (2018) who explored the implications for SCM in circular supply chains comparing it with the traditional and sustainable supply chains. Batista, Bourlakis, et al. (2018) contributed to the understanding of supply chain circularity (i.e. restorative and regenerative processes of CE). Winkler and Kaluza (2006) highlighted the importance of establishing Sustainable Supply Chain Networks to implement an integrated waste management system to achieve sustainable economic growth. Adopting an SSCM approach was considered to be helpful for organizations to create a blended business and environmental value, thus providing the impetus for organizations to adopt CE (Park et al., 2010), while others consider the integration of CE and CLSC as 'circular supply chains' (Lapko et al., 2018; Mishra et al., 2018). Circular and CLSCs focus more on value recovery operations through reverse logistics (Bernon et al., 2018; Larsen et al., 2018). GSCM and CE are also considered as concepts overlapping and supporting each other (Liu et al., 2018). In order to integrate the CE concept into GSCM, Kazancoglu et al. (2018) proposed a new holistic conceptual GSCM performance assessment framework, integrating environmental, economic, logistics, operational, organizational and marketing performance.

4.1.2 Drivers and barriers

A number of studies have identified drivers (Bressanelli, Adrodegari, et al., 2018; Govindan & Hasanagic, 2018; Huybrechts et al., 2018; Mangla et al., 2018; Ranta et al., 2018) and barriers (Govindan & Hasanagic, 2018; Mangla et al., 2018; Masi et al., 2018; Milios et al., 2018; Ranta et al., 2018) to CSCM development and implementation. However, it is important to note that drivers and barriers significantly vary by geographic and industrial contexts. This needs to be further explored for a widespread implementation of CSCM across the globe.

4.1.3 Indicators and measurement tools

Howard et al. (2018) argued that the abundance of CE indicators (typically fragmented and disjointed), makes it difficult for firms to monitor, report and communicate progress towards the implementation of CE. Therefore, they proposed a new framework for the development of CE indicators which link to the core goals, principles and concepts of a CE. With regard to CSCM, Jain et al. (2018) developed a strategic framework for measuring CSCM using the supply chain operations reference (SCOR) model, but they primarily focused on the environmental dimension and not the social and economic dimensions.

Linder et al. (2017) proposed a novel circularity metric based on the ratio of recirculated economic value to total product value, using value chain costs as an estimator. This metric can enable producers and customers to quantify product-level circularity and contribute towards the transition to more sustainable CE. Di Maio et al. (2017) introduced a ‘value-based resource efficiency’ (VRE) indicator to measure resource efficiency and circularity using the market value of resources as opposed to traditional approaches. This highlighted the range of available circularity metrics from being focused on product-level circularity informing about products being ‘bad’ or ‘good’ in terms of resource efficiency to being focused on value-based assessment of resource efficiency and CE-related performance of supply chain actors.

4.1.4 Industry applications and performance

The implementation of CSCM at a micro level has increased in various industries (Batista, Gong, et al., 2018; Hahladakis & Iacovidou, 2018; Jain et al., 2018; Laso et al., 2018; Leising et al., 2018; Nasir et al., 2017; Stewart & Niero, 2018; Vlajic et al., 2018). For example, O'Connor et al. (2016) presented strategies for “Material Supply Chain Sustainability” using principles of Green Engineering and the vision of CE focused upon the electronics sector. Franco (2017) identified the challenges faced by incumbent firms in the textile industry along their value chains (from product design to take-back and reprocessing) in developing circular products. Mohamed Abdul Ghani et al. (2017) stressed the need for systematic understanding and implementation of CE principles for GHG reduction across the construction supply chain industries in the US. Golev and Corder (2017) performed a detailed analysis of metal flows and values associated with e-waste in the Australian metal value chain. With an estimated metal recovery value from e-waste of about US$370 million in 2014, the metal losses associated with e-waste are worth US$60–70 million a year, mainly due to 25% of e-waste being landfilled. Winans et al. (2017) focused on the application and assessment of CE in the industries representing critical research gaps (i.e. agricultural industries and chemical/biochemical industry products and value chains). The plastics and food supply chain wastes were concluded to provide interesting and viable organic “waste-to-resource" opportunities (Clark, 2017). Overall, the papers selected for the study revealed that integrating CE into SCM helped to improve environmental performance (Genovese et al., 2017; Nasir et al., 2017; Niero & Olsen, 2016) along with economic performance (Zhu et al., 2010; Zhu, Geng, et al., 2011).

4.2 Integrating CE into individual supply chain functions

The transition towards CE requires considerable transformations in business models, supply chain configurations, and practices related to product/service design, production, consumption, waste management, reuse, and recycling (Hobson, 2016; Mendoza et al., 2017). There were implications for logistics flows at all supply chain stages (Bicket et al., 2014). Consequently, some firms have adopted various micro-level CE practices (of organizations' operations and supply chains) (Ghisellini et al., 2016). These included eco-design or green design (Winkler, 2011a), green procurement (Zhu et al., 2010), cleaner production and EoL management based on Reduction, Reuse and Recycle (3R principles) (Geng et al., 2012; Lieder & Rashid, 2016; Su et al., 2013).

Quite interestingly, Masi et al. (2017) discovered that, since the emergence of CE in SCM, no new practices have been featured under the label of circular supply chain. Similarly, by analyzing the current CE implementation cases, Kalmykova et al. (2017) concluded that 'Recovery, Consumption and Use' parts of the value chain have received the most attention, whereas, 'Manufacturing, Distribution and Sales' are rarely involved in CE implementation.

4.2.1 CE & Product/Service Design

Product/service design for CE has crucial roles in fostering materials and energy recirculation in CEs (Clark et al., 2016; Laurenti et al., 2015). Building upon CE and sustainability concepts, the product/service design functions need to be fundamentally changed as the product/service design greatly influences the whole product/service's value chain (De los Rios & Charnley, 2017; Jensen & Remmen, 2017). Sustainable packaging design and product labelling have also been regarded as important aspects of the circular design strategy (Bovea, Ibáñez-Forés, et al., 2018; Bovea, Quemades-Beltrán, et al., 2018; Steenis et al., 2018). Designers must respond to very different social, economic and environmental needs and must adopt holistic approaches to problem solving. They must change their design thinking and interpretation of associated practices that lead to the CE transition by creating products and services that match all inherent criteria of the circular business model (Andrews, 2015; Sihvonen & Partanen, 2018). Moreover, the role of chemistry to provide the basis of innovative products (e.g. designed to be reused, recycled, or the feedstock renewed through natural processes) is crucial to creating a world without waste (Clark et al., 2016).

The current literature on design functions offers various design strategies and circular business models based on the notion of product life extension and closed loop systems (Bakker et al., 2014; den Hollander et al., 2017; Moreno et al., 2016; Sumter et al., 2018). Bocken et al. (2016) introduced the taxonomy of slowing, closing, and narrowing resource loops by building upon previous research. Moreno et al. (2016) developed a conceptual model and mapped the identified circular design strategies against circular business model archetypes. The den Hollander et al. (2017) team further extended Bocken's work by making a distinction between circular product design and eco-design. According to den Hollander et al. (2017), the waste hierarchy described in the European Waste Framework Directive (EC, 2009) is one of the guiding principles of eco-design, which details a priority order for managing waste, i.e. moving from prevention of waste, to reuse, recycling, recovery, and disposal. However, circular product design relates to Stahel's (2010) work based on the Inertia Principle and to the concept of product integrity. Bovea and Pérez-Belis (2018) identified design guidelines required for a better circular product. Their study findings suggest that there is an urgent need to incorporate lifetime extension and product/component reuse guidelines in circular product design strategies.

Recently, the adoption of design for dismantling (DFD) has increased in many industrial sectors, partly motivated by recent technological advancements that offer cost savings besides extended product responsibility regulations. The DFD offers values to products not only at the EoL stage but also during the usage, life-time and maintenance stages (Sabaghi et al., 2016). Tian and Chen (2014) illustrated the use of the DFD method by reducing the number of incompatible polymers in vehicle dashboards. The DFD resulted in easy separation and recycling of polymers with mechanical methods, and eliminated chemical separation methods. Vanegas et al. (2018) proposed a robust method, titled the 'ease of Disassembly Metric' (eDiM) to calculate the disassembly time, modelled using the Maynard operation sequence technique (MOST). Important design implications (e.g. design for disassembly) for better CE were also presented in the computer industry (Talens Peiró et al., 2017) and in the crucial area of managing the supply of critical materials (Peck et al., 2015).

4.2.2 CE & Procurement

Introducing CE into the procurement function will redefine price, quality, time and value for money principles in procurement (Meehan & Bryde, 2011). The CE requires raw materials to be technically restorative or biologically regenerative so that there are no negative impacts upon the environment (Genovese et al., 2017). Green procurement has been a very active research topic (Blome et al., 2014). However, probably due to the newness of the CE philosophy, we only found three studies that integrated CE in procurement management.

Based on the CE principles, Witjes and Lozano (2016) proposed a public procurement framework, which included technical and non-technical product/service specifications. The framework provides guidelines for reducing raw material utilization and improving resource efficiency through recovery and lower waste generation. A similar CE-oriented study by Popa and Popa (2016) addressed the issue of green industrial acquisitions and focused on improving resource efficiency. It considered not only the environmental advantages and disadvantages of diverse options for industrial product acquisitions but also possibilities for complete reuse of the materials of the used products.

Integrating CE principles in SCM has been viewed as potentially viable for managing supply disruptions of critical and strategic materials. Sprecher et al. (2017) introduced resilience metrics for quantifying the resilience of critical material supply chains to disruptions based on CE principles. On the other hand, Gaustad et al. (2018) indicated that many firms are not able to allocate the required time and resources to track these dynamic, complex issues. They suggested that circularity strategies such as recycling, lean principles, dematerialization and diversification have a significant potential for reducing the vulnerabilities in material supply.

4.2.3 CE & Production

Reduction of resource consumption in the production processes has become essential for manufacturing industries to maintain competitiveness and survive in today's sustainability era (Ridaura et al., 2018). As a result, manufacturing industries have started adopting sustainable manufacturing practices and CE in their supply chains to mitigate environmental risks (Moktadir et al., 2018). In this context, green manufacturing has been widely recognized as a strategic model for sustainable development. It incorporates principles such as environmental protection, resource and energy conservation, and waste reduction along with the production economy (Zhou et al., 2012). Rehman et al. (2016) argued that adopting green production practices not only offers long-term cost savings but also improves brand image, regulatory compliance, and investors' interest (Dubey et al., 2015). Yet, there are some concerns over increased operating cost for firms implementing green manufacturing (Mao & Wang, 2018).

Increasing material efficiency in terms of reduced generation of industrial waste, extraction and consumption of resources, energy demands and carbon emissions, have led to the development of many strategies in the manufacturing industry (Shahbazi et al., 2016). In order to achieve improved material efficiency in a CE context, green manufacturing (Dubey et al., 2015; Rehman et al., 2016; Zhou et al., 2012) and cleaner production (Brown & Stone, 2007; Cui & Song, 2009) are two highly relevant terms that are often used interchangeably in the literature as ways to help to achieve the needed improvements. We consider cleaner production to encompass green manufacturing as it covers not only manufacturing but also service activities. Cleaner production is defined as a production method which is not only concerned with people's needs, but also with environmental protection, energy conservation, and waste and emission reduction (Cui & Song, 2009). Cleaner production also seeks to prevent the use of non-renewable and harmful inputs (Ghisellini et al., 2016). In more general terms, cleaner production aims to increase overall economic efficiency while simultaneously reducing damage and risks for humans and the environment (Brown & Stone, 2007). Apparently, cleaner production is essential for achieving the CE vision (Li et al., 2010). However, cleaner production practices are yet to be fully implemented in many industries. For example, Ghisellini et al. (2018) found a predominant role in legislative and economic barriers in the Chinese construction industry in inhibiting companies to implement cleaner production practices.

Cleaner production has been a hot topic in production research. In fact, the *Journal of Cleaner Production* is devoted to the research topic and has grown in reputation and in the number of articles published each year in this area. Surprisingly, very few studies have explicitly integrated CE's circularity philosophy into cleaner production. Among the few exceptions, Li and Ma (2015) reported that integrating CE into cleaner production achieved significant energy savings and emission-reductions in a papermaking industry park in China. Leslie et al. (2016) developed a new screening method to investigate toxic chemicals and persistent organic pollutants (POP) including brominated diphenyl ether flame retardants (POP-BDEs) in order to promote cleaner production and to reduce human and ecological exposure to toxic, bio-accumulative and persistent chemicals via plastics. Antoniou and Zabaniotou (2015) presented waste-to-resource treatment of EoL tyres (ELT) using pyrolysis (i.e. decomposition brought about by high temperatures) from a cleaner production and CE approach. The pyrolysis method turned ELT into high-value solid material having absorptive properties along with heat conversion in the process.

Overall, cleaner production practices are considered a key enabler of CE practices at a micro level with implications for other supply chain functions, such as circular product design, consumption, and EoL and waste management (Sousa-Zomer, Magalhães, Zancul, Campos, et al., 2018).

4.2.4 CE and Logistics

Both consumers and governmental legislation have pushed organizations to redesign their logistics networks to become more environmentally friendly while remaining cost efficient (Frota Neto et al., 2008). 'Green logistics' is recognized as producing and distributing goods in a sustainable way, taking account of environmental and social factors. This includes measuring the environmental impacts of various distribution strategies, reducing energy requirements in logistics-related activities, reducing wastages, and treatment of residual wastages (Sbihi & Eglese, 2010). While the focus has been on traditional logistics which seeks to organize forward distribution, i.e. the transport, warehousing, and inventory management from suppliers to customers, reverse logistics is also known to play a key role towards sustainable development (Sun, 2017).

CE is expected to have many implications for logistics management. So far, the efforts to integrate CE into logistics have mostly been observed in reverse logistics. Dhakal et al. (2016) highlighted the significant roles of secondary markets in extracting the value from products and also helping to promote the reuse of products in relation to reverse logistics, CE and sustainability. Esposito et al. (2018) developed a conceptual model of a closed loop recovery system by integrating national postal service networks into reverse logistics to help to optimize CE functions. Among the quantitative works related to reverse logistics, Dente and Tavasszy (2018) introduced logistics modeling to explore the possible impacts of circular and functional economy on freight transportation and its emissions. Sun (2017) developed a measurement model to calculate carbon emissions from reverse logistics and explored factors influencing reverse logistics carbon footprints. Bernon et al. (2018) made an attempt to embed CE values in consumer retail reverse logistics operations.

4.2.5 CE & Consumption

The CE philosophy has stimulated a shift towards a more sustainable consumption model in which valuable resources are reused and less waste is created (EMF, 2013). Consumption in the CE context and circular solutions is becoming an area of increased scholarly attention with particular interests in exploring drivers, barriers, the nature, meaning, and dynamics of circular consumption (Camacho-Otero et al., 2018). It is gaining traction in the global mobile phone market as a solution to increasing resource use (Wieser & Tröger, 2016). Canning (2006) studied electronic waste collection schemes in mobile phone supply chains in the UK. He suggested that consumers must cooperate in returning unwanted phones and be willing to accept refurbished ones for the collection schemes to be effective. Van Weelden et al. (2016) examined the main factors that influence consumers to accept refurbished mobile phones in Germany. They found that refurbished products are often rejected by consumers due to their lack of awareness of what the term actually entails. Wieser and Tröger (2016) studied consumers' motivations regarding mobile phone consumption in Austria using dimensions such as the timing of replacement, repair, and reuse of mobile phones. They found consumers' perceptions of obsolescence to be a central consideration of mobile phone replacement, repair, and reuse. The findings of these three studies agreed with each other: the transition toward CE requires changes in consumer behaviours and they may be achieved by an awareness campaign and sustainability education. The product design function must be changed, however, to make it more optimal. For example, a Dutch company has now designed and is producing a totally repairable mobile phone. That will change consumers' attitudes dramatically or at least it should or might.

Jurgilevich et al. (2016) applied the CE philosophy in the sustainable food system in Finland for a transition towards a circular food system. They discussed challenges and potential solutions for circular production and consumption. Wang and Hazen (2016) studied the automobile industry in China. They found that information on cost, quality, and green attributes of remanufactured products affects consumers' perception of risk and value, which consequently influences consumers' purchase intentions of remanufactured products. Castellani et al. (2015) presented a case study of a second-hand goods shop and quantified the environmental benefits of reusing goods in terms of avoided impacts using life cycle assessment. They found a potential for significant avoided impacts by adopting sustainable consumption approaches (e.g. reuse) in many sectors including apparel, furniture, etc.

Overall, there is greater need to design appropriate policy and firm-level measures to enhance the awareness about circular consumption, noting that cultural differences play a significant role in framing consumer attitude towards circularity and nature in general (Gaur et al., 2018; Lakatos et al., 2018).

4.2.6 CE & EoL and Waste Management

EoL and waste management in CSCM is considered critically important for recovering the remaining value within a product to its maximum utility (Liang Cong et al., 2017b). Recirculation of used components and materials has significant economic and environmental performance implications (van Loon & Van Wassenhove, 2017). However, there is a lack of understanding of the true potential of EoL management for CE in many business sectors (Parajuly & Wenzel, 2017). In the extant literature, various EoL resource recovery approaches are discussed. These include: repurposing/recontextualizing, refurbishing, remanufacturing and recycling.

Repurposing has been described as the identification of a new use for a product that can no longer be used in its original form (Long et al., 2016). den Hollander et al. (2017) introduced a new term “recontextualizing” (replacing repurposing) for the use of an obsolete product or its components without any remedial actions in a different context from its originally designed use. In a CE context, a recent feasibility study based on a sample of 246 notebook computers found that 9% of the EoL notebooks could be repurposed as thin computers without incurring any cost (Coughlan et al., 2018).

Refurbishing is a process to restore used products to a functional and satisfactory condition, without dismantling the products completely (Rathore et al., 2011). Refurbishing can be applied to regain value from used products and to reduce waste. An efficient refurbishing process enables easy maintenance, recovery, and modification of products after the EoL cycle (van Weelden et al., 2016). However, there is a need to develop refurbishing guidelines and standards because the lack of them has led to variations in production, quality issues, and poor recognition of products (Sharma et al., 2016).

Remanufacturing recovers the residual value of used products by bringing them to a new-like condition (Debo et al., 2005). Typically, remanufacturing is preferred to other EoL processes because the remanufactured product is more environmentally friendly, higher in quality, and has a longer extended life (Hartwell & Marco, 2016; King et al., 2006). However, ambiguity surrounding the true meaning of other related CE activities, such as repair, reconditioning and refurbishment, and uncertainty in managing intellectual property (IP) issues in many industries inhibit organizations from adopting a remanufacturing strategy (Hartwell & Marco, 2016). On the other hand, lack of consumer acceptance of remanufactured products throughout the world prevents supply chains from unlocking the full potential of remanufacturing (Hazen et al., 2017;

Wang & Kuah, 2018). The diversity of product types, design features, and material compositions also pose serious policy and practical challenges (Liang Cong et al., 2017a; Zhang et al., 2011).

Various authors have suggested different strategies and ways to handle and optimize remanufacturing operations in a CE context. For example, Krystofik et al. (2018) introduced a term “adaptive remanufacturing” to suggest the use of an EoL product core to create a similar but non-identical product, thus enabling more viable lifecycles when compared to traditional remanufacturing. Zhang and Chen (2015) emphasized the adoption of more energy efficient and cleaner remanufacturing strategies. Jiang et al. (2016) used mathematical models to select an optimal remanufacturing process-planning solution for the new arrival of used parts by utilizing the knowledge generated from remanufacturing of existing parts. Others have developed simulations for predicting the performance of remanufacturing systems operating under uncertainties (Low & Ng, 2018) and various production control policies (Gaspari et al., 2017).

Our literature search also identified several examples of CE-inspired *recycling* practices in different industries. The steel industry is regarded as an integral part of the CE model. Given the recyclable nature of the material itself, steel scrap which can be recovered from products (Broadbent, 2016; Diener & Tillman, 2016; Wübbeke & Heroth, 2014) is an important resource for steelmaking. Despite having huge potential for increased profits, the literature highlights several barriers ranging from economic, policy, information, and technology-related barriers in recycling value chains, which prevent firms recycling and reusing metals (Densley Tingley et al., 2017; Golev & Corder, 2016; Wübbeke & Heroth, 2014). On the other hand, better regulations and effective use of taxation, encouraging R&D in metals, establishment of extended producer responsibilities systems (Gumley, 2014; Sirmon & Hitt, 2009) and use of robust forecasting models (Gauffin et al., 2016) were discussed as the possible remedies to the lack of metal recycling. In the construction industry, Jiménez-Rivero and García-Navarro (2016); (2017) developed performance indicators and presented best practices for the management of EoL gypsum under the framework of the European collaborative project GtoG (Gypsum to Gypsum) (Marlet, 2014). Tyres and agricultural plastic waste recycling are other examples where the pyrolysis technique has been successfully applied (Antoniou & Zabaniotou, 2015; Rentizelas et al., 2018). Recycling systems for post-consumer plastic packaging have huge potential to positively contribute towards circularity (Brouwer et al., 2018; Hahladakis et al., 2018).

Moreover, understanding the links between economic activities and waste generation is critically important to help achieve CE goals (Salemdeeb et al., 2016). Integrating CE into EoL and waste management faces some practical challenges. Prevalent EoL materials management is concerned with collecting waste for material recovery (Singh & Ordoñez, 2016). However, to support other EoL processes, for example, reuse, the collection systems need to be improved to prevent physical damage to the EoL products during the collection process. Cobo et al. (2018) describe such a system as a circular integrated waste management system (CIWMS) that enhances the circularity of resources by strengthening the link between waste treatment and resource recovery. This is especially important in the case of waste electrical and electronic equipment (WEEE) products because they are often vulnerable to damage and the recovery or reuse of critical metals as a secondary supply source offers both economic and environmental benefits (Işıldar et al., 2018; Parajuly & Wenzel, 2017). With regard to minimizing transport emissions, mobile collection methods are found to be the lowest impact and a low total cost solution when compared with stationary collection methods (Nowakowski & Mrówczyńska, 2018).

Appropriate treatment of EoL products (particularly WEEE) has been a popular item on regulators' agendas (Atalay & Ravi, 2012). Many countries have adopted product take-back schemes based on the concept of extended producer responsibility (EPR) where producers are physically or financially responsible for the collection of EoL electronics and their recovery so as to divert hazardous materials away from landfills (Botelho et al., 2016; Favot et al., 2016; Gu et al., 2017; Manomaivibool & Hong, 2014; Polzer et al., 2016). Optimizing EPR schemes help to promote collection and recycling of both hazardous and critical materials by closing material loops and also incentivize eco-design (Richter & Koppejan, 2016).

4.3 CE and Supporting business Models

The inability of prevalent linear economic models to manage the current sustainability issues has led to the development of new business models based on the CE philosophy (Gorissen et al., 2016; Goyal et al., 2018). Nußholz (2017) defined a circular business model (CBM) as *"how a company creates, captures, and delivers value with the value creation logic designed to improve resource efficiency through contributing to extending useful life of products and parts (e.g., through long-life design, repair and remanufacturing) and closing material loops"* (p.12). Linder and Williander (2017) further described the conceptual logic of creation logic in CBM as *"utilizing the economic value retained in products after use in the production of new offerings"* (p. 2).

Several researchers have contributed to the development of CBMs. Roos (2014) outlined the process of CBM development and proposed specific questions for creating an appropriate business model for a circular value chain. Lüdeke-Freund et al. (2018) performed a morphological analysis of 26 CBMs from literature to be able to identify a broad range of business model design options and proposed six major CBM patterns of closing resource loops. Bocken, Miller, et al. (2017); Bocken et al. (2018) provide in-depth insights on how established businesses might pursue business model experimentation for sustainability and circularity goals.

Various business model frameworks have also been proposed in the extant literature. Lewandowski (2016) modified the traditional business model canvas and further included take-back systems and adoption factors to develop an extended framework for designing business models for CE. Mendoza et al. (2017) proposed a novel, 'backcasting and eco-design for the circular economy' (BECE) framework aimed at helping companies to develop sustainable business models that translate CE principles into industrial practices. The BECE framework has proven equally successfully in a product as well as service-oriented business applications (Heyes et al., 2018). Urbinati et al. (2017) proposed a taxonomy of CE business models to distinguish how some companies have implemented cost efficiency improvements in their adoption of CE. Their CE business model canvas framework introduced adoption of circularity along two dimensions: customer value proposition and interface (value proposition to customers) and value network (interaction with suppliers and restructuring internal activities). Recently, an environmental value propositions table (EVPT) and a step-by-step evaluation approach of CE business models were developed by Manninen et al. (2018).

van Loon et al. (2017) provide empirical evidence of the total cost of ownership for consumers and profitability for manufacturers in CBMs. Their study results provide interesting insights for firms wanting to make a transition from selling to leasing products in the presence of an effective second-hand market structure. However, it is important to note that moving from ownership to services (for example, leasing) does not automatically contribute to environmental rents unless consumption patterns change accordingly (Junnila et al., 2018). For example, access-based services for cars are more successful when compared to smartphones where such models have largely failed (Hobson et al., 2018; Poppelaars et al., 2018). Lieder et al. (2018) present another example of customer preferences and acceptance of circular business model (pay per use washing machines) in Sweden.

In addition, many studies have identified and discussed the role of various drivers/enablers (Mativenga et al., 2017; Rizos et al., 2016; Veleva & Bodkin, 2017) as important factors for successful implementation of CBMs while others have identified barriers (Linder & Williander, 2017; Oghazi & Mostaghel, 2018; Rizos et al., 2016; Singh & Giacosa, 2018; Sousa-Zomer, Magalhães, Zancul, & Cauchick-Miguel, 2018; Spring & Araujo, 2017; Whalen et al., 2018) hindering the implementation of CBMs.

Product-Service Systems (PSS) represent a hybrid class of business model for CE (Vasantha et al., 2015). A PSS *"consists of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling specific needs of customers"* (Tukker, 2015, p. 81). The PSSes exemplify a range of business models from being 'product-orientated with a few extra services included' to more 'result-oriented' services with no predetermined product involved (Hobson, 2016; Yang et al., 2018). Pialot et al. (2017) further expanded the scope of PSS by proposing "Upgradable Product Service System (Up-PSS)". Up-PSS combines the upgradability concept with optimized maintenance, EoL management and the servitization of the offer. Product upgradability in a PSS context is further explained by Khan et al. (2018) in their review paper. However, according to Kjaer et al. (2018), PSS does not automatically lead to achieving CE's vision of resource decoupling, i.e. decoupling economic growth from resource consumption. It only happens when there is a decrease in resource usage irrespective of the growth rate of the economic driver.

Overall, CBMs including PSSes promise significant cost savings and radical reductions in environmental impacts (Linder & Williander, 2017) in addition to improved entrepreneurial opportunities for services connected to products involving both forward and reverse supply chains (Spring & Araujo, 2017).

4.4 CE and the Role of Technology/ Role of Technology in fostering CSCM

A comprehensive understanding of how innovative and emerging technologies can support the transition towards CSCM is crucial. Yet, the research in this critical area is in its infancy. Industry 4.0 is the term used for the fourth industrial revolution that is enabled by smart technologies such as the Internet of Things (IoT), augmented reality, 3D printing (additive manufacturing), big data analytics, cloud computing, simulation, industrial automation and cybersecurity (Nascimento et al., 2018). Although research concerning the integration of Industry 4.0 technologies into CSCM is in its early stages, there is already some clear evidence showing a promising future in line with achieving a CE vision (Lopes de Sousa Jabbour et al., 2018).

In the last few years, WEEE has become a serious environmental issue given the rate of technological change and the throwaway culture in most consumer societies. L. Cong et al. (2017) claimed that most of the value recovery from EoL products (e.g. WEEE) is being carried out without rational planning, which results in a loss of recoverable value embedded in EoL materials and components. Esmaeilian et al. (2018) proposed an IoT-enabled waste management (WEEE) framework for smart and zero waste sustainable cities while connecting waste management to the whole product life cycle. Their proposed framework is based on four interrelated strategies, being waste prevention, upstream waste separation, on-time waste collection, and proper value recovery of collected waste. In order to optimize the WEEE recycling process, Alvarez-de-los-Mozos and Renteria (2017) proposed the introduction of collaborative robots into the recycling lines to work in collaboration with humans in enhancing the recovery of valuable components and materials.

Giurco et al. (2014) discussed future trends in 3D printing and its possible application in CE. However, the entire discussion relied on conceptual scenarios given the lack of supporting business cases. While 3D printing offers substantial promise for CE, there are significant barriers in its way (Garmulewicz et al., 2018). Limited knowledge on the extent to which 3D printing affects the sustainability and circularity premises leaves more questions than answers (Despeisse et al., 2017). Zhong and Pearce (2018) present an interesting case of a 3D printing application in a CE context. They upscaled the plastic waste from computer waste into 3D printing filament and produced valuable consumer products such as a camera tripod, SD card holder and camera hood. The study results show significant economic and environmental benefits from tightening the CE loop.

Another stream of research relates to the roles of big data in CSCM. A recent paper documented a significant impact of big data and predictive analytics on the supply chain sustainability performance (Dubey, Gunasekaran, Childe, Papadopoulos, Luo, et al., 2017). However, our review identified only one study related to the application of big data in CE. Jabbour et al. (2017) in their research proposed a framework of CE and large-scale data (big data) in CE. They presented a relational matrix illustrating the complexities of CE, big data and stakeholder management in CE. They developed several propositions to advance the literature in this emerging field.

5 Future Research Directions

The review presented above showed that CSCM is still an emerging research field. Most relevant publications are conceptual works and case studies, which is typical for a research field that is still in its infancy. A few specific research topics in CSCM, including supply chain performance and EoL product management, have received relatively more attention. Nevertheless, much more research work must be done on all supply chain functions in order to reap the full potential of

CSCM. There are many technical, process, and incentive issues to overcome in order to make CE a reality. We, therefore, call for research in the following directions that are important to CSCM but have received very little or no attention. Based on the review results, Table 5 outlines the importance of each research direction, the extent of the relevant knowledge gap, potential impact of conducting research in the research direction, and the urgency for further research. Given that CE is a promising new frontier in sustainable thinking, we believe that advancing CSCM in the following areas will substantially enhance SSCM and GSCM to aid organizations to achieve a higher level of sustainability performance.

Table 5: Summary of future research directions in CSCM

Future research directions	Importance	Knowledge gap	Potential impact	Urgency
Design for circularity	Very high	Very large	Critical	Very urgent
Procurement and CSCM	High	Very large	Moderate	Urgent
Biodegradable packaging for CSCM	Very high	Large	Critical	Very urgent
Circular supply chain collaboration and coordination	Very high	Large	Critical	Very urgent
Identifying drivers and barriers of CSCM	Very High	Large	Critical	Very urgent
Circular consumption	High	Large	Moderate	Urgent
Product liabilities and producer's responsibility	Very high	Very large	Critical	Very urgent
Technologies and CSCM	High	Very Large	Critical	Urgent

5.1 Design for circularity

It is clear that CSCM requires a complete rethinking of the way products, processes, and supply chains are designed (Aminoff & Kettunen, 2016; Bakker et al., 2014; Flink, 2017). Design for circularity is a cornerstone of CSCM. Ample research opportunities exist in CE-driven processes innovations, supply chain design for EoL management, and new product design methods/techniques including DFD (Tian & Chen, 2014), design for remanufacturing (Ijomah et al., 2007), and design for recycling (Gaustad et al., 2010).

5.2 Procurement and CSCM

Procurement is a strategic function of many organizations, playing a vital role in a firm's sustainability performance. Surprisingly, much less research has been conducted on integrating circular thinking in procurement than in most other supply chain functions. The CSCM requires products with new or stronger features such as durability, reliability, and reusability to support life cycle extension, easy recovery of resources, and minimal wastage. More research is needed to integrate CE-oriented performance indicators into procurement and supplier management (Nissinen et al., 2009) to reduce the environmental impacts of products/services throughout their life cycle (Tarantini et al., 2011).

5.3 Biodegradable packaging for CSCM

Every year, the world produces millions of tons of non-biodegradable plastics for packaging which creates severe environmental problems (Mohanty et al., 2000). For example, in China, packaging waste is the 4th largest source of pollution (Zhang & Zhao, 2012). The new CSCM requires packaging materials to have characteristics such as availability from renewable sources, recyclability, and compostability. They should also be of low cost and should possess physical and chemical properties for easy customization for diverse uses. Recently, significant progress has been made in obtaining biodegradable packaging materials such as polylactide (PLA), an aliphatic polyester (Ahmed & Varshney, 2011), and polysaccharide (SSPS) based on soluble soybean products (Tajik et al., 2013). Packaging solutions based on biodegradable materials deserve much future research and investments for enhancing the rate of transition to CEs.

5.4 Circular supply chain collaboration and coordination

In a CE, waste residuals from a process/supply chain become resources for another process/supply chain. This requires long-term collaboration, not only among supply chain partners (Flink, 2017) but also among different supply chains. Many research opportunities lie in the areas of incentives and strategic value alignment (Genovese et al., 2017), collaboration and coordination mechanisms including contracts, supply chain integration, and knowledge management with suppliers, customers, and other stakeholders to keep used products/components/materials in circulation (Aminoff & Kettunen, 2016; Grimm et al., 2016; Stewart & Niero, 2018).

5.5 Drivers and barriers of CSCM

Drivers and barriers of CSCM are likely to vary in different contexts. So far, only a few studies have investigated challenges in the information technologies (IT) and electronics industries in China (Park et al., 2010), and textile (Flink, 2017) and retail industries in Finland (Aminoff & Kettunen, 2016). Investigations are urgently needed on how cultural and industrial sector-specific contexts affect the drivers and barriers of CSCM. Furthermore, research is necessary to prioritize the drivers and barriers in a specific context in order to devise the most effective intervention policies to prevent and/or to overcome them.

5.6 Circular consumption

Despite a few early studies (Canning, 2006; Jurgilevich et al., 2016; van Weelden et al., 2016; Wang & Hazen, 2016; Xue & Yang, 2010), the consumer perspective on circular products has been largely unexplored. More research is required to explore how circular products can be made more appealing to customers. For example, marketing strategies based on demonstrating product reliability, innovative offerings, warranty, and assurance of quality control mechanisms may be developed to shape positive consumer attitudes towards circular products (Hazen et al., 2017). Given that many consumers are unwilling to return used products (van Weelden et al., 2016), it is important to study strategies and incentives for changing consumer behaviours to support the cause of circularity.

5.7 Product liabilities and producer’s responsibility

The expansion of CEs will require systematic product take-back by producers to recover resources through EoL management. Therefore, EoL and waste management scenarios must address:

- Liability due to toxic substances used in production or usage of the products causing a new set of human health and environmental health consequences.
- Liability due to malfunctioning of products.
- Liability due to mismanagement of materials during the life cycle or life cycles of substances used in the synthesis and production of products as well as in the operation of products and in the management of materials at the EoL/recycling phases.

Future research is needed to investigate the feasibility and effectiveness of extended producer responsibility legislation (King et al., 2006; Zhu et al., 2010) to hold producers accountable for their products, even long after a sale to end customers. An alternative approach is PSS, a 'functional service' model in which the producers retain the ownership of physical products and act as service providers focusing on the service the end user wants (Nasir et al., 2017). The PSS systems can be designed to help to facilitate EoL management by manufacturers. It can substantially reduce the need for production activities in a shared economy, resulting in lower environmental impacts (Tukker, 2015).

5.8 Technologies and CSCM

Technologies can be enablers of sustainable development, but their role in CSCM has not been well researched. Recently, the *Journal of Cleaner Production* published a special issue titled "Improving natural resource management and human health to ensure sustainable societal development based upon insights gained from working within 'Big Data Environments'", a review of waste prevention through 3R under the concept of circular economy in China. However, none of the included papers integrated circular thinking! Ample room is left for exploring big data analytics for CSCM. Also, 3D printing, another promising technology, has become an important driving force for realizing high-efficiency and low-cost customized production. Researchers need to investigate the CE issues arising from the proliferation of product varieties and the consequent short lifecycle of customized products (Despeisse et al., 2017; Helen et al., 2016).

In addition, the internet of things (IoT) and Radio Frequency Identification (RFID) technologies can be used in CSCM to improve traceability and to enhance lifecycle information management (Zhang et al., 2010). Moreover, there is an urgent need to integrate the CE principles into an enterprises' information systems (EIS) (Jensen & Remmen, 2017).

6 Conclusions

The evolving visions and actions in planning and implementing CEs have been increasingly recognized as better alternatives than the prevalent linear (take, make, dispose) economic model. It offers much potential to help organizations achieve breakthroughs in sustainability performance. Consequently, integrating CE into SCM has received growing research interest. However, much confusion over the terms related to supply chain sustainability remain. It was argued in this study that the advancement of the field is hindered by the lack of understanding of what CSCM actually entails and which research directions are of strategic importance. In response, we provided a definition of CSCM out of the broader literature. Using this definition as a base we then conducted a structured review of the literature to gain an in-depth understanding of the current status of CSCM research. The field is promising and warrants many further studies using the CSCM conceptualization presented in this paper, which covers restorative and regenerative processes, appropriate business models (closed and open loop) and supply chain functions (reorientation) to achieve a zero-waste vision. Finally, the authors suggested future research directions (summarized in Table 5) based on the importance of the research direction, current knowledge gap in the extant literature, potential impact of future research on the research direction and the level of urgency required for action and implementation. Overall, the research provided timely guidance to help researchers, practitioners, and policy-makers to understand how to operationalize CEs from a supply chain perspective to substantially enhance SSCM and GSCM.

This literature review has some limitations. We have only reviewed publications in English. There might be an important loss of knowledge through not including publications in other languages. Some relevant publications in the forms of conference papers, industry reports, books, and book chapters were cited in this research paper. However, they were not included in the structured literature review as the review methodology deliberately focused on academic journal articles to ensure the quality of the publications reviewed. The field of CSCM is developing rapidly. Therefore, it is necessary to update the literature review in a few years' time to keep up with the progress of the research field. We hope that this literature review will help to accelerate the transition to equitable, sustainable, liveable, post-fossil carbon societies. We invite readers to provide feedback for further advancing this promising research field.

Appendix A. Supplementary data

Chapter 3 / Manuscript 2- Circular supply chain management: Performance outcomes and the role of eco-industrial parks in China

Prelude

This chapter/manuscript is built on the CSCM conceptualisation presented in Chapter 2. Given that the scope of CSCM is broad, including implications for business model reconfiguration as well as the reorientation of supply chain functions, this chapter/manuscript focuses on the firm and supply chain level aspects and its impact on the organizational performance. In doing so, a new construct, namely CSCM, consisting of four operational practices such as circular product design, circular procurement, cleaner production and EoL and waste management, is developed, which represents firms' transition towards CE. Moreover, the role of eco-industrial parks is investigated. On the other hand, the firm performance is measured using a combination of conventional measures such as environmental performance, cost performance, financial performance as well as a newly developed measure, i.e., resource circularity performance. Overall, the findings of this manuscript contribute to the SCM sustainability literature and provide insights to guide the managers in adopting CSCM practices more effectively.

This manuscript is prepared in compliance with the *Journal of Operations Management's (JOM)* author guidelines; therefore, the spelling in this manuscript may slightly differ from the other chapters. Moreover, the original numbering of captions for tables and figures is also retained from the JOM version.

1. Introduction

The current rate of natural resource consumption is quite alarming, and its subsequent effects on the planet's sustainability are devastating in terms of creating severe resource security issues. According to the United Nations Environmental Programme's (UNEP) International Resource Panel (2019) report, natural resource extraction has more than tripled since 1970 causing a significant ecological overshoot (i.e., annual demand on resources exceeding what Earth can regenerate) (Global Footprint Network, 2020). Today humanity uses the equivalent of 1.75 Earths to provide the resources we use and absorb our waste. If the current trends continue, it is estimated that, by the year 2030, we will need two Earth planets to meet human needs (European Commission, 2020b).

The worldwide shift towards the circular economy (CE) is seen as a viable solution to the prevalent resource security problem (Mathews et al., 2018). CE makes a distinction from the traditional linear model of "take, make, dispose" by developing an industrial system based on restorative and regenerative design thinking, thus decoupling economic development from resource extraction and environmental impacts (Ellen MacArthur Foundation, 2019b; Gartner, 2019; Zhu et al., 2019). The CE conceptualization (based on CE building blocks such as *reverse flows, circular design, and circular business models*) offered by the Ellen MacArthur Foundation has provided a major impetus to organizations making the transition towards CE (Ellen MacArthur Foundation, 2019a). Similarly, according to the leading organizations and management consultancies around the world, such as the World Economic Forum, McKinsey & Company, Accenture, and PwC, enabling CEs will lead to trillions of dollars in savings while protecting the environment (Atasu et al., 2018; Mathews et al., 2018).

In recent years, CE has gained increased attention in the supply chain sustainability literature and practice (Agrawal et al., 2019; Genovese et al., 2017; Hobson, 2016; Nasir et al., 2017; Van Wassenhove, 2019). Circular supply chain management (CSCM) has emerged as a new and compelling perspective in the supply chain sustainability domain (Farooque, Zhang, Thürer, et al., 2019). According to a recent Gartner (2019) report, leading global companies, such as Apple, Dell, HP, Cisco Systems, and AkzoNobel, are continuously investing in supply chain innovations by adopting circularity in their supply chains. Another Gartner (2018) report states, "With all that we see in the sustainability domain, one thing is abundantly clear — the future of supply chain is circular, not linear" (p. 7).

CSCM advances circular thinking across all supply chain stages and functions (Farooque, Zhang, Thürer, et al., 2019). A transition from a linear to a circular format requires considerable transformations in business models, supply chain configurations, and practices such as product/service design, production, logistics, consumption, waste management, reuse, and recycling (Bicket et al., 2014; Hobson, 2016; Mendoza et al., 2017). Corresponding to these requirements, firms have adopted various supply chain practices to incorporate circular thinking (Ghisellini et al., 2016). However, in the past two decades, researchers continued to focus more on the traditional sustainability concepts (such as sustainable supply chains, green supply chains, environmental supply chains, and closed-loop supply chains). Meanwhile, CSCM practices have remained far less known in the extant literature. The supply chain sustainability research did not consider the CE concept until the naissance of CSCM (Farooque, Zhang, Thürer, et al., 2019). Therefore, the new innovative perspectives offered by CSCM as part of an integrated system and how it affects economic and environmental performance remains largely unexplored (Agrawal et al., 2019). Although CE is extremely strong, based on the economic, social, and environmental benefits (Atasu et al., 2018; Mathews et al., 2018), due to the lack of conceptualization of CSCM, some earlier research attempts have reported contradictory results with regard to the economic viability of CSCM. For example, Zhu et al. (2010) and Zhu, Geng, et al. (2011) indicated positive economic performance; whereas, Genovese et al. (2017) and Nasir et al. (2017) suggested CSCM implementation may be economically challenging.

On the other hand, the transformation of an economy from a linear to a circular format is not without challenges. Both China and Europe have been striving to realize the CE vision for decades. Despite sharing a common conceptual basis, the Chinese perspective on CE is considered much broader due to its strong policy framework, and differences in the industrial structure and governance system (McDowall et al., 2017). China's distinctive feature of having more than half of its manufacturing industries operating in industrial parks and export processing zones has been the biggest advantage for its CE development (Mathews et al., 2018). As part of its CE development strategy, China has been focused on transforming the existing industrial parks into eco-industrial parks (EIPs) intending to close loops in resource flow (also known as industrial symbiosis) in accordance with CE principles (Mathews et al., 2018). EIP development for the purpose of industrial symbiosis is increasingly being considered a useful strategy to support CE implementation. In fact, EIPs are regarded as the actual realization of the industrial symbiosis concept (Chertow, 2000; Chertow, 2007). However, there is a lack of knowledge on the role of EIP development and industrial symbiosis practices from a supply chain perspective (Herczeg et al., 2018). Specifically, the research concerning the role of EIPs on the adoption of CSCM and its performance implications is missing in the extant literature.

Given these research gaps, this research set out to achieve the following objectives:

1. To examine the impact of CSCM on organizational performance in the Chinese manufacturing industry.
2. To understand whether being located within an EIP affects the likelihood of CSCM adoption and implementation in the Chinese manufacturing industry.
3. To examine whether being located within an EIP moderate the CSCM practice-performance relationship.

Drawing upon the Natural Resource Based View (NRBV) of the firm (Hart, 1995; Hart & Dowell, 2011), Contingent NRBV (Aragón-Correa & Sharma, 2003), and a review of the existing literature, this study contributes in several ways. Firstly, we[3] theorize and develop a construct to measure CSCM, besides introducing a new dimension to measure CSCM performance in terms of resource circularity. Secondly, we empirically examine how CSCM adoption affects firm performance in the Chinese manufacturing industry context. Thirdly, we demonstrate the relationship between firms located inside and outside of EIPs and their CSCM adoption. To the best of our knowledge, no prior research has provided a holistic view of CSCM and its resulting impact on firm performance. Moreover, to date, the role of EIPs and industrial symbiosis in a supply chain context has remained unclear in the extant literature. Overall, this research offers significant contributions to the supply chain sustainability literature.

For the purpose of this research, the Chinese manufacturing industry is considered the most suitable research context mainly for two reasons. Firstly, the Chinese government has taken a lead by promoting CE as a part of mainstream national policy for sustainable development for about

[3] This manuscript adopts the ‘we’ form as it was published as a jointly authored paper with supervisors/advisors.

two decades (Geng et al., 2012). Consequently, many industries have adopted various supply chain practices to demonstrate their transition towards CE. This provides a research opportunity to investigate the impact of CSCM on the performance outcomes of manufacturing firms operating in China. Secondly, China is the country with the most developed EIP infrastructure in the world. It is most likely that, given the conducive environment, firms operating within EIPs would have made good progress towards CE and CSCM implementation. It is important to note that not all the traditional industrial parks and export processing have been transformed into EIPs as yet. Therefore, many firms in China still operate outside the EIPs. This provides an interesting opportunity, where the progress towards CSCM adoption and its performance implications can be evaluated for firms operating inside and outside of EIPs.

The remainder of the paper is organized as follows. In section 2, we present the theoretical background, and develop hypotheses in section 3. In section 4 we describe the research methodology. Next, we present the study results in section 5, and discuss our research findings, contributions and implications in section 6. Conclusions, research limitations and future research directions are provided in section 7.

2. Theoretical Background

2.1 NRBV and supply chain sustainability

The NRBV (Hart, 1995; Hart & Dowell, 2011) emerged as an extension to the resource-based view of the firm (RBV). The RBV explains how firms achieve sustained above-normal returns and competitive advantages by drawing on distinctive resources and capabilities (Barney, 1991; Rugman & Verbeke, 2002). Hart (1995) proposed NRBV in his seminal work by extending RBV to include a previously ignored relationship between a firm and its natural environment, developing NRBV. The NRBV argues for an integrated way of dealing with the natural environment by developing dynamic capability of proactive environmental strategies including: pollution prevention, product stewardship and sustainable development for sustained competitive advantage (Hart, 1995). *Pollution prevention* seeks to prevent emissions, effluents and waste, which can create a competitive advantage for a firm by the resultant low cost. It involves continuous improvement which refers to an organization's systematic efforts to explore and apply new ways to incrementally improve its operations (Anand et al., 2009). *Product stewardship* expands the scope of pollution prevention by enabling firms to minimize the life cycle burden of the firms' products. It involves integration of environmental concerns into product design and development processes through strong stakeholder engagement, creating potential for competitive advantage through pre-empting competition. Finally, *sustainable development* represents a shared vision for minimizing environmental impact of a firm's growth and development through strong engagement with external stakeholders, which creates future position and long term competitiveness (Hart, 1995). Revisiting the original NRBV framework, Hart and Dowell (2011) bifurcated the sustainable development into clean technology and bottom-of-the-pyramid practices intending to provide more focused directions on this under-researched area. Overall, NRBV suggests that using particular sets of practices consistent with proactive environmental strategies can enhance organizational performance (Graham & Potter, 2015; Hart & Dowell, 2011).

The NRBV has been a key theoretical lens in supply chain sustainability research (Choi & Hwang, 2015; Cucciella et al., 2012; Joe et al., 2016; McDougall et al., 2016; Mitra & Datta, 2014; Schmidt et al., 2017; Shang et al., 2010). However, most of the empirical works on NRBV have primarily focused on pollution prevention strategies, whereas product stewardship or sustainable development strategies have received much less attention (Hart & Dowell, 2011). As CSCM provides a broader view of supply chain sustainability, the CSCM construct presented in this research relates to both pollution prevention and product stewardship strategies, which are considered relevant at a firm and supply chain level. We do not consider sustainable development strategies as they are mainly concerned with the industrial level decisions. Furthermore, it involves engagement with a broader range of external stakeholders such as competitors and governments who are not directly involved in the firm and supply chain level decisions (Graham & Potter, 2015). Overall, the research argues that CSCM is well aligned with NRBV aiming to circulate material resources indefinitely into the future (Hart & Dowell, 2011). In the following subsection, we link the two NRBV strategies with CSCM practices.

2.2 Circular supply chain management (CSCM)

The integration of CE in supply chain management (SCM) is not new. According to a recent literature review on CSCM by Farooque, Zhang, Thürer, et al. (2019), the term "circular supply chain" first appeared in 2006. Since then, a number of studies (for example, Canning, 2006; De Angelis et al., 2018; Genovese et al., 2017; Mishra et al., 2018; Nasir et al., 2017) reported this term to link CE with SCM. However, it was not clear until Farooque, Zhang, Thürer, et al. (2019), who established a comprehensive integrated view and definition of CSCM as follows:

"CSCM is the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems. It systematically restores technical materials and regenerates biological materials toward a zero-waste vision through system-wide innovation in business models and supply chain functions from product/service design to end-of-life and waste management, involving all stakeholders in a product/service lifecycle including parts/product manufacturers, service providers, consumers, and users" (p. 484).

This definition clearly outlines the systematic integration of circular thinking in SCM. Firstly, CSCM involves restorative (for technical materials) and regenerative (for biological materials) cycles designed based on CE philosophy. It represents a paradigm shift in supply chain sustainability research from a linear "cradle-to-grave" to a circular "cradle-to-cradle" approach (Genovese et al., 2017).

Secondly, the zero-waste vision of CSCM goes beyond the narrow scope of traditional supply chain sustainability terms. For example, CSCM further extends the boundary of sustainable supply chain management (Golicic & Smith, 2013; Paulraj et al., 2017; Seuring & Müller, 2008) and green supply chain management (Li et al., 2019; Liu et al., 2012; Schmidt et al., 2017; Zhu, Geng, et al., 2011) by encouraging the use of non-virgin materials through a systematic circulation of resources within supply chains systems (Andersen, 2007; Genovese et al., 2017). Similarly, Van Wassenhove (2019), in his recent article published in *Production and Operations Management*, acknowledged the fact that CE offers a much broader sustainability perspective as compared to closed-loop supply chains (Guide & Van Wassenhove, 2006). CSCM does not restrict the scope of value recovery from end-of-life (EoL) products within the producer's supply chain only. In contrast, firms in a circular supply chain go further by recovering value from EoL products and/or wastes by collaborating with other firms within and/or outside of their industry sector (Weetman, 2017) including secondary supply chains and/or involving new auxiliary channel members (Moula et al., 2017).

Last but not least, Agrawal et al. (2019), in a recent publication in *Manufacturing & Service Operations Management*, highlighted the significance of the Ellen MacArthur Foundation's CE building blocks as operational strategies for organizations making the transition to a CE. The Ellen MacArthur Foundation's building blocks for a CE include: circular economy design, new business models and reverse cycle enablers, further complemented by enablers and favorable system conditions (Agrawal et al., 2019). In this study, we focus on the supply chain operational level practices and do not include business models or enabling conditions which are more at a strategic level in order to allow an in-depth investigation of the practice-performance relationship.

2.2.1 CSCM Practices

Based on the extant literature we conceptualize four CSCM practices, namely, circular product design, circular procurement, cleaner production and EoL product and waste management. We take a broad perspective of CSCM and include relevant practices that play a vital role to establish circularity in the supply chains. Table 1 compares the CSCM practices with the related constructs from the extant literature.

In the transition to a CE, the design function needs a fundamental change as the product design greatly influences the whole product's value chain. Past literature on green and environmentally friendly supply chain practices have recognized the importance of design function as a tool to minimize environmental impacts of products over their useable life and afterwards (Bovea & Pérez-Belis, 2012; Brezet, 1997; Luttropp & Lagerstedt, 2006; Zhu, Sarkis, et al., 2007). Circular product design represents a new design concept that is consistent with CE philosophy. It introduces design principles based on circularity and end-of-life thinking, which make a clear distinction from previous design concepts reflected in the extant supply chain sustainability research (Farooque, Zhang, Thürer, et al., 2019). Moreover, circular product design encompasses both design for product integrity (i.e., preventing and reversing obsolescence at a product and component level) and design for recycling (i.e., preventing and reversing obsolescence at a material level) concepts as explained by den Hollander et al. (2017).

In the past research, green purchasing (Min & Galle, 1997, 2001) and environmental purchasing (Carter & Carter, 1998; Carter et al., 1998) practices have been seen as environmentally-conscious way of sourcing raw materials. However, the existing green and environmental purchasing concepts do not integrate CE philosophy in the purchasing function. The principles of CE assume that the raw materials used in production systems must not have any harmful effects on the environment (Genovese et al., 2017). Therefore, the purchasing function of firms operating in circular supply chains must adhere to the CE requirements both at the strategic and practice levels (González-Benito, 2007) to nurture circular procurement practices for a CE. In principle, circular procurement strives for the use of natural, non-virgin, renewable, biodegradable/restorable and non-hazardous materials in production of circular products. The European Commission (2020a) defines circular procurement as purchasing practices which seek to contribute to the closed energy and material loops within supply chains, whilst avoiding or at least minimizing, negative environmental impacts and waste creation across the whole lifecycle.

Cleaner production is regarded as one of the key enablers of CE at the firm level (Bilitewski, 2012; Ghisellini et al., 2016; Sousa-Zomer, Magalhães, Zancul, Campos, et al., 2018). UNEP defines cleaner production as "the continuous application of an integrated preventative environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment" (p. 3) . Cleaner production practices have significantly contributed to pollution prevention and waste reduction of industrial production systems (Su et al., 2013). In general, the cleaner production practices imply material/energy conservation and efficiency, elimination of toxic raw materials and toxic emissions, as well as reduction of overall environmental impacts along the product's entire life cycle (van Berkel et al., 1997).

To establish circularity in supply chains, EoL products and waste management activities are considered critically important for recirculating and recovering the residual value within the product system. Broadly, this involves a systematic approach towards managing circular resource flow of good/materials/energy through effective use of reuse, refurbishing, remanufacturing and recycling strategies and a supporting collection system (Farooque, Zhang, Thürer, et al., 2019). Unlike closed-loop supply chains (Guide & Van Wassenhove, 2003), the scope of resource recirculation and recovery in circular supply chains is not just restricted to the original supply chains (see Jacobs and Subramanian (2012) for extended producer responsibility program as an example). Rather firms engage in collaborative arrangements within and outside of their industry sectors to maximize the utility of used and/or EoL products and materials instead of being a source of waste (Farooque, Zhang, Thürer, et al., 2019; Van Wassenhove, 2019).

Overall, the CSCM practices presented above link with both the pollution prevention and product stewardship strategies of NRBV theory to form a comprehensive and integrated systems perspective of CE at SCM functional level. For example, cleaner production practices, which represent the environmental efforts of a firm at the internal operations level, are aimed at pollution prevention at its source in the production process on a continuous improvement basis (Buysse & Verbeke, 2003; Cucciella et al., 2012; Paulraj et al., 2017; Thoumy & Vachon, 2012; Vachon & Klassen, 2006b). On the other hand, circular product design and circular procurement represent the proactive stance of a firm in minimizing the environmental impact of the product system, and are aimed at realizing product stewardship through strong stakeholder engagement (Cucciella et al., 2012; Hart & Dowell, 2011). Moreover, EoL & waste management represent a "take-back" strategy for resource recirculation and recovery as part of the broad product stewardship strategy (Hart, 1995).

Table 1: CCSM practices vs SCM sustainability practices

CSCM practice	Related construct(s)	Key Differences
Circular product design	**Eco-design** (Bovea & Pérez-Belis, 2012; Brezet, 1997; Luttropp & Lagerstedt, 2006) **Design for environment** (Cucciella et al., 2012; Sarkis, 1998; Sroufe, 2003) **Green design** (Golicic & Smith, 2013; Sonia, 2014; Vachon & Klassen, 2006a; Zhu & Sarkis, 2007) **Sustainable product design** (Chen et al., 2012; Kleindorfer et al., 2005)	There are fundamental distinctions between circular product design and competing design concepts in terms of principles, strategies and methods (for detailed discussion please see, den Hollander et al., 2017). Circularity and end-of-life thinking is an integral part of circular product design philosophy (Farooque, Zhang, Thürer, et al., 2019).
Circular procurement	**Green procurement** (Blome et al., 2014; Carter & Jennings, 2002) **Green purchasing** (Min & Galle, 1997; Sonia, 2014; Zsidisin George, 1998) **Environmental purchasing** (Carter & Carter, 1998; Carter et al., 1998; Carter et al., 2000)	CE principles have remained absent in the extant green and environmental purchasing practices (Farooque, Zhang, Thürer, et al., 2019). Circular procurement focuses on the use of non-virgin raw material seeking to contribute to the closed energy and material loops within supply chains (European Commission, 2020a).
Cleaner production	**Sustainable manufacturing/production** (Golicic & Smith, 2013; Linton et al., 2007) **Green manufacturing** (Mao & Wang, 2019; Sonia, 2014; Zhu & Sarkis, 2007)	An explicit focus on manufacturing/production practices has been missing in the extant supply chain sustainability research. Cleaner production is considered as a key enabler of CE practices at a micro level with implications for other supply chain functions. However, the topic has received more individual attention and has seldom been reflected as part of integrated strategy for sustainability in supply chains (Farooque, Zhang, Thürer, et al., 2019; Sousa-Zomer, Magalhães, Zancul, Campos, et al., 2018).
EoL product & waste management	**Reverse logistics** (Carter & Ellram, 1998; Kleindorfer et al., 2005; Van Hoek, 1999)	The transition from narrowly-focused closed-loop recycling with original supply chains to a systematic approach towards resource recirculation and value recovery at a much broader level including collaborative

	Green logistics (Dekker et al., 2012; Lai & Wong, 2012; Murphy Paul, 2003; Sonia, 2014) **Environmental recycling and waste practices** (Pullman et al., 2009; Sroufe, 2003)	arrangements within and outside of original supply chains and industrial sectors (Farooque, Zhang, Thürer, et al., 2019).

2.3 Contingent NRBV

Aragón-Correa and Sharma (2003) explained how contingency factors (i.e. uncertainty, complexity and munificence) moderate the relationship between proactive environmental strategies and competitive advantage. *Uncertainty or dynamism* reflects "the unpredictability and volatility of the changes in an industry that heighten the uncertainty of firms' predictions" (Chen et al., 2017, p. 127). Aragón-Correa and Sharma (2003) classified uncertainties into two groups: 1) uncertainties based on managerial perceptions and 2) uncertainties based on environment's objective features. *Complexity* is defined as 'the number, multiplicity, and distribution of external contextual factors and refers to the heterogeneity and concentration within an industry' (Chen et al., 2017, p. 128). The greater the number of contextual factors in the general business environment, the more is complex the business environment (Aragón-Correa and Sharma, 2003). *Munificence* refers to a degree to which 'the abundance and availability of external resources that can support organizational growth' (Chen et al., 2017, p. 127). Aragón-Correa and Sharma (2003) argue that munificence in terms of a high concentration of similar firms and specialized supplies within a geographical area increases the opportunity to acquire resources for developing dynamic capabilities of a proactive environmental strategy.

Previous research in the supply chain sustainability domain has extensively studied the practice-performance relationship; however, only a few studies have assessed the impact of contingency factors affecting the environmental strategy to competitive advantage linkage (Aragón-Correa & A. Rubio-López, 2007; Brulhart et al., 2019; Hartmann & Vachon, 2018; Schmidt et al., 2017). These studies provide empirical support to the contingent NRBV proposition that firms possessing similar capabilities may still develop different approaches to environmental management and/or obtain differential levels of competitive advantage with similar environmental strategies (Aragón-Correa & Sharma, 2003). In this regard, identification of the contingencies affecting CSCM practice-performance relationship would be of great theoretical and practical significance. In a later section, we link how being located within an EIP affects the CSCM practice-performance relationship as a contingency factor.

2.4 Role of EIPs in fostering CE and CSCM

The CE movement has become popularized throughout the world. While China and Europe have developed their policy frameworks, the CE concept has been adopted by many other economies as well (Murray et al., 2017). With regard to CE implementation, the underlying distinction between China and other parts of the world lies in the industrial structure and governance systems (Mathews & Tan, 2016; McDowall et al., 2017). Western economies have struggled for decades to get firms to collaborate along supply chain networks (Mathews & Tan, 2016). This is where the Chinese EIP infrastructure enters the picture (Mathews et al., 2018).

A commonly accepted international definition of EIP is as follows:

"An eco-industrial park or estate is a community of manufacturing and service businesses located together on a common property. Member businesses seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues" (Lowe, 2001, p.1).

In China, the EIP concept was first introduced by the United Nations Environment Programme in 1997 (Shi et al., 2012). The Ministry of Ecology and Environment of China (previous names 'Ministry of Environmental Protection' and 'State Environmental Protection Administration') started promotion of EIPs in the country and established the first national trial EIP in August 2001 (Zhu, Lowe, et al., 2007). Since then, the Chinese government has taken several measures including legislative and policy formulation and establishment of regulatory mechanisms, and provided financial support to develop and promote EIPs for achieving sustainable industrial development and CE goals (Zhu et al., 2015). According to Mathews et al. (2018) and Geng et al.

(2019), so far China has strategically developed more than 50 certified EIPs mainly by converting existing industrial parks into EIPs.

In the Chinese manufacturing industry, EIPs represent a unique context where uncertainty, complexity and munificence for firms operating within EIPs would be considered high (Aragón-Correa & Sharma, 2003). For example, firms operating inside EIPs get involved in buyer-supplier relationships of a highly symbiotic and complex nature, whereby they exchange physical materials, energy and services among themselves (Chertow, 2007; Susur et al., 2019). Firms within EIPs can replace production inputs with wastes and by-products of others, thus saving on raw material purchase and waste disposal costs (Mathews et al., 2018). In this regard, EIPs represent a munificent environment allowing firms to obtain resources more easily and better than competitors (i.e., firms outside EIPs). However, at the same time, this presents unique challenges and uncertainties for firms when comparing firms' operations in an EIP (i.e., industrial symbiosis) with typical supply chain network operations. Firstly, the products exchanged in industrial symbiosis networks are outside the core business of typical manufacturing firms. Secondly, the exchanges are not usually available upon demand, and the quantity and quality vary based on other factors such as production volume and production technologies being used by other firms in the industrial symbiosis network.

3. Hypothesis Development

3.1 CSCM and firm performance

The focus on economic performance while also considering environmental and social impacts, also known as the triple bottom line (Elkington, 2004), has remained a central facet of the supply chain sustainability domain. For the last two decades, supply chain sustainability research has been contributing to provide empirical support for an association between the proactive environmental strategies and sustainable competitive advantage as proposed in the NRBV (Hart, 1995; Hart & Dowell, 2011). The positive association between NRBV strategies (i.e., pollution prevention and product stewardship) and improved environmental and economic performance is well established in the extant literature (Cousins Paul, 2019; Geng et al., 2017; Graham & Potter, 2015; Kitsis & Chen, 2019; Mitra & Datta, 2014; Pullman et al., 2009; Rao & Holt, 2005; Russo & Fouts, 1997; Schmidt et al., 2017).

Similarly, the case to transform the economy from a linear to a circular format is seen to be extremely strongly based on the economic, social, and environmental benefits (Atasu et al., 2018; Mathews et al., 2018). In the academic literature, there is a growing consensus among researchers that integrating CE in SCM helps to improve environmental performance. For example, recent case studies from various industries (Genovese et al., 2017; Nasir et al., 2017; Niero & Olsen, 2016) and other empirical works (Zhu et al., 2010; Zhu, Geng, et al., 2011) have all shown that significant environmental advantages can be achieved by making a transition to CE. In the extant supply chain sustainability research, environmental performance has mainly accounted for reduction in air and water emissions, effluents and solid wastes, and toxic materials (Zhu, Geng, et al., 2011; Zhu & Sarkis, 2004; Zhu, Sarkis, et al., 2013). Based on this discussion, firms implementing CSCM practices are likely to achieve better environmental outcomes; we, therefore, hypothesize that:

H1: Firms having higher levels of adoption of CSCM will demonstrate better environmental performance.

In addition to measuring the environmental performance in terms of reduced levels of emissions and wastage, as presented above, firms need to capture other important dimensions of environmental benefits arising from CSCM implementation. Resource consumption and conservation (i.e., materials and energy) are highly regarded in the CE literature (Clark et al., 2016; Ellen MacArthur Foundation, 2020; Li et al., 2010; Shahbazi et al., 2016). However, the environmental consequences of consumption of materials and energy are seldom reflected in the performance metrices (Kazancoglu et al., 2018; Paulraj et al., 2017). As noted earlier, CSCM practices greatly emphasize the usage of non-virgin raw materials, and clean and renewable energy in the design and production of circular products. Thus, it is imperative to broaden the scope of environmental performance by including measures related to energy and material circularity. Thus, we propose the following hypothesis:

H2: Firms having higher levels of adoption of CSCM will demonstrate better resource circularity performance.

On the other hand, there are some contradictory findings with regard to the economic viability of the circular supply chains. According to Genovese et al. (2017) and Nasir et al. (2017), the implementation of circular supply chains may be challenging from an economic point of view, suggesting that bottom-up circular initiatives at supply chain level might need to be incentivized through top-down governmental support (Genovese et al., 2017). However, Zhu et al. (2010); Zhu, Geng, et al. (2011), found a positive relationship between CE practices and CE targeted performance (including economic and environmental performance) along with a moderating role of environmental supply chain cooperation. These contradictory findings lead to a critical question: Is CE/CSCM economically viable as well?

The answer to this question may not be as straight forward. Overall, both the positive and negative effects of CSCM implementation on economic performance may potentially be justifiable. The failure to obtain consistent results among studies could be due to the following reasons. Firstly, there are significant differences in the research design, measurement items and methodology among the previous studies. For example, the studies by Genovese et al. (2017) and Nasir et al. (2017) are based on case studies while their explicit focus remained on environmental performance. Other studies by Zhu et al. (2010); Zhu, Geng, et al. (2011) involved survey methods with a broad focus on sustainability performance dimensions.

Secondly, as a matter of fact, there is a lack of CE metrics in mainstream economic models which still maintain a linear thinking as indicated by Mathews and Tan (2016). The extant literature on supply chain sustainability has been dominated by a number of concepts, such as sustainable supply chains, green supply chains, environmental supply chains, and closed-loop supply chains, whereas none of these concepts has systematically integrated the CE philosophy into SCM (Farooque, Zhang, & Liu, 2019; Farooque, Zhang, Thürer, et al., 2019). In this context, the previous studies by Zhu et al. (2010); Zhu, Geng, et al. (2011) did not account for circularity in the measurement items related to CE practices. Apparently, the CE practices construct only reflects a mere repositioning of measurement items from their seminal work on green supply chain management (see, for example, Zhu and Sarkis (2004), for measurement items related to green supply chain practices). Therefore, there is a need to develop new metrics that reflect the circularity in the relevant practices.

Thirdly, there seems to be a lack of distinction between short-term and long-term cost-benefit analysis with regard to CE implementation. The CE/CSCM implementation is costly and requires significant upfront investment (Geng et al., 2009); this may indicate negative economic outcome in the short-term. For example, a general increase in investment for CE (i.e., infrastructure, equipment and technology), CE-related training costs and higher manufacturing costs due to a firm's inability to achieve economies of scale might be observed in the short term. However, CSCM implementation offers potential long-term economic benefits in the form of improved material efficiency and energy usage (Su et al., 2013) as recycled, regenerated and locally-sourced raw materials are usually cheaper, thereby increasing profits (Mathews & Tan, 2016). Similarly, other measures for improved cost performance include decrease in materials purchasing cost, decrease in energy consumption cost, and decrease of fees for waste water discharge and treatment (Zhu & Sarkis, 2004). Furthermore, improved business performance in terms of growth in sales, return on sales, growth in profit, growth in market share and return on investment (ROI) (Flynn et al., 2010; Kazancoglu et al., 2018; Paulraj et al., 2017) could also be considered as important measures to assess the financial viability of CSCM practices.

In this research, we do not consider the short-term negative impact of investments for CE and CSCM; rather, we focus on the broad economic performance dimension by looking at the cost and financial performance aspects of CSCM implementation in the long-term. In light of the above reasons, we hypothesize the following:

H3: Firms having higher levels of adoption of CSCM will demonstrate better cost performance.

H4: Firms having higher levels of adoption of CSCM will demonstrate better financial performance.

3.2 Eco-Industrial Parks and CSCM practice-performance relationship

Drawing upon the contingent NRBV, scholars have sought to identify how industry context affects the adoption of environmental strategies (Chen et al., 2017). As noted previously, the elements of environmental uncertainty, complexity and munificence are inherent in an EIP setting. Firms operating inside EIPs can experience a high degree of dynamism or uncertainty, which makes understanding or predicting the impact of changes in the business environment quite difficult for the managers (Aragón-Correa & Sharma, 2003). For example, the availability, volume and quality of material and/or waste exchange in EIPs is typically more in the control of the waste producers than of the waste users, thus resulting in uncertain situations and potential mismatch of demand and supply. From a contingent NRBV perspective, firms when faced with dynamism or uncertainty try to develop capabilities and reconfigure their resources that allow them to find ways of competing in an uncertain context (Aragón-Correa & Sharma, 2003). Similarly, firms inside EIPs become engaged in what is called industrial symbiosis - a complex interaction of traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and/or by-products (Chertow, 2000). Taking the contingent NRBV viewpoint, Aragón-Correa and Sharma (2003) argue that decision makers cope with complexity by making incremental changes. Other propose that increased complexity allows firms to leverage and develop their internal capabilities, in order to counter the competition (Mar Fuentes-Fuentes et al., 2004). Lastly, firms operating inside EIPs have a unique advantage over others (i.e., non EIP firms) where these firms get involved in industrial symbiosis in addition to developing collaborative relationships with supply chain partners for CSCM and sustainability (Klassen & Vachon, 2003; Lee, 2004; Nidumolu et al., 2014). Thus, munificence in the form of availability of sufficient resources for firms operating inside EIP makes it easier for firms to experiment and innovate (Aragón-Correa & Sharma, 2003) and provides the grounds for more effective environmental management (Hartmann & Vachon, 2018). In light of the above reasons, we hypothesise:

H5: Firms located inside EIPs will demonstrate higher levels of CSCM practices adoption.

Furthermore, the contingent NRBV argues that the contextual factors (i.e., uncertainty or dynamism, complexity and munificence) have the potential to moderate the environmental strategy and competitive advantage relationship (Aragón-Correa & Sharma, 2003). Recent research has found empirical support for the moderating role of contextual factors (Hartmann & Vachon, 2018; Schmidt et al., 2017). According to Hartmann and Vachon (2018), a higher degree of munificence strengthens the linkage between environmental management and environmental performance. Similarly, they suggest that environmental management in complex environments facilitates better outcomes. They further argue that the impact of dynamism or uncertainty can either have a positive or a negative moderating effect, depending on the context.

In the context of this research, we argue that being located in an EIP is a contextual factor, which has the potential to moderate the CSCM practice-performance relationship. The industrial symbiosis is seen as a major contributor to supporting this argument. According to Domenech et al. (2019), industrial symbiosis focuses on the optimization of the materials cycle and fulfills the CE principles of reusing, recycling and remanufacturing, thereby increasing resource efficiency, reducing waste and pollution, and bringing about environmental and economic benefits. In the Chinese manufacturing industry, firms inside an EIP need to integrate environmental requirements from the park administrative authority into their supply chain activities such as product design, purchasing and production. They also need to report their waste production along with the potential requirements for reused products and other materials for recycling purposes (Zhu et al., 2015). According to reports, the environmental performance (including eco-efficiency) in many EIPs has improved, besides creating huge savings on raw material purchase and waste disposal costs (Mathews et al., 2018). For example, a typical Chinese industrial park, in Guangxi province, saves more than 2 million tonnes of CO2 emissions a year by using less energy and circulating materials (Sun et al., 2017). Given these arguments, we hypothesize:

H6a: The relationship between CSCM and environmental performance will be stronger in firms located inside EIPs.

H6b: The relationship between CSCM and resource circularity performance will be stronger in firms located inside EIPs.

H6c: The relationship between CSCM and cost performance will be stronger in firms located inside EIPs.

H6d: The relationship between CSCM and financial performance will be stronger in firms located inside EIPs.

3.3 Control variables

In our study, we controlled for three variables. Firstly, we controlled for firm size which was measured using the number of employees. Large firms tend to have access to a greater number of resources. According to the RBV, availability of resources or capabilities greatly influences what the firm can and cannot do because the formulation and implementation of strategies require commitment of scarce resources (Pullman et al., 2009). Larger firms have relatively more resources (Boyer et al., 1996) and flexibility (Koufteros et al., 2007) to implement environmental management practices such as CE, which can be costly and requires significant upfront investment (Geng et al., 2009). Therefore, they are more likely to have well-developed CSCM practices as compared to smaller firms.

Secondly, ownership type or structure is seen to affect the implementation of sustainability-related practices especially in the Chinese context (Jiang et al., 2013; Li & Zhang, 2010). State-owned enterprises outnumber any other ownership type in China. On one hand, these state-owned enterprises receive a lot of support and assistance to implement CE (Geng et al., 2009) but, at the same time, they face more pressure from the government (Li et al., 2019). However, Zhu and Geng (2013) found that foreign firm are more proactive in implementing supply chain sustainability practices at a higher level, followed by state-owned and private manufacturers in China.

Thirdly, CE implementation and/or adoption varies between industries as some industries may have a comparative advantage over others in lending themselves to more circular initiatives. For example, recirculation of metal scrap is much easier when compared to extracting metal from industrial sludge, which requires chemical treatment and, therefore, could be more challenging (Van Wassenhove, 2019). Moreover, different industries may need different supply chain actors to collaborate along with a diverse range of techniques in waste management and resource recovery procedures (Farooque, Zhang, & Liu, 2019).

Figure 1 presents the conceptual model of this study.

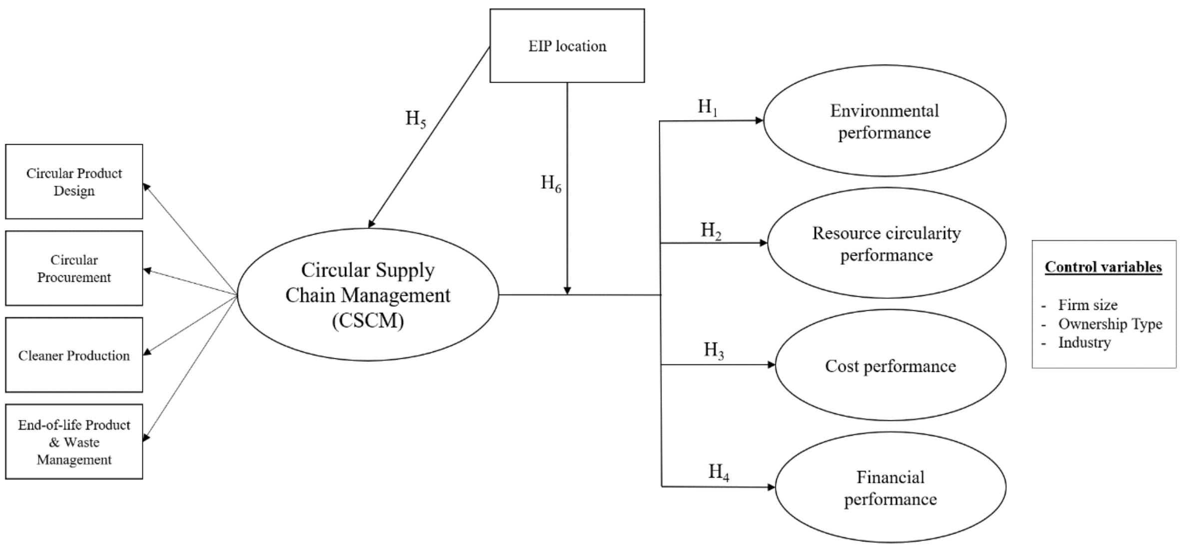

Figure 1: Conceptual Model

4. Methodology

4.1 Sample and data collection

Data for this study were collected as part of a larger study focused on CSCM adoption in the Chinese manufacturing sector. A snowball sampling approach, which is a commonly used means of obtaining data from a variety of firms in various industries (Martins et al., 2002), was involved in the survey. Our survey methodology is contextually appropriate and in line with previous studies (Zhu, Geng, et al., 2011; Zhu & Sarkis, 2004) where authors have reported difficulties in obtaining data for organizational practices in the Chinese manufacturing industry.

In order to obtain a large sample size, the questionnaires were distributed using multiple channels. Firstly, researchers used their own professional network (one of the co-authors works as the Secretary General of a regional Logistics Management Club in Northern China). Secondly, a team of postgraduate and MBA students at a large state university was hired to provide some additional support in data collection. Thirdly, officials working in local government agencies in northern China also provided help to collect data from respondents within their network. An effort was made to collect data from two respondents per organization: one for the independent variables and one for the dependent variables. Out of 900 questionnaires distributed via all channels to various manufacturing firms, a total of 360 was returned (response rate = 40%). Around 110 individual respondents raised queries and wrote some additional comments about their companies' CSCM practices. Our survey sample covered all the six greater administrative areas of China and a vast majority of provincial-level divisions (i.e. 23 out of 34 divisions). Details are presented in Appendix A, Table A1. All the questionnaires were scrutinized, and a large proportion of responses (nearly 30% of collected responses) were rejected based on their response to screening items (i.e. attentiveness to scale variations), response patterns and missing data (Edwards, 2019). Overall, these efforts ensured the rigor of the data collection process for obtaining quality data. A final sample of 255 responses meeting the assumptions related to normality, constant variance and outliers, was considered appropriate for the analysis purposes in this study. Table 2 provides a summary of the sample distribution. Other demographics-related information is presented in Appendix A, Table A2.

Table 2: Sample characteristics

Variable	Inside EIP	Percentage	Outside EIP	Percentage	Total	Percentage
Firm Size						
< 100	22	44.0%	28	56.0%	50	19.6%
101-500	37	45.1%	45	54.9%	82	32.2%
501-1000	16	41.0%	23	59.0%	39	15.3%
1001-3000	13	35.1%	24	64.9%	37	14.5%
3001-8000	7	31.8%	15	68.2%	22	8.6%
> 8001	8	32.0%	17	68.0%	25	9.8%
Ownership Type						
State Owned	20	30.3%	46	69.7%	66	25.9%
Collective	0	0.0%	5	100.0%	5	2.0%
Private	61	48.4%	65	51.6%	126	49.4%
Foreign Owned	7	33.3%	14	66.7%	21	8.2%
Joint Venture	15	41.7%	21	58.3%	36	14.1%
Others	0	0.0%	1	100.0%	1	0.4%
Industry						
Food/beverage/wine/tobacco	4	30.8%	9	69.2%	13	5.1%
Metallurgy	7	30.4%	16	69.6%	23	9.0%
Basic metals/metal product/machinery/equipment	32	43.8%	41	56.2%	73	28.6%
Textile/apparel/leather	2	33.3%	4	66.7%	6	2.4%
Electronics/communication	6	66.7%	3	33.3%	9	3.5%
Building material/building and decorative	2	18.2%	9	81.8%	11	4.3%
Transport equipment/vehicle	5	26.3%	14	73.7%	19	7.5%
Electrical appliances/household appliances	12	63.2%	7	36.8%	19	7.5%
Rubber/plastics	1	100.0%	0	0.0%	1	0.4%
Coke/petroleum	2	33.3%	4	66.7%	6	2.4%
Chemical	1	10.0%	9	90.0%	10	3.9%
Pharmaceutical/treatment	9	45.0%	11	55.0%	20	7.8%
Food/beverage/wine/tobacco	0	0.0%	2	100.0%	2	0.8%
Metallurgy	11	73.3%	4	26.7%	15	5.9%
Others	9	32.1%	19	67.9%	28	11.0%
Total	103	40.0%	152	60.0	255	100.0%

4.2 Constructs development and measurement issues

An extensive review of related literature was done to develop the measurement items for constructs related to CSCM practices and firm performance. We tested CSCM practices as a second-order reflective construct to capture the overall traits of CSCM practices adoption and implementation. The items measuring for the first-order constructs were adapted from: Brezet (1997); Zhu, Geng, et al. (2011); den Hollander et al. (2017) for circular product design; Carter and Carter (1998); Zhu, Geng, et al. (2011) for circular procurement; Sousa-Zomer, Magalhães, Zancul, Campos, et al. (2018); Zeng et al. (2010); Zhu, Geng, et al. (2013) for cleaner production; and Carter and Ellram (1998); Hsu et al. (2013) for EoL product and waste management. Items measuring circular supply chain practices were measured using five-point Likert scales anchored by 1 = not at all and 5 = to full extent; thus representing the implementation situation of these practices in the respective organizations in the last year.

The performance-related variables consist of environmental, resource circulation, cost and financial performance. The participants were asked to evaluate their firm's performance in the current year (a time lag of one year between practices and performance measures) against each item in comparison with the main competitor in the industry. We adapted environmental and resource circulation performance measures from Yang et al. (2013); Zhu, Geng, et al. (2011), cost performance measures from Zhu and Sarkis (2004) and financial performance measures from Flynn et al. (2010). Items measuring performance were measured by using seven-point Likert scales anchored by 1 = significantly lower and 7 = significantly higher. This approach of collecting data for outcome variables at time periods that follow the antecedent variables provides a lag between the implementation of practices and realization of results, thereby reducing potential bias (Dobrzykowski et al., 2016). Perceptual measures were used throughout for all items including firm performance following Singh et al.'s (2011) supportive argument in favor of using perceptual measures as opposed to limited collections of incomplete objective data.

As the items were adapted from English-language literature, a rigorous translation/back-translation process was followed to ensure conceptual equivalence (Paulraj et al., 2017). The scales were first translated into Chinese and subsequently translated back into English by two translators to check for discrepancies with the original English version. Prior to administering the survey, two rounds of pilot tests and face-to-face discussions involving seven senior executives in each round from large-scale Chinese manufacturers were conducted. This qualitative assessment of the measurement items helped us improve the survey instrument by ensuring clarity, content validity and reduced the likelihood of misinterpretations before its distribution to a larger sample.

4.3 Data analysis procedure

Structural equation modeling (SEM) was used to test the effects of CSCM practices on firm performance as hypothesized in H1-H4. For H5, a nonparametric Kruskal–Wallis H test was used to determine differences among groups of the independent variable (i.e., measured as yes/no to ask whether a firm was located in an EIP) on a dependent variable (i.e., measured on a Likert-scale for CSCM practices adoption). For H6, a chi-square difference test and multigroup analysis (MGA) were used to assess the moderating role of being located in an EIP on the CSCM practices-performance relationship. We used the IBM® SPSS® Amos 25 software package for data analysis purposes.

4.4 Bias assessment

a) Non-response bias

The full-scale survey was administered during June-September 2019. We tested for non-response bias on all variables by comparing early (first 30 responses) and late respondents (last 30 responses) using a t-test. We found no significant differences.

b) Response type and firm location

Given that a survey involving a matched response (i.e., two respondents per organization, one for the independent variables and one for the dependent variables) in SCM research is quite challenging, we allowed a single respondent to fill in the questionnaire if a matched response was not possible. As a result, we ended up receiving a mix of matched responses (n=75) and single respondent (n=180) based questionnaires. Similarly, the survey was distributed equally among firms located inside and/or outside an EIP. The final sample included responses from firms located inside (n= 103) and outside (n= 152) an EIP. Hence, to ensure an unbiased sample for this study, initially we performed a t-test comparing both response types and firm's location and found no significant statistical difference.

To further validate this claim, we conducted a chi-square difference test. The CFA was subjected to a two-stage multigroup analysis (MGA) (Bollen, 2014; Jöreskog, 1998) separately for both the grouping variables (i.e., response type and firm's location). In the first stage of MGA, the CFA model was tested in which all the parameters were freely estimated in the presence of the groups. The second step was to determine if the MGA showed a significant change in model fit when all the parameters being influenced by the grouping variable and/or moderator were constrained to be equal across the two groups. If a significant reduction in model fit indices occurred, then this would suggest that the moderator was acting. Applying the conventional cut-off value of 0.05, this indicates that the same pattern of measurement relationships exists for the two groups. Thus, our analysis did not suggest any significant difference or moderating effect (Table 3).

Table 3: Chi-square difference test

(Response type: 1= single respondent, 2= matched response)						
Model	**χ^2**	**df**	**CFI**	**SRMR**	**RMSEA**	**PClose**
Unconstrained	1786.21	1154	0.905	0.074	0.047	0.913
Constrained	1823.15	1188	0.905	0.074	0.046	0.90
Difference	36.942	34	0.00	0.00	0.001	0.946
p-value	0.335					
(Firm's location: 1= inside EIP, 2= outside EIP)						
Model	**χ^2**	**df**	**CFI**	**SRMR**	**RMSEA**	**PClose**
Unconstrained	1802.096	1152	0.901	0.088	0.047	0.872
Constrained	1845.901	1188	0.900	0.095	0.047	0.90
Difference	43.805	36	0.001	0.007	0.00	0.028
p-value	0.174					

Note: Although a similar MGA process was followed for testing the differences between groups, separate MGAs were performed for different reasons: firstly, to assess the bias due to different response types (i.e., single vs matched response); secondly, to assess the moderating role EIP location as a categorical moderator.

c) Common method bias

Several approaches were adopted during the research design stage to reduce the likelihood and effect of common method bias as recommended by Podsakoff et al. (2003).

Firstly, we separated the measurements related to the dependent and independent variables into two different parts requiring response from two different respondents within the same organization. Part 1 included questions on dependent variables and required response from a senior executive working in the department of administration, strategy, finance, or performance, or someone who was familiar with the overall management and overall performance of the firm. Similarly, part 2 included questions on independent variables and required response from a senior executive working in the department of operations, supply chain, product design, administration, or someone who was familiar with operations activities of the firm. However, due to the anticipated challenges in getting matched responses from manufacturing firms, a single respondent was also allowed to respond to the whole questionnaire in case a matched response was not possible.

Secondly, we used different measurement scales in the questionnaire to eliminate the impact of consistency in the response patterns. For example, the scale used for environmental and cost performance variables implied response in terms of lower emissions, wastage and cost as means to achieve better performance. Whereas, the same scale implied response in terms of increased use of renewable energy, restored (non-virgin) materials and higher profits, as an indication of better performance. These variations also allowed us to measure respondents' engagement in the process and helped us filter unengaged responses.

As the majority of data (approx. 70%) for this study was obtained from a single source in each company with a self-report questionnaire, common method bias may be a serious concern (Guide Jr. & Ketokivi, 2015). Based on the MGA (Table 3), the results from the single respondent group were not statistically different from matched response group; therefore, a major concern related to common method bias was not indicated in this study. In order to detect the presence and severity of common method bias, we performed three tests: firstly, we conducted Harman's (1976) single-factor test in which the un-rotated factor analysis with eigenvalue greater than 1 was used. The results of this test showed the presence of eight different factors, and the first factor explained only a fraction of the variance (19.3%) in the data. Secondly, we performed a common latent factor test (Podsakoff et al., 2003). In this test, a latent factor is introduced to the original measurement model. The results showed that the fit for the original measurement model (i.e., $\chi 2/df = 1.67$, CFI = 0.947, and RMESA = 0.051) was similar to the fit for the model including the common latent factor (i.e., $\chi 2/df = 1.57$, CFI = 0.952, and RMESA = 0.047). We conducted a third test following the procedure recommended by Widaman (1985). Using this approach, we tested two latent variable models – a measurement model with just the traits and a measurement model with method factor in addition to traits. Using the CFI change cutoff criterion of 0.01 (Cheung &

Rensvold, 2002), the model fit indices do not show significant improvement. Also, the path coefficients and their significance were not much different between the two models, suggesting that they were robust despite of the inclusion of a methods factor. Based on the results of these analyses we conclude that common method bias is unlikely to influence the validity of results presented in this study.

4.5 Measurement Model: validity and reliability

Both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to assess convergent validity (i.e., items assigned to a construct contribute roughly equally to the construct's measurement). Factor loadings (all above 0.50) from EFA as presented in Table B1 (Appendix B) suggest that our indicators exhibit convergent validity (Hair et al., 2006). In CFA, we used two different measurement models for assessing the independent and dependent factors, as different scale anchors were used for independent and dependent indicators (Paulraj et al., 2017). The convergent validity of the constructs was generally supported by the estimated factor loadings of items on constructs. All standardized loadings were greater than 0.5, statistically significant ($p < 0.001$) and positive (Table 4).

Table 4: Model Validity Measures

Constructs	M	SD	CR	AVE	1	2	3	4	5
1. Environmental performance	5.15	0.99	0.93	0.72	**0.846**				
***2.* Resource circularity performance**	3.97	1.24	0.79	0.65	0.001	**0.805**			
3. Cost performance	4.38	0.76	0.84	0.53	0.285**	-0.014	**0.728**		
4. Financial performance	4.27	1.19	0.95	0.75	0.166*	0.135	0.421**	**0.866**	
5. Circular Supply Chain Management	3.25	0.73	0.80	0.51	0.168*	0.156	0.164*	0.290**	**0.71**

Value on the diagonal is the square root of AVE.
* p< 0.050
** p< 0.01

We assessed discriminant validity (i.e., items only estimate the construct to which they are assigned and not any others) by comparing average variance extracted (AVE) to the squared correlation between two constructs. The AVE values (all above 0.5) as presented in Table 4 were found to be greater than inter-construct correlations, thus indicating no discriminant validity concerns (Fornell & Larcker, 1981). Finally, we assessed reliability using the composite reliability (CR) as well as Cronbach's alpha. Table 5 shows that the coefficients are acceptable (all values above 0.7) for newly-developed constructs (Hair et al., 2006).

As in typical SEM analyses, a number of commonly reported indices were obtained to assess the goodness-of-fit of model with data. These fit indices were as follows: $\chi 2/df = 1.67$; comparative fit index (CFI) = 0.947; standardised root mean square residual (SRMR) = 0.068; root mean square error of approximation (RMSEA) = 0.051 and PClose = 0.362. However, there is no simple way to decide how well these indices describe goodness-of-fit (Singh et al., 2011). Based on the conventional cutoffs for model fit suggested by Hu and Bentler (1999), our model fit is considered acceptable for CFI and excellent for other indices. Other scholars, for example, Guide and Ketokivi (2015), encourage authors to use inferential procedures (such as chi-square test) as opposed to non-inferential thumb rules to support their claims on good model fit. However, it is well established that the chi-square test is sensitive to sample size and model complexity; therefore, studies with large sample size (>200) rarely report non-significant chi-square (Tabachnick et al., 2007). In such cases, authors disregard the significant chi-square statistic, see for example Singh et al. (2011). Based on this discussion, for our study with a relatively large sample size, we believe we have obtained an adequate level of fit to perform subsequent analysis using the current model.

Table 5: Construct items (factor loadings and reliability)

Construct	Measurement Items	Loading	Cronbach's Alpha
CSCM Practices: Please evaluate the extent of circular product design, circular procurement, cleaner production and end-of-life product & waste management practices in your organization (1= not at all; 5= to full extent)			
Circular Product Design	Design of products for re-contextualising, re-purposing, repair, refurbishing, remanufacturing	0.81	0.86
	Design of products for recycling	0.90	
	Design of products for ease of disassembly	0.74	
	Design of products to use recycled materials	0.68	
Circular procurement	Require your main suppliers to use materials that are used (non-virgin), repaired, refurbished, remanufactured or recycled	0.58	0.75
	Require your main suppliers to use environmentally friendly packaging (e.g. non-hazardous and recycled etc.)	0.67	
	Consider the impact of transportation emissions when selecting suppliers	0.71	
	Require suppliers to have an environmental management system (e.g. ISO 14001)	0.68	
Cleaner Production	Improve employee environmental consciousness through training and evaluation	0.73	0.91
	Improve processes to reduce/eliminate waste	0.82	
	Improve processes to increase energy efficiency through the use of clean technologies	0.88	
	Increase investment in equipment for environmental protection	0.78	
	Environmental issues are considered in the processes of production planning and technology innovation	0.81	
End-of-Life Product and Waste Management*	Collect expired/unsold products from distribution network	0.68	0.88
	Collect used/end of life products from customers	0.69	
	Return products to suppliers	0.70	
	Require your main suppliers to collect their packaging materials from your firm (i.e. packaging materials of supplied materials or components)	0.86	
	Collect packaging from customers	0.82	
Firm Performance: Please indicate your firm's environmental, energy and resource circulation, cost and financial performance in comparison with your main competitor (1= substantially lower; 7=substantially higher)			
Environmental Performance	Emission of greenhouse gases (e.g. CO2, SOx, NOx...)	0.82	0.93
	Waste water (e.g. sewage)	0.89	
	Other wastes (e.g. oily waste, sludge and rubbish)	0.91	
	Total amount of hazardous and toxic waste	0.84	
	Consumption of hazardous/harmful/toxic materials	0.76	
Resource Circularity Performance	Usage of renewable energy sources	0.82	0.65**
	Percent of materials reused, refurbished, remanufactured, recycled	0.79	
Cost Performance	Cost of purchased materials	0.82	0.86
	Operational cost	0.89	
	Energy consumption cost	0.78	
	Waste treatment fee	0.62	
	Waste discharge/disposal fee	0.60	
Financial Performance	Growth in sales revenue	0.77	0.95
	Return on sales	0.92	
	Growth in profit	0.96	
	Net Profit Margin	0.96	
	Return on investment (ROI)	0.89	
	Growth in market share	0.66	

* For possible reuse, refurbishing, remanufacturing or recycling; ** since the scale comprises two items, Pearson r correlation, instead of Cronbach's alpha, was used to assess the reliability. The correlation is significant at $p < 0.01$

5. Results

5.1 SEM results

The results of the structural analysis yielded acceptable fit statistics: $\chi2$ = 186.53 (df = 122, $\chi2$ /df = 1.53, p < 0.001), CFI = 0.94, TLI = 0.92, and RMSEA = 0.052 (0.036, 0.066). Table 6 provides a summary of SEM analysis. Hypotheses H1, H3 and H4 were supported (p < 0.05) with CSCM positively related to environmental, cost and financial performance. However, we did not find support for H2, suggesting that CSCM practice is not significantly related to resource circularity performance (p < 0.10).

Table 6: Structural Equation Modeling Results

	Dependent Variables			
	Environmental Performance	**Resource Circularity Performance**	**Cost Performance**	**Financial Performance**
<u>Control Variables</u>				
Ownership Type Dummy[a]				
1. State owned	-0.58	0.43	-0.73	-0.22
2. Collective	-0.29	0.09	-0.27	-0.05
3. Private	-0.67	0.51	-0.71	-0.17
4. Foreign owned	-0.24	0.39	-0.50	-0.13
5. Joint venture	-0.45	0.32	-0.54	-0.14
Firm Size Dummy[b]				
1. Less than 100	0.01	0.01	0.09	0.09
2. 101–500	-0.06	0.01	0.08	0.09
3. 501-1000	-0.06	0.03	0.11	0.00
4. 1001-3000	0.13	0.88	-0.05	0.42
5. 3001-8000	-0.09	-0.03	0.03	0.09
Industry Dummy[c]				
1. Food/beverage/wine/tobacco	0.06	-0.05	-0.04	0.05
2. Metallurgy	0.09	0.12	0.02	-0.01
3. Basic metals/metal product/machinery/equipment	0.17	-0.09	-0.11	0.07
4. Textile/apparel/leather	0.04	0.03	0.00	0.05
5. Electronics/communication	0.05	0.08	0.00	0.17*
6. Building material/building and decorative	0.03	-0.05	-0.05	0.02
7. Transport equipment/vehicle	-0.04	-0.11	-0.10	-0.03
8. Electrical appliances/household appliances	0.12	0.19*	-0.12	-0.03
9. Rubber/plastics	-0.04	-0.17*	-0.12	-0.08
10. Coke/petroleum	0.02	0.00	-0.01	0.18*
11. Chemical	0.23*	-0.01	0.02	0.16*
12. Pharmaceutical/treatment	0.12	-0.06	0.18*	0.15*
<u>Main Variable</u>				
CSCM practices (H1-H4)	0.226*	0.142	0.221*	0.366**
R^2	0.153	0.164	0.182	0.224

* p < 0.05; ** p < 0.01; [a] the baseline for ownership dummy variable is the "others" category; [b] the baseline for firm size dummy is the category with more than 8000 employees; [c] the baseline for industry dummy is the "others" category.

5.2 MGA results

As presented in Table 3, the chi-square different test suggested no categorical moderation role of being located in an EIP. We performed a path analysis for more in-depth analysis; however, none of the paths were found to be significantly different (see Table 8). Hence, H6 on the moderating role of firm location in CSCM practice-performance relationship was not supported.

Table 7: Kruskal-Wallis H test results

Hypothesis	Construct	Categories: EIP Location (Yes) n=103 Mean (SD)	Categories: EIP Location (No) n=152 Mean (SD)	χ^2 (df)	Sig
H5	CSCM	3.42 (0.65)	3.13 (0.76)	8.624 (1)	0.003

Note: CSCM practices were measured on a five-point Likert scale (1=not at all; 5=to full extent)

5.3 Kruskal-Wallis H Test results

The results indicate that there are significant differences (sig < 0.05) in the adoption of CSCM depending on the firms' location inside or outside EIPs. Moreover, as shown in Table 7, firms located inside EIP show higher levels of CSCM adoption as compared to firms located outside EIPs. Hence, we found significant support for H5.

Table 8: MGA results

Hypothesis	Path direction	Coefficients (β)): EIP Location (Yes)	Coefficients (β)): EIP Location (No)	*t*-value*
H6	a) CSCM → Environmental Performance	0.227	0.120	-0.97
	b) CSCM → Resource Circularity Performance	0.123	0.141	-0.08
	c) CSCM → Cost Performance	0.230	0.145	-1.06
	d) CSCM → Financial Performance	0.183	0.346	0.99

*All *t*-values were insignificant at $p < 0.05$ thus indicating that none of the paths were statistically different from each other

5.4 Post-hoc robustness tests

To shed more light on our proposed model, we conducted multiple post-hoc analyses. To assess the robustness of our findings concerning hypotheses H1-H4, we reran the SEM with each CSCM practice category as a standalone latent variable (see Table 9). Circular product design, circular procurement and cleaner production practices were found to have a significant effect on environmental, cost and financial performance dimensions respectively. However, their effect on resource circularity performance was found to be insignificant. On the contrary, EoL product and waste management showed statistically insignificant relationships with environmental and financial performance respectively, whereas we found a positive and significant relationship with resource circularity performance. Overall, these results suggest that our original model with CSCM as a second-order construct is more suitable and robust (Diamantopoulos & Winklhofer, 2001; Mishra et al., 2013).

A further probe into CSCM practice categories using Kruskal-Wallis H test suggested higher adoption levels of circular procurement, cleaner production and EoL product and waste management practices by firms inside EIPs; however, circular product design was found to be adopted at the same levels irrespective of firm location (see Table 10). These results support the robustness of H5 as three out of four practices are observed to be adopted at higher levels by firms inside EIPs.

Table 9: Structural Equation Modeling Results (individual practices)

Structural paths	Coefficients (β)
Circular Product Design	
Environmental Performance	0.256**
Resource Circularity Performance	0.084
Cost Performance	0.156*
Financial Performance	0.308**
Circular Procurement	
Environmental Performance	0.135**
Resource Circularity Performance	0.084
Cost Performance	0.164*
Financial Performance	0.183
Cleaner Production	
Environmental Performance	0.296**
Resource Circularity Performance	0.084
Cost Performance	0.189**
Financial Performance	0.228**
End-of-Life Product & Waste Management	
Environmental Performance	0.035
Resource Circularity Performance	0.174*
Cost Performance	0.079
Financial Performance	0.102

* $p < 0.05$; ** $p < 0.01$

Table 10: Kruskal-Wallis H test (individual practices)

	Categories		
Variable	EIP Location (Yes) n=103 Mean (SD)	EIP Location (No) n=152 Mean (SD)	Sig
Circular Product Design	3.49 (0.98)	3.25 (1.03)	0.055
Circular Procurement	3.32 (0.87)	2.96 (0.99)	0.003
Cleaner Production	4.18 (0.80)	3.94 (0.84)	0.018
EoL Product and Waste Management	2.66 (1.05)	2.36 (1.14)	0.014

6. Discussion

The results presented in Table 6 show that CSCM practices have a positive and significant effect on environmental performance as hypothesized in H1 ($\beta=0.226$, $p<0.05$). This affirms the importance of CE/CSCM to offer environmental benefits in terms of reduced emissions and lower wastages. This outcome is consistent with several studies (Agrawal et al., 2019; Genovese et al., 2017; Mathews et al., 2018; Zhu, Geng, et al., 2011).

Surprisingly, H2 on the relationship between CSCM and resource circularity performance is not supported ($\beta=0.142$, $0.05<p<0.1$). The lack of support for H2 perhaps suggests that the Chinese manufacturing firms are more focused on pollution prevention while product stewardship strategies receive less attention. This is also evidenced by a relatively low mean score of EoL and waste management activities adoption (see Table 10). Overall, it suggests great challenges in advancing circularity, despite efforts, and the need for more research.

For H3 ($\beta=0.226$, $p<0.05$) and H4 ($\beta=0.366$, $p<0.01$), our results show significant statistical support. This outcome suggests CSCM is positively associated with cost and financial performance dimensions. These results represent one of the key contributions of this study as they provide empirical evidence to dispel the contradictory findings with regard to economic viability of CE practices. Our results are in agreement (Agrawal et al., 2019; Mathews et al., 2018; Van Wassenhove, 2019; Zhu et al., 2010; Zhu, Geng, et al., 2011) with several studies that found that firms adopting CE/CSCM can significantly benefit by achieving lower cost and increased profitability.

Overall, the study results, further supported by post-hoc analysis, are in agreement with the proponents of CE, including the Ellen MacArthur Foundation, that CSCM (built on CE building blocks), when exercised as a uniform strategy, leads to significant economic and environmental benefits for firms. Although the results show that Chinese manufacturers have adopted CSCM to some extent (mean value of above 3 indicates reasonable adoption), it is still not at a high level. This is understandable given that CE implementation has predominantly been considered at macro (i.e., cities, provinces, and regions) and meso levels (i.e., eco-industrial parks) (Ghisellini et al., 2016), whereas, the implementation of CE at a micro level (i.e., firm or supply chain) remains unclear (Farooque, Zhang, Thürer, et al., 2019). As a pioneering work, this research provides a comprehensive and holistic view of CE implementation at a firm and supply chain level; the CSCM construct and practices within could be considered as a starting point towards further development of circular supply chains leading to better firm performance.

For H5 (sig < 0.05), our results show significant support (see Table 7). This outcome provides empirical evidence that firms inside EIPs have adopted CSCM at higher levels when compared to those outside EIPs. This result confirms Mathews et al.'s (2018) viewpoint on the role of EIPs in fostering CE implementation. As such, EIPs' development provides a significant opportunity for countries aiming to reduce the environmental burden of their development activities. The Chinese model for EIP development provides a good example for the rest of the world.

However, our study results do not show any categorical moderation effect of a firm's location in an EIP on the CSCM practice-performance relationship (see Table 8). Thus, H6(a,b,c,d) are not supported (see Table 8). This outcome suggests that firms adopting CSCM achieve performance outcomes irrespective of whether they are located inside an EIP or not. It suggests that performance is mainly driven by practices. Another possible explanation for the lack of evidence to support a moderation effect could be due to the underlying differences between the firm's operations in an industrial symbiosis network and a typical supply chain network as explained earlier. Firstly, industrial symbiosis network partners are not necessarily firms' core supply chain partners; therefore, the material exchange between industrial symbiosis partners may not be as effective as other important factors related to material exchanges, such as its availability when demanded, volume and quality etc. Secondly, firms operating inside EIPs need to integrate the park administrative authorities' requirements into their supply chain activities (Zhu et al., 2015). However, firms operating outside the EIPs only focus on strengthening relationships with their supply chain partners, focusing on material recovery and circularity; moreover, they are not bound to follow additional requirements of park authorities and, hence, enjoy more freedom to adopt CSCM based on their strategic needs.

In summary, transitioning to a CE has become a global interest. China, Japan and South Korea have national strategies for enabling the circular economy. Europe has also made serious efforts to transform into a CE. Similarly, there is huge potential for economic and environmental benefits for other countries experiencing rapid economic development such as Brazil and India. It is important to note that CE is a multifaceted domain and its implementation requires coordinated efforts from various stakeholders, including governments at all different levels, industries, local businesses, non-governmental organizations, and customers, to cooperate to steward our valuable resources for the best outcomes (Esposito et al., 2015). A lot of work needs to be done in terms of getting firms to collaborate along circular supply chains (Mathews & Tan, 2016). The study results are likely to encourage manufacturing industries all around the globe to adopt CSCM in a bid to achieve higher levels of sustainability performance. As a pioneering work in the CSCM practice-performance relationship, this study makes novel contributions by presenting how firms and supply chains can make a transition to CE and achieve sustained competitive advantage. Overall, the research findings constitute significant contributions to the supply chain sustainability literature and to the development of CSCM.

6.1 Implications for theory

This study makes a significant contribution by developing new constructs and measurement items for the CSCM, which integrates four operational practices such as circular product design, circular procurement, cleaner production and EoL and waste management through extensive review of the literature and validating the newly-developed measures from academic and industry experts. Furthermore, this research clarifies the contradictions related to the long-term economic viability of circular supply chains by providing more representative measures to cover the broad aspect of economic performance relevant to CSCM. Similarly, the environmental performance viewpoint has been broadened with the addition of a relevant construct, i.e., resource circularity.

A number of studies in the past used the NRBV framework to link SCM sustainability practices with firm performance (Golicic & Smith, 2013; Graham et al., 2018; Vachon & Klassen, 2008). Similarly, we link CSCM with the NRBV framework to develop a conceptual model including two of the strategic capabilities outlined within the NRBV framework, namely, pollution prevention and product stewardship (Hart, 1995). In doing so, our study contributes to further development of the NRBV framework in three ways. Firstly, it is among the first to link the new and compelling supply chain sustainability perspective, CSCM, with the NRBV framework.

Secondly, our study confirms the robustness of the NRBV framework and its applicability in CSCM research for future researchers. Lastly, our study contributes to the further development of NRBV by providing empirical support for two of its hypotheses relating to pollution prevention and product stewardship strategies, and competitive advantage relationships.

Moreover, the research findings contribute to the contingent NRBV (Aragón-Correa & Sharma, 2003) literature by suggesting that the contextual role of being located inside an EIP positively influences the firm's ability to develop and adopt higher levels of CSCM capabilities. Hence, our study results are consistent with previous studies supporting the contingency view of supply chain sustainability and performance linkage (Maletič et al., 2018; Schmidt et al., 2017; Sirmon & Hitt, 2009).

6.2 Implications for practice

Our study offers several practical implications. Firstly, this research provides a reference point for managers to develop CSCM given a lack of clarity on how to implement CE at a firm and supply chain level. In essence, managers must realize that CSCM practices are built on the CE principles aiming to substitute the use of virgin resources with resources gathered by means of recirculation and restoration of existing material base. In CSCM, the products are intentionally designed for circularity throughout their life cycle. This means the materials used in products are not meant to be disposed of at the end of their life cycle, thus creating no wastage. Similarly, the resources required to make circular products are mainly sourced from EoL materials that would otherwise be discarded. In this way the two functional ends of circular supply chains (i.e. circular product design and EoL product and waste management activities) become the most critical functions of SCM to establish circularity along with the support of circular procurement and cleaner production practices. According to a recent article by Geng et al. (2019), circular products made from reworked plastics are around 80% cheaper, provided costs of EoL product and waste management activities such as collecting, sorting and processing are kept low.

Secondly, the CSCM practice-performance relationship is clearly spelled out. We hold a similar thought to that expressed by Van Wassenhove (2019), that commercial companies cannot afford to engage in sustainable operations from an environmental or social perspective, if this leads to poor economic performance. For example, Li et al. (2019) found that green SCM practices measured as ecology practices and internal improvement practices have significant positive impacts on firm performance, while external improvement practices negatively affect the firms' positive economic performance. Despite the unexpected negative performance outcome, Li et al. (2019) encourage firms to adopt innovative measures such as enhancing resource recycling and developing eco-design capabilities to experience enhanced economic performance without any empirical evidence to support it. In the early section, we have already pointed out the issue concerning the lack of consensus and inconsistent findings on the economic benefits associated with supply chain sustainability practices. The balanced view of CSCM to firm performance presented in this research would help to dispel the contradictions with regard to economic viability of circular supply chains. With this clarity, managers can confidently develop strategies and find ways to adopt CSCM including business model innovations.

Thirdly, it is quite evident that the implementation of a CE offers numerous opportunities for organizational gains in supply chains; however, most firms and supply chains cannot fully utilize CE benefits in terms of resource recirculation, restoration and recovery within their original supply chain structures. Therefore, firms need to develop systemic sustainability collaborations for circularity, focusing both on the business processes and the outcomes (Nidumolu et al., 2014). For example, systemic collaboration with carefully selected stakeholders (e.g., municipal waste management authorities or retailers) with an explicit focus on improving processes (i.e., EoL product and waste management) or an outcome (i.e., resource consumption) could be worked out to tackle complex challenges. In this regard, stakeholder integration for product stewardship activities is highly regarded in the extant literature (Fowler & Hope, 2007; Hart, 1995; Hart & Dowell, 2011). Firms operating inside EIPs have a unique advantage as the industrial symbiosis environment provides a natural form of collaboration required for circularity. However, our recommendation to develop systemic collaboration is generally relevant at a firm and supply chain level, irrespective of the firm's location.

7. Conclusions

Businesses across the globe are taking an increasing interest in transforming to a CE given its huge potential to boost environmental and social benefits. CSCM, which integrates CE in SCM, is being considered as a new and innovative perspective in the extant supply chain sustainability domain. This study analyzed the CSCM practice-performance relationship and the role of EIPs in the Chinese manufacturing industry. The study results provide empirical evidence of a significant direct relationship between CSCM practices and various dimensions of firm performance. EIPs are seen to play a pivotal role in the development of a CE, and firms inside EIPs display higher levels of CSCM practices adoption. Finally, our study results indicate no moderation effect of being located inside an EIP on the CSCM practice-performance relationship.

This research offers several original contributions. Firstly, this study is a pioneering work that provides a comprehensive integrated view of CSCM at a firm and supply chain level including new construct development and its validation. This comprehensive view of CSCM provides guidelines on how individual firms can make a transition to CE and gain performance benefits. Secondly, our study results contribute to dispelling the contradictions due to inconsistent findings with regard to the economic viability of CE. Our results show that CSCM adoption is positively associated with environmental, cost and financial performance dimensions. However, to our surprise, we did not find significant support for resource circularity performance. This suggests that CSCM, especially the two functional ends of circular supply chains, i.e., circular product design, and EoL product and waste management activities, is still far from being adopted at the optimal levels. Thirdly, our study contributes to the understanding of an EIP's role from a firm and supply chain perspective. Our results show that firms operating inside EIPs adopt CSCM at a higher level due to engagement in industrial symbiosis network relationships. However, the CSCM practice-performance relationship is not affected by the EIP location factor. These results reveal that, although EIP infrastructure helps firms in CSCM adoption, there is an equal opportunity for all firms (located inside or outside EIPs) to gain performance benefits associated with CSCM. This lies in developing systemic collaborations for circularity and sustainability with all key supply chain stakeholders.

Despite the considerable contributions stated above, this study has some limitations that might be opportunities for future research. Firstly, CSCM is inherently a multidimensional construct and we selected four operational practices or building blocks representing the restorative cycle (for technical materials or nutrients) to underpin the CSCM construct. Future research may consider developing appropriate measures to incorporate the aspects of regenerative cycle (for biological materials or nutrients) in the CSCM conceptualization. Furthermore, this study broadly focused on the environmental and economic performance outcomes of CSCM, and future research can investigate social outcomes. Secondly, our sample comprises Chinese manufacturing firms across various industries. We chose the Chinese context given the country's remarkable efforts and achievements in CE implementation. Similarly, other countries and regions such as Europe have taken promising initiatives in CE implementation. We suggest future research to study the CSCM implementation in the European context to strengthen the validity and generalisability of CSCM practice-performance relationship presented in this research. Thirdly, although we controlled for industry, we notice that the CSCM practice-performance relationship is stronger in certain industries, possibly because some industries lend themselves to circular initiatives more than others. Therefore, we suggest that future research focus on a specific industry or group of related industries to take a closer look at industrial influences and contingencies affecting this relationship. Finally, due to difficulty in data collection, the majority of our sample contains data collected from single sources. Although, we did not find any evidence of common method bias affecting our study results, future research may consider the possibility of using secondary data and/or objective data to gain new insights and interpretations.

Chapter 4 / Manuscript 3- Barriers to circular food supply chains in China

Prelude

Chapter 2 highlighted the importance of exploring contextual barriers hindering the development of CE in SCM (i.e., CSCM). Furthermore, the findings from chapter 3 suggest that higher levels of CSCM adoption is positively associated with environmental, cost, and financial performance. However, firms are still struggling to finds ways to improve resource circularity. Given the need to identify contextual barriers to CSCM, this manuscript focuses on the empirical investigation of barriers to circular food supply chains in China.

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1. Introduction

Food loss and waste throughout the supply chain is considered to be a significant contributor to overall waste production (Borrello et al., 2016). It is estimated that about one-third of the world's edible food (approximately 1.3 billion tons) is lost or wasted throughout global food supply chains (FAO 2011). Increasing food waste is thus becoming an issue for global food security and environmental governance, having significant environmental, economic, and social impacts (Liu et al., 2013; Stenmarck et al., 2016b). According to *Nature*'s recent special issue on the circular economy (CE), China's consumption of the world's resources and the amount of waste generated pose a severe threat to the world's sustainability (Mathews & Tan, 2016). In 2014, China produced 3.2 billion tonnes of solid industrial waste, of which 1.2 billion tonnes (about 37.5%) could not be recovered by any means (reuse, recycling/composting or incineration) and was, therefore, sent to landfills (Mathews & Tan, 2016). In China, about one-sixth (35 million tonnes) of the total grain produced is wasted annually in the production, processing and transportation because of inadequate infrastructure, knowledge and technology, poor equipment and logistical issues that are exacerbated by a decentralized agricultural production system (Cui & Shoemaker, 2018; Liu et al., 2013).

Faced with these severe waste management and environmental challenges (Geng et al., 2013), the Chinese government has adopted various policies, legislation, and financial measures to strengthen its CE programme (Mathews & Tan, 2016). CE is an industrial system based on restorative and regenerative design thinking, far more sustainable than the dominant linear economic model (make, use, dispose) (Stahel, 2016). In CE, outputs from one organization are turned into inputs for another through biological (natural decomposition) and technical (remanufacturing, refurbishing, and recycling) cycles, aiming to thereby generate no waste at all (EMF 2014; EMF 2019). Because of its promising vision, CE has been embraced not only by the Chinese government but also many other governments, including those of the European Union, Japan, Australia, and New Zealand, for their economies.

From a supply chain perspective, CE has quickly become an influential driving force behind supply chain sustainability, both in research and in practice (Genovese et al., 2017; Hobson, 2016; Nasir et al., 2017), offering a new and innovative sustainability frontier in supply chain management (SCM). The integration of CE in the supply chain has been termed a circular supply chain in the extant literature (Batista, Bourlakis, et al., 2018; Farooque & Zhang, 2017; Genovese et al., 2017). The 14th annual global Supply Chain Top 25 report for 2018, published by Gartner, states that moving to circular supply chains is one of the most prevalent trends among global supply chain leaders, including Apple, Coca-Cola, HP Inc., Schneider Electric, Cisco Systems, Colgate-Palmolive, and BASF. This widely-recognized Gartner report affirms that “the future of supply chain is circular, not linear” (Aronow et al., 2018).

Since making CE part of its national development policy in 2008, China has been investing billions of dollars in CE-oriented pilot projects. They range from cleaner production applications in specific sectors to the development of national and regional eco-industrial parks (EIPs) (Geng et al., 2013). However, linking firms by circular supply chains to cooperate in turning outputs into inputs (i.e. waste into resources) has been the main obstacle to successful implementation of CE (Mathews & Tan, 2016). The transition towards CE requires considerable transformations in supply chain practices related to design, production, consumption, waste management, reuse, and recycling (Hobson, 2016). There are also implications for logistics flows at all supply chain stages (Bicket et al., 2014). Thus, at a micro level (that of organizations' operations and supply chain), the integration of CE into SCM is the biggest hurdle in transforming China into a CE.

Previous studies on the CE concept and implementation in China (Geng & Doberstein, 2008; Geng et al., 2012; Geng et al., 2009; Su et al., 2013) have broadly discussed some challenges/barriers at a macro level (that of regional economies). However, most of these conceptual studies offer a general perspective which might not be fully applicable in the supply chain (micro level) context. Among the few studies on CE with a supply chain perspective, Govindan and Hasanagic (2018) and Tura et al. (2019) developed a multi-perspective CE framework including drivers, barriers and practices using the systematic literature review and case study methods respectively, but they did not perform systematic prioritization or analyze interrelationships among the identified factors. Mangla et al. (2018) identified and analyzed barriers to the circular supply chain in the Indian automotive industry. However, the Indian context is least acknowledged for CE implementation; it is without support or direction from policies, and very few industries there are seeking true circularity at a micro level (Shenoy, 2016). The context of this research, the Chinese food sector, is distinct from these few studies in terms of the involved country and industry. China has a history of promoting green and sustainable supply chain practices for over two decades with the later inclusion of CE as part of national development policy since 2008 (Geng et al., 2012; Su et al., 2013). Moreover, for CE implementation different industries may need different supply chain actors to collaborate along with a diverse range of techniques in waste management and resource recovery procedures. Therefore, identification of industry-specific barriers and their interrelationships is necessary in order to overcome the challenges to implementation.

Globally, food supply chains are responsible for a large amount of solid waste (Hoornweg et al., 2013), greenhouse gas (GHG) emissions (Brundtland, 1987; Genovese et al., 2017), soil degradation, and water and energy consumption (Morone et al., 2019). Global food loss and waste generate around 8% of total anthropogenic GHG emissions, almost equivalent (87%) to global road transport emissions, and ranking as the third top emitter after China and the USA (FAO 2015). However, research concerning food supply chains' sustainability practices has been scarce. Specifically, the conceptualization of circular food supply chains, i.e. food supply chains that integrate CE philosophy, is missing in the extant literature. It is also unclear what organizational theories can be applied to studying relevant barriers. Therefore, this paper aims to narrow the research gap by achieving the following objectives:

- To illustrate the concept of circular food supply chain
- To develop a theoretical framework grounded in multiple organizational theories for identifying barriers to integrating CE into food SCM
- To systematically analyze the causal-effect relationships among the barriers in order to find the key barriers in China

This research makes several original contributions. Firstly, it contributes to the literature by advancing the theoretical understanding of circular supply chains – a new sustainability frontier beyond traditional supply chain sustainability paradigms. Secondly, the research develops a theoretical framework drawing on multiple organizational theories to identify barriers to integrating CE in SCM. Thirdly, to the best of our knowledge, this is the first research attempt to systematically investigate and prioritize barriers in the Chinese food supply chain context. A Fuzzy Decision-Making Trial and Evaluation Laboratory (DEMATEL) method – a widely recognized scientific prioritization technique for barrier studies (Kaur et al., 2017; Venkatesh et al., 2017; Zhu et al., 2014) – is used to analyze the causal-effect relationships among the barriers. Fourthly, this research provides a multi-stakeholder analysis of barriers to circular food supply chains, going beyond the dominant focal firm viewpoint to a dyadic supply chain perspective, which includes downstream supply chain members, such as retailers and customers, who are least focused upon (Petljak et al., 2018; Stone & Rahimifard, 2018; Touboulic et al., 2018). Finally, this study offers practical insights into overcoming barriers to circular food supply chains in China and in the contexts of other countries and industries which face similar challenges. It also sheds light on which organizational theories are most suitable for guiding similar studies.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 conceptualizes circular food supply chains, presents the theoretical framework, and identifies barriers. Section 4 explains the fuzzy DEMATEL method and the data collection process. Section 5 presents the results, analysis, and findings. Section 6 discusses research implications, insights, and future research directions. Section 7 concludes the research.

2. **Literature Review**

2.1 CE in China

Chinese interest in CE was inspired by the recycling laws enacted in Germany and Japan in the late 1990s. In 2004, the Chinese National Development and Reform Commission (NDRC) was assigned the responsibility of promoting CE throughout the country. Soon after, China's 11th five-year plan (2006-2010) devoted a whole chapter to CE, focusing on resource recovery and recycling. In 2007, the NDRC released the first-ever national CE indicators[4] (Geng et al., 2012). In 2008, the National People's Congress passed the "Circular Economy Promotion Law of the People's Republic of China," making China the first country in the world to legislate CE as part of its national sustainable development policy (Geng et al., 2012; Su et al., 2013).

CE has been implemented in China at three levels: macro (cities, provinces, and regions), meso (eco-industrial parks), and micro (company or consumer level) (Ghisellini et al., 2016; Zhijun & Nailing, 2007). Implementation at the macro level involves integration and redesign of the

[4] The CE indicators were later updated in 2017.
NRDC (National Development and Reform Commission). (2017). *Notice of the Evaluation Index System for the Development of Circular Economy*. Retrieved 16 July 2018. (In Chinese) from http://www.ndrc.gov.cn/zcfb/zcfbtz/201701/t20170112_834922.html]

industrial system, infrastructure, cultural framework, and social system, along with support for CE initiatives at city, provincial, and regional levels (Ghisellini et al., 2016; Ness, 2008; Zhijun & Nailing, 2007). For example, macro-level eco-city pilot projects have been implemented in Beijing, Shanghai, Tianjin, and Dalian, aiming to achieve CE goals in relation to resource efficiency, waste prevention, and emissions reduction (Geng et al., 2009; Su et al., 2013).

The meso-level implementation is the development of EIPs, industrial symbiosis districts, and networks (Su et al., 2013; Yuan et al., 2006). In EIPs, industries engage in what is called industrial symbiosis: a complex interaction of resource exchange (material, water, energy and by-products) and cooperation for waste and pollution reduction to help achieve sustainable development goals (Ghisellini et al., 2016; Yu et al., 2015). The EIP concept was first introduced in China in the late 1990s (Fang et al., 2007). Since then, China under its National Demonstration Eco-industrial Parks (NDEIPs) programme and National Pilot Circular Economy Zones (NPCEZs) has developed the world's largest national EIP network consisting of 85 nationally-approved EIPs (as of May 2014), with an additional 26 planned for future construction (Zeng et al., 2017).

The micro-level implementation entails firms incorporating circularity into their production systems and cooperating with supply chain partners to move materials in a circular pattern throughout the supply chains (Winkler, 2011b). At this level, eco-design and cleaner production are considered as preparatory CE practices (Ghisellini et al., 2016). Being the most-adopted CE practice globally, cleaner production has been promoted in China under the "Cleaner Production Promotion Law" since 2002 (Su et al., 2013).

Despite all the developments and efforts, China's progress towards CE has been modest (Mathews & Tan, 2016). The knowledge of CE best practices is still inadequate. There are challenging barriers to making the economy circular (Geng et al., 2009).

2.2 Supply chain sustainability and circular supply chain

There has been great enthusiasm for and growing interest in SCM for CE (Aminoff & Kettunen, 2016; Batista, Bourlakis, et al., 2018; Batista, Gong, et al., 2018; Bressanelli, Perona, et al., 2018; De Angelis et al., 2018; Govindan & Hasanagic, 2018; Kazancoglu et al., 2018; Liu et al., 2018; Ying & Li-jun, 2012). For example, as the global volume of e-waste increases with economic growth, Awasthi et al. (2018) called for a CE approach in which e-waste is considered as an opportunity for recycling or recovering valuable metals. In the SCM literature on sustainability, a number of concepts (such as those of sustainable supply chains, green supply chains, environmental supply chains, and closed-loop supply chains) have been introduced, and sometimes used interchangeably (Gurtu et al., 2015) to express the integration of sustainability concepts in SCM (Ahi & Searcy, 2015). Green, environmental, and sustainable SCM practices have been largely focused on environmental/ecological impacts, corporate governance, and social issues respectively (Batista, Bourlakis, et al., 2018). Similarly, the term "closed-loop supply chains" simultaneously comprehends forward and reverse supply chain operations (Govindan & Soleimani, 2017). Table 1 presents some of the most-cited definitions of supply chain sustainability terms in the extant literature.

Table 1: Definitions of supply chain sustainability terms

Supply chain sustainability terms	Authors	Definition
Sustainable SCM	Seuring and Müller (2008)	"The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements"
Green SCM	Srivastava (2007)	"Integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life"
Environmental SCM	Zsidisin and Siferd (2001)	"The set of supply chain management policies held, actions taken, and relationships formed in response to concerns related to natural environment with regards to the design, acquisition, production, distribution, use, reuse, and disposal of the firm's goods and services".
Closed Loop Supply chains	Guide and Van Wassenhove (2006)	"Design, control, and operation of a system to maximize value creation over the entire life cycle of a product with the dynamic recovery of value from different types and volumes of returns over time"

From Table 1, it is evident that these existing supply chain sustainability terms represent different degrees of sustainable thinking. However, none of them integrates circular thinking (i.e. the essence of the CE philosophy) into SCM (Bernon et al., 2018; Kazancoglu et al., 2018; Lapko et al., 2018; Larsen et al., 2018; Liu et al., 2018; Masi et al., 2017; Mishra et al., 2018; Rakesh Kumar & Ravi, 2015). CE significantly enriches the narrative of supply chain sustainability by integrating restorative and regenerative design thinking (Batista, Bourlakis, et al., 2018). Another important aspect differentiating CE from existing sustainability thinking is its "zero-waste" vision (Veleva et al., 2017). Circular supply chains consider waste as a resource; therefore, they are designed to regenerate natural capital to the biosphere so that biological materials can be utilized again and again indefinitely, via subsequent ecological cycles of plants and animals.

2.3 Food supply chain sustainability in China and CE-related barrier studies

As mentioned earlier, the Food and Agriculture Organization (FAO) of the United Nations estimates that about one-third of edible food (approximately 1.3 billion tons) is lost or wasted throughout global food supply chains (i.e. from initial agricultural production to final household consumption) (Organisation, 2011). Moreover, the sustainability of food supply chains is threatened by other issues, including those of the growing population, increasing demand for food, inefficiencies in resource use and food distribution, and severe environmental impacts. Integrating CE into food SCM is a potentially viable solution to resolve waste management challenges in the Chinese food supply chains (Jurgilevich et al., 2016). At present, there is a high percentage of food remnants in municipal solid waste in China due to the lack of source separation, making it difficult to use incineration for waste-to-energy production (Tai et al., 2011). Although food supply chains are an essential part of a CE implementation driven by the Chinese government (Mylan et al., 2016), research in this domain has been scarce. The extant literature offers little understanding of the barriers to circular food supply chains in China.

Table 2: Previous studies on barriers to CE implementation

Authors	Research Context	Scope	Methodology
Geng and Doberstein (2008)	China; Industry not specified	CE at a macro level	Review paper
Shi et al. (2008)	China; Industry not specified (SME's sector)	Cleaner production at a micro level	Analytic hierarchy process (AHP)
Geng et al. (2009)	China; Industry not specified	CE at a macro level	Review paper (country report)
Geng et al. (2010)	China; Industry not specified	CE at a macro level	Case study
Su et al. (2013)	China; Industry not specified	CE at a macro level	Review paper
Govindan and Hasanagic (2018)	Research context not specified	CE at macro, meso, and micro levels	Review paper
Mangla et al. (2018)	India; Automotive Industry	CE at meso and micro levels	Interpretive Structural Modelling (ISM)
Tura et al. (2019)	Finland; Multiple Industries	CE at macro, meso, and micro levels	Case study

Some relevant studies have broadly discussed barriers to implementing CE in China at a macro level. Table 2 summarizes the contexts and scopes of these studies, along with a few barrier studies on different countries. Apparently, they do not cover specific barriers to circular food supply chains in China.

To summarize the literature review, the concept of circular supply chains articulates a new frontier in supply chain sustainability thinking. Its zero-waste vision is far more sustainable than those of traditional supply chain sustainability concepts. Furthermore, this zero-waste vision is not only desirable but also achievable by regeneratively and restoratively designing products and their supply chain processes. China has legislated CE as part of its national development strategy; however, barriers persist in its transition to making the economy circular. Food industry is of strategic importance to the world, but little research has investigated barriers to circular food supply chains. This research narrows an important gap in the literature by studying these barriers as they are in China and by systematically prioritizing the causal-effect relationships among them.

3. **Circular food supply chains and their barriers in China**

3.1 Conceptualizing the circular food supply chain

Figure 1 illustrates the concept of a circular food supply chain. Unlike a linear food supply chain, in which waste is sent to landfills at multiple stages, a circular food supply chain has a zero-waste vision. It requires a complete rethinking by integrating circularity into the design of food products, their packaging, and supply chain processes. On one hand, waste generation should be designed out of the supply chain system, or at least minimized at all supply chain stages. On the other hand, a collection system must be in place for unavoidable waste generated along the way, at various supply chain stages, including those of agricultural production, postharvest handling and storage, processing, distribution, and consumption (Liu, 2014) for resource recovery purposes. CE mimics the natural ecosystem by transforming the so-called waste into valuable feedstock through its regenerative cycle and thereby allows the transition to circular supply chains (EMF, 2012a; Morone et al., 2019).

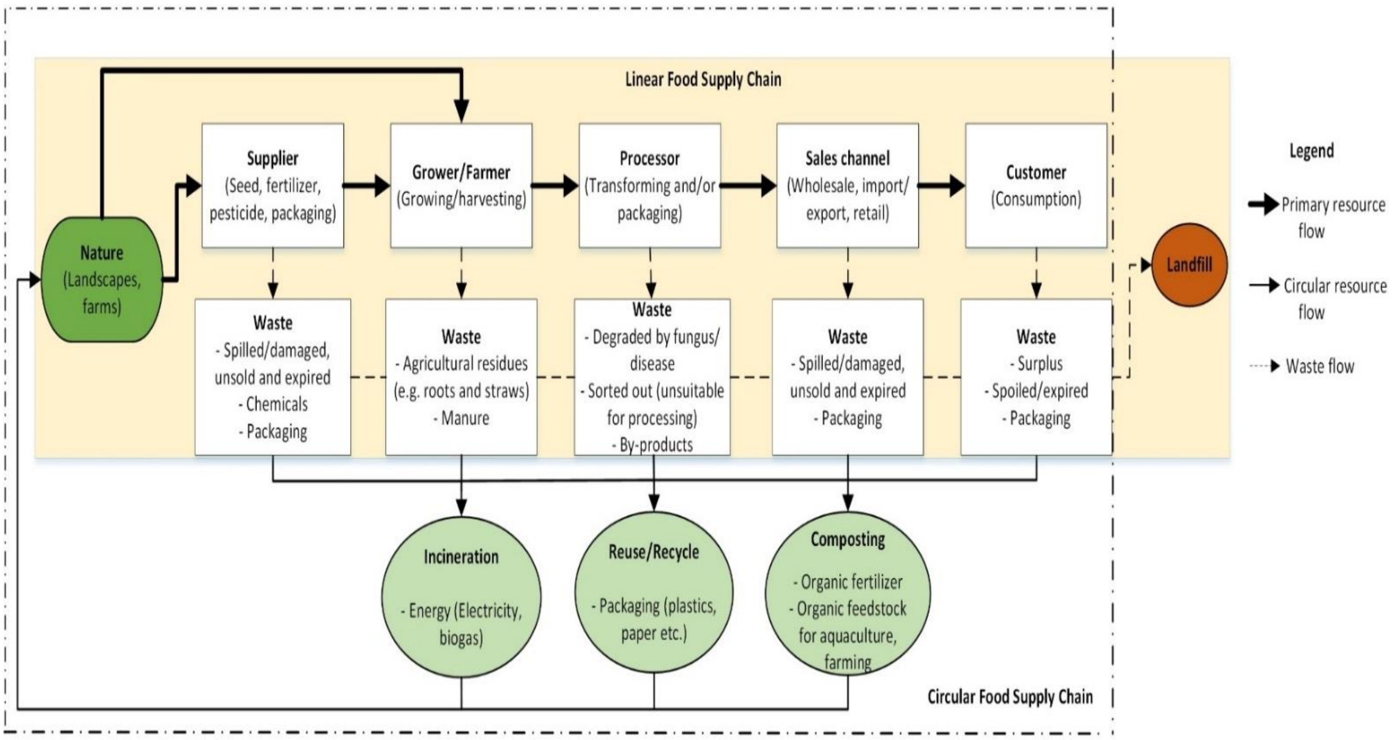


Figure 1: Circular Food Supply Chain

There are success stories of circular food supply chains which enable value-creation networks of facilities for cascading value from organic by-products (Borrello et al., 2016). For example, Enterra Feed Corporation (Canada) uses a black soldier fly (Hermetia illucens) to naturally bio-convert unsold food collected from local grocers and food processors into feedstock and fertilizer (Stenmarck et al., 2016a). Other applications include bio-refineries where agri-food residues are transformed into proteins, sugars, plastics, medicines, and fuel using enzymes and bacteria (Mirabella et al., 2014). Despite a promising future and a growing interest in circular food supply chains, such applications are still very rare. There are challenging barriers impeding the development and implementation of circular food supply chains.

3.2 Theoretical Framework for Identifying Barriers in China

This research develops a theoretical framework for identifying barriers to integrating CE in SCM. Following Carter and Dale's (2008) example, the framework is grounded in several of the most well-recognized organizational theories. The framework was conceptualized through an iterative process involving a concentrated review of the literature, synthesis, and then refinement. Overall, the process had two stages. In the first, an initial list of barriers was prepared based on an extensive literature review. A series of discussions on this initial list was held with two academicians specialized in supply chain sustainability and CE, and with three government officials representing a regional 'Development and Reform Commission' in China. Then, based on these discussions and in light of organizational theories, the most relevant barriers were shortlisted, categorized and described. In the second stage, three rounds of focus group meetings were organized with over 30 participants managing food supply chains. Overall, their input helped to refine the list of barriers and to ensure validity in the wider economic, social, and political context in China (Yin, 2013).

The resource-based view (RBV) of the firm explains how firms achieve sustained above-normal returns and competitive advantages by drawing on distinctive resources and capabilities (Barney, 1991; Rugman & Verbeke, 2002). The RBV defines resources as *"all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness"* (Barney, 1991, p. 101). These resources can include human, information technology, capital, equipment and knowledge resources (Sarkis et al., 2010). The adoption of environmentally-friendly practices depends on the interplay of organizational culture and managerial process involving various human resource factors as identified by Daily and Huang (2001). In this regard, the dynamic capabilities theory, rooted in the RBV (Barney, 1991; Rugman & Verbeke, 2002), offers a precise theoretical lens through which to understand this phenomenon. The term "dynamic capabilities" refers to a firm's ability to maintain a fit with its changing business environment (Teece et al., 1997). The dynamic fit is achieved by appropriately developing management capabilities, new resource configurations and organizational thoughts (Eisenhardt & Martin, 2000; Lawson & Samson, 2001; Rauer & Kaufmann, 2015).

From the dynamic capabilities and RBV perspectives, an organization's inability to acquire strategic resources and develop capabilities to innovate sustainability practices could be a barrier to integrating CE in SCM. Implementing CE can be costly and requires upfront investment (Geng et al., 2009). Therefore, lack of financial resources has always been a major hurdle in CE implementation, particularly for small and medium-sized enterprises (SMEs) (Shi et al., 2008; Walker et al., 2008). Moreover, integrating the restorative and regenerative philosophies of CE in the existing food supply chain systems means facing technical and technological challenges. Limited technical expertise (Shi et al., 2008) and lack of information on CE-compatible technologies (Geng & Doberstein, 2008) and on industry best practices/performance indicators impede the integration of CE in SCM. Furthermore, lack of management commitment and inadequate capacity, resistance to change (Shi et al., 2008), and inconducive organizational culture all limit organizational vision and managerial approach, in turn limiting the development of dynamic capabilities to adopt and implement CE. Therefore, drawing on theoretical arguments in RBV, we[5] put forward the following three barriers:

B1: Lack of financial resources

B2: Limited expertise, technology, and information

B3: Organizational culture and management

Contingency theory describes a firm's performance as an outcome of "fit or match" between its structure and processes on one hand and environmental conditions on the other (Lawrence & Lorsch, 1967; Miller, 1987). According to contingency theory, firms often shape their business environment by formulating appropriate strategies to deal with uncertainty (Thompson, 1967). CE implementation, then, is contingent on the environmental and economic benefits associated with it (Geng et al., 2009). Therefore, barriers exist when the management is uncertain about the benefits, and especially when the current processes and technologies are still profitable (Shi et al., 2008). In addition, the implications of high cost (Giunipero et al., 2012) and lack of economies of scale with CE serve as barriers to integrating CE in SCM. Therefore, we put forward the following two barriers:

B4: Uncertainty about benefits

B5: Lack of economies of scale

Institutional theory (DiMaggio & Powell, 1983) explains how organizations respond to institutional pressures; seek to adopt or legitimize themselves in the sight of stakeholders; and adopt homogeneous, institutionalized structures and practices (Jennings & Zandbergen, 1995; North, 1990). There are three types of institutional pressure – coercive, mimetic, and normative isomorphism. Coercive isomorphism exists where powerful stakeholders such as government agencies and regulatory bodies impose certain rules and regulations. Mimetic isomorphism is when organizations imitate competitors' path to success. Normative isomorphism is related to

[5] This manuscript adopts the 'we' form as it was published as a jointly authored paper with supervisors/advisors.

external stakeholders such as customers, non-government organizations, pressure groups, and media organizations that demand what constitutes appropriate and legitimate behaviour. Institutional theory shares some common understandings with stakeholder theory (Donaldson & Preston, 1995; Freeman, 2010). The latter suggests that companies produce externalities that affect many stakeholders (both internal and external to the firm), and that the subsequent pressure from those stakeholders results in significant motivation for organizations to adopt proactive environmental strategies (Buysse & Verbeke, 2003).

Ample research has provided evidence that institutional and stakeholder pressures have driven the adoption of environmentally friendly practices (Hsu et al., 2013; Sarkis et al., 2010; Zhu & Sarkis, 2007; Zhu, Sarkis, et al., 2013). Conversely, the lack of pressure or inappropriate pressure mechanisms can be barriers (Walker et al., 2008). For example, Geng and Doberstein (2008) believe that China's legal system does not provide a unified platform to promote innovations like CE due to its fragmented policies. Other studies have also mentioned weak environmental regulations and enforcement as barriers to environmentally friendly practices (Geng et al., 2010; Walker et al., 2008). Geng et al. (2010) further argue that the Chinese political system does not provide a formal institutional channel through which the general public can influence environmental policies. Thus, low public awareness of and participation in CE activities has been a barrier to promoting CE (Geng et al., 2009). Therefore, we consider the following two barriers to integrating CE in SCM:

B6: Weak environmental regulations and enforcement

B7: Lack of market preference/pressure

Furthermore, integrating CE in SCM requires supply chain actors to collaborate and support each other. In this regard, we borrow insights from the resource dependence theory (Pfeffer, 1972; Pfeffer & Pfeffer, 1981). This theory proposes that organizations are interdependent (Finkelstein, 1997). Hence, barriers could arise when an organization's supply chain actors are not willing to collaborate and support the implementation of CE. Therefore, we consider the following barrier:

B8: Lack of collaboration/support from supply chain actors

Figure 2 presents the theoretical framework of identified barriers which hinder the integration of CE in SCM. Table 3 provides a complete description of the identified barriers.

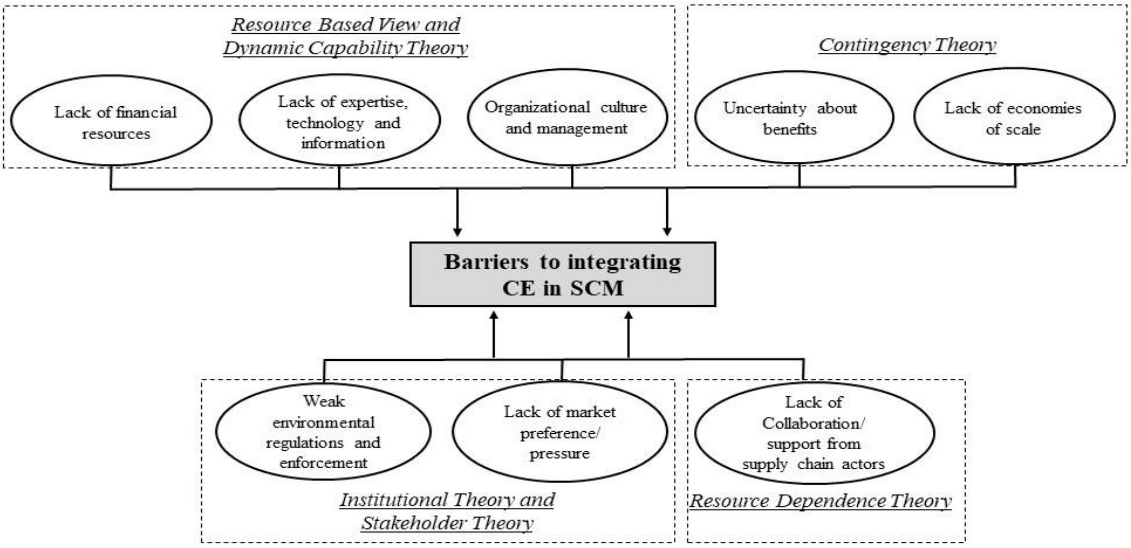


Figure 2: A theoretical framework for identifying barriers to integrating CE in SCM

Table 3: Description of barriers

Barriers	Description
B1: Lack of financial resources	Lack of financial resources available to implement CE
B2: Limited expertise, technology, and information	Lack of design, process, and supply chain expertise, technology, and/or technical support Lack of information about the available technologies and best practices
B3: Organizational culture and management	Organizational culture hinders the adoption of CE Lack of management commitment, and inadequate management capacity Resistance to change
B4: Uncertainty about benefits	Uncertainty about the potential environmental and economic benefits of CE including subsidies/tax benefits Implementing CE practices requires replacement of current technologies that are still profitable
B5: Lack of economies of scale	Lack of economies of scale in implementing CE High cost of implementing CE and the possible adverse effect on scale economy
B6: Weak environmental regulations and enforcement	Weak environmental regulations and enforcement to support CE implementation
B7: Lack of market preference/pressure	Lack of market preference and pressure from both customers and consumers
B8: Lack of collaboration/support from supply chain actors	Supply chain actors are reluctant to collaborate/support CE initiatives

4. **Methodology**

4.1 Questionnaire development and data collection

A questionnaire was designed, in English, to facilitate the data collection for DEMATEL analysis, capturing the views of evaluators, based on our theoretical framework presented above. The questionnaire provided an explanation of the study objectives and description of each barrier to guide the evaluators. It was then translated into the Chinese language. Two researchers proficient in both English and Chinese checked it to ensure an accurate translation. Two rounds of pilot tests were conducted with three evaluators to get feedback about the design of the questionnaire. Based on their feedback, two rounds of revisions were made to ensure content validity by eliminating ambiguity and possible confusion.

The finalized questionnaire was randomly distributed to 300 potential evaluators by email or post to be anonymously completed by senior executives/managers/supply chain heads and business owners. A convenience sampling method was adopted to seek responses from customers. The distribution and collection of the questionnaire were supported by three branches of a regional government in northern China, namely, the Development and Reform Commission, the Bureau of Commerce, and Food Safety Committee. Senior officials from these government departments were also requested to participate as evaluators considering their active involvement in CE implementation being an external supply chain stakeholder. Efforts were made to involve evaluators who represent farmers/farming cooperatives. However, after analysing the first six responses from farmers/farming cooperatives, the researchers were concerned about data quality and decided to exclude them from the research scope to ensure the validity and reliability of the whole data set. The data quality issue associated with farmers/farming cooperatives is complex. The researchers suspected a diverse range of causes, including the complexity of the CE concept (which was difficult for many farmers to fully comprehend), the respondents' limited knowledge of supply chain dynamics beyond the farm gate, and their lack of incentive to participate in the research.

Group	Evaluator type	Frequency	Percentage
Food processor	Food processors/manufacturers	32	30.5%
Sales & distribution channel	Supermarket (13) Import/Export (9) E-Retailer (6) Wholesaler (3)	31	*29.5%*
Customer	Buyers/consumers	35	33.3%
Government	Government officials	7	6.7%
Total number of evaluators		105	100%

Figure 3: Classification of evaluators

The final evaluators involved in this research are categorized into four groups: food processors (food processing/manufacturing companies), sales and distribution channels (supermarkets, import/export businesses, e-retailers, and wholesalers), customers (buyers/consumers of the final product) and government officials (external supply chain stakeholder). A total of 112 questionnaires were returned, among which 105 complete responses were considered valid for the DEMATEL analysis. Figure 3 shows the classification of these 105 evaluators. More details about the evaluators are given in Appendix 1.

4.2 Barrier study techniques

To uncover the complicated interdependencies among barriers, it is necessary to employ a scientific prioritization tool. In the extant literature, a number of sophisticated techniques are available for such analysis, including Interpretive Structural Modelling (ISM), Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), and Structural Equation modelling (SEM). In recent years, the DEMATEL technique has become increasingly popular (Venkatesh et al., 2017). It is centred on graph theory and analyzes complex causal relationships through quantitative methods (via matrices and diagrams) (Fu et al., 2012; Shao et al., 2016). Table 4 compares DEMATEL with the above-mentioned research methods.

Table 4: A comparison of DEMATEL with ISM/AHP/ANP/SEM

DEMATEL	ISM	AHP	ANP	SEM
DEMATEL helps to uncover the causal interactions among the variables based on their cause and effect groups	ISM uncovers the contextual interactions among variables based on their driving potential and dependencies	AHP does not provide any interdependencies between and among the variables, but rather is used to draw their hierarchical structure	ANP can provide interdependencies between and among the variables; this method is less accepted due to its complexity	SEM is an 'a priori' method, mainly used for theoretical development; it requires a large sample size

Source: Adopted from Mangla et al. (2018)

Both DEMATEL and ISM can be used to analyze the interrelationships among factors (Baykasoğlu & Gölcük, 2015). However, according to Kumar and Dixit (2018), ISM is a macro-oriented approach used to break down complex systems into sub-systems, whereas DEMATEL is a relatively micro-oriented approach that helps to determine the intensity of relationships (both direct and indirect) among the variables, as well as to visualize causal relationships on an impact-relations map (Kumar & Dixit, 2018). Thus, DEMATEL was found to be more suitable than ISM for this study.

ANP is an extension of the AHP method (Saaty, 2013), improving on the former's accuracy in predictions and priority calculations in cases of networks with dependent criteria. However, ANP does not provide interrelationships among variables, and that is where DEMATEL is considered better (Vujanović et al., 2012).

Highlighting the well-established fact that correlation does not establish causality, Guide and Ketokivi (2015) advocated the use of correct methods when making causality claims. Statistical techniques such as regression and SEM analysis do not automatically establish causality. Moreover, these techniques typically require specific parametric assumptions for the data and a large sample size (Bai & Sarkis, 2013). DEMATEL is more suitable than multivariate regression analysis and SEM for barrier studies, as the latter techniques were not designed to fully evaluate the interactions and causal relationships among various factors (Dou et al., 2014; Hu et al., 2011). With the DEMATEL technique, on the other hand, the causal dimensions of a complex system are converted into a structural model that is easy to understand, furthermore visualizing them in cause and effect groups (Gandhi et al., 2015; Kaur et al., 2017). It is also used to rank the variables and does not require a large amount of data (Bai et al., 2017).

The comparisons presented above explain why DEMATEL suits barrier studies. Some recent DEMATEL-based barrier studies in the supply chain sustainability domain have looked at low-carbon supply chain cooperation practices (Bai et al., 2017), green SCM practices (Gandhi et al., 2015; Kaur et al., 2017), and renewable energy resources selection (Büyüközkan & Güleryüz, 2016).

4.3 Fuzzy DEMATEL technique

This study used a fuzzy DEMATEL approach to overcome the inherent vagueness and bias in human judgments (Govindan, Diabat, et al., 2015; Govindan, Kannan, et al., 2015; Tseng et al., 2013; Wu & Lee, 2007). Triangular fuzzy numbers (TFNs) ranging between 0 and 1 were used to denote the linguistic expressions of the evaluators.

As in previous studies (Kaur et al., 2017; Lin, 2013; Venkatesh et al., 2017; Zhu et al., 2014), a six-step DEMATEL process was used to prioritize the barriers and examine their interrelationships.

4.3.1 Step 1: Developing a fuzzy pairwise comparison matrix

In the first step, we defined a fuzzy pairwise comparison scale to develop the initial direct-relation matrix. We used the following five-point scale: 0 = no influence, 1 = very low influence, 2 = low influence, 3 = high influence and 4 = very high influence. Following the steps of previous studies (Venkatesh et al., 2017; Wu, 2012), the fuzzy linguistic scale values and their corresponding TFNs are shown in Table 5.

Table 5: Fuzzy linguistic scale

Scale values	Linguistic variable	Corresponding TFNs
0	No Influence (NO)	0,0,0.25
1	Very Low Influence (VL)	0,0.25,0.5
2	Low Influence (L)	0.25,0.5,0.75
3	High Influence (H)	0.5,0.75,1.0
4	Very high Influence (VH)	0.75,1.0,1.0

The evaluators completed a pairwise comparison of the barriers using the scale provided in Table 6. Moreover, they ranked the barriers in order of their importance, based on their industry knowledge and experience. Through this approach, we could compare the DEMATEL rankings with the important rankings provided by the evaluators. A sample of pairwise comparison and importance ranking is shown in Appendix 2.

4.3.2 Step 2: Obtaining a fuzzy pairwise initial direct-relation matrix (A)

The initial direct-relation matrix was transformed into a crisp matrix by the defuzzification process to obtain initial direct-relation matrix (A). We used a weighted average method to defuzzify the direct-relation matrix, following a previous study by Venkatesh et al. (2017).

4.3.3 Step 3: Developing a normalized direct-relation matrix (D)

The normalized direct-relation matrix (D) was obtained through equations (1) and (2).

$$m = min\left[\frac{1}{\max \sum_{j=1}^{n}|\alpha_{ij}|}\right], \left[\frac{1}{\max \sum_{i=1}^{n}|\alpha_{ij}|}\right] \quad (1)$$

$$D = m \times A \quad (2)$$

4.3.4 Step 4: Developing a total relations matrix (T)

The total relation matrix (T) was developed based on Equation (3), where I represents an $n \times n$ identity matrix. The total relation matrices (T) are shown in Appendix 3.

$$T = (I - D)^{-1} \quad (3)$$

Where I = Identity matrix; T = Total relation matrix, $T = \left[t_{ij}\right]_{n \times n}$

4.3.5 Step 5: Calculating the sum of rows (R) and sum of columns (C)

The computation of the sum of rows (R) and sum of columns (C) was performed using equations (4) and (5).

$$R = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \quad (4)$$

$$C = \left[\sum_{j=1}^{n} \mathrm{t}_{ij}\right]_{1\times n} \quad (5)$$

4.3.6 Step 6: Drawing a prominence-causal relationship diagram

The row values (R) represent the overall effects produced by barrier i on barrier j. Similarly, the column values (C) represent the overall effects on barrier i from barrier j. Moreover, the prominence value $(R + C)$ and net causal-effect value $(R - C)$ were also calculated. A barrier with a high prominence value deserves immediate attention because its total influences are significant, i.e. affecting other barriers while also being affected by other barriers. A barrier with a high net causal-effect value is of fundamental importance as it is a root cause of other barriers (Venkatesh et al., 2017; Zhu et al., 2014).

5. **Results, analysis, and findings**

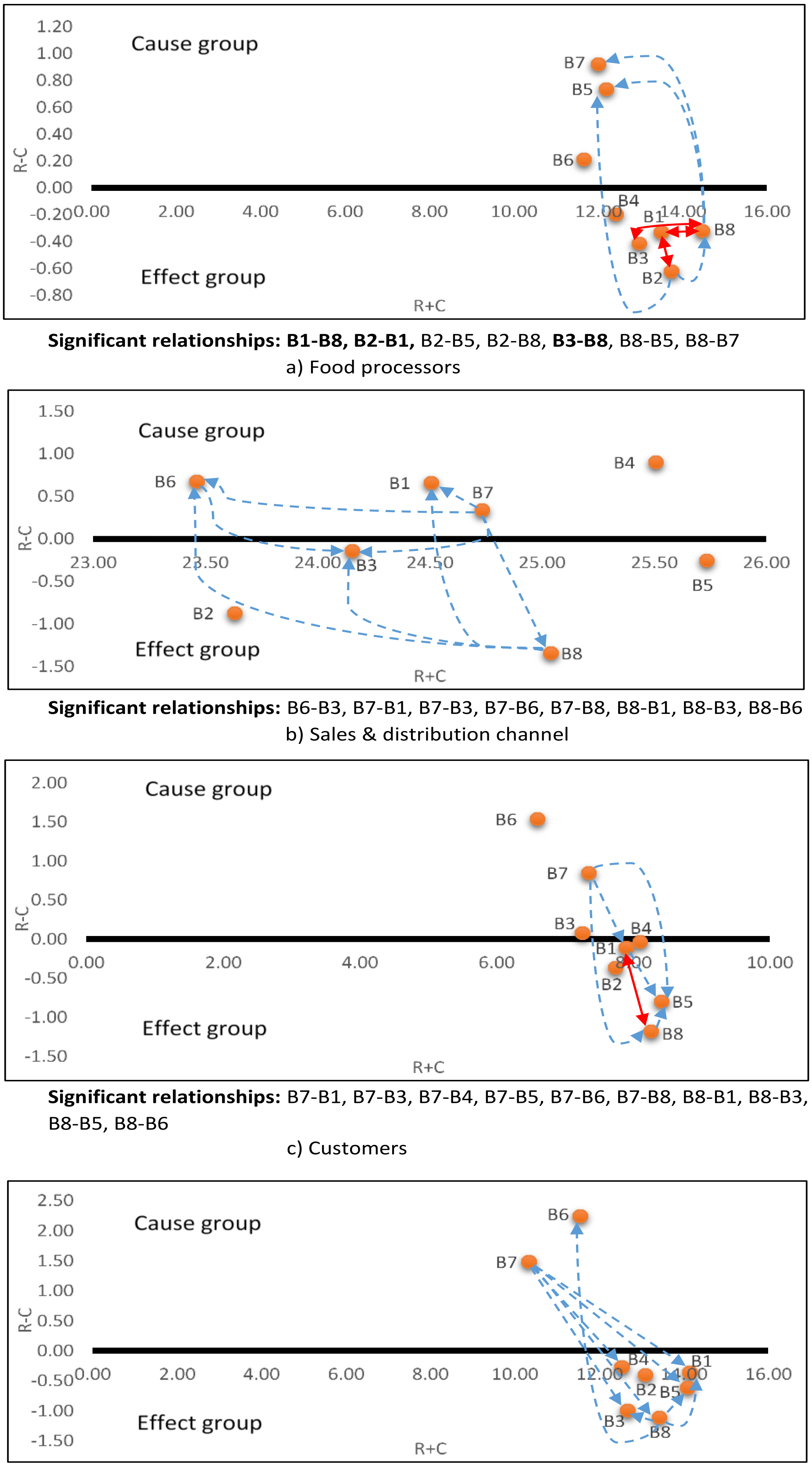
The overall DEMATEL results (prominence/net cause-effect values and evaluators' importance rankings) are summarized in Table 6. The prominence-causal relationship diagrams were developed for all evaluating groups. These diagrams are mapped in Figure 3. The arrows represent interrelationships between barriers, with a one-way arrow representing a one-way relationship and a two-way arrow, a two-way relationship. We only mapped significant relationships above a threshold value (Ø) calculated by adding one standard deviation to the mean of the total relation matrix (T) as a benchmark following Fu et al. (2012). All the significant relationships (above Ø value) are highlighted as bold values in Appendix 3. These significant relationships are also plotted in Figure 4.

Table 6 and Figure 4 show some disparities in the results on key barriers across the four evaluating groups. This seems logical given the difference in their roles in food supply chains. As shown in Figure 4(a), food processors consider lack of market preference/pressure (B7), lack of economies of scale (B5) and weak environmental regulations and enforcement (B6) as the most significant cause barriers. Sales and distribution channels (see Figure 4(b)) categorize uncertainty about benefits (B4), weak environmental regulations and enforcement (B6), lack of financial resources (B1) and lack of market preference/pressure (B7) as the most significant cause barriers. Results in Figure 4(c) show that customers identify weak environmental regulations and enforcement (B6), lack of market preference/pressure (B7) and organizational culture and management (B3) as significant cause barriers. The government officials group as an external stakeholder identified weak environmental regulations and enforcement (B6) and lack of market preference/pressure (B7) as significant cause barriers (Figure 4(d)).

Table 6: A summary of evaluators' importance rankings and DEMATEL analysis results

	Food Processors			Sales & Distribution Channels			Customers			Government Officials		
Barriers	R+C	R-C	Ranking*	R+C	R-C	Ranking*	R+C	R-C	Ranking*	R+C	R-C	Ranking*
B1	13.49	-0.33	1	24.51	0.66	2	7.89	-0.11	1	14.14	-0.36	1
B2	13.73	-0.62	2	23.63	-0.87	1	7.74	-0.36	3	13.09	-0.40	2
B3	12.96	-0.41	5	24.15	-0.14	3	7.25	0.08	2	12.67	-0.99	3
B4	12.41	-0.19	6	25.51	0.90	6	8.10	-0.03	7	12.53	-0.27	6
B5	12.19	0.74	3	25.73	-0.25	7	8.41	-0.79	4	14.09	-0.61	8
B6	11.66	0.21	7	23.46	0.68	5	6.60	1.54	5	11.55	2.25	5
B7	12.00	0.92	8	24.73	0.34	8	7.35	-0.85	8	10.33	1.49	6
B8	14.47	-0.32	4	25.04	-1.34	4	8.26	-1.18	6	13.42	-1.11	3

*Evaluator group's importance rankings



Significant relationships: **B1-B8, B2-B1,** B2-B5, B2-B8, **B3-B8**, B8-B5, B8-B7
a) Food processors

Significant relationships: B6-B3, B7-B1, B7-B3, B7-B6, B7-B8, B8-B1, B8-B3, B8-B6
b) Sales & distribution channel

Significant relationships: B7-B1, B7-B3, B7-B4, B7-B5, B7-B6, B7-B8, B8-B1, B8-B3, B8-B5, B8-B6
c) Customers

Significant relationships: B1-B5, **B1-B8,** B7-B1, B7-B5, B7-B8, B8-B5
d) Government officials

Barrier definition:

B1: Lack of financial resources

B2: Limited expertise, technology, and information

B3: Organizational culture and management

B4: Uncertainty about benefits

B5: Lack of economies of scale

B6: Weak environmental regulations and enforcement

B7: Lack of market preference/pressure

B8: Lack of collaboration/ support from supply chain actors

Figure 4: DEMATEL prominence-causal relationship diagrams

Table 7 summarizes the overall results and highlights the barriers assigned the highest prominence values and net causal-effect values across the four evaluating groups. This research considered a barrier as a key cause or prominent barrier only if the same is reflected in the results of at least three evaluator groups. Therefore, weak environmental regulations and enforcement (B6) and lack of market preference/pressure (B7) are identified as key cause barriers, whereas lack of collaboration/support from supply chain actors (B8) is identified as the only prominent barrier under the established criteria. To our surprise, the prominent barriers and key cause barriers are obviously different from barriers' rankings based on the evaluator's importance rankings across the three groups (see Table 6). This suggests that the real important barriers, namely the prominent and key cause barriers, are quite different from the ones perceived by the evaluators.

Table 7: Barriers with the highest prominence and net cause-effect values

Barriers	Prominence	Net-cause
B1: Lack of financial resources		
B2: Limited expertise, technology, and information		
B3: Organizational culture and management		
B4: Uncertainty about benefits		
B5: Lack of economies of scale		
B6: Weak environmental regulations and enforcement		All stakeholders
B7: Lack of market preference/pressure		All Stakeholders
B8: Lack of collaboration/support from supply chain actors	Food processors, Sales & distribution channels, and Customers	

Note: Barriers highlighted in bold have the highest prominence/net cause-effect values rated by at least three evaluator groups

6. **Discussion**

6.1 Theoretical contributions

This paper makes multiple theoretical contributions to supply chain sustainability research. Firstly, it establishes the circular supply chain as a new frontier in supply chain sustainability research and practice. The circular supply chain's zero-waste vision is not only desirable, but also achievable by means of restorative and regenerative design and system-wide innovations to achieve circularity of materials. In the context of the food sector, this study illustrates how a circular food supply chain differs from a linear (traditional) one.

Secondly, this research develops a theoretical framework of barriers to integrating CE in SCM, using multiple organizational theories. The framework is not only based on literature but also refined and validated based on inputs from experienced food supply chain professionals, government officials, and academic researchers. The general applicability of the framework is demonstrated in a quantitative study of barriers to circular food supply chains in China using the fuzzy DEMATEL technique.

Thirdly, the DEMATEL analysis results show that resource dependence theory (Pfeffer & Salancik, 2003) is most relevant for explaining the prominent barrier(s), while institutional theory and stakeholder theory is most relevant for the key cause barriers. Specifically, the most prominent barrier, B8 (lack of collaboration/support from supply chain actors), which requires immediate intervention, is linked with resource dependence theory. In the extant literature, resource dependence theory has broadly been applied across the research domains for more than three decades to explain how organizations reduce environmental interdependence and uncertainty (Hillman et al., 2009). B6 (weak environmental regulations and enforcement) and B7 (lack of market preference/pressure), being the most significant cause barriers, are grounded in institutional theory and stakeholder theory. Institutional theory has risen to prominence as a popular and powerful theory offering an explanation for organizational actions (Dacin et al., 2002), especially with regard to supply chain sustainability issues (Zhu, Sarkis, et al., 2011). Pressures from stakeholders and institutions are taken seriously by many firms, and they necessitate proactive sustainability strategies (Tate et al., 2010).

Fourthly, the results suggest the barriers derived from the RBV, dynamic capabilities theory, and contingency theory are overall less significant in integrating CE in the Chinese food supply chains. This does not mean that these theories are not relevant or are invalid, but only suggests they have relatively limited power for explaining the concerned organizational behaviours in the context of the Chinese food supply chains. A possible explanation of this finding is that the RBV, dynamic capabilities theory and contingency theory were developed primarily for explaining organizations' competitive advantage in economic performance (Barney, 1991; Gulati & Sytch, 2007; Teece et al., 1997), rather than in environmental sustainability performance. Further research studies are required to deepen our understanding on the applicability of these theories for explaining organizational behaviours in sustainability-related practices.

Finally, it is interesting to discover that the key barriers revealed by the DEMATEL analysis are quite different from the ones rated by the evaluators based on their importance rankings (Table 6). This shows that the results are non-intuitive. Therefore, it is essential to employ a scientific prioritization technique like fuzzy DEMATEL to uncover the hidden causal-effect relationships among barriers. These identified causal-effect relationships can be used as a reference for future empirical investigations.

6.2 Practical implications of prominent barrier(s)

This study focuses on different stakeholders of food supply chains in China. Taking a broader perspective to discuss the relevance of the results at a supply chain level, we first discuss the barrier(s) with the highest prominence value(s), as they have the potential to affect and/or be affected by other barriers and, therefore, managers and policy makers should prioritize addressing or circumventing these in the short run. B8 (Lack of collaboration/support from supply chain actors) has the highest prominence value.

As discussed earlier, the implementation of CE is costly and affects various supply chain functions. CE in the food sector implies the use of more natural and organic ingredients in growing/farming as well as processing and manufacturing stages. To decrease the packaging waste, CE implies the use of environmentally-friendly, biodegradable packaging materials. In manufacturing, CE requires the implementation of cleaner production technologies to conserve energy and reduce waste and emissions. Logistics implications include the design of green and efficient logistics networks for forward and reverse product flows. Moreover, on the consumption side, customer and public participation in CE is critically important for the end-of-life management of leftovers, of unwanted, expired or waste food, and of packaging materials for resource recovery purposes. In this regard, collection and processing of the waste streams could be quite challenging at supply chain level. It is, therefore, unsurprising to see lack of collaboration/support from supply chain actors (B8) as the most prominent barrier to successful implementation of CE at supply chain level. This is consistent with Hau Lee's *Triple A supply chain strategy* which suggests that lack of alignment among supply chain partners causes the failure of many supply chain practices (Lee, 2004).

On the other hand, research suggests that the implementation of the CE offers numerous opportunities for organizational gains in supply chains (Govindan & Hasanagic, 2018). For example, in most industries, including the food sector, many by-products cannot be efficiently reused or recycled within an individual plant, thus providing a potential collaboration opportunity with surrounding firms, and this also encourages the establishment and maintenance of a formal regional eco-industrial network (Geng & Doberstein, 2008). From a strategic viewpoint, we suggest systemic sustainability collaboration (Atasu et al., 2018) among key food supply chain players (food processors, sales and distribution channels and customer) in China with an explicit focus on improving economic and environmental impact outcomes. A recent study by Morone et al. (2019) found that collaboration among supply chain members had a positive impact on environmental and financial performance in China. Moreover, improved collaboration between municipal waste management systems and supermarkets/food e-retailers may also be effective to streamline the end-of-life resource recovery and consequently, and to mitigate uncertainties surrounding the economic and environmental benefits of implementing CE. The collaborative arrangement can also be extended to involve external stakeholders such as government, non-governmental organizations, and academicians to stimulate long-term sustainability innovations.

6.3 Practical implications of key cause barriers

Barriers with the highest net causal-effect values have the greatest long-term impact on the whole system, so they should be paid more attention. B6 (weak environmental regulations and enforcement) has the highest net causal-effect value. Although China has taken the lead by adopting and promoting CE as a national policy, enforcement of such environmental regulations has been more problematic than their promulgation, plagued by low bureaucratic status and prevalent corruption (Geng et al., 2010). The NDRC, being mandated to promote CE across China, needs to develop an effective enforcement mechanism to implement CE at the micro level. Notably, the CE indicators published by the NDRC have been designed for the macro and meso levels, whereas micro-level indicators are absent (Geng et al., 2012), which affects the promotion of CE at that level. Su et al. (2013) argue that standardized micro-level indicators may fail to capture CE progress in different firms and industries. However, to ensure CE implementation at the micro level, it is imperative to develop relevant indicators. The NDRC may consider broad standards and indicators for the micro level that can be adapted or tailored by firms to reflect their specific characteristics, conditions, and problems. These indicators should include detailed descriptions, industry-specific goals, and standardized procedures for collecting, measuring, and submitting the required data (Geng et al., 2012). More stringent regulatory mechanisms need to be in place for monitoring and enforcing the indicator system. The food industry, along with other industries, should become acquainted with these indicators to ensure maximum compliance.

The other barrier with a high causal-effect value is B7 (lack of market preference/pressure). In China, most of the policies surrounding environmental initiatives do not involve any public consultation. The absence of any formal institutional structure for this in the Chinese political system as indicated by Geng et al. (2010) further weakens the public interest in and awareness of environmental initiatives; in contrast CE. Borrello et al. (2017) found that appropriate incentivization of food take-back programmes positively affected consumers' participation and commitment in circular loops. We suggest an extensive promotion campaign using media such as internet, social media, TV, radio, and newsletters, in addition to interactive platforms like exhibitions, conferences, and workshops. To sustain the public interest and awareness over the long term, it is essential to incorporate CE and environmental education in schools.

6.4 Summary of New Insights and Future Research Directions

This research provided a multi-stakeholder perspective on barriers to circular food supply chains. The results offer insights for all stakeholders, irrespective of how direct or indirect their involvement is. This subsection summarizes new insights that were not reported in the extant literature and discusses important research directions for further studies.

China, being the first country in the world to legislate CE as part of its national development strategy, has enacted a raft of government-driven legislation to push CE implementation. However, weak enforcement of such environmental regulations was found to be a key cause barrier in the food sector. This is ironic and thought-provoking, given the Chinese government's stance on CE. The other key cause barrier is that most Chinese consumers and businesses care little about environmental protection; hence, there is a lack of public commitment to and support for the government's CE aspiration. These findings have serious implications for the importance of policy makers in China addressing issues in bureaucracy, governance, corruption, and environmental education.

Previous CE-related barrier studies focused on the macro- and meso-level implementation. From a micro perspective, this study identified lack of collaboration/support from supply chain actors as a barrier not previously reported. The finding is significant, because this barrier emerged as the only one identified as prominent by all three supply chain stakeholders. It provides empirical evidence to back Mathews and Tan's Mathews and Tan (2016) claim that the main obstacle to successful implementation of CE in China is getting firms linked by circular supply chains. EIPs, as facilitating physical infrastructure, have been developed by the Chinese government to achieve the goal, but they do not seem to be enough to stimulate a transformation to circular supply chains. Future research may investigate how to further facilitate and incentivize firms' collaboration to make their supply chains circular. Smart enabling technologies, including the internet of things (IoT), big data analytics, and blockchains, have developed rapidly in recent years. Future research may examine their use and effectiveness for circular supply chain management. There is also ample room for researchers to investigate the role of soft infrastructure, including reward and penalty systems, supply chain incentive alignment, product stewardship (Jensen & Remmen, 2017), extended producer responsibility (Kunz et al., 2018), and sustainable product-service systems (Kjaer et al., 2018).

The circular supply chain is a relatively new but promising domain in supply chain sustainability research. We call for more research contributions in this growing field. For many decades, the focus of waste management has been on improving the efficiency and effectiveness of operations. However, this traditional thinking can never achieve CE's zero-waste vision. In a CE context, waste management requires a much sharper focus on value recovery, i.e. turning waste into resources. Furthermore, CE requires a rethinking of product/service design in order to not generate waste at all, wherever possible. More work is required researching innovative design of products/services and building up circular business models and supply chain processes.

Furthermore, circular supply chain barriers are context-dependent, as behaviour barriers vary by culture, and different product sectors may require a different set of supply chain actors to collaborate to turn waste into resources. In addition, barriers are dynamic, as they may evolve over time. Therefore, it is necessary to conduct circular supply chain barrier studies in contexts different from that of this study. Our theoretical framework may serve as a guide for future studies. Since this barrier study identified three theories as most relevant (namely resource dependence theory, institutional theory, and stakeholder theory), they can be focused on in broader empirical studies on circular supply chains.

7. Conclusions

The rate of China’s consumption of global resources and the production of solid waste poses a severe threat to the world’s sustainability. To overcome the challenges associated with recirculation of waste materials, the Chinese government has invested heavily in implementing CE over the last decade. However, the progress has been modest due to obstacles to linking firms in circular supply chains that cooperate to turn outputs into inputs. This study identifies and analyses the specific barriers to integrating CE in SCM in the context of food supply chains in

China. The severity of adverse environmental impacts of food supply chains and scarcity of research on their sustainability practices make this issue worth investigating.

The first original contribution of this research is in conceptualizing circular food supply chains, in the context of integrating CE philosophy in SCM, a new frontier in supply chain sustainability research and practice. Secondly, this research develops a theoretical framework drawing on multiple organizational theories to identify barriers to integrating CE in SCM. The quantitative analysis results show that resource dependence theory, institutional theory, and stakeholder theory are most relevant for integrating CE in the Chinese food supply chains. Thirdly, to the best of our knowledge, this is the first attempt to systematically investigate and prioritize the barriers to circular food supply chains in China. Viewpoints from four evaluating groups (food processors, sales and distribution channels, customers, and government officials) were explored. The results suggest weak environmental regulations and enforcement and lack of market preference/pressure as the key cause barriers. Moreover, lack of collaboration/support from supply chain actors emerges as the most prominent barrier. The results are non-intuitive, which proves the necessity of employing a scientific prioritization technique like fuzzy DEMATEL. Finally, this study discusses theoretical and practical implications for overcoming/circumventing the barriers. It offers new insights for future research directions in supply chain sustainability.

Despite several contributions, this study has its limitations. Firstly, the list of barriers identified in the study was far from exhaustive, although it was enough to meet the research objectives.

Future studies may expand the list of barriers under the most relevant theoretical lenses identified in this study to suit their research objectives. Secondly, the study analyzed responses from multiple food supply chain stakeholders in China. However, farmers, who are among the important food supply chain stakeholders, could not be included in the analysis due to data quality issues. Lastly but not the least, the cross-sectional survey design uncovered barriers at a given point in time but were unable to reveal how barriers evolved over time. Future research may consider a longitudinal study to generate more insights.

Chapter 5

5. Conclusion

This final chapter summarises the thesis and its findings. The theoretical and practical implications of the research are discussed. The original contributions of this thesis are highlighted and discussed. Lastly, research limitations and future research directions are presented.

5.1 Research summary and key findings

This thesis puts forward the conceptualisation of CSCM, analyses the CSCM to performance relationship, including the role of eco-industrial parks, and identifies the barriers to CSCM development. This thesis comprises three manuscripts (chapter 2-4). A summary of each manuscript is provided in the later sub-sections.

5.1.1 Manuscript 1: Conceptualisation of CSCM and a structured literature review

The circular economy has been increasingly recognised as a better alternative than the prevalent linear (take, make, dispose) economic model. It offers much potential to help organisations achieve breakthroughs in sustainability performance. Integrating CE into SCM is a relatively new research field with most of the significant works published in the last few years. Despite growing research interest, there exists much confusion on the terms related to supply chain sustainability. The advancement of the field is hindered by the lack of understanding of what CSCM actually entails and which research directions are of strategic importance. Therefore, manuscript 1 (chapter

2) addresses the following research question: *What is circular supply chain management and its current state of research in the light of extant SCM sustainability literature?*

In response to the research question, this study developed a systematic classification of relevant SCM sustainability terms to serve as a basis to propose a definition for CSCM. Using the definition as a base, a structured literature review of 261 research articles was conducted to gain an in-depth understanding of the current status of CSCM research and to provide insights into what has been done and what research needs to be done in the future for the further development of this promising research field.

5.1.2 Manuscript 2: CSCM practice-performance relationship and the role of eco-industrial parks

The increasing role and influence of CE in SCM has led to the development of CSCM as a new and compelling perspective in the SCM sustainability domain. China has made great efforts to promote CE over the last two decades. In their transition towards CE, Chinese manufacturing firms have adopted a number of supply chain practices to achieve better sustainability performance. However, there is a lack of empirical evidence on how these practices form a unified CSCM strategy and lead firms to higher levels of performance. Similarly, the contextual role of a firm's EIP location on the adoption of CSCM and their performance implications has not been empirically explored. Therefore, manuscript 2 (Chapter 3) addresses the following research question: *What is the impact of CSCM practices on firm performance and how does being located in an eco-industrial park (EIP) affect the CSCM to firm performance relationship?*

In response, this research developed a conceptual model based on the Natural Resource-Based View (NRBV), Contingent NRBV and the literature on CSCM. Using statistical analysis of the collected data from 255 Chinese manufacturing firms, the following results were established. Firstly, CSCM, when exercised as a uniform strategy, has a significant positive effect on environmental, cost and financial performance. However, quite surprisingly, the results do not show significant improvements in resource circularity performance, probably due to the modest progress towards CE. Secondly, firms located inside EIPs adopt CSCM at higher levels as compared to firms located outside EIPs. Thirdly, the contextual factor of being located within an EIP does not seem to moderate the CSCM practice-performance relationship, suggesting no significant difference among EIP and non-EIP firms in terms of performance outcomes, further suggesting that performance is driven by practices rather than firms' location. Based on the study results, several theoretical and practical implications are provided to inform future research and supply chain practitioners.

5.1.3. Manuscript 3: Barriers to integrating CE in SCM

Faced with severe waste management and environmental challenges, the Chinese government has adopted various measures including policy, legislation and financial measures, to strengthen its CE programme. However, the progress has been modest and there are significant barriers in linking firms by circular supply chains to cooperate to turn outputs into inputs (i.e. waste into resources). Given these issues, this study identifies and analyses the specific barriers to integrating CE in SCM in the context of food supply chains in China. The severity of adverse environmental impacts of food supply chains and scarcity of research on their sustainability practices make this issue worth investigating. Specifically, this chapter (chapter 4, manuscript 3) addresses the following research question: *What are the key barriers to integration of CE in SCM (CSCM) and how do these barriers interact with each other?*

In response, this paper developed a theoretical framework grounded in multiple organisational theories, for identifying the relevant barriers to integrating CE philosophy in food SCM. A fuzzy DEMATEL method was applied to examine the causal-effect relationships among the identified barriers based on a survey of 105 responses from Chinese food supply chain stakeholders. The results suggest two key cause barriers: weak environmental regulations and enforcement, and lack of market preference/pressure. Lack of collaboration/support from supply chain actors was identified as the most prominent barrier. The study offers practical insights for overcoming barriers to integrating CE into SCM in the context of the Chinese food sector, as well as in other contexts where similar challenges are faced. It also sheds light on which organisational theories are most suitable for guiding similar studies.

5.2 Research implications

The findings of this thesis offer important contributions to the SCM sustainability literature besides the practical insights to a variety of supply chain stakeholders. These key contributions are summarised in the following subsections.

5.2.1 Theoretical implications

This research introduces CSCM as a new and compelling perspective to the supply chain sustainability domain. A multifaceted and holistic view of CSCM including a unified definition and a pioneering structured review of the literature are presented. Moreover, empirical analysis of CSCM practice-performance relationship at the firm level and the role of EIPs at the supply chain level, as well as barriers to CSCM development, are the main highlights of the significant theoretical contributions offered by this thesis.

The first significant theoretical contribution of this thesis is to define CSCM and map the current state of research on all the aspects and facets of CSCM research, with an aim of providing a comprehensive integrated view of the field. The structure review of 261 articles presented in this thesis is by far the most comprehensive literature review of CSCM research.

Secondly, this research contributes by developing a new construct, namely CSCM consisting of four operational practices such as circular product design, circular procurement, EoL and waste management. The measurement items for CSCM were developed through extensive review of the literature and were validated by academic and industry experts. Similarly, the firm performance viewpoint is also broadened with the addition of a relevant construct, i.e. resource circularity and its measurement items. The study on barriers to CSCM development is among only a few studies to focus on micro levels barriers, as previous studies have mainly focused on macro and meso level implementation issues and barriers.

Thirdly, this thesis contextualises several relevant organisational theories for investigating the CSCM practice–performance link and for identifying barriers to integrating CE in SCM. This provides an opportunity to test these theories and shed light on their relevance in the CSCM research context. CSCM is linked with NRBV theory of the firms to develop a conceptual model related to two of the strategic capabilities outlined within the NRBV framework, namely pollution prevention and product stewardship, whereas contingent NRBV has been used as a theoretical lens to support the moderating role of firms' EIP location as a contextual factor on the practices-performance relationship. In addition, this study further develops a theoretical framework of barriers to integrating CE in SCM using multiple organisational theories, and contributes by identifying resource-dependence theory, institutional theory and stakeholder theory as the most relevant theories that may be focused in the CSCM barriers research.

5.2.2 Practical implications

The research offers important practical implications and timely guidance to help supply chain practitioners and policy makers.

Implications for supply chain practitioners

The research findings offer important practical implications for supply chain practitioners in the manufacturing industry. This research serves as a reference point for managers to operationalise CSCM. A thorough understanding of integrating CE philosophy at a broad supply chain and its functional level is provided to guide managers on how to implement CE at a firm and supply chain level. Moreover, the role of business model innovation and technology intervention is also highlighted. The CSCM to firm performance relationship is clearly spelled out. The results presented in this research are very important for supply chain practitioners to develop effective CSCM strategies to gain environmental, cost and financial benefits.

However, lack of collaboration/support from supply chain actors is a significant barrier to the development of CSCM. It is noted that most firms and supply chains cannot fully utilise CE benefits in terms of resource recirculation, restoration and recovery within their original supply chain structures. Therefore, supply chain practitioners are advised to develop systemic sustainability collaborations for circularity and sustainability, focusing on both the business processes and the firm performance outcomes. Apparently, the firms operating inside EIPs have a unique advantage as industrial symbiosis network operations inside EIPs provide a natural form of collaboration required for circularity. However, all firms irrespective of their location are advised to develop systemic collaboration for CSCM as its adoption level among manufacturing firms is not very high and CSCM implementation offers numerous opportunities for organisational gains in supply chains.

Implications for policy

For policy makers our study results suggest that there is a need for placing more stringent regulatory mechanisms to monitor and enforce CE at the firm and supply chain level. In the Chinese manufacturing industry context, the concerned government agencies need to develop standards and indicators for CE implementation that can be adapted or tailored by firms at the micro-level. The manufacturing industry should be made familiar with these indicators to ensure maximum compliance. Similarly, the general public and consumer interest levels in CE need to be elevated through various approaches such as awareness campaigns, interactive platforms and incorporating environmental education in school curricula.

5.3 Research contributions

This section summarises the most important original contributions of this thesis in the SCM sustainability domain.

1. *Identification of the research topic:* Given the dominance of traditional SCM sustainability concepts in the literature, there has been some conceptual confusion surrounding CSCM, which inhibits a clear distinction of CSCM from other supply chain sustainability concepts. The relationship between CSCM and firm performance and the role of EIPs in

this relationship is clearly missing in the extant literature. Moreover, the barriers to integrating CE into SCM at a micro level have not been identified or analysed. This hinders the implementation and development of CSCM. Overall, this thesis adopts an innovative design approach where it attempts to define a concept, and analyse its performance outcomes, as well as identify and systemically analyse barriers to its further development to provide a holistic view.

2. *Structured literature review and future research directions*: This study is among the pioneering works to conduct a structured review of the literature on CSCM. Manuscript 1 offers a unified definition of CSCM; in addition, it provides a comprehensive integrated view of the field and suggests several potential areas for future research such as design for circularity, procurement and CSCM, biodegradable packaging, circular supply chain collaboration and coordination, drivers and barriers of CSCM, circular consumption, product liabilities and producer's responsibility, and technologies and CSCM.
3. *Performance outcome of CSCM and the role of EIPs:* Manuscript 2 confirms a positive and significant relationship between CSCM and firm performance in terms of environmental, cost and financial performance dimensions. Quite surprisingly, the study results do not show significant improvements in resource circularity performance, potentially due to the modest progress towards CE. It also found that firms located inside EIPs adopt CSCM at higher levels as compared to firms located outside EIPs. However, locating in an EIP does not moderate the CSCM practice-performance relationship,

suggesting that performance is driven by practices rather than firms' location. The practical insights reveal the importance of developing systemic collaborations for circularity and sustainability with all key supply chain stakeholders in order to gain performance benefits associated with CSCM.

4. *Barriers to circular food supply chain in China and circumventing measures:* Manuscript 3 identifies the weak environmental regulations and enforcement, and lack of market preference/pressure as the key cause barriers. Furthermore, lack of collaboration/support from supply chain actors is identified as a prominent barrier to integrating CE into SCM. To overcome these barriers, this research suggests systemic sustainability collaboration among key food supply chain players in China, with an explicit focus on improving economic and environmental impact outcomes. Moreover, this research further suggests designing and launching an extensive promotion campaign using media such as internet, social media, TV, radio and newsletters, beside interactive platforms like exhibitions, conferences and workshops. In order to sustain the public interest and awareness over the long term, CE and environmental education needs to be introduced in the schools.

5. *Theoretical contributions:* This thesis advances theoretical contributions by defining CSCM and mapping the current state of research on all the aspects and facets of CSCM research to provide a comprehensive integrated view of the field. A new construct, namely CSCM consisting of four operational practices, such as circular product design, circular procurement, cleaner production and EoL and waste management, is developed through

extensive review and its measurement items are validated by academic and industry experts. Similarly, the firm performance viewpoint is also broadened with the addition of a relevant construct, i.e. resource circularity and its measurement items. The research further links CSCM with Natural Resource Based View (NRBV) of the firms and contingent NRBV to develop a conceptual model essentially for theory-testing purposes. It further develops a theoretical framework of barriers to integrating CE in SCM using multiple organisational theories and contributes by identifying resource dependence theory, institutional theory and stakeholder theory as the most relevant theories that may be focused in the CSCM barriers research.

6. *Practical implications*: At the practice level, this thesis provides a reference point to SCM practitioners on how to implement CE/CSCM at the firm and supply chain level. The positive and significant CSCM to performance link provides a clarity and encouragement to SCM practitioners to implement CSCM and bring innovations into their business models. Moreover, the identification of barriers serves an important purpose of helping managers and policymakers in developing appropriate strategies and in prioritising relevant barriers to which more attention should be paid.

5.4 Limitations and future research directions

5.4.1 Limitations

Despite the considerable contributions stated above, this thesis has several limitations. Firstly, there are limitations due to the research design in each manuscript. The structured literature review on CSCM (manuscript 1) is limited to journal articles published in English, to ensure the quality of review results. Although some important contributions in the form of conference papers, industry reports, books and book chapters are referenced, such publication types were not included in the scope of the review itself. Moreover, the scope of the CSCM practice-performance relationship (manuscript 2) is also limited to firm and supply chain operational-level considerations only. The strategic levels dimensions of CSCM (such as business model innovations) are not considered in this research. Similarly, the firm performance broadly covers the environmental and economic performance dimensions, but the social sustainability aspects are not considered in this research. The CSCM barriers study (manuscript 3) is limited to identifying the most relevant barriers at firm and supply chain level; therefore, the list of barriers presented in the study is far from exhaustive, although it was considered adequate to meet the research objectives.

Secondly, there are limitations due to cross-sectional survey design used for primary data collection. Both the CSCM to performance relationship and the barriers to integrating CE into

SCM were uncovered at a given point in time. Thus, the development of CSCM, its impact on the firm performance and how the barriers to CSCM development evolved over time are not captured in this research.

Lastly, the empirical studies (i.e. manuscripts 2 and 3) are limited to the Chinese manufacturing industry context. Although the Chinese context is considered best suited to the scope of the research presented in this thesis, the research findings may not be fully applicable in other contexts.

5.4.2 Future research directions

Given that CE is a promising new frontier in sustainable thinking, there are ample opportunities for SCM sustainability researchers in the newly-conceptualised CSCM domain.

Firstly, the structured literature review results reveal several important areas where more research is required. These include design for circularity, procurement and CSCM, biodegradable packaging, circular supply chain collaboration and coordination, drivers and barriers of CSCM, circular consumption, product liabilities and producer's responsibility, and technologies and CSCM. These potential research areas may be prioritised by future researchers as there are significant knowledge gaps in the extant literature, and given the level of urgency required for action and implementation in these important research directions.

Secondly, future empirical research may consider including (but not being limited to) the aspects of regenerative cycle, social sustainability and business model innovations to broaden the scope of CSCM conceptualisation. Identification of relevant barriers in these areas may also be considered by future researchers.

Last but not least, the studies presented in this thesis provide an opportunity for future researchers to contextualise the findings in different settings. For example, in the Chinese manufacturing context, future research may consider focusing on a specific industry or group of related industries to take a closer look at industrial influences and contingencies affecting the CSCM practice-performance relationship. Similarly, future studies may explore additional industry-specific barriers under the most relevant theoretical lenses identified in this study. In addition, the thesis deliberations also encourage comparative studies of CSCM implementation in other contexts such as Europe to strengthen the validity and generalisability of the thesis findings and outcome.

6. References

Accenture. (2020). *Waste to Wealth: Creating advantage in a circular economy*. Retrieved 04/02/2020 from https://www.accenture.com/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Strategy_7/Accenture-Waste-Wealth-Infographic.pdf

Agrawal, V. V., Atasu, A., & Wassenhove, L. N. V. (2019). OM Forum—New Opportunities for Operations Management Research in Sustainability. *Manufacturing & Service Operations Management*, *21*(1), 1-12. https://doi.org/10.1287/msom.2017.0699

Ahi, P., & Searcy, C. (2013). A comparative literature analysis of definitions for green and sustainable supply chain management. *Journal of Cleaner Production*, *52*, 329-341. https://doi.org/https://doi.org/10.1016/j.jclepro.2013.02.018.

Ahi, P., & Searcy, C. (2015). An analysis of metrics used to measure performance in green and sustainable supply chains. *Journal of Cleaner Production*, *86*(Supplement C), 360-377. https://doi.org/https://doi.org/10.1016/j.jclepro.2014.08.005

Ahmed, J., & Varshney, S. K. (2011). Polylactides—Chemistry, Properties and Green Packaging Technology: A Review. *International Journal of Food Properties*, *14*(1), 37-58. https://doi.org/https://doi.org/10.1080/10942910903125284

Alvarez-de-los-Mozos, E., & Renteria, A. (2017). Collaborative Robots in e-waste Management [Article]. *Procedia Manufacturing, 11*, 55-62. https://doi.org/https://doi.org/10.1016/j.promfg.2017.07.133

Aminoff, A., & Kettunen, O. (2016). Sustainable Supply Chain Management in a Circular Economy—Towards Supply Circles. In R. Setchi, R. J. Howlett, Y. Liu, & P. Theobald (Eds.), *Sustainable Design and Manufacturing 2016* (pp. 61-72). Springer International Publishing. https://doi.org/https://doi.org/10.1007/978-3-319-32098-4_6

Anand, G., Ward, P. T., Tatikonda, M. V., & Schilling, D. A. (2009). Dynamic capabilities through continuous improvement infrastructure. *Journal of Operations Management, 27*(6), 444-461. https://doi.org/https://doi.org/10.1016/j.jom.2009.02.002

Andersen, M. S. (2007). An introductory note on the environmental economics of the circular economy [journal article]. *Sustainability Science, 2*(1), 133-140. https://doi.org/https://doi.org/10.1007/s11625-006-0013-6

Andrews, D. (2015). The circular economy, design thinking and education for sustainability [Article]. *Local Economy, 30*(3), 305-315. https://doi.org/https://doi.org/10.1177/0269094215578226

Anne, T., & Helen, W. (2015). Theories in sustainable supply chain management: a structured literature review. *International Journal of Physical Distribution & Logistics Management, 45*(1/2), 16-42. https://doi.org/https://doi.org/10.1108/IJPDLM-05-2013-0106

Ansari, Z. N., & Kant, R. (2017). A state-of-art literature review reflecting 15 years of focus on sustainable supply chain management. *Journal of Cleaner Production, 142*(Part 4), 2524-2543. https://doi.org/https://doi.org/10.1016/j.jclepro.2016.11.023

Antoniou, N., & Zabaniotou, A. (2015). Experimental proof of concept for a sustainable End of Life Tyres pyrolysis with energy and porous materials production [Article]. *Journal of Cleaner Production, 101*, 1-14. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.03.101

Aragón-Correa, J. A., & A. Rubio-López, E. (2007). Proactive Corporate Environmental Strategies: Myths and Misunderstandings. *Long Range Planning, 40*(3), 357-381. https://doi.org/https://doi.org/10.1016/j.lrp.2007.02.008

Aragón-Correa, J. A., & Sharma, S. (2003). A Contingent Resource-Based View of Proactive Corporate Environmental Strategy. *Academy of Management Review, 28*(1), 71-88. https://doi.org/https://doi.org/10.5465/amr.2003.8925233

Aronow, S., Ennis, K., & Romano, J. (2018). *The Gartner Supply Chain Top 25 for 2018*. Retrieved 25 February 2019 from https://www.gartner.com/doc/3875506?

Atalay, A., & Ravi, S. (2012). Extended Producer Responsibility for E-Waste: Individual or Collective Producer Responsibility? *Production and Operations Management, 21*(6), 1042-1059. https://doi.org/https://doi.org/10.1111/j.1937-5956.2012.01327.x

Atasu, A., Agrawal, V., Rinaldi, M., Herb, R., & Ulku, S. (2018). Rethinking Sustainability in Light of the EU's New Circular Economy Policy. *Harvard business review*, Article H04C68-PDF-ENG. https://hbr.org/2018/07/rethinking-sustainability-in-light-of-the-eus-new-circular-economy-policy

Awasthi, A. K., Cucchiella, F., D'Adamo, I., Li, J., Rosa, P., Terzi, S., Wei, G., & Zeng, X. (2018). Modelling the correlations of e-waste quantity with economic increase. *Science of the Total Environment, 613-614*, 46-53. https://doi.org/https://doi.org/10.1016/j.scitotenv.2017.08.288

Bai, C., & Sarkis, J. (2013). A grey-based DEMATEL model for evaluating business process management critical success factors. *International Journal of Production Economics, 146*(1), 281-292. https://doi.org/https://doi.org/10.1016/j.ijpe.2013.07.011

Bai, C., Sarkis, J., & Dou, Y. (2017). Constructing a process model for low-carbon supply chain cooperation practices based on the DEMATEL and the NK model. *Supply Chain Management: An International Journal, 22*(3), 237-257. https://doi.org/doi:10.1108/SCM-09-2015-0361

Bakker, C., Wang, F., Huisman, J., & Den Hollander, M. (2014). Products that go round: Exploring product life extension through design [Article]. *Journal of Cleaner Production, 69*, 10-16. https://doi.org/https://doi.org/10.1016/j.jclepro.2014.01.028

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management, 17*(1), 99-120. https://doi.org/https://doi.org/10.1177/014920639101700108

Batista, L., Bourlakis, M., Smart, P., & Maull, R. (2018). In search of a circular supply chain archetype–a content-analysis-based literature review [Review]. *Production Planning and Control, 29*(6), 438-451. https://doi.org/10.1080/09537287.2017.1343502

Batista, L., Gong, Y., Pereira, S., Jia, F., & Bittar, A. (2018). Circular supply chains in emerging economies–a comparative study of packaging recovery ecosystems in China and Brazil [Article in Press]. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2018.1558295

Baykasoğlu, A., & Gölcük, İ. (2015). Development of a novel multiple-attribute decision making model via fuzzy cognitive maps and hierarchical fuzzy TOPSIS. *Information Sciences, 301*, 75-98. https://doi.org/https://doi.org/10.1016/j.ins.2014.12.048

Bernon, M., Tjahjono, B., & Ripanti, E. F. (2018). Aligning retail reverse logistics practice with circular economy values: an exploratory framework [Article]. *Production Planning and Control, 29*(6), 483-497. https://doi.org/10.1080/09537287.2018.1449266

Bicket, M., Guilcher, S., Hestin, M., Hudson, C., Razzini, P., Tan, A., ten Brink, P., van Dijl, E., Vanner, R., & Watkins, E. (2014). *Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains*. Retrieved 25/02/2018 from http://bookshop.europa.eu/en/scoping-study-to-identify-potential-circular-economy-actions-priority-sectors-material-flows-and-value-chains-pbKH0114775/

Bilitewski, B. (2012). The Circular Economy and its Risks. *Waste Management, 32*(1), 1-2. https://doi.org/https://doi.org/10.1016/j.wasman.2011.10.004

Blaikie, N. (2009). *Designing social research*. Polity.

Blome, C., Hollos, D., & Paulraj, A. (2014). Green procurement and green supplier development: antecedents and effects on supplier performance. *International Journal of Production Research, 52*(1), 32-49. https://doi.org/https://doi.org/10.1080/00207543.2013.825748

Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy [Article]. *Journal of Industrial and Production Engineering, 33*(5), 308-320. https://doi.org/https://doi.org/10.1080/21681015.2016.1172124

Bocken, N. M. P., Miller, K., Weissbrod, I., Holgado, M., & Evans, S. (2017). Business model experimentation for circularity: Driving sustainability in a large international clothing retailer [Article]. *Economics and Policy of Energy and the Environment, 2017*(1), 85-122. https://doi.org/https://doi.org/10.3280/EFE2017-001006

Bocken, N. M. P., Olivetti, E. A., Cullen, J. M., Potting, J., & Lifset, R. (2017). Taking the Circularity to the Next Level: A Special Issue on the Circular Economy. *Journal of Industrial Ecology, 21*(3), 476-482. https://doi.org/https://doi.org/10.1111/jiec.12606

Bocken, N. M. P., Schuit, C. S. C., & Kraaijenhagen, C. (2018). Experimenting with a circular business model: Lessons from eight cases [Article in Press]. *Environmental Innovation and Societal Transitions, 28*, 79-95. https://doi.org/10.1016/j.eist.2018.02.001

Bollen, K. A. (2014). *Structural equations with latent variables* (Vol. 210). John Wiley & Sons.

Borrello, M., Caracciolo, F., Lombardi, A., Pascucci, S., & Cembalo, L. (2017). Consumers' Perspective on Circular Economy Strategy for Reducing Food Waste. *Sustainability (Switzerland), 9*(1), 141. https://doi.org/doi:10.3390/su9010141

Borrello, M., Lombardi, A., Pascucci, S., & Cembalo, L. (2016). The Seven Challenges for Transitioning into a Bio-based Circular Economy in the Agri-food Sector. *Recent Patents on Food, Nutrition & Agriculture, 8*(1), 39-47. http://www.ingentaconnect.com/content/ben/pfna/2016/00000008/00000001/art00010

Botelho, A., Ferreira Dias, M., Ferreira, C., & Pinto, L. M. C. (2016). The market of electrical and electronic equipment waste in Portugal: Analysis of take-back consumers' decisions [Article]. *Waste Management and Research, 34*(10), 1074-1080. https://doi.org/https://doi.org/10.1177/0734242X16658546

Bovea, M. D., Ibáñez-Forés, V., Pérez-Belis, V., Juan, P., Braulio-Gonzalo, M., & Díaz-ávalos, C. (2018). Incorporation of circular aspects into product design and labelling: Consumer preferences [Article]. *Sustainability (Switzerland), 10*(7), Article 2311. https://doi.org/10.3390/su10072311

Bovea, M. D., & Pérez-Belis, V. (2012). A taxonomy of ecodesign tools for integrating environmental requirements into the product design process. *Journal of Cleaner Production, 20*(1), 61-71. https://doi.org/https://doi.org/10.1016/j.jclepro.2011.07.012

Bovea, M. D., & Pérez-Belis, V. (2018). Identifying design guidelines to meet the circular economy principles: A case study on electric and electronic equipment [Article]. *Journal of Environmental Management, 228*, 483-494. https://doi.org/10.1016/j.jenvman.2018.08.014

Bovea, M. D., Quemades-Beltrán, P., Pérez-Belis, V., Juan, P., Braulio-Gonzalo, M., & Ibáñez-Forés, V. (2018). Options for labelling circular products: Icon design and consumer preferences [Article]. *Journal of Cleaner Production, 202*, 1253-1263. https://doi.org/10.1016/j.jclepro.2018.08.180

Boyer, K. K., Ward, P. T., & Leong, G. K. (1996). Approaches to the factory of the future. An empirical taxonomy. *Journal of Operations Management, 14*(4), 297-313. https://doi.org/https://doi.org/10.1016/S0272-6963(96)00093-9

Bressanelli, G., Adrodegari, F., Perona, M., & Saccani, N. (2018). Exploring how usage-focused business models enable circular economy through digital technologies [Article]. *Sustainability (Switzerland), 10*(3), Article 639. https://doi.org/10.3390/su10030639

Bressanelli, G., Perona, M., & Saccani, N. (2018). Challenges in supply chain redesign for the Circular Economy: a literature review and a multiple case study [Article in Press]. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2018.1542176

Brezet, H. (1997). *Ecodesign, a promising approach to sustainable production and consumption*. United Nations Environmental Program (UNEP).

Broadbent, C. (2016). Steel's recyclability: demonstrating the benefits of recycling steel to achieve a circular economy [Article]. *International Journal of Life Cycle Assessment, 21*(11), 1658-1665. https://doi.org/https://doi.org/10.1007/s11367-016-1081-1

Brouwer, M. T., Thoden van Velzen, E. U., Augustinus, A., Soethoudt, H., De Meester, S., & Ragaert, K. (2018). Predictive model for the Dutch post-consumer plastic packaging recycling system and implications for the circular economy [Article]. *Waste Management, 71*, 62-85. https://doi.org/10.1016/j.wasman.2017.10.034

Brown, G., & Stone, L. (2007). Cleaner production in New Zealand: taking stock. *Journal of Cleaner Production, 15*(8), 716-728. https://doi.org/https://doi.org/10.1016/j.jclepro.2006.06.025

Brulhart, F., Gherra, S., & Quelin, B. V. (2019). Do Stakeholder Orientation and Environmental Proactivity Impact Firm Profitability? [journal article]. *Journal of Business Ethics, 158*(1), 25-46. https://doi.org/10.1007/s10551-017-3732-y

Brundtland, G. H. (1987). World commission on environment and development (1987): Our common future. *World Commission for Environment and Development*. http://www.un-documents.net/wced-ocf.htm

Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done? *Qualitative Research, 6*(1), 97-113. https://doi.org/https://doi.org/10.1177/1468794106058877

Bryman, A. (2015). *Social research methods*. Oxford university press.

Buysse, K., & Verbeke, A. (2003). Proactive environmental strategies: A stakeholder management perspective. *Strategic Management Journal, 24*(5), 453-470.

Büyüközkan, G., & Güleryüz, S. (2016). An integrated DEMATEL-ANP approach for renewable energy resources selection in Turkey. *International Journal of Production Economics, 182*, 435-448. https://doi.org/https://doi.org/10.1016/j.ijpe.2016.09.015

Camacho-Otero, J., Boks, C., & Pettersen, I. N. (2018). Consumption in the circular economy: A literature review [Article]. *Sustainability (Switzerland), 10*(8), Article 2758. https://doi.org/10.3390/su10082758

Canning, L. (2006). Rethinking market connections: mobile phone recovery, reuse and recycling in the UK. *Journal of Business & Industrial Marketing, 21*(5), 320-329. https://doi.org/https://doi.org/10.1108/08858620610681623

Carter, C. R., & Carter, J. R. (1998). Interorganizational Determinants of Environmental Purchasing: Initial Evidence from the Consumer Products Industries*. *Decision Sciences, 29*(3), 659-684. https://doi.org/10.1111/j.1540-5915.1998.tb01358.x

Carter, C. R., & Ellram, L. M. (1998). Reverse logistics: a review of the literature and framework for future investigation. *Journal of business logistics, 19*(1), 85.

Carter, C. R., Ellram, L. M., & Ready, K. J. (1998). Environmental Purchasing: Benchmarking Our German Counterparts. *International Journal of Purchasing and Materials Management, 34*(3), 28-38. https://doi.org/10.1111/j.1745-493X.1998.tb00299.x

Carter, C. R., & Jennings, M. M. (2002). Social responsibility and supply chain relationships. *Transportation Research Part E: Logistics and Transportation Review, 38*(1), 37-52. https://doi.org/https://doi.org/10.1016/S1366-5545(01)00008-4

Carter, C. R., Kale, R., & Grimm, C. M. (2000). Environmental purchasing and firm performance: an empirical investigation. *Transportation Research Part E: Logistics and Transportation Review, 36*(3), 219-228. https://doi.org/https://doi.org/10.1016/S1366-5545(99)00034-4

Carter, R. C., & Dale, S. R. (2008). A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution & Logistics Management, 38*(5), 360-387. https://doi.org/https://doi.org/10.1108/09600030810882816

Castellani, V., Sala, S., & Mirabella, N. (2015). Beyond the throwaway society: A life cycle-based assessment of the environmental benefit of reuse [Article]. *Integrated Environmental Assessment and Management, 11*(3), 373-382. https://doi.org/https://doi.org/10.1002/ieam.1614

Chakraborty, S. (2010). Concise chronological road map of evolving green supply chain management concepts: a review. *IUP Journal of Supply Chain Management, 7*(4), 7-25.

Chen, C., Zhu, J., Yu, J.-Y., & Noori, H. (2012). A new methodology for evaluating sustainable product design performance with two-stage network data envelopment analysis. *European Journal of Operational Research, 221*(2), 348-359. https://doi.org/https://doi.org/10.1016/j.ejor.2012.03.043

Chen, H., Zeng, S., Lin, H., & Ma, H. (2017). Munificence, Dynamism, and Complexity: How Industry Context Drives Corporate Sustainability. *Business Strategy and the Environment, 26*(2), 125-141. https://doi.org/10.1002/bse.1902

Chertow, M. R. (2000). Industrial symbiosis: literature and taxonomy. *Annual review of energy and the environment, 25*(1), 313-337.

Chertow, M. R. (2007). "Uncovering" Industrial Symbiosis. *Journal of Industrial Ecology, 11*(1), 11-30. https://doi.org/10.1162/jiec.2007.1110

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating Goodness-of-Fit Indexes for Testing Measurement Invariance. *Structural Equation Modeling: A Multidisciplinary Journal, 9*(2), 233-255. https://doi.org/10.1207/S15328007SEM0902_5

Choi, D., & Hwang, T. (2015). The impact of green supply chain management practices on firm performance: the role of collaborative capability [journal article]. *Operations Management Research, 8*(3), 69-83. https://doi.org/https://doi.org/10.1007/s12063-015-0100-x

Clark, J. H. (2017). From waste to wealth using green chemistry: The way to long term stability [Review]. *Current Opinion in Green and Sustainable Chemistry, 8*, 10-13. https://doi.org/https://doi.org/10.1016/j.cogsc.2017.07.008

Clark, J. H., Farmer, T. J., Herrero-Davila, L., & Sherwood, J. (2016). Circular economy design considerations for research and process development in the chemical sciences [Review]. *Green Chemistry, 18*(14), 3914-3934. https://doi.org/https://doi.org/10.1039/c6gc00501b

Cobo, S., Dominguez-Ramos, A., & Irabien, A. (2018). From linear to circular integrated waste management systems: a review of methodological approaches [Article]. *Resources, Conservation and Recycling, 135*, 279-295. https://doi.org/10.1016/j.resconrec.2017.08.003

Cong, L., Zhao, F., & Sutherland, J. W. (2017a). Integration of dismantling operations into a value recovery plan for circular economy [Article]. *Journal of Cleaner Production, 149*, 378-386. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.02.115

Cong, L., Zhao, F., & Sutherland, J. W. (2017b). Product Redesign for Improved Value Recovery via Disassembly Bottleneck Identification and Removal. *Procedia CIRP, 61*(Supplement C), 81-86. https://doi.org/https://doi.org/10.1016/j.procir.2016.11.216

Cong, L., Zhao, F., & Sutherland, J. W. (2017). Value recovery from end-of-use products facilitated by automated dismantling planning [Article]. *Clean Technologies and Environmental Policy, 19*(7), 1867-1882. https://doi.org/https://doi.org/10.1007/s10098-017-1370-9

Coughlan, D., Fitzpatrick, C., & McMahon, M. (2018). Repurposing end of life notebook computers from consumer WEEE as thin client computers – A hybrid end of life strategy for the Circular Economy in electronics [Article]. *Journal of Cleaner Production, 192*, 809-820. https://doi.org/10.1016/j.jclepro.2018.05.029

Cousins Paul, D. (2019). Investigating green supply chain management practices and performance: The moderating roles of supply chain ecocentricity and traceability. *International Journal of Operations & Production Management, 39*(5), 767-786. https://doi.org/10.1108/IJOPM-11-2018-0676

Craig, R. C., & Easton, P. L. (2011). Sustainable supply chain management: evolution and future directions. *International Journal of Physical Distribution & Logistics Management, 41*(1), 46-62. https://doi.org/https://doi.org/10.1108/09600031111101420

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage.

Cucciella, F., Koh, L., Guang Shi, V., Lenny Koh, S., Baldwin, J., & Cucchiella, F. (2012). Natural resource based green supply chain management. *Supply Chain Management: An International Journal, 17*(1), 54-67. https://doi.org/https://doi.org/10.1108/13598541211212203

Cui, H., & Song, X. (2009). The Study on Countermeasures of Promoting Energy-Saving and Emissions-Reducing Based on Circular Economy Theory. 2009 IITA International Conference on Services Science, Management and Engineering,

Cui, K., & Shoemaker, S. P. (2018). A look at food security in China. *npj Science of Food, 2*(1), 4. https://doi.org/10.1038/s41538-018-0012-x

Dacin, M. T., Goodstein, J., & Scott, W. R. (2002). Institutional Theory and Institutional Change: Introduction to the Special Research Forum. *The Academy of Management Journal, 45*(1), 45-56. https://doi.org/10.2307/3069284

Daily, B. F., & Huang, S. C. (2001). Achieving sustainability through attention to human resource factors in environmental management. *International Journal of Operations & Production Management, 21*(12), 1539-1552. https://doi.org/https://doi.org/10.1108/01443570110410892

Darom, N. A. M., & Hishamuddin, H. (2016). Integration of economic and environmental aspects in sustainable supply chain management: A review. Proceedings of the 6th International Conference on Industrial Engineering and Operations Management, Kuala Lumpur, Malaysia,

De Angelis, R., Howard, M., & Miemczyk, J. (2018). Supply chain management and the circular economy: towards the circular supply chain [Article]. *Production Planning and Control, 29*(6), 425-437. https://doi.org/10.1080/09537287.2018.1449244

De los Rios, I. C., & Charnley, F. J. S. (2017). Skills and capabilities for a sustainable and circular economy: The changing role of design. *Journal of Cleaner Production, 160*(Supplement C), 109-122. https://doi.org/https://doi.org/10.1016/j.jclepro.2016.10.130

Debo, L. G., Toktay, L. B., & Wassenhove, L. N. V. (2005). Market Segmentation and Product Technology Selection for Remanufacturable Products. *Management Science, 51*(8), 1193-1205. https://doi.org/https://doi.org/10.1287/mnsc.1050.0369

Dekker, R., Bloemhof, J., & Mallidis, I. (2012). Operations Research for green logistics–An overview of aspects, issues, contributions and challenges. *European Journal of Operational Research, 219*(3), 671-679.

den Hollander, M. C., Bakker, C. A., & Hultink, E. J. (2017). Product Design in a Circular Economy: Development of a Typology of Key Concepts and Terms [Article]. *Journal of Industrial Ecology, 21*(3), 517-525. https://doi.org/https://doi.org/10.1111/jiec.12610

Densley Tingley, D., Cooper, S., & Cullen, J. (2017). Understanding and overcoming the barriers to structural steel reuse, a UK perspective [Article]. *Journal of Cleaner Production, 148*, 642-652. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.02.006

Dente, S. M. R., & Tavasszy, L. A. (2018). Impacts of trade related sustainability strategies on freight transportation: Modelling framework and application for France [Article]. *Transportation Research Part D: Transport and Environment, 58*, 308-319. https://doi.org/10.1016/j.trd.2017.04.006

Despeisse, M., Baumers, M., Brown, P., Charnley, F., Ford, S. J., Garmulewicz, A., Knowles, S., Minshall, T. H. W., Mortara, L., Reed-Tsochas, F. P., & Rowley, J. (2017). Unlocking value for a circular economy through 3D printing: A research agenda [Article]. *Technological Forecasting and Social Change, 115*, 75-84. https://doi.org/https://doi.org/10.1016/j.techfore.2016.09.021

Dhakal, M., Smith, M. H., & Newbery, R. (2016). Secondary market: A significant aspect in reverse logistics and sustainability [Article]. *International Journal of Sustainability in Economic, Social, and Cultural Context, 12*(1), 24-35. https://doi.org/https://doi.org/10.18848/2325-1115/CGP

Di Maio, F., Rem, P. C., Baldé, K., & Polder, M. (2017). Measuring resource efficiency and circular economy: A market value approach [Article]. *Resources, Conservation and Recycling, 122*, 163-171. https://doi.org/https://doi.org/10.1016/j.resconrec.2017.02.009

Diamantopoulos, A., & Winklhofer, H. M. (2001). Index Construction with Formative Indicators: An Alternative to Scale Development. *Journal of Marketing Research, 38*(2), 269-277. https://doi.org/10.1509/jmkr.38.2.269.18845

Diener, D. L., & Tillman, A. M. (2016). Scrapping steel components for recycling - Isn't that good enough? Seeking improvements in automotive component end-of-life [Article]. *Resources, Conservation and Recycling, 110*, 48-60. https://doi.org/https://doi.org/10.1016/j.resconrec.2016.03.001

DiMaggio, P. J., & Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. *American Sociological Review, 48*(2), 147-160. https://doi.org/https://doi.org/10.2307/2095101

Dobrzykowski, D. D., McFadden, K. L., & Vonderembse, M. A. (2016). Examining pathways to safety and financial performance in hospitals: A study of lean in professional service operations. *Journal of Operations Management, 42-43*, 39-51. https://doi.org/https://doi.org/10.1016/j.jom.2016.03.001

Domenech, T., Bleischwitz, R., Doranova, A., Panayotopoulos, D., & Roman, L. (2019). Mapping Industrial Symbiosis Development in Europe_ typologies of networks, characteristics, performance and contribution to the Circular Economy. *Resources, Conservation and Recycling, 141*, 76-98. https://doi.org/https://doi.org/10.1016/j.resconrec.2018.09.016

Donaldson, T., & Preston, L. E. (1995). The Stakeholder Theory of the Corporation: Concepts, Evidence, and Implications. *Academy of Management Review, 20*(1), 65-91. https://doi.org/https://doi.org/10.5465/amr.1995.9503271992

Dou, Y., Sarkis, J., & Bai, C. (2014). Government Green Procurement: A Fuzzy-DEMATEL Analysis of Barriers. Supply Chain Management Under Fuzziness: Recent Developments and Techniques, Berlin, Heidelberg.

Du, L., Lianqing, Y., & Rao, C. (2010). The construction research on Rapid-Response Eco-Supply Chain of the textile industry based on the circular economy. International Conference on E-Health Networking Digital Ecosystems and Technologies (EDT), Dubey, R., Gunasekaran, A., Childe, S. J., Papadopoulos, T., & Fosso Wamba, S. (2017). World class sustainable supply chain management: critical review and further research directions. *The International Journal of Logistics Management, 28*(2), 332-362. https://doi.org/https://doi.org/10.1108/IJLM-07-2015-0112

Dubey, R., Gunasekaran, A., Childe, S. J., Papadopoulos, T., Luo, Z., Wamba, S. F., & Roubaud, D. (2017). Can big data and predictive analytics improve social and environmental sustainability? *Technological Forecasting and Social Change*. https://doi.org/https://doi.org/10.1016/j.techfore.2017.06.020

Dubey, R., Gunasekaran, A., & Samar Ali, S. (2015). Exploring the relationship between leadership, operational practices, institutional pressures and environmental performance: A framework for green supply chain. *International Journal of Production Economics, 160*(Supplement C), 120-132. https://doi.org/https://doi.org/10.1016/j.ijpe.2014.10.001

EC (European Commission). (2009). *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives*. Retrieved 15/03/2018) from http://eur-lex.europa.eu/eli/dir/2008/98/oj

Edwards, J. R. (2019). Response invalidity in empirical research: Causes, detection, and remedies. *Journal of Operations Management, 65*(1), 62-76. https://doi.org/10.1016/j.jom.2018.12.002

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic Capabilities: What Are They? *Strategic Management Journal, 21*(10/11), 1105-1121. http://www.jstor.org/stable/3094429

Elkington's, J. (2004). Enter the triple bottom line. *The triple bottom line: Does it all add up, 11*(12), 1-16.

Elkington, J. (1997). *Cannibals with forks: The triple bottom line of 21st-century business*. Oxford: Capstone Publishing.

Elkington, J. (1998). Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environmental Quality Management, 8*(1), 37-51. https://doi.org/10.1002/tqem.3310080106

Elkington, J. (2004). Enter the triple bottom line. In A. Henriques & J. Richardson (Eds.), *The triple bottom line: Does it all add up* (Vol. 11, pp. 1-16). Earthscan, London.

Ellen MacArthur Foundation. (2012a). *Towards the circular economy*. https://www.ellenmacarthurfoundation.org/publications/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an-accelerated-transition

Ellen MacArthur Foundation. (2012b). *Towards the circular economy*. Retrieved 14/03/2018) from https://www.ellenmacarthurfoundation.org/publications/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an-accelerated-transition

Ellen MacArthur Foundation. (2013). *Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition* (Vol. 1).

https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

Ellen MacArthur Foundation. (2014). *Towards the circular economy: Accelerating the scale-up across global supply chains* (Vol. 3). https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Towards-the-circular-economy-volume-3.pdf

Ellen MacArthur Foundation. (2017). *What is a circular economy?* Retrieved 14/03/2018) from https://www.ellenmacarthurfoundation.org/circular-economy

Ellen MacArthur Foundation. (2019a). *Building blocks of a circular economy*. Retrieved 18/10/2019 from https://www.ellenmacarthurfoundation.org/circular-economy/concept/building-blocks

Ellen MacArthur Foundation. (2019b). *The circular economy concept*. Retrieved 13/10/2019 from https://www.ellenmacarthurfoundation.org/circular-economy/concept

Ellen MacArthur Foundation. (2020). *What is a circular economy?* Retrieved 04/02/2020 from https://www.ellenmacarthurfoundation.org/circular-economy

Esmaeilian, B., Wang, B., Lewis, K., Duarte, F., Ratti, C., & Behdad, S. (2018). The future of waste management in smart and sustainable cities: A review and concept paper [Review]. *Waste Management, 81*, 177-195. https://doi.org/10.1016/j.wasman.2018.09.047

Esposito, M., Tse, T., & Soufani, K. (2015). Is the Circular Economy a New Fast-Expanding Market? *Thunderbird International Business Review*.

Esposito, M., Tse, T., & Soufani, K. (2018). Reverse logistics for postal services within a circular economy [Article]. *Thunderbird International Business Review, 60*(5), 741-745. https://doi.org/10.1002/tie.21904

European Commission. (2020a). *Circular Procurement*. Retrieved 20/01/2020 from https://ec.europa.eu/environment/gpp/circular_procurement_en.htm

European Commission. (2020b). *Global demand for resources*. Retrieved 05/02/2020 from https://ec.europa.eu/knowledge4policy/foresight/topic/aggravating-resource-scarcity/global-demand-resources-materials_en

Fahimnia, B., Sarkis, J., & Davarzani, H. (2015). Green supply chain management: A review and bibliometric analysis. *International Journal of Production Economics, 162*, 101-114. https://doi.org/https://doi.org/10.1016/j.ijpe.2015.01.003

Fang, Y., Côté, R. P., & Qin, R. (2007). Industrial sustainability in China: Practice and prospects for eco-industrial development. *Journal of Environmental Management, 83*(3), 315-328. https://doi.org/10.1016/j.jenvman.2006.03.007

Farooque, M., & Zhang, A. (2017). Supply chain management for the circular economy: A review and a classification of terms. . Proceedings of the 15th ANZAM Operations, Supply Chain and Services Management Symposium, Farooque, M., Zhang, A., & Liu, Y. (2019). Barriers to circular food supply chains in China. *Supply Chain Management: An International Journal, 24*(5), 677-696. https://doi.org/10.1108/SCM-10-2018-0345

Farooque, M., Zhang, A., Thürer, M., Qu, T., & Huisingh, D. (2019). Circular supply chain management: A definition and structured literature review. *Journal of Cleaner Production, 228*, 882-900. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.04.303

Favot, M., Veit, R., & Massarutto, A. (2016). The evolution of the Italian EPR system for the management of household Waste Electrical and Electronic Equipment (WEEE). Technical and economic performance in the spotlight [Article]. *Waste Management, 56*, 431-437. https://doi.org/https://doi.org/10.1016/j.wasman.2016.06.005

Finkelstein, S. (1997). Interindustry Merger Patterns and Resource Dependence: A Replication and Extension of Pfeffer (1972). *Strategic Management Journal, 18*(10), 787-810.

Flink, A. (2017). Ecological supply chain in circular economy: Adopting circular economy principles in cotton textile supply chain Case: Finlayson Ltd. http://www.doria.fi/bitstream/handle/10024/133878/gradu_flink.pdf?sequence=2&isAllowed=y

Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management, 28*(1), 58-71. https://doi.org/https://doi.org/10.1016/j.jom.2009.06.001

Food and Agricultural Organisation. (2015). *Food wastage footprint & climate change*. Food and Agricultural Organisation of United Nations. Retrieved 13/02/2019 from http://www.fao.org/3/a-bb144e.pdf

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research, 18*(1), 39-50. https://doi.org/10.1177/002224378101800104

Fowler, S. J., & Hope, C. (2007). Incorporating sustainable business practices into company strategy. *Business Strategy and the Environment, 16*(1), 26-38.

Franco, M. A. (2017). Circular economy at the micro level: A dynamic view of incumbents' struggles and challenges in the textile industry [Article]. *Journal of Cleaner Production, 168*, 833-845. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.09.056

Freeman, R. E. (2010). *Strategic management: A stakeholder approach*. Cambridge university press.

Frota Neto, J. Q., Bloemhof-Ruwaard, J. M., van Nunen, J. A. E. E., & van Heck, E. (2008). Designing and evaluating sustainable logistics networks. *International Journal of Production Economics, 111*(2), 195-208. https://doi.org/https://doi.org/10.1016/j.ijpe.2006.10.014

Fu, X., Zhu, Q., & Sarkis, J. (2012). Evaluating green supplier development programs at a telecommunications systems provider. *International Journal of Production Economics, 140*(1), 357-367. https://doi.org/https://doi.org/10.1016/j.ijpe.2011.08.030

Gandhi, S., Mangla, S. K., Kumar, P., & Kumar, D. (2015). Evaluating factors in implementation of successful green supply chain management using DEMATEL: A case study. *International Strategic Management Review, 3*(1), 96-109. https://doi.org/https://doi.org/10.1016/j.ism.2015.05.001

Gao, D., Xu, Z., Ruan, Y. Z., & Lu, H. (2017). From a systematic literature review to integrated definition for sustainable supply chain innovation (SSCI). *Journal of Cleaner Production, 142*(Part 4), 1518-1538. https://doi.org/https://doi.org/10.1016/j.jclepro.2016.11.153

Garetti, M., & Taisch, M. (2012). Sustainable manufacturing: trends and research challenges. *Production Planning & Control, 23*(2-3), 83-104. https://doi.org/10.1080/09537287.2011.591619

Garmulewicz, A., Holweg, M., Veldhuis, H., & Yang, A. (2018). Disruptive Technology as an Enabler of the Circular Economy: What Potential Does 3D Printing Hold? [Article]. *California Management Review, 60*(3), 112-132. https://doi.org/10.1177/0008125617752695

Gartner. (2018). *The Gartner Supply Chain Top 25 for 2018*. I. Gartner. https://www.gartner.com/document/3875506?ref=solrAll&refval=233953722

Gartner. (2019). *The Gartner Supply Chain Top 25 for 2019*. I. Gartner. https://www.gartner.com/document/3913625?ref=solrAll&refval=233953722

Gaspari, L., Colucci, L., Butzer, S., Colledani, M., & Steinhilper, R. (2017). Modularization in material flow simulation for managing production releases in remanufacturing [Article]. *Journal of Remanufacturing, 7*(2-3), 139-157. https://doi.org/https://doi.org/10.1007/s13243-017-0037-3

Gauffin, A., Andersson, N. Å. I., Storm, P., Tilliander, A., & Jönsson, P. G. (2016). The global societal steel scrap reserves and amounts of losses [Article]. *Resources, 5*(3), Article 27. https://doi.org/https://doi.org/10.3390/resources5030027

Gaur, J., Mani, V., Banerjee, P., Amini, M., & Gupta, R. (2018). Towards building circular economy: A cross-cultural study of consumers' purchase intentions for reconstructed products [Article in Press]. *Management Decision*. https://doi.org/10.1108/MD-07-2018-0728

Gaustad, G., Krystofik, M., Bustamante, M., & Badami, K. (2018). Circular economy strategies for mitigating critical material supply issues [Article]. *Resources, Conservation and Recycling, 135*, 24-33. https://doi.org/10.1016/j.resconrec.2017.08.002

Gaustad, G., Olivetti, E., & Kirchain, R. (2010). Design for Recycling. *Journal of Industrial Ecology, 14*(2), 286-308. https://doi.org/https://doi.org/10.1111/j.1530-9290.2010.00229.x

Geng, R., Mansouri, S. A., & Aktas, E. (2017). The relationship between green supply chain management and performance: A meta-analysis of empirical evidences in Asian emerging economies. *International Journal of Production Economics, 183*, 245-258. https://doi.org/https://doi.org/10.1016/j.ijpe.2016.10.008

Geng, Y., & Doberstein, B. (2008). Developing the circular economy in China: Challenges and opportunities for achieving 'leapfrog development'. *International Journal of Sustainable Development & World Ecology, 15*(3), 231-239. https://doi.org/https://doi.org/10.3843/SusDev.15.3:6

Geng, Y., Fu, J., Sarkis, J., & Xue, B. (2012). Towards a national circular economy indicator system in China: an evaluation and critical analysis. *Journal of Cleaner Production, 23*(1), 216-224. https://doi.org/https://doi.org/10.1016/j.jclepro.2011.07.005

Geng, Y., Sarkis, J., & Bleischwitz, R. (2019). How to globalize the circular economy. *565*, 153-155. https://doi.org/10.1038/d41586-019-00017-z

Geng, Y., Sarkis, J., Ulgiati, S., & Zhang, P. (2013). Measuring China's Circular Economy. *Science, 339*(6127), 1526-1527. https://doi.org/10.1126/science.1227059

Geng, Y., Xinbei, W., Qinghua, Z., & Hengxin, Z. (2010). Regional initiatives on promoting cleaner production in China: a case of Liaoning. *Journal of Cleaner Production, 18*(15), 1502-1508. https://doi.org/https://doi.org/10.1016/j.jclepro.2010.06.028

Geng, Y., Zhu, Q., Doberstein, B., & Fujita, T. (2009). Implementing China's circular economy concept at the regional level: A review of progress in Dalian, China. *Waste Management, 29*(2), 996-1002. https://doi.org/https://doi.org/10.1016/j.wasman.2008.06.036

Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. C. L. (2017). Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications [Article]. *Omega (United Kingdom), 66*, 344-357. https://doi.org/https://doi.org/10.1016/j.omega.2015.05.015

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems [Review]. *Journal of Cleaner Production, 114*, 11-32. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.09.007

Ghisellini, P., Ji, X., Liu, G., & Ulgiati, S. (2018). Evaluating the transition towards cleaner production in the construction and demolition sector of China: A review [Article]. *Journal of Cleaner Production, 195*, 418-434. https://doi.org/10.1016/j.jclepro.2018.05.084

Giunipero, L. C., Hooker, R. E., & Denslow, D. (2012). Purchasing and supply management sustainability: Drivers and barriers. *Journal of Purchasing and Supply Management, 18*(4), 258-269. https://doi.org/https://doi.org/10.1016/j.pursup.2012.06.003

Giurco, D., Littleboy, A., Boyle, T., Fyfe, J., & White, S. (2014). Circular economy: Questions for responsible minerals, additive manufacturing and recycling of metals [Article]. *Resources, 3*(2), 432-453. https://doi.org/https://doi.org/10.3390/resources3020432

Global Footprint Network. (2020). *World Footprint*. Retrieved 05/02/2020 from https://www.footprintnetwork.org/our-work/ecological-footprint/

Golev, A., & Corder, G. D. (2016). Typology of options for metal recycling: Australia's perspective [Article]. *Resources, 5*(1), Article 1. https://doi.org/https://doi.org/10.3390/resources5010001

Golev, A., & Corder, G. D. (2017). Quantifying metal values in e-waste in Australia: The value chain perspective [Article]. *Minerals Engineering, 107*, 81-87. https://doi.org/https://doi.org/10.1016/j.mineng.2016.10.021

Golicic, S. L., & Smith, C. D. (2013). A Meta-Analysis of Environmentally Sustainable Supply Chain Management Practices and Firm Performance. *Journal of Supply Chain Management, 49*(2), 78-95. https://doi.org/https://doi.org/10.1111/jscm.12006

González-Benito, J. (2007). A theory of purchasing's contribution to business performance. *Journal of Operations Management, 25*(4), 901-917. https://doi.org/10.1016/j.jom.2007.02.001

Gorissen, L., Vrancken, K., & Manshoven, S. (2016). Transition thinking and business model innovation-towards a transformative business model and new role for the reuse centers of Limburg, Belgium [Article]. *Sustainability (Switzerland), 8*(2), Article 112. https://doi.org/https://doi.org/10.3390/su8020112

Govindan, K., Diabat, A., & Madan Shankar, K. (2015). Analyzing the drivers of green manufacturing with fuzzy approach. *Journal of Cleaner Production, 96*(Supplement C), 182-193. https://doi.org/https://doi.org/10.1016/j.jclepro.2014.02.054

Govindan, K., & Hasanagic, M. (2018). A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective [Article in Press]. *International Journal of Production Research*, 1-34. https://doi.org/10.1080/00207543.2017.1402141

Govindan, K., Kannan, D., & Shankar, M. (2015). Evaluation of green manufacturing practices using a hybrid MCDM model combining DANP with PROMETHEE. *International Journal of Production Research, 53*(21), 6344-6371. https://doi.org/https://doi.org/10.1080/00207543.2014.898865

Govindan, K., & Soleimani, H. (2017). A review of reverse logistics and closed-loop supply chains: a Journal of Cleaner Production focus. *Journal of Cleaner Production, 142*(Part 1), 371-384. https://doi.org/https://doi.org/10.1016/j.jclepro.2016.03.126

Govindan, K., Soleimani, H., & Kannan, D. (2015). Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future. *European Journal of Operational Research, 240*(3), 603-626. https://doi.org/https://doi.org/10.1016/j.ejor.2014.07.012

Goyal, S., Esposito, M., & Kapoor, A. (2018). Circular economy business models in developing economies: Lessons from India on reduce, recycle, and reuse paradigms [Article]. *Thunderbird International Business Review, 60*(5), 729-740. https://doi.org/10.1002/tie.21883

Graham, S., Graham, B., & Holt, D. (2018). The relationship between downstream environmental logistics practices and performance. *International Journal of Production Economics, 196*, 356-365. https://doi.org/https://doi.org/10.1016/j.ijpe.2017.12.011

Graham, S., & Potter, A. (2015). Environmental operations management and its links with proactivity and performance: A study of the UK food industry. *International Journal of Production Economics, 170*, 146-159. https://doi.org/https://doi.org/10.1016/j.ijpe.2015.09.021

Gray, D. E. (2013). *Doing research in the real world*. Sage.

Grimm, J. H., Hofstetter, J. S., & Sarkis, J. (2016). Exploring sub-suppliers' compliance with corporate sustainability standards. *Journal of Cleaner Production, 112, Part 3*, 1971-1984. https://doi.org/https://doi.org/10.1016/j.jclepro.2014.11.036

Grix, J. (2002). Introducing students to the generic terminology of social research. *Politics, 22*(3), 175-186.

Gu, Y., Wu, Y., Xu, M., Wang, H., & Zuo, T. (2017). To realize better extended producer responsibility: Redesign of WEEE fund mode in China [Article]. *Journal of Cleaner Production, 164*, 347-356. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.06.168

Guide Jr., V. D. R., & Ketokivi, M. (2015). Notes from the Editors: Redefining some methodological criteria for the journal⋆. *Journal of Operations Management, 37*(1), v-viii. https://doi.org/10.1016/s0272-6963(15)00056-x

Guide, V., & Van Wassenhove, L. (2003). Business aspects of closed-loop supply chains. Business Aspects of Closed-loop Supply Chains: Exploring the Issues. *Carnegie Bosch Institute, Pittsburgh, Pennsylvania*, 17-42.

Guide, V. D. R., & Ketokivi, M. (2015). Notes from the Editors: Redefining some methodological criteria for the journal. *Journal of Operations Management, 37*, v-viii. https://doi.org/https://doi.org/10.1016/S0272-6963(15)00056-X

Guide, V. D. R., & Van Wassenhove, L. N. (2006). Closed-Loop Supply Chains: An Introduction to the Feature Issue (Part 1). *Production and Operations Management, 15*(3), 345-350. https://doi.org/https://doi.org/10.1111/j.1937-5956.2006.tb00249.x

Gulati, R., & Sytch, M. (2007). Dependence Asymmetry and Joint Dependence in Interorganizational Relationships: Effects of Embeddedness on a Manufacturer's Performance in Procurement Relationships. *Administrative Science Quarterly, 52*(1), 32-69. https://doi.org/10.2189/asqu.52.1.32

Gumley, W. (2014). An analysis of regulatory strategies for recycling and re-use of metals in Australia [Article]. *Resources, 3*(2), 395-415. https://doi.org/https://doi.org/10.3390/resources3020395

Gurtu, A., Searcy, C., & Jaber, M. (2015). An analysis of keywords used in the literature on green supply chain management. *Management Research Review, 38*(2), 166-194. https://doi.org/https://doi.org/10.1108/MRR-06-2013-0157

Hahladakis, J. N., & Iacovidou, E. (2018). Closing the loop on plastic packaging materials: What is quality and how does it affect their circularity? [Article]. *Science of the Total Environment, 630*, 1394-1400. https://doi.org/10.1016/j.scitotenv.2018.02.330

Hahladakis, J. N., Purnell, P., Iacovidou, E., Velis, C. A., & Atseyinku, M. (2018). Post-consumer plastic packaging waste in England: Assessing the yield of multiple collection-recycling schemes [Article]. *Waste Management, 75*, 149-159. https://doi.org/10.1016/j.wasman.2018.02.009

Hair, J. F., Black, W. C., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (5th ed.). Pearson Prentice-Hall, New Jersey.

Harland, C. M., Lamming, R. C., Walker, H., Phillips, W. E., Caldwell, N. D., Johnsen, T. E., Knight, L. A., & Zheng, J. (2006). Supply management: is it a discipline? *International Journal of Operations & Production Management, 26*(7), 730-753. https://doi.org/https://doi.org/10.1108/01443570610672211

Harman, H. H. (1976). *Modern factor analysis*. University of Chicago press.

Hart, S. L. (1995). A Natural-Resource-Based View of the Firm. *The Academy of Management Review, 20*(4), 986-1014. https://doi.org/https://doi.org/10.2307/258963

Hart, S. L., & Dowell, G. (2011). Invited Editorial: A Natural-Resource-Based View of the Firm:Fifteen Years After. *Journal of Management, 37*(5), 1464-1479. https://doi.org/https://doi.org/10.1177/0149206310390219

Hartmann, J., & Vachon, S. (2018). Linking Environmental Management to Environmental Performance: The Interactive Role of Industry Context. *Business Strategy and the Environment, 27*(3), 359-374. https://doi.org/10.1002/bse.2003

Hartwell, I., & Marco, J. (2016). Management of intellectual property uncertainty in a remanufacturing strategy for automotive energy storage systems [Article]. *Journal of Remanufacturing, 6*(1), Article 3. https://doi.org/https://doi.org/10.1186/s13243-016-0025-z

Hazen, B. T., Mollenkopf, D. A., & Wang, Y. (2017). Remanufacturing for the Circular Economy: An Examination of Consumer Switching Behavior. *Business Strategy and the Environment, 26*(4), 451-464. https://doi.org/https://doi.org/10.1002/bse.1929

Helen, R., Norbert, B., & Kulwant, S. P. (2016). 3D printing services: classification, supply chain implications and research agenda. *International Journal of Physical Distribution & Logistics Management, 46*(10), 886-907. https://doi.org/https://doi.org/10.1108/IJPDLM-07-2016-0210

Herczeg, G., Akkerman, R., & Hauschild, M. Z. (2018). Supply chain collaboration in industrial symbiosis networks. *Journal of Cleaner Production, 171*, 1058-1067. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.10.046

Heyes, G., Sharmina, M., Mendoza, J. M. F., Gallego-Schmid, A., & Azapagic, A. (2018). Developing and implementing circular economy business models in service-oriented technology companies [Article]. *Journal of Cleaner Production, 177*, 621-632. https://doi.org/10.1016/j.jclepro.2017.12.168

Hillman, A. J., Withers, M. C., & Collins, B. J. (2009). Resource Dependence Theory: A Review. *Journal of Management, 35*(6), 1404-1427. https://doi.org/10.1177/0149206309343469

Hobson, K. (2016). Closing the loop or squaring the circle? Locating generative spaces for the circular economy. *Progress in Human Geography, 40*(1), 88-104. https://doi.org/https://doi.org/10.1177/0309132514566342

Hobson, K., Lynch, N., Lilley, D., & Smalley, G. (2018). Systems of practice and the Circular Economy: Transforming mobile phone product service systems [Article]. *Environmental Innovation and Societal Transitions, 26*, 147-157. https://doi.org/10.1016/j.eist.2017.04.002

Hodgson, G. (2005). Institutions and economic development: constraining, enabling and reconstituting. *Reimagining Growth: Towards a Renewal of Development Theory. London: Zed Books*, 85-98.

Hoornweg, D., Bhada-Tata, P., & Kennedy, C. (2013). Environment: Waste production must peak this century. *Nature, 502*(7473), 615-617. https://www.nature.com/news/environment-waste-production-must-peak-this-century-1.14032

Howard, M., Hopkinson, P., & Miemczyk, J. (2018). The regenerative supply chain: a framework for developing circular economy indicators [Article in Press]. *International Journal of Production Research*. https://doi.org/10.1080/00207543.2018.1524166

Hsu, C.-C., Choon Tan, K., Hanim Mohamad Zailani, S., & Jayaraman, V. (2013). Supply chain drivers that foster the development of green initiatives in an emerging economy. *International Journal of Operations & Production Management, 33*(6), 656-688. https://doi.org/https://doi.org/10.1108/IJOPM-10-2011-0401

Hu, H.-Y., Chiu, S.-I., Cheng, C.-C., & Yen, T.-M. (2011). Applying the IPA and DEMATEL models to improve the order-winner criteria: A case study of Taiwan's network communication equipment manufacturing industry. *Expert Systems with Applications, 38*(8), 9674-9683. https://doi.org/https://doi.org/10.1016/j.eswa.2011.01.147

Hu, L. t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55. https://doi.org/10.1080/10705519909540118

Huybrechts, D., Derden, A., Van den Abeele, L., Vander Aa, S., & Smets, T. (2018). Best available techniques and the value chain perspective [Article]. *Journal of Cleaner Production, 174*, 847-856. https://doi.org/10.1016/j.jclepro.2017.10.346

Ijomah, W. L., McMahon, C. A., Hammond, G. P., & Newman, S. T. (2007). Development of robust design-for-remanufacturing guidelines to further the aims of sustainable development. *International Journal of Production Research, 45*(18-19), 4513-4536. https://doi.org/https://doi.org/10.1080/00207540701450138

IRP (International Resource Panel). (2019). *Global Resources Outlook 2019: Natural Resources for the Future We Want*. Nairobi, Kenya. Retrieved 14/01/2020 from https://wedocs.unep.org/handle/20.500.11822/27518

Işıldar, A., Rene, E. R., van Hullebusch, E. D., & Lens, P. N. L. (2018). Electronic waste as a secondary source of critical metals: Management and recovery technologies [Article]. *Resources, Conservation and Recycling, 135*, 296-312. https://doi.org/10.1016/j.resconrec.2017.07.031

Jabbour, C. J. C., Jabbour, A. B. L. D. S., Sarkis, J., & Filho, M. G. (2017). Unlocking the circular economy through new business models based on large-scale data: An integrative framework and research agenda [Article in Press]. *Technological Forecasting and Social Change*. https://doi.org/https://doi.org/10.1016/j.techfore.2017.09.010

Jacobs, B. W., & Subramanian, R. (2012). Sharing Responsibility for Product Recovery Across the Supply Chain. *Production and Operations Management, 21*(1), 85-100. https://doi.org/10.1111/j.1937-5956.2011.01246.x

Jain, S., Jain, N. K., & Metri, B. (2018). Strategic framework towards measuring a circular supply chain management [Article]. *Benchmarking, 25*(8), 3238-3252. https://doi.org/10.1108/BIJ-11-2017-0304

Jennings, P. D., & Zandbergen, P. A. (1995). Ecologically Sustainable Organizations: An Institutional Approach. *Academy of Management Review, 20*(4), 1015-1052. https://doi.org/https://doi.org/10.5465/amr.1995.9512280034

Jensen, J. P., & Remmen, A. (2017). Enabling Circular Economy Through Product Stewardship [Article]. *Procedia Manufacturing, 8*, 377-384. https://doi.org/https://doi.org/10.1016/j.promfg.2017.02.048

Jiang, L., Waller, D. S., & Cai, S. (2013). Does ownership type matter for innovation? Evidence from China. *Journal of Business Research, 66*(12), 2473-2478. https://doi.org/https://doi.org/10.1016/j.jbusres.2013.05.037

Jiang, Z., Jiang, Y., Wang, Y., Zhang, H., Cao, H., & Tian, G. (2016). A hybrid approach of rough set and case-based reasoning to remanufacturing process planning [Article in Press]. *Journal of Intelligent Manufacturing*, 1-14. https://doi.org/https://doi.org/10.1007/s10845-016-1231-0

Jiménez-Rivero, A., & García-Navarro, J. (2016). Indicators to Measure the Management Performance of End-of-Life Gypsum: From Deconstruction to Production of Recycled Gypsum [Article]. *Waste and Biomass Valorization, 7*(4), 913-927. https://doi.org/https://doi.org/10.1007/s12649-016-9561-x

Jiménez-Rivero, A., & García-Navarro, J. (2017). Best practices for the management of end-of-life gypsum in a circular economy. *Journal of Cleaner Production, 167*, 1335-1344. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.05.068

Joe, M., Mickey, H., & E., J. T. (2016). Dynamic development and execution of closed-loop supply chains: a natural resource-based view. *Supply Chain Management: An International Journal, 21*(4), 453-469. https://doi.org/https://doi.org/10.1108/SCM-12-2014-0405

Jöreskog, K. G. (1998). Interaction and nonlinear modeling: Issues and approaches. *Interaction and nonlinear effects in structural equation modeling*, 239-250.

Junnila, S., Ottelin, J., & Leinikka, L. (2018). Influence of reduced ownership on the environmental benefits of the circular economy [Article]. *Sustainability (Switzerland), 10*(11), Article 4077. https://doi.org/10.3390/su10114077

Jurgilevich, A., Birge, T., Kentala-Lehtonen, J., Korhonen-Kurki, K., Pietikäinen, J., Saikku, L., & Schösler, H. (2016). Transition towards Circular Economy in the Food System. *Sustainability (Switzerland), 8*(1), 69. https://doi.org/https://doi.org/10.3390/su8010069

Kalmykova, Y., Sadagopan, M., & Rosado, L. (2017). Circular economy - From review of theories and practices to development of implementation tools [Article]. *Resources, Conservation and Recycling, 135*, 190-201. https://doi.org/https://doi.org/10.1016/j.resconrec.2017.10.034

Kaur, J., Sidhu, R., Awasthi, A., Chauhan, S., & Goyal, S. (2017). A DEMATEL based approach for investigating barriers in green supply chain management in Canadian manufacturing firms. *International Journal of Production Research*, 1-21. https://doi.org/10.1080/00207543.2017.1395522

Kazancoglu, Y., Kazancoglu, I., & Sagnak, M. (2018). A new holistic conceptual framework for green supply chain management performance assessment based on circular economy [Article]. *Journal of Cleaner Production, 195*, 1282-1299. https://doi.org/10.1016/j.jclepro.2018.06.015

Khan, M. A., Mittal, S., West, S., & Wuest, T. (2018). Review on upgradability – A product lifetime extension strategy in the context of product service systems [Article]. *Journal of Cleaner Production, 204*, 1154-1168. https://doi.org/10.1016/j.jclepro.2018.08.329

King, A. M., Burgess, S. C., Ijomah, W., & McMahon, C. A. (2006). Reducing waste: repair, recondition, remanufacture or recycle? *Sustainable Development, 14*(4), 257-267. https://doi.org/https://doi.org/10.1002/sd.271

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling, 127*, 221-232. https://doi.org/https://doi.org/10.1016/j.resconrec.2017.09.005

Kitsis, A. M., & Chen, I. J. (2019). Do motives matter? Examining the relationships between motives, SSCM practices and TBL performance. *Supply Chain Management: An International Journal, ahead-of-print*(ahead-of-print). https://doi.org/10.1108/scm-05-2019-0218

Kjaer, L. L., Pigosso, D. C. A., Niero, M., Bech, N. M., & McAloone, T. C. (2018). Product/Service-Systems for a Circular Economy: The Route to Decoupling Economic Growth from

Resource Consumption? [Article in Press]. *Journal of Industrial Ecology*. https://doi.org/10.1111/jiec.12747

Klassen, R. D., & Vachon, S. (2003). Collaboration and evaluation in the supply chain: Their impact on plant-level environmental investment. *Production and Operations Management, 12*(3), 336-352. https://doi.org/10.1111/j.1937-5956.2003.tb00207.x

Kleindorfer, P. R., Singhal, K., & Van Wassenhove, L. N. (2005). Sustainable Operations Management. *Production and Operations Management, 14*(4), 482-492. https://doi.org/10.1111/j.1937-5956.2005.tb00235.x

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy: The Concept and its Limitations. *Ecological Economics, 143*, 37-46. https://doi.org/https://doi.org/10.1016/j.ecolecon.2017.06.041

Koufteros, X. A., Edwin Cheng, T. C., & Lai, K.-H. (2007). "Black-box" and "gray-box" supplier integration in product development: Antecedents, consequences and the moderating role of firm size. *Journal of Operations Management, 25*(4), 847-870. https://doi.org/https://doi.org/10.1016/j.jom.2006.10.009

Krippendorff, K. (2004). *Content analysis: An introduction to its methodology*. Sage.

Kristensen, H. S., & Mosgaard, M. A. (2020). A review of micro level indicators for a circular economy – moving away from the three dimensions of sustainability? *Journal of Cleaner Production, 243*, 118531. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.118531

Krystofik, M., Luccitti, A., Parnell, K., & Thurston, M. (2018). Adaptive remanufacturing for multiple lifecycles: A case study in office furniture [Article]. *Resources, Conservation and Recycling, 135*, 14-23. https://doi.org/10.1016/j.resconrec.2017.07.028

Kumar, A., & Dixit, G. (2018). An analysis of barriers affecting the implementation of e-waste management practices in India: A novel ISM-DEMATEL approach. *Sustainable Production and Consumption, 14*, 36-52. https://doi.org/https://doi.org/10.1016/j.spc.2018.01.002

Kunz, N., Mayers, K., & Van Wassenhove, L. N. (2018). Stakeholder Views on Extended Producer Responsibility and the Circular Economy [Article]. *California Management Review, 60*(3), 45–70. https://doi.org/10.1177/0008125617752694

Lai, K.-h., & Wong, C. W. (2012). Green logistics management and performance: Some empirical evidence from Chinese manufacturing exporters. *Omega (United Kingdom), 40*(3), 267-282.

Lakatos, E. S., Cioca, L. I., Dan, V., Ciomos, A. O., Crisan, O. A., & Barsan, G. (2018). Studies and investigation about the attitude towards sustainable production, consumption and waste generation in line with circular economy in Romania [Article]. *Sustainability (Switzerland), 10*(3), Article 865. https://doi.org/10.3390/su10030865

Lapko, Y., Trianni, A., Nuur, C., & Masi, D. (2018). In Pursuit of Closed-Loop Supply Chains for Critical Materials: An Exploratory Study in the Green Energy Sector [Article in Press]. *Journal of Industrial Ecology*. https://doi.org/10.1111/jiec.12741

Larsen, S. B., Masi, D., Jacobsen, P., & Godsell, J. (2018). How the reverse supply chain contributes to a firm's competitive strategy: a strategic alignment perspective [Article]. *Production Planning and Control, 29*(6), 452-463. https://doi.org/10.1080/09537287.2017.1390178

Laso, J., García-Herrero, I., Margallo, M., Vázquez-Rowe, I., Fullana, P., Bala, A., Gazulla, C., Irabien, Á., & Aldaco, R. (2018). Finding an economic and environmental balance in value chains based on circular economy thinking: An eco-efficiency methodology applied to the fish canning industry [Article]. *Resources, Conservation and Recycling, 133*, 428-437. https://doi.org/10.1016/j.resconrec.2018.02.004

Laurenti, R., Sinha, R., Singh, J., & Frostell, B. (2015). Some pervasive challenges to sustainability by design of electronic products - A conceptual discussion [Article]. *Journal of Cleaner Production, 108*, 281-288. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.08.041

Lawrence, P. R., & Lorsch, J. W. (1967). Differentiation and Integration in Complex Organizations. *Administrative Science Quarterly, 12*(1), 1-47. https://doi.org/https://doi.org/10.2307/2391211

Lawson, B., & Samson, D. (2001). Developing innovation capability in organisations: A dynamic capabilities approach. *International Journal of Innovation Management, 05*(03), 377-400. https://doi.org/https://doi.org/10.1142/s1363919601000427

Lee, H. L. (2004). The triple-A supply chain. *Harvard business review, 82*(10), 102-113.

Leedy, P. D., & Ormrod, J. E. (2005). *Practical research*. Pearson Custom.

Leising, E., Quist, J., & Bocken, N. (2018). Circular Economy in the building sector: Three cases and a collaboration tool [Article]. *Journal of Cleaner Production, 176*, 976-989. https://doi.org/10.1016/j.jclepro.2017.12.010

Leslie, H. A., Leonards, P. E. G., Brandsma, S. H., de Boer, J., & Jonkers, N. (2016). Propelling plastics into the circular economy - weeding out the toxics first [Article]. *Environment International, 94*, 230-234. https://doi.org/https://doi.org/10.1016/j.envint.2016.05.012

Leszczynska, A., & Maryniak, A. (2017). Sustainable supply chain - a review of research fields and a proposition of future exploration. *International Journal of Sustainable Economy, 9*(2), 159-179. https://doi.org/https://doi.org/10.1504/ijse.2017.083367

Lewandowski, M. (2016). Designing the business models for circular economy-towards the conceptual framework [Review]. *Sustainability (Switzerland), 8*(1), 1-28. https://doi.org/https://doi.org/10.3390/su8010043

Li, G., Li, L., Choi, T.-M., & Sethi, S. P. (2019). Green supply chain management in Chinese firms: Innovative measures and the moderating role of quick response technology. *Journal of Operations Management, n/a*(n/a). https://doi.org/10.1002/joom.1061

Li, H., Bao, W., Xiu, C., Zhang, Y., & Xu, H. (2010). Energy conservation and circular economy in China's process industries. *Energy, 35*(11), 4273-4281. https://doi.org/https://doi.org/10.1016/j.energy.2009.04.021

Li, W., & Zhang, R. (2010). Corporate Social Responsibility, Ownership Structure, and Political Interference: Evidence from China [journal article]. *Journal of Business Ethics, 96*(4), 631-645. https://doi.org/10.1007/s10551-010-0488-z

Li, Y., & Ma, C. (2015). Circular economy of a papermaking park in China: A case study [Article]. *Journal of Cleaner Production, 92*, 65-74. https://doi.org/https://doi.org/10.1016/j.jclepro.2014.12.098

Lieder, M., Asif, F. M. A., Rashid, A., Mihelič, A., & Kotnik, S. (2018). A conjoint analysis of circular economy value propositions for consumers: Using "washing machines in Stockholm" as a case study [Article]. *Journal of Cleaner Production, 172*, 264-273. https://doi.org/10.1016/j.jclepro.2017.10.147

Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of Cleaner Production, 115*(Supplement C), 36-51. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.12.042

Lin, R.-J. (2013). Using fuzzy DEMATEL to evaluate the green supply chain management practices. *Journal of Cleaner Production, 40*(Supplement C), 32-39. https://doi.org/https://doi.org/10.1016/j.jclepro.2011.06.010

Linder, M., Sarasini, S., & van Loon, P. (2017). A Metric for Quantifying Product-Level Circularity [Article]. *Journal of Industrial Ecology, 21*(3), 545-558. https://doi.org/https://doi.org/10.1111/jiec.12552

Linder, M., & Williander, M. (2017). Circular Business Model Innovation: Inherent Uncertainties [Article]. *Business Strategy and the Environment, 26*(2), 182-196. https://doi.org/https://doi.org/10.1002/bse.1906

Linton, J. D., Klassen, R., & Jayaraman, V. (2007). Sustainable supply chains: An introduction. *Journal of Operations Management, 25*(6), 1075-1082.

Liu, G. (2014). Food Losses and Food Waste in China. *OECD Food, Agriculture and Fisheries Papers, 66*, 29. https://www.oecd-ilibrary.org/content/paper/5jz5sq5173lq-en

Liu, G., Liu, X., & Cheng, S. (2013). Food security: Curb China's rising food wastage [Correspondence]. *Nature, 498*, 170. https://doi.org/10.1038/498170c

Liu, J., Feng, Y., Zhu, Q., & Sarkis, J. (2018). Green supply chain management and the circular economy: Reviewing theory for advancement of both fields [Review]. *International Journal of Physical Distribution and Logistics Management, 48*(8), 794-817. https://doi.org/10.1108/IJPDLM-01-2017-0049

Liu, X., Yang, J., Qu, S., Wang, L., Shishime, T., & Bao, C. (2012). Sustainable Production: Practices and Determinant Factors of Green Supply Chain Management of Chinese Companies. *Business Strategy and the Environment, 21*(1), 1-16. https://doi.org/10.1002/bse.705

Liu, Y., & Bai, Y. (2014). An exploration of firms' awareness and behavior of developing circular economy: An empirical research in China. *Resources, Conservation and Recycling, 87*(Supplement C), 145-152. https://doi.org/https://doi.org/10.1016/j.resconrec.2014.04.002

Long, E., Kokke, S., Lundie, D., Shaw, N., Ijomah, W., & Kao, C.-c. (2016). Technical solutions to improve global sustainable management of waste electrical and electronic equipment (WEEE) in the EU and China [journal article]. *Journal of Remanufacturing, 6*(1), 1. https://doi.org/10.1186/s13243-015-0023-6

Lopes de Sousa Jabbour, A. B., Jabbour, C. J. C., Godinho Filho, M., & Roubaud, D. (2018). Industry 4.0 and the circular economy: a proposed research agenda and original roadmap for sustainable operations [Article in Press]. *Annals of Operations Research*, 1-14. https://doi.org/10.1007/s10479-018-2772-8

Low, J. S. C., & Ng, Y. T. (2018). Improving the Economic Performance of Remanufacturing Systems through Flexible Design Strategies: A Case Study Based on Remanufacturing Laptop Computers for the Cambodian Market [Article]. *Business Strategy and the Environment, 27*(4), 503-527. https://doi.org/10.1002/bse.2017

Lowe, E. (2001). Eco-industrial park handbook for Asian developing countries: Report to Asian Development Bank. *Environment Department, Indigo Development, Oakland, CA*. http://www.indigodev.com/Defining_EIP.html

Lüdeke-Freund, F., Gold, S., & Bocken, N. M. (2018). A Review and Typology of Circular Economy Business Model Patterns [Article in Press]. *Journal of Industrial Ecology*. https://doi.org/10.1111/jiec.12763

Luttropp, C., & Lagerstedt, J. (2006). EcoDesign and The Ten Golden Rules: generic advice for merging environmental aspects into product development. *Journal of Cleaner Production, 14*(15), 1396-1408. https://doi.org/https://doi.org/10.1016/j.jclepro.2005.11.022

Maletič, M., Maletič, D., & Gomišček, B. (2018). The role of contingency factors on the relationship between sustainability practices and organizational performance. *Journal of Cleaner Production, 171*, 423-433. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.09.172

Malviya, R. K., & Ravi, K. (2015). Green supply chain management (GSCM): a structured literature review and research implications. *Benchmarking: An International Journal, 22*(7), 1360-1394. https://doi.org/https://doi.org/10.1108/BIJ-01-2014-0001

Mangla, S. K., Luthra, S., Mishra, N., Singh, A., Rana, N. P., Dora, M., & Dwivedi, Y. (2018). Barriers to effective circular supply chain management in a developing country context [Article].

Production Planning and Control, 29(6), 551-569. https://doi.org/10.1080/09537287.2018.1449265

Manninen, K., Koskela, S., Antikainen, R., Bocken, N., Dahlbo, H., & Aminoff, A. (2018). Do circular economy business models capture intended environmental value propositions? [Article]. *Journal of Cleaner Production, 171*, 413-422. https://doi.org/10.1016/j.jclepro.2017.10.003

Manomaivibool, P., & Hong, J. H. (2014). Two decades, three WEEE systems: How far did EPR evolve in Korea's resource circulation policy? [Review]. *Resources, Conservation and Recycling, 83*, 202-212. https://doi.org/https://doi.org/10.1016/j.resconrec.2013.10.011

Mao, Y., & Wang, J. (2018). Is green manufacturing expensive? Empirical evidence from China [Article in Press]. *International Journal of Production Research*, 1-13. https://doi.org/10.1080/00207543.2018.1480842

Mao, Y., & Wang, J. (2019). Is green manufacturing expensive? Empirical evidence from China. *International Journal of Production Research, 57*(23), 7235-7247. https://doi.org/10.1080/00207543.2018.1480842

Mar Fuentes-Fuentes, M., Albacete-Sáez, C. A., & Lloréns-Montes, F. J. (2004). The impact of environmental characteristics on TQM principles and organizational performance. *Omega (United Kingdom), 32*(6), 425-442. https://doi.org/https://doi.org/10.1016/j.omega.2004.02.005

Marlet, C. (2014). GtoG Life + Project: First step towards gypsum circular economy [Article]. *ZKG International, 67*(4), 48-55. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84900444695&partnerID=40&md5=44339abdc8c6be694966a33b49c4d423

Martins, L. L., Eddleston, K. A., & Veiga, J. F. (2002). Moderators of the Relationship Between Work-Family Conflict and Career Satisfaction. *Academy of Management Journal, 45*(2), 399-409. https://doi.org/10.5465/3069354

Masi, D., Day, S., & Godsell, J. (2017). Supply chain configurations in the circular economy: A systematic literature review [Review]. *Sustainability (Switzerland), 9*(9), Article 1602. https://doi.org/https://doi.org/10.3390/su9091602

Masi, D., Kumar, V., Garza-Reyes, J. A., & Godsell, J. (2018). Towards a more circular economy: exploring the awareness, practices, and barriers from a focal firm perspective [Article]. *Production Planning and Control, 29*(6), 539-550. https://doi.org/10.1080/09537287.2018.1449246

Mathews, J. A., & Tan, H. (2016). Circular economy: Lessons from China. *Nature, 531*(7595), 440-442. https://doi.org/https://doi.org/10.1038/531440a

Mathews, J. A., Tan, H., & Hu, M.-C. (2018). Moving to a Circular Economy in China: Transforming Industrial Parks into Eco-industrial Parks. *California Management Review, 60*(3), 157-181. https://doi.org/10.1177/0008125617752692

Mativenga, P. T., Agwa-Ejon, J., Mbohwa, C., Sultan, A. A. M., & Shuaib, N. A. (2017). Circular Economy Ownership Models: A view from South Africa Industry [Article]. *Procedia Manufacturing, 8*, 284-291. https://doi.org/https://doi.org/10.1016/j.promfg.2017.02.036

Maynard, M. (1994). Methods, practice and epistemology: The debate about feminism and research. *Researching women's lives from a feminist perspective, 10*, 26.

Mayring, P. (2003). Qualitative inhaltsanalyse [Qualitative content analysis]. *Qualitative Forschung, 3*, 468-475.

McDonough, W., & Braungart, M. (2003). Towards a sustaining architecture for the 21st century: the promise of cradle-to-cradle design. *Industry and environment, 26*(2), 13-16.

McDonough, W., & Braungart, M. (2010). *Cradle to cradle: Remaking the way we make things*. North point press.

McDougall, N., Wagner, B., & MacBryde, J. (2016). Exploring Dynamic Natural-Resource-Based Capabilities for Sustainable Agri-food Chains. In R. Setchi, R. J. Howlett, Y. Liu, & P. Theobald, *Sustainable Design and Manufacturing 2016* Cham.

McDowall, W., Geng, Y., Huang, B., Barteková, E., Bleischwitz, R., Türkeli, S., Kemp, R., & Doménech, T. (2017). Circular Economy Policies in China and Europe. *Journal of Industrial Ecology, 21*(3), 651-661. https://doi.org/10.1111/jiec.12597

McKelvey, B. (2002). Managing coevolutionary dynamics. 18th EGOS Conference, Barcelona, Spain,

McKinsey & Company. (2020). *Mapping the benefits of a circular economy*. Retrieved 04/02/2020 from https://www.mckinsey.com/business-functions/sustainability/our-insights/mapping-the-benefits-of-a-circular-economy

Meehan, J., & Bryde, D. (2011). Sustainable procurement practice. *Business Strategy and the Environment, 20*(2), 94-106. https://doi.org/https://doi.org/10.1002/bse.678

Meho, L. I., & Yang, K. (2007). Impact of data sources on citation counts and rankings of LIS faculty: Web of science versus scopus and google scholar. *Journal of the American Society for Information Science and Technology, 58*(13), 2105-2125. https://doi.org/doi:10.1002/asi.20677

Mendoza, J. M. F., Sharmina, M., Gallego-Schmid, A., Heyes, G., & Azapagic, A. (2017). Integrating Backcasting and Eco-Design for the Circular Economy: The BECE Framework. *Journal of Industrial Ecology, 21*(3), 526-544. https://doi.org/https://doi.org/10.1111/jiec.12590

Meredith, J. (1998). Building operations management theory through case and field research. *Journal of Operations Management, 16*(4), 441-454. https://doi.org/https://doi.org/10.1016/S0272-6963(98)00023-0

Milios, L., Holm Christensen, L., McKinnon, D., Christensen, C., Rasch, M. K., & Hallstrøm Eriksen, M. (2018). Plastic recycling in the Nordics: A value chain market analysis [Article]. *Waste Management, 76*, 180-189. https://doi.org/10.1016/j.wasman.2018.03.034

Miller, D. (1987). The structural and environmental correlates of business strategy. *Strategic Management Journal, 8*(1), 55-76. https://doi.org/https://doi.org/10.1002/smj.4250080106

Min, H., & Galle, W. P. (1997). Green purchasing strategies: trends and implications. *Journal of Supply Chain Management, 33*(3), 10.

Min, H., & Galle, W. P. (2001). Green purchasing practices of US firms. *International Journal of Operations & Production Management, 21*(9), 1222-1238.

Mirabella, N., Castellani, V., & Sala, S. (2014). Current options for the valorization of food manufacturing waste: a review. *Journal of Cleaner Production, 65*, 28-41. https://doi.org/https://doi.org/10.1016/j.jclepro.2013.10.051

Mishra, A. N., Devaraj, S., & Vaidyanathan, G. (2013). Capability hierarchy in electronic procurement and procurement process performance: An empirical analysis. *Journal of Operations Management, 31*(6), 376-390. https://doi.org/10.1016/j.jom.2013.07.011

Mishra, J. L., Hopkinson, P. G., & Tidridge, G. (2018). Value creation from circular economy-led closed loop supply chains: a case study of fast-moving consumer goods [Article]. *Production Planning and Control, 29*(6), 509-521. https://doi.org/10.1080/09537287.2018.1449245

Mitra, S., & Datta, P. P. (2014). Adoption of green supply chain management practices and their impact on performance: an exploratory study of Indian manufacturing firms. *International Journal of Production Research, 52*(7), 2085-2107. https://doi.org/https://doi.org/10.1080/00207543.2013.849014

Mohamed Abdul Ghani, N. M. A., Egilmez, G., Kucukvar, M., & S. Bhutta, M. K. (2017). From green buildings to green supply chains: An integrated input-output life cycle assessment and optimization framework for carbon footprint reduction policy making [Article]. *Management of Environmental Quality: An International Journal, 28*(4), 532-548. https://doi.org/https://doi.org/10.1108/MEQ-12-2015-0211

Mohanty, A., Misra, M., & Hinrichsen, G. (2000). Biofibres, biodegradable polymers and biocomposites: an overview. *Macromolecular materials and Engineering, 276*(1), 1-24.

Moktadir, M. A., Rahman, T., Rahman, M. H., Ali, S. M., & Paul, S. K. (2018). Drivers to sustainable manufacturing practices and circular economy: A perspective of leather industries in Bangladesh [Article]. *Journal of Cleaner Production, 174*, 1366-1380. https://doi.org/10.1016/j.jclepro.2017.11.063

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: a comparative analysis [journal article]. *Scientometrics, 106*(1), 213-228. https://doi.org/10.1007/s11192-015-1765-5

Morali, O., & Searcy, C. (2013). A Review of Sustainable Supply Chain Management Practices in Canada [journal article]. *Journal of Business Ethics, 117*(3), 635-658. https://doi.org/https://doi.org/10.1007/s10551-012-1539-4

Moreno, M., De los Rios, C., Rowe, Z., & Charnley, F. (2016). A conceptual framework for circular design [Article]. *Sustainability (Switzerland), 8*(9), Article 937. https://doi.org/https://doi.org/10.3390/su8090937

Morone, P., Falcone, P. M., & Lopolito, A. (2019). How to promote a new and sustainable food consumption model: A fuzzy cognitive map study. *Journal of Cleaner Production, 208*, 563-574. https://doi.org/https://doi.org/10.1016/j.jclepro.2018.10.075

Moula, M. E., Sorvari, J., & Oinas, P. (2017). *Constructing a green circular society*. Faculty of Social Sciences, University of Helsinki, Finland. Retrieved 15/03/2018) from https://helda.helsinki.fi/bitstream/handle/10138/231630/ebook2017(pdf).pdf?sequence=1

Murphy Paul, R. (2003). Green perspectives and practices: a “comparative logistics” study. *Supply Chain Management: An International Journal, 8*(2), 122-131. https://doi.org/10.1108/13598540310468724

Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context [journal article]. *Journal of Business Ethics, 140*(3), 369-380. https://doi.org/10.1007/s10551-015-2693-2

Mylan, J., Holmes, H., & Paddock, J. (2016). Re-Introducing Consumption to the ‘Circular Economy’: A Sociotechnical Analysis of Domestic Food Provisioning. *Sustainability (Switzerland), 8*(8), 794. https://doi.org/10.3390/su8080794

Nascimento, D. L. M., Alencastro, V., Quelhas, O. L. G., Caiado, R. G. G., Garza-Reyes, J. A., Lona, L. R., & Tortorella, G. (2018). Exploring Industry 4.0 technologies to enable circular economy practices in a manufacturing context: A business model proposal [Article in Press]. *Journal of Manufacturing Technology Management*. https://doi.org/10.1108/JMTM-03-2018-0071

Nasir, M. H. A., Genovese, A., Acquaye, A. A., Koh, S. C. L., & Yamoah, F. (2017). Comparing linear and circular supply chains: A case study from the construction industry [Article]. *International Journal of Production Economics, 183*, 443-457. https://doi.org/https://doi.org/10.1016/j.ijpe.2016.06.008

Ness, D. (2008). Sustainable urban infrastructure in China: Towards a Factor 10 improvement in resource productivity through integrated infrastructure systems. *International Journal of Sustainable Development & World Ecology, 15*(4), 288-301. https://doi.org/10.3843/SusDev.15.4:2a

Nidumolu, R., Ellison, J., Whalen, J., & Billman, E. (2014). The collaboration imperative. *Harvard business review, 92*(4), 76-84. https://hbr.org/2014/04/the-collaboration-imperative-2

Niero, M., & Olsen, S. I. (2016). Circular economy: To be or not to be in a closed product loop? A Life Cycle Assessment of aluminium cans with inclusion of alloying elements [Article]. *Resources, Conservation and Recycling, 114*, 18-31. https://doi.org/https://doi.org/10.1016/j.resconrec.2016.06.023

Nissinen, A., Parikka-Alhola, K., & Rita, H. (2009). Environmental criteria in the public purchases above the EU threshold values by three Nordic countries: 2003 and 2005. *Ecological Economics, 68*(6), 1838-1849. https://doi.org/https://doi.org/10.1016/j.ecolecon.2008.12.005

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge university press.

Nowakowski, P., & Mrówczyńska, B. (2018). Towards sustainable WEEE collection and transportation methods in circular economy - Comparative study for rural and urban settlements [Article]. *Resources, Conservation and Recycling, 135*, 93-107. https://doi.org/10.1016/j.resconrec.2017.12.016

NRDC (National Development and Reform Commission). (2017). *Notice of the Evaluation Index System for the Development of Circular Economy*. Retrieved 16 July 2018. (In Chinese) from http://www.ndrc.gov.cn/zcfb/zcfbtz/201701/t20170112_834922.html

Nußholz, J. L. K. (2017). Circular business models: Defining a concept and framing an emerging research field [Article]. *Sustainability (Switzerland), 9*(10), Article 1810. https://doi.org/https://doi.org/10.3390/su9101810

O'Connor, M. P., Zimmerman, J. B., Anastas, P. T., & Plata, D. L. (2016). A strategy for material supply chain sustainability: Enabling a circular economy in the electronics industry through green engineering [Article]. *ACS Sustainable Chemistry and Engineering, 4*(11), 5879-5888. https://doi.org/https://doi.org/10.1021/acssuschemeng.6b01954

Oghazi, P., & Mostaghel, R. (2018). Circular business model challenges and lessons learned-An industrial perspective [Article]. *Sustainability (Switzerland), 10*(3), Article 739. https://doi.org/10.3390/su10030739

Organisation, F. a. A. (2011). *Food Loss and Food Waste*. Food and Agricultural Organisation. Retrieved 28/11/2017 from http://www.fao.org/food-loss-and-food-waste/en/

Parajuly, K., & Wenzel, H. (2017). Potential for circular economy in household WEEE management. *Journal of Cleaner Production, 151*, 272-285. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.03.045

Park, J., Sarkis, J., & Wu, Z. (2010). Creating integrated business and environmental value within the context of China's circular economy and ecological modernization [Article]. *Journal of Cleaner Production, 18*(15), 1492-1499. https://doi.org/https://doi.org/10.1016/j.jclepro.2010.06.001

Paulraj, A., Chen, I. J., & Blome, C. (2017). Motives and Performance Outcomes of Sustainable Supply Chain Management Practices: A Multi-theoretical Perspective [journal article]. *Journal of Business Ethics, 145*(2), 239-258. https://doi.org/10.1007/s10551-015-2857-0

Peck, D., Kandachar, P., & Tempelman, E. (2015). Critical materials from a product design perspective [Article]. *Materials and Design, 65*, 147-159. https://doi.org/https://doi.org/10.1016/j.matdes.2014.08.042

Petljak, K., Zulauf, K., Štulec, I., Seuring, S., & Wagner, R. (2018). Green supply chain management in food retailing: survey-based evidence in Croatia. *Supply Chain Management: An International Journal, 23*(1), 1-15. https://doi.org/doi:10.1108/SCM-04-2017-0133

Pfeffer, J. (1972). Merger as a Response to Organizational Interdependence. *Administrative Science Quarterly, 17*(3), 382-394. https://doi.org/https://doi.org/10.2307/2392151

Pfeffer, J., & Pfeffer, J. (1981). *Power in organizations* (Vol. 33). Pitman Marshfield, MA.

Pfeffer, J., & Salancik, G. R. (2003). *The external control of organizations: A resource dependence perspective*. Stanford University Press.

Pialot, O., Millet, D., & Bisiaux, J. (2017). "Upgradable PSS": Clarifying a new concept of sustainable consumption/production based on upgradablility [Article]. *Journal of Cleaner Production, 141*, 538-550. https://doi.org/https://doi.org/10.1016/j.jclepro.2016.08.161

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of applied psychology, 88*(5), 879.

Polzer, V. R., Pisani, M. A. J., & Persson, K. M. (2016). The importance of extended producer responsibility and the national policy of solid waste in Brazil [Review]. *International Journal of Environment and Waste Management, 18*(2), 101-119. https://doi.org/https://doi.org/10.1504/IJEWM.2016.080398

Popa, V. N., & Popa, L. I. (2016). Green Acquisitions And Lifecycle Management Of Industrial Products In The Circular Economy. IOP Conference Series: Materials Science and Engineering,

Poppelaars, F., Bakker, C., & van Engelen, J. (2018). Does access trump ownership? Exploring consumer acceptance of access-based consumption in the case of smartphones [Article]. *Sustainability (Switzerland), 10*(7), Article 2133. https://doi.org/10.3390/su10072133

Preston, F. (2012). *A Global Redesign?: Shaping the Circular Economy*. Chatham House London. https://s3.amazonaws.com/academia.edu.documents/32547802/A_global_redesign_-_shaping_the_circular_economy.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1507426850&Signature=PJor1ZoA4DxUDXfTpmqjVtrguug%3D&response-content-disposition=inline%3B%20filename%3Dbriefing_paper_A_Global_Redesign_Shaping.pdf

Pullman, M. E., Maloni, M. J., & Carter, C. R. (2009). Food for thought: Social versus environmental sustainability practices and performance outcomes. *Journal of Supply Chain Management, 45*(4), 38-54. https://doi.org/https://doi.org/10.1111/j.1745-493X.2009.03175.x

Rakesh Kumar, M., & Ravi, K. (2015). Green supply chain management (GSCM): a structured literature review and research implications. *Benchmarking: An International Journal, 22*(7), 1360-1394. https://doi.org/10.1108/BIJ-01-2014-0001

Ranta, V., Aarikka-Stenroos, L., Ritala, P., & Mäkinen, S. J. (2018). Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe [Article]. *Resources, Conservation and Recycling, 135*, 70-82. https://doi.org/10.1016/j.resconrec.2017.08.017

Rao, P., & Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance? *International Journal of Operations & Production Management, 25*(9), 898-916. https://doi.org/https://doi.org/10.1108/01443570510613956

Rathore, P., Kota, S., & Chakrabarti, A. (2011). Sustainability through remanufacturing in India: a case study on mobile handsets. *Journal of Cleaner Production, 19*(15), 1709-1722. https://doi.org/https://doi.org/10.1016/j.jclepro.2011.06.016

Rauer, J., & Kaufmann, L. (2015). Mitigating External Barriers to Implementing Green Supply Chain Management: A Grounded Theory Investigation of Green-Tech Companies' Rare Earth Metals Supply Chains. *Journal of Supply Chain Management, 51*(2), 65-88. https://doi.org/https://doi.org/10.1111/jscm.12063

Rehman, M. A., Seth, D., & Shrivastava, R. L. (2016). Impact of green manufacturing practices on organisational performance in Indian context: An empirical study. *Journal of Cleaner Production, 137*(Supplement C), 427-448. https://doi.org/https://doi.org/10.1016/j.jclepro.2016.07.106

Rentizelas, A., Shpakova, A., & Mašek, O. (2018). Designing an optimised supply network for sustainable conversion of waste agricultural plastics into higher value products [Article]. *Journal of Cleaner Production, 189*, 683-700. https://doi.org/10.1016/j.jclepro.2018.04.104

Richter, J. L., & Koppejan, R. (2016). Extended producer responsibility for lamps in Nordic countries: Best practices and challenges in closing material loops [Article]. *Journal of Cleaner Production, 123*, 167-179. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.06.131

Ridaura, G., Llorens-Cervera, S., Carrillo, C., Buj-Corral, I., & Riba-Romeva, C. (2018). Equipment suppliers integration to the redesign for emissions reuse in industrial processes [Article]. *Resources, Conservation and Recycling, 131*, 75-85. https://doi.org/10.1016/j.resconrec.2017.10.030

Rizos, V., Behrens, A., van der Gaast, W., Hofman, E., Ioannou, A., Kafyeke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., & Topi, C. (2016). Implementation of circular economy business models by small and medium-sized enterprises (SMEs): Barriers and enablers [Article]. *Sustainability (Switzerland), 8*(11), Article 1212. https://doi.org/https://doi.org/10.3390/su8111212

Roos, G. (2014). Business model innovation to create and capture resource value in future circular material chains [Article]. *Resources, 3*(1), 248-274. https://doi.org/https://doi.org/10.3390/resources3010248

Rugman, A. M., & Verbeke, A. (2002). Edith Penrose's contribution to the resource-based view of strategic management. *Strategic Management Journal, 23*(8), 769-780. https://doi.org/https://doi.org/10.1002/smj.240

Russo, M. V., & Fouts, P. A. (1997). A Resource-Based Perspective On Corporate Environmental Performance And Profitability. *Academy of Management Journal, 40*(3), 534-559. https://doi.org/https://doi.org/10.2307/257052

Saaty, T. L. (2013). Analytic hierarchy process. In Gass S.I. & M. C. Fu (Eds.), *Encyclopedia of operations research and management science* (pp. 52-64). Springer.

Sabaghi, M., Mascle, C., & Baptiste, P. (2016). Evaluation of products at design phase for an efficient disassembly at end-of-life [Article]. *Journal of Cleaner Production, 116*, 177-186. https://doi.org/10.1016/j.jclepro.2016.01.007

Salemdeeb, R., Al-Tabbaa, A., & Reynolds, C. (2016). The UK waste input-output table: Linking waste generation to the UK economy [Article]. *Waste Management and Research, 34*(10), 1089-1094. https://doi.org/https://doi.org/10.1177/0734242X16658545

Sarkis, J. (1998). Evaluating environmentally conscious business practices. *European Journal of Operational Research, 107*(1), 159-174.

Sarkis, J., Gonzalez-Torre, P., & Adenso-Diaz, B. (2010). Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. *Journal of Operations Management, 28*(2), 163-176. https://doi.org/https://doi.org/10.1016/j.jom.2009.10.001

Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. *Environmental Development, 17*, 48-56.

Sbihi, A., & Eglese, R. W. (2010). Combinatorial optimization and Green Logistics [journal article]. *Annals of Operations Research, 175*(1), 159-175. https://doi.org/https://doi.org/10.1007/s10479-009-0651-z

Scheel, C., & Vasquez, M. (2013). Regional wealth creation by leveraging residues and waste. *Vie & sciences de l'entreprise*(2), 72-92. https://doi.org/https://doi.org/10.3917/vse.194.0072

Scheel, C., & Vazquez, M. (2011). The role of innovation and technology in industrial ecology systems for the sustainable development of emerging regions. *Journal of sustainable development, 4*(6), 197. https://doi.org/http://dx.doi.org/10.5539/jsd.v4n6p197

Schmidt, C. G., Foerstl, K., & Schaltenbrand, B. (2017). The Supply Chain Position Paradox: Green Practices and Firm Performance. *Journal of Supply Chain Management, 53*(1), 3-25. https://doi.org/https://doi.org/10.1111/jscm.12113

Seman, N. A. A., Zakuan, N., Jusoh, A., Arif, M. S. M., & Saman, M. Z. M. (2012). Green supply chain management: a review and research direction. *International Journal of Managing Value and supply chains, 3*(1), 1-18.

Senge, P. M., Carstedt, G., & Porter, P. L. (2001). Next industrial revolution. *MIT Sloan management review, 42*(2), 24-38.

Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production, 16*(15), 1699-1710. https://doi.org/https://doi.org/10.1016/j.jclepro.2008.04.020

Shahbazi, S., Wiktorsson, M., Kurdve, M., Jönsson, C., & Bjelkemyr, M. (2016). Material efficiency in manufacturing: swedish evidence on potential, barriers and strategies [Article]. *Journal of Cleaner Production, 127*, 438-450. https://doi.org/https://doi.org/10.1016/j.jclepro.2016.03.143

Shang, K.-C., Lu, C.-S., & Li, S. (2010). A taxonomy of green supply chain management capability among electronics-related manufacturing firms in Taiwan. *Journal of Environmental Management, 91*(5), 1218-1226. https://doi.org/https://doi.org/10.1016/j.jenvman.2010.01.016

Shao, J., Taisch, M., & Ortega-Mier, M. (2016). A grey-DEcision-MAking Trial and Evaluation Laboratory (DEMATEL) analysis on the barriers between environmentally friendly products and consumers: practitioners' viewpoints on the European automobile industry. *Journal of Cleaner Production, 112*, 3185-3194. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.10.113

Sharma, V., Garg, S. K., & Sharma, P. B. (2016). Identification of major drivers and roadblocks for remanufacturing in India. *Journal of Cleaner Production, 112*(Part 3), 1882-1892. https://doi.org/https://doi.org/10.1016/j.jclepro.2014.11.082

Shenoy, M. (2016). Industrial Ecology in Developing Countries. In R. Clift & A. Druckman (Eds.), *Taking Stock of Industrial Ecology* (pp. 229-245). Springer International Publishing. https://doi.org/10.1007/978-3-319-20571-7_11

Shi, H., Peng, S. Z., Liu, Y., & Zhong, P. (2008). Barriers to the implementation of cleaner production in Chinese SMEs: government, industry and expert stakeholders' perspectives. *Journal of Cleaner Production, 16*(7), 842-852. https://doi.org/https://doi.org/10.1016/j.jclepro.2007.05.002

Shi, H., Tian, J., & Chen, L. (2012). China's Quest for Eco-industrial Parks, Part I. *Journal of Industrial Ecology, 16*(1), 8-10. https://doi.org/10.1111/j.1530-9290.2012.00454.x

Sihvonen, S., & Partanen, J. (2018). A survey of perceived prevalence of selected environmental topics in product development, and their relationships with employee's ecological concern [Article]. *Journal of Cleaner Production, 199*, 1116-1129. https://doi.org/10.1016/j.jclepro.2018.07.092

Singh, J., & Ordoñez, I. (2016). Resource recovery from post-consumer waste: important lessons for the upcoming circular economy [Article]. *Journal of Cleaner Production, 134*, 342-353. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.12.020

Singh, P., & Giacosa, E. (2018). Cognitive biases of consumers as barriers in transition towards circular economy [Article in Press]. *Management Decision*. https://doi.org/10.1108/MD-08-2018-0951

Singh, P. J., Power, D., & Chuong, S. C. (2011). A resource dependence theory perspective of ISO 9000 in managing organizational environment. *Journal of Operations Management, 29*(1), 49-64. https://doi.org/https://doi.org/10.1016/j.jom.2010.04.002

Sirmon, D. G., & Hitt, M. A. (2009). Contingencies within dynamic managerial capabilities: interdependent effects of resource investment and deployment on firm performance. *Strategic Management Journal, 30*(13), 1375-1394. https://doi.org/10.1002/smj.791

Sonia, M. L. (2014). Effects of supply chain position on the motivation and practices of firms going green. *International Journal of Operations & Production Management, 34*(1), 93-114. https://doi.org/10.1108/IJOPM-04-2012-0133

Sousa-Zomer, T. T., Magalhães, L., Zancul, E., Campos, L. M. S., & Cauchick-Miguel, P. A. (2018). Cleaner production as an antecedent for circular economy paradigm shift at the micro-level: Evidence from a home appliance manufacturer [Article]. *Journal of Cleaner Production, 185*, 740-748. https://doi.org/10.1016/j.jclepro.2018.03.006

Sousa-Zomer, T. T., Magalhães, L., Zancul, E., & Cauchick-Miguel, P. A. (2018). Exploring the challenges for circular business implementation in manufacturing companies: An empirical investigation of a pay-per-use service provider [Article]. *Resources, Conservation and Recycling, 135*, 3-13. https://doi.org/10.1016/j.resconrec.2017.10.033

Souza, G. C. (2013). Closed-Loop Supply Chains: A Critical Review, and Future Research. *Decision Sciences, 44*(1), 7-38. https://doi.org/https://doi.org/10.1111/j.1540-5915.2012.00394.x

Sprecher, B., Daigo, I., Spekkink, W., Vos, M., Kleijn, R., Murakami, S., & Kramer, G. J. (2017). Novel Indicators for the Quantification of Resilience in Critical Material Supply Chains, with a 2010 Rare Earth Crisis Case Study [Article]. *Environmental Science and Technology, 51*(7), 3860-3870. https://doi.org/https://doi.org/10.1021/acs.est.6b05751

Spring, M., & Araujo, L. (2017). Product biographies in servitization and the circular economy [Article]. *Industrial Marketing Management, 60*, 126-137. https://doi.org/https://doi.org/10.1016/j.indmarman.2016.07.001

Srivastava, S. K. (2007). Green supply-chain management: A state-of-the-art literature review. *International Journal of Management Reviews, 9*(1), 53-80. https://doi.org/https://doi.org/10.1111/j.1468-2370.2007.00202.x

Sroufe, R. (2003). Effects of environmental management systems on environmental management practices and operations. *Production and Operations Management, 12*(3), 416-431. https://doi.org/10.1111/j.1937-5956.2003.tb00212.x

Stahel, W. (2010). *The performance economy*. Springer.

Stahel, W. R. (2016). The circular economy. *Nature, 531*(7595), 435-438. https://doi.org/https://doi.org/10.1038/531435a

Steenis, N. D., van der Lans, I. A., van Herpen, E., & van Trijp, H. C. M. (2018). Effects of sustainable design strategies on consumer preferences for redesigned packaging [Article]. *Journal of Cleaner Production, 205*, 854-865. https://doi.org/10.1016/j.jclepro.2018.09.137

Stenmarck, Å., Jensen, C., Quested, T., & Moates, G. (2016a). *Estimates of European food waste levels*. http://www.eu-fusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf

Stenmarck, Å., Jensen, C., Quested, T., & Moates, G. (2016b). *Estimates of European food waste levels*. European Commission. https://doi.org/https://ec.europa.eu/food/safety/food_waste_en

Stewart, R., & Niero, M. (2018). Circular economy in corporate sustainability strategies: A review of corporate sustainability reports in the fast-moving consumer goods sector [Article]. *Business Strategy and the Environment, 27*(7), 1005-1022. https://doi.org/10.1002/bse.2048

Stone, J., & Rahimifard, S. (2018). Resilience in agri-food supply chains: a critical analysis of the literature and synthesis of a novel framework. *Supply Chain Management: An International Journal, 23*(3), 207-238. https://doi.org/doi:10.1108/SCM-06-2017-0201

Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013). A review of the circular economy in China: moving from rhetoric to implementation. *Journal of Cleaner Production, 42*(Supplement C), 215-227. https://doi.org/https://doi.org/10.1016/j.jclepro.2012.11.020

Sumter, D., Bakker, C., & Balkenende, R. (2018). The role of product design in creating circular business models: A case study on the lease and refurbishment of baby strollers [Article]. *Sustainability (Switzerland), 10*(7), Article 2415. https://doi.org/10.3390/su10072415

Sun, L., Li, H., Dong, L., Fang, K., Ren, J., Geng, Y., Fujii, M., Zhang, W., Zhang, N., & Liu, Z. (2017). Eco-benefits assessment on urban industrial symbiosis based on material flows analysis and emergy evaluation approach: A case of Liuzhou city, China. *Resources, Conservation and Recycling, 119*, 78-88. https://doi.org/https://doi.org/10.1016/j.resconrec.2016.06.007

Sun, Q. (2017). Research on the influencing factors of reverse logistics carbon footprint under sustainable development [Article]. *Environmental Science and Pollution Research, 24*(29), 22790-22798. https://doi.org/https://doi.org/10.1007/s11356-016-8140-9

Susur, E., Hidalgo, A., & Chiaroni, D. (2019). A strategic niche management perspective on transitions to eco-industrial park development: A systematic review of case studies. *Resources, Conservation and Recycling, 140*, 338-359. https://doi.org/https://doi.org/10.1016/j.resconrec.2018.06.002

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). *Using multivariate statistics* (Vol. 5). Pearson Boston, MA.

Tai, J., Zhang, W., Che, Y., & Feng, D. (2011). Municipal solid waste source-separated collection in China: A comparative analysis. *Waste Management, 31*(8), 1673-1682. https://doi.org/https://doi.org/10.1016/j.wasman.2011.03.014

Tajik, S., Maghsoudlou, Y., Khodaiyan, F., Jafari, S. M., Ghasemlou, M., & Aalami, M. (2013). Soluble soybean polysaccharide: A new carbohydrate to make a biodegradable film for sustainable green packaging. *Carbohydrate Polymers, 97*(2), 817-824. https://doi.org/https://doi.org/10.1016/j.carbpol.2013.05.037

Talens Peiró, L., Ardente, F., & Mathieux, F. (2017). Design for Disassembly Criteria in EU Product Policies for a More Circular Economy: A Method for Analyzing Battery Packs in PC-Tablets and Subnotebooks [Article]. *Journal of Industrial Ecology, 21*(3), 731-741. https://doi.org/https://doi.org/10.1111/jiec.12608

Tarantini, M., Loprieno, A. D., & Porta, P. L. (2011). A life cycle approach to Green Public Procurement of building materials and elements: A case study on windows. *Energy, 36*(5), 2473-2482. https://doi.org/https://doi.org/10.1016/j.energy.2011.01.039

Tate, W. L., Ellram, L. M., & Kirchoff, J. F. (2010). CORPORATE SOCIAL RESPONSIBILITY REPORTS: A THEMATIC ANALYSIS RELATED TO SUPPLY CHAIN MANAGEMENT. *Journal of Supply Chain Management, 46*(1), 19-44. https://doi.org/10.1111/j.1745-493X.2009.03184.x

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509-533. https://doi.org/https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Thompson, J. D. (1967). *Organizations in action: Social science bases of administrative theory*. Transaction publishers.

Thoumy, M., & Vachon, S. (2012). Environmental projects and financial performance: Exploring the impact of project characteristics. *International Journal of Production Economics, 140*(1), 28-34. https://doi.org/https://doi.org/10.1016/j.ijpe.2012.01.014

Tian, J., & Chen, M. (2014). Sustainable design for automotive products: Dismantling and recycling of end-of-life vehicles. *Waste Management, 34*(2), 458-467. https://doi.org/https://doi.org/10.1016/j.wasman.2013.11.005

Toffel, M. W. (2004). Strategic Management of Product Recovery. *California Management Review, 46*(2), 120-141. https://doi.org/10.2307/41166214

Touboulic, A., Matthews, L., & Marques, L. (2018). On the road to carbon reduction in a food supply network: a complex adaptive systems perspective. *Supply Chain Management:*

An International Journal, 23(4), 313-335. https://doi.org/doi:10.1108/SCM-06-2017-0214

Tseng, M.-L., Wang, R., Chiu, A. S. F., Geng, Y., & Lin, Y. H. (2013). Improving performance of green innovation practices under uncertainty. *Journal of Cleaner Production, 40*(Supplement C), 71-82. https://doi.org/https://doi.org/10.1016/j.jclepro.2011.10.009

Tukker, A. (2015). Product services for a resource-efficient and circular economy - A review [Review]. *Journal of Cleaner Production, 97*, 76-91. https://doi.org/https://doi.org/10.1016/j.jclepro.2013.11.049

Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S., & Valkokari, P. (2019). Unlocking circular business: A framework of barriers and drivers. *Journal of Cleaner Production, 212*, 90-98. https://doi.org/https://doi.org/10.1016/j.jclepro.2018.11.202

UNEP (United Nations Environment Programme). (1994). *Government Strategies and Policies for Cleaner Production*. Paris. Retrieved 23/10/2019 from http://hdl.handle.net/1721.1/1560

United Nations General Assembly. (2005). World summit outcome. *Resolution Adopted by the General Assembly, 24*.

Urbinati, A., Chiaroni, D., & Chiesa, V. (2017). Towards a new taxonomy of circular economy business models [Article]. *Journal of Cleaner Production, 168*, 487-498. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.09.047

Vachon, S., & Klassen, R. D. (2006a). Extending green practices across the supply chain: the impact of upstream and downstream integration. *International Journal of Operations & Production Management, 26*(7), 795-821. https://doi.org/doi:10.1108/01443570610672248

Vachon, S., & Klassen, R. D. (2006b). Green project partnership in the supply chain: the case of the package printing industry. *Journal of Cleaner Production, 14*(6), 661-671.

Vachon, S., & Klassen, R. D. (2008). Environmental management and manufacturing performance: The role of collaboration in the supply chain. *International Journal of Production Economics, 111*(2), 299-315.

van Berkel, R., Willems, E., & Lafleur, M. (1997). The Relationship between Cleaner Production and Industrial Ecology. *Journal of Industrial Ecology, 1*(1), 51-66. https://doi.org/10.1162/jiec.1997.1.1.51

Van Hoek, R. I. (1999). From reversed logistics to green supply chains. *Supply Chain Management: An International Journal, 4*(3), 129-135.

van Loon, P., Delagarde, C., & Van Wassenhove, L. N. (2017). The role of second-hand markets in circular business: a simple model for leasing versus selling consumer products [Article in Press]. *International Journal of Production Research*, 1-14. https://doi.org/10.1080/00207543.2017.1398429 van Loon, P., & Van Wassenhove, L. N. (2017). Assessing the economic and environmental impact of remanufacturing: a decision support tool for OEM suppliers [Article in Press]. *International Journal of Production Research*, 1-13. https://doi.org/https://doi.org/10.1080/00207543.2017.1367107

Van Wassenhove, L. N. (2019). Sustainable Innovation: Pushing the Boundaries of Traditional Operations Management. *Production and Operations Management, n/a*(n/a). https://doi.org/10.1111/poms.13114

van Weelden, E., Mugge, R., & Bakker, C. (2016). Paving the way towards circular consumption: Exploring consumer acceptance of refurbished mobile phones in the Dutch market [Article]. *Journal of Cleaner Production, 113*, 743-754. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.11.065

Vanegas, P., Peeters, J. R., Cattrysse, D., Tecchio, P., Ardente, F., Mathieux, F., Dewulf, W., & Duflou, J. R. (2018). Ease of disassembly of products to support circular economy strategies [Article]. *Resources, Conservation and Recycling, 135*, 323-334. https://doi.org/10.1016/j.resconrec.2017.06.022

Vasantha, G. V. A., Roy, R., & Corney, J. R. (2015). Advances in Designing Product-Service Systems [Review]. *Journal of the Indian Institute of Science, 95*(4), 429-447. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84954180177&partnerID=40&md5=65878ee7eee8bb0824c4aef6126f3ed4

Veleva, V., & Bodkin, G. (2017). Emerging drivers and business models for equipment reuse and remanufacturing in the US: lessons from the biotech industry [Article in Press]. *Journal of Environmental Planning and Management*, 1-23. https://doi.org/https://doi.org/10.1080/09640568.2017.1369940

Veleva, V., Bodkin, G., & Todorova, S. (2017). The need for better measurement and employee engagement to advance a circular economy: Lessons from Biogen's "zero waste" journey. *Journal of Cleaner Production, 154*, 517-529. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.03.177

Venkatesh, V. G., Zhang, A., Luthra, S., Dubey, R., Subramanian, N., & Mangla, S. (2017). Barriers to coastal shipping development: An Indian perspective. *Transportation Research Part D: Transport and Environment, 52*(Part A), 362-378. https://doi.org/https://doi.org/10.1016/j.trd.2017.03.016

Vlajic, J. V., Mijailovic, R., & Bogdanova, M. (2018). Creating loops with value recovery: empirical study of fresh food supply chains [Article]. *Production Planning and Control, 29*(6), 522-538. https://doi.org/10.1080/09537287.2018.1449264

Vujanović, D., Momčilović, V., Bojović, N., & Papić, V. (2012). Evaluation of vehicle fleet maintenance management indicators by application of DEMATEL and ANP. *Expert Systems with Applications, 39*(12), 10552-10563. https://doi.org/https://doi.org/10.1016/j.eswa.2012.02.159

Walker, H., Di Sisto, L., & McBain, D. (2008). Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors. *Journal of Purchasing and Supply Management, 14*(1), 69-85. https://doi.org/https://doi.org/10.1016/j.pursup.2008.01.007

Wang, P., & Kuah, A. T. H. (2018). Green marketing cradle-to-cradle: Remanufactured products in Asian markets [Article]. *Thunderbird International Business Review, 60*(5), 783-795. https://doi.org/10.1002/tie.21925

Wang, Y., & Hazen, B. T. (2016). Consumer product knowledge and intention to purchase remanufactured products [Article]. *International Journal of Production Economics, 181*, 460-469. https://doi.org/https://doi.org/10.1016/j.ijpe.2015.08.031

Weetman, C. (2017). *A Circular Economy Handbook for Business and Supply Chains: Repair, Remake, Redesign, Rethink* (Vol. 1) [Book]. Kogan Page. https://www.koganpage.com/product/supply-chains-for-a-circular-economy-9780749476755# (Kogan Page)

Whalen, K. A., Milios, L., & Nussholz, J. (2018). Bridging the gap: Barriers and potential for scaling reuse practices in the Swedish ICT sector [Article]. *Resources, Conservation and Recycling, 135*, 123-131. https://doi.org/10.1016/j.resconrec.2017.07.029

Widaman, K. F. (1985). Hierarchically Nested Covariance Structure Models for Multitrait-Multimethod Data. *Applied Psychological Measurement, 9*(1), 1-26. https://doi.org/10.1177/014662168500900101

Wieser, H., & Tröger, N. (2016). Exploring the inner loops of the circular economy: Replacement, repair, and reuse of mobile phones in Austria [Article]. *Journal of Cleaner Production, 172*, 3042-3055. https://doi.org/https://doi.org/10.1016/j.jclepro.2017.11.106

Winans, K., Kendall, A., & Deng, H. (2017). The history and current applications of the circular economy concept [Review]. *Renewable and Sustainable Energy Reviews, 68*, 825-833. https://doi.org/https://doi.org/10.1016/j.rser.2016.09.123

Winkler, H. (2011a). Closed-loop production systems-A sustainable supply chain approach [Article]. *CIRP Journal of Manufacturing Science and Technology, 4*(3), 243-246. https://doi.org/https://doi.org/10.1016/j.cirpj.2011.05.001

Winkler, H. (2011b). Closed-loop production systems—A sustainable supply chain approach. *CIRP Journal of Manufacturing Science and Technology, 4*(3), 243-246. https://doi.org/10.1016/j.cirpj.2011.05.001

Winkler, H., & Kaluza, B. (2006). Sustainable supply chain networks - A new approach for effective waste management [Article]. *WIT Transactions on Ecology and the Environment, 92*, 501-510. https://doi.org/https://doi.org/10.2495/WM060521

Witjes, S., & Lozano, R. (2016). Towards a more Circular Economy: Proposing a framework linking sustainable public procurement and sustainable business models [Article]. *Resources, Conservation and Recycling, 112*, 37-44. https://doi.org/https://doi.org/10.1016/j.resconrec.2016.04.015

World Commission on Environment and Development. (1987). *Our common future*. New York, NY: Oxford University Press.

Wu, H.-q., Shi, Y., Xia, Q., & Zhu, W.-d. (2014). Effectiveness of the policy of circular economy in China: A DEA-based analysis for the period of 11th five-year-plan. *Resources, Conservation and Recycling, 83*(Supplement C), 163-175. https://doi.org/https://doi.org/10.1016/j.resconrec.2013.10.003

Wu, W.-W. (2012). Segmenting critical factors for successful knowledge management implementation using the fuzzy DEMATEL method. *Applied Soft Computing, 12*(1), 527-535. https://doi.org/https://doi.org/10.1016/j.asoc.2011.08.008

Wu, W.-W., & Lee, Y.-T. (2007). Developing global managers' competencies using the fuzzy DEMATEL method. *Expert Systems with Applications, 32*(2), 499-507. https://doi.org/https://doi.org/10.1016/j.eswa.2005.12.005

Wübbeke, J., & Heroth, T. (2014). Challenges and political solutions for steel recycling in China [Article]. *Resources, Conservation and Recycling, 87*, 1-7. https://doi.org/https://doi.org/10.1016/j.resconrec.2014.03.004

Xue, H. y., & Yang, D. h. (2010). Implementing Circular Consumption by Means of Second-Hand Goods Market. 2010 International Conference on Management and Service Science,

Yang, C.-S., Lu, C.-S., Haider, J. J., & Marlow, P. B. (2013). The effect of green supply chain management on green performance and firm competitiveness in the context of container shipping in Taiwan. *Transportation Research Part E: Logistics and Transportation Review, 55*(Supplement C), 55-73. https://doi.org/https://doi.org/10.1016/j.tre.2013.03.005

Yang, M., Smart, P., Kumar, M., Jolly, M., & Evans, S. (2018). Product-service systems business models for circular supply chains [Article]. *Production Planning and Control, 29*(6), 498-508. https://doi.org/10.1080/09537287.2018.1449247

Yin, R. K. (2013). *Case study research: Design and methods*. Sage publications.

Ying, J., & Li-jun, Z. (2012). Study on Green Supply Chain Management Based on Circular Economy. *Physics Procedia, 25*(Supplement C), 1682-1688. https://doi.org/https://doi.org/10.1016/j.phpro.2012.03.295

Yu, F., Han, F., & Cui, Z. (2015). Evolution of industrial symbiosis in an eco-industrial park in China. *Journal of Cleaner Production, 87*(Supplement C), 339-347. https://doi.org/10.1016/j.jclepro.2014.10.058

Yuan, Z., Bi, J., & Moriguichi, Y. (2006). The Circular Economy: A New Development Strategy in China. *Journal of Industrial Ecology, 10*(1-2), 4-8. https://doi.org/10.1162/108819806775545321

Zeng, H., Chen, X., Xiao, X., & Zhou, Z. (2017). Institutional pressures, sustainable supply chain management, and circular economy capability: Empirical evidence from Chinese eco-industrial park firms. *Journal of Cleaner Production, 155*(Part 2), 54-65. https://doi.org/10.1016/j.jclepro.2016.10.093

Zeng, S. X., Meng, X. H., Yin, H. T., Tam, C. M., & Sun, L. (2010). Impact of cleaner production on business performance. *Journal of Cleaner Production, 18*(10), 975-983. https://doi.org/https://doi.org/10.1016/j.jclepro.2010.02.019

Zhang, G., & Zhao, Z. (2012). Green Packaging Management of Logistics Enterprises. *Physics Procedia, 24*(Part B), 900-905. https://doi.org/https://doi.org/10.1016/j.phpro.2012.02.135

Zhang, J. H., & Chen, M. (2015). Assessing the impact of China's vehicle emission standards on diesel engine remanufacturing [Article]. *Journal of Cleaner Production, 107*, 177-184. https://doi.org/https://doi.org/10.1016/j.jclepro.2015.03.103

Zhang, T., Chu, J., Wang, X., Liu, X., & Cui, P. (2011). Development pattern and enhancing system of automotive components remanufacturing industry in China. *Resources, Conservation and Recycling, 55*(6), 613-622. https://doi.org/https://doi.org/10.1016/j.resconrec.2010.09.015

Zhang, T., Wang, X., Chu, J., Liu, X., & Cui, P. (2010). Automotive recycling information management based on the internet of things and RFID technology. Advanced Management Science (ICAMS), 2010 IEEE International Conference on,

Zhijun, F., & Nailing, Y. (2007). Putting a circular economy into practice in China. *Sustainability Science, 2*(1), 95-101. https://doi.org/10.1007/s11625-006-0018-1

Zhong, S., & Pearce, J. M. (2018). Tightening the loop on the circular economy: Coupled distributed recycling and manufacturing with recyclebot and RepRap 3-D printing [Article]. *Resources, Conservation and Recycling, 128*, 48-58. https://doi.org/10.1016/j.resconrec.2017.09.023

Zhou, M., Pan, Y., Chen, Z., Yang, W., & Li, B. (2012). Selection and evaluation of green production strategies: analytic and simulation models. *Journal of Cleaner Production, 26*(Supplement C), 9-17. https://doi.org/https://doi.org/10.1016/j.jclepro.2011.12.014

Zhu, J., Fan, C., Shi, H., & Shi, L. (2019). Efforts for a Circular Economy in China: A Comprehensive Review of Policies. *Journal of Industrial Ecology, 23*(1), 110-118. https://doi.org/10.1111/jiec.12754

Zhu, Q., & Geng, Y. (2013). Drivers and barriers of extended supply chain practices for energy saving and emission reduction among Chinese manufacturers. *Journal of Cleaner Production, 40*, 6-12.

Zhu, Q., Geng, Y., & Lai, K.-h. (2010). Circular economy practices among Chinese manufacturers varying in environmental-oriented supply chain cooperation and the performance implications. *Journal of Environmental Management, 91*(6), 1324-1331. https://doi.org/https://doi.org/10.1016/j.jenvman.2010.02.013

Zhu, Q., Geng, Y., & Lai, K.-h. (2011). Environmental Supply Chain Cooperation and Its Effect on the Circular Economy Practice-Performance Relationship Among Chinese Manufacturers. *Journal of Industrial Ecology, 15*(3), 405-419. https://doi.org/https://doi.org/10.1111/j.1530-9290.2011.00329.x

Zhu, Q., Geng, Y., & Sarkis, J. (2013). Motivating green public procurement in China: An individual level perspective. *Journal of Environmental Management, 126*, 85-95. https://doi.org/https://doi.org/10.1016/j.jenvman.2013.04.009

Zhu, Q., Geng, Y., Sarkis, J., & Lai, K.-H. (2015). Barriers to Promoting Eco-Industrial Parks Development in China. *Journal of Industrial Ecology, 19*(3), 457-467. https://doi.org/10.1111/jiec.12176

Zhu, Q., Lowe, E. A., Wei, Y.-a., & Barnes, D. (2007). Industrial Symbiosis in China: A Case Study of the Guitang Group. *Journal of Industrial Ecology, 11*(1), 31-42. https://doi.org/10.1162/jiec.2007.929

Zhu, Q., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operations Management, 22*(3), 265-289. https://doi.org/https://doi.org/10.1016/j.jom.2004.01.005

Zhu, Q., & Sarkis, J. (2007). The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International Journal of Production Research, 45*(18-19), 4333-4355. https://doi.org/https://doi.org/10.1080/00207540701440345

Zhu, Q., Sarkis, J., & Lai, K.-h. (2007). Green supply chain management: pressures, practices and performance within the Chinese automobile industry. *Journal of Cleaner Production, 15*(11), 1041-1052. https://doi.org/https://doi.org/10.1016/j.jclepro.2006.05.021

Zhu, Q., Sarkis, J., & Lai, K.-h. (2011). An institutional theoretic investigation on the links between internationalization of Chinese manufacturers and their environmental supply chain management. *Resources, Conservation and Recycling, 55*(6), 623-630. https://doi.org/10.1016/j.resconrec.2010.12.003

Zhu, Q., Sarkis, J., & Lai, K.-h. (2013). Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices. *Journal of Purchasing and Supply Management, 19*(2), 106-117.

Zhu, Q., Sarkis, J., & Lai, K.-h. (2014). Supply chain-based barriers for truck-engine remanufacturing in China. *Transportation Research Part E: Logistics and Transportation Review, 68*(Supplement C), 103-117. https://doi.org/https://doi.org/10.1016/j.tre.2014.05.001

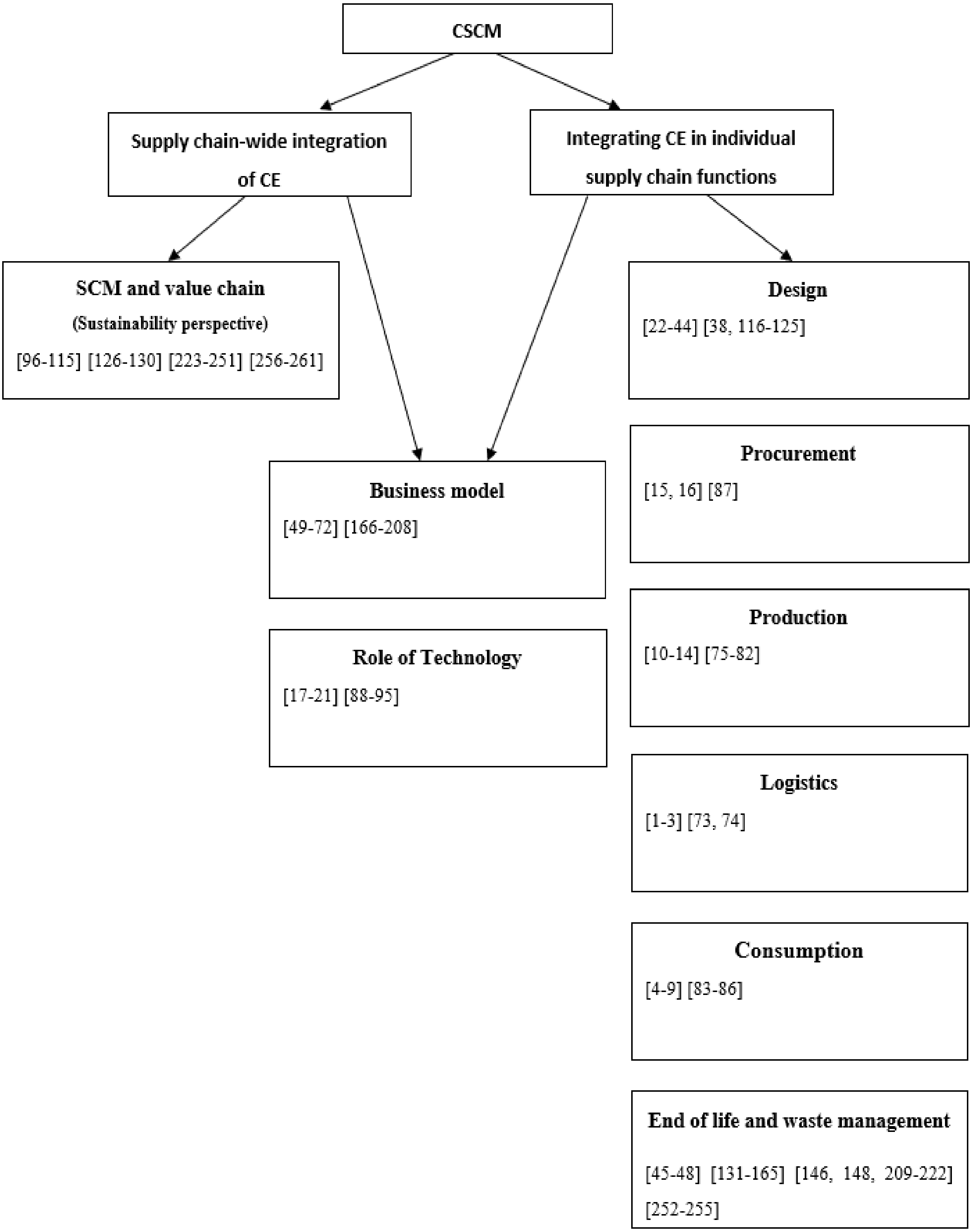
Zsidisin, G. A., & Siferd, S. P. (2001). Environmental purchasing: a framework for theory development. *European Journal of Purchasing & Supply Management, 7*(1), 61-73. https://doi.org/https://doi.org/10.1016/S0969-7012(00)00007-1

Zsidisin George, A. (1998). Purchasing's involvement in environmental issues: a multi-country perspective. *Industrial Management & Data Systems, 98*(7), 313-320. https://doi.org/10.1108/02635579810241773

7. Appendices

Manuscript 1

Appendix A: Classification of literature on CSCM



1. Dhakal, M., M.H. Smith, and R. Newbery, *Secondary market: A significant aspect in reverse logistics and sustainability.* International Journal of Sustainability in Economic, Social, and Cultural Context, 2016. **12**(1): p. 24-35.
2. Sun, Q., *Research on the influencing factors of reverse logistics carbon footprint under sustainable development.* Environmental Science and Pollution Research, 2017. **24**(29): p. 22790-22798.
3. Dente, S.M.R. and L.A. Tavasszy, *Impacts of trade related sustainability strategies on freight transportation: Modelling framework and application for France.* Transportation Research Part D: Transport and Environment, 2017.
4. Jurgilevich, A., et al., *Transition towards Circular Economy in the Food System.* Sustainability, 2016. **8**(1): p. 69.
5. Canning, L., *Rethinking market connections: mobile phone recovery, reuse and recycling in the UK.* Journal of Business & Industrial Marketing, 2006. **21**(5): p. 320-329.
6. van Weelden, E., R. Mugge, and C. Bakker, *Paving the way towards circular consumption: Exploring consumer acceptance of refurbished mobile phones in the Dutch market.* Journal of Cleaner Production, 2016. **113**: p. 743-754.
7. Wieser, H. and N. Tröger, *Exploring the inner loops of the circular economy: Replacement, repair, and reuse of mobile phones in Austria.* Journal of Cleaner Production, 2016. **172**: p. 3042-3055.
8. Wang, Y. and B.T. Hazen, *Consumer product knowledge and intention to purchase remanufactured products.* International Journal of Production Economics, 2016. **181**: p. 460-469.
9. Castellani, V., S. Sala, and N. Mirabella, *Beyond the throwaway society: A life cycle-based assessment of the environmental benefit of reuse.* Integrated Environmental Assessment and Management, 2015. **11**(3): p. 373-382.
10. Leslie, H.A., et al., *Propelling plastics into the circular economy - weeding out the toxics first.* Environment International, 2016. **94**: p. 230-234.
11. Shahbazi, S., et al., *Material efficiency in manufacturing: swedish evidence on potential, barriers and strategies.* Journal of Cleaner Production, 2016. **127**: p. 438-450.
12. Antoniou, N. and A. Zabaniotou, *Experimental proof of concept for a sustainable End of Life Tyres pyrolysis with energy and porous materials production.* Journal of Cleaner Production, 2015. **101**: p. 1-14.
13. Li, Y. and C. Ma, *Circular economy of a papermaking park in China: A case study.* Journal of Cleaner Production, 2015. **92**: p. 65-74.
14. Low, J.S.C., et al., *Adaptation of the Product Structure-based Integrated Life cycle Analysis (PSILA) technique for carbon footprint modelling and analysis of closed-loop production systems.* Journal of Cleaner Production, 2016. **120**: p. 105-123.
15. Witjes, S. and R. Lozano, *Towards a more Circular Economy: Proposing a framework linking sustainable public procurement and sustainable business models.* Resources, Conservation and Recycling, 2016. **112**: p. 37-44.
16. Sprecher, B., et al., *Novel Indicators for the Quantification of Resilience in Critical Material Supply Chains, with a 2010 Rare Earth Crisis Case Study.* Environmental Science and Technology, 2017. **51**(7): p. 3860-3870.
17. Cong, L., F. Zhao, and J.W. Sutherland, *Value recovery from end-of-use products facilitated by automated dismantling planning.* Clean Technologies and Environmental Policy, 2017. **19**(7): p. 1867-1882.
18. Despeisse, M., et al., *Unlocking value for a circular economy through 3D printing: A research agenda.* Technological Forecasting and Social Change, 2017. **115**: p. 75-84.

19. Jabbour, C.J.C., et al., *Unlocking the circular economy through new business models based on large-scale data: An integrative framework and research agenda.* Technological Forecasting and Social Change, 2017.
20. Alvarez-de-los-Mozos, E. and A. Renteria, *Collaborative Robots in e-waste Management.* Procedia Manufacturing, 2017. **11**: p. 55-62.
21. Giurco, D., et al., *Circular economy: Questions for responsible minerals, additive manufacturing and recycling of metals.* Resources, 2014. **3**(2): p. 432-453.
22. Kane, G.M., C.A. Bakker, and A.R. Balkenende, *Towards design strategies for circular medical products.* Resources, Conservation and Recycling, 2018. **135**: p. 38-47.
23. Lieder, M., et al., *Towards circular economy implementation in manufacturing systems using a multi-method simulation approach to link design and business strategy.* International Journal of Advanced Manufacturing Technology, 2017. **93**(5-8): p. 1953-1970.
24. Tian, J. and M. Chen, *Sustainable design for automotive products: Dismantling and recycling of end-of-life vehicles.* Waste Management, 2014. **34**(2): p. 458-467.
25. Broadbent, C., *Steel's recyclability: demonstrating the benefits of recycling steel to achieve a circular economy.* International Journal of Life Cycle Assessment, 2016. **21**(11): p. 1658-1665.
26. Laurenti, R., et al., *Some pervasive challenges to sustainability by design of electronic products - A conceptual discussion.* Journal of Cleaner Production, 2015. **108**: p. 281-288.
27. De los Rios, I.C. and F.J.S. Charnley, *Skills and capabilities for a sustainable and circular economy: The changing role of design.* Journal of Cleaner Production, 2017. **160**: p. 109-122.
28. Bakker, C., et al., *Products that go round: Exploring product life extension through design.* Journal of Cleaner Production, 2014. **69**: p. 10-16.
29. den Hollander, M.C., C.A. Bakker, and E.J. Hultink, *Product Design in a Circular Economy: Development of a Typology of Key Concepts and Terms.* Journal of Industrial Ecology, 2017. **21**(3): p. 517-525.
30. Bocken, N.M.P., et al., *Product design and business model strategies for a circular economy.* Journal of Industrial and Production Engineering, 2016. **33**(5): p. 308-320.
31. Dalhammar, C., *Industry attitudes towards ecodesign standards for improved resource efficiency.* Journal of Cleaner Production, 2016. **123**: p. 155-166.
32. Whalen, K. and D. Peck, *In the loop - Sustainable, circular product design and critical materials.* International Journal of Automation Technology, 2014. **8**(5): p. 664-676.
33. Tecchio, P., et al., *In search of standards to support circularity in product policies: A systematic approach.* Journal of Cleaner Production, 2017. **168**: p. 1533-1546.
34. Sihvonen, S. and J. Partanen, *Implementing environmental considerations within product development practices: A survey on employees' perspectives.* Journal of Cleaner Production, 2016. **125**: p. 189-203.
35. Bundgaard, A.M., M.A. Mosgaard, and A. Remmen, *From energy efficiency towards resource efficiency within the Ecodesign Directive.* Journal of Cleaner Production, 2017. **144**: p. 358-374.
36. Sabaghi, M., C. Mascle, and P. Baptiste, *Evaluation of products at design phase for an efficient disassembly at end-of-life.* Journal of Cleaner Production, 2016.
37. Sihvonen, S. and J. Partanen, *Eco-design practices with a focus on quantitative environmental targets: An exploratory content analysis within ICT sector.* Journal of Cleaner Production, 2017. **143**: p. 769-783.

38. Vanegas, P., et al., *Ease of disassembly of products to support circular economy strategies.* Resources, Conservation and Recycling, 2018. **135**: p. 323-334.
39. Cayzer, S., P. Griffiths, and V. Beghetto, *Design of indicators for measuring product performance in the circular economy.* International Journal of Sustainable Engineering, 2017. **10**(4-5): p. 289-298.
40. Talens Peiró, L., F. Ardente, and F. Mathieux, *Design for Disassembly Criteria in EU Product Policies for a More Circular Economy: A Method for Analyzing Battery Packs in PC-Tablets and Subnotebooks.* Journal of Industrial Ecology, 2017. **21**(3): p. 731-741.
41. Peck, D., P. Kandachar, and E. Tempelman, *Critical materials from a product design perspective.* Materials and Design, 2015. **65**: p. 147-159.
42. Moreno, M., et al., *A conceptual framework for circular design.* Sustainability (Switzerland), 2016. **8**(9).
43. Andrews, D., *The circular economy, design thinking and education for sustainability.* Local Economy, 2015. **30**(3): p. 305-315.
44. Clark, J.H., et al., *Circular economy design considerations for research and process development in the chemical sciences.* Green Chemistry, 2016. **18**(14): p. 3914-3934.
45. Tong, X., et al., *Towards an inclusive circular economy: Quantifying the spatial flows of e-waste through the informal sector in China.* Resources, Conservation and Recycling, 2018. **135**: p. 163-171.
46. Singh, J. and I. Ordoñez, *Resource recovery from post-consumer waste: important lessons for the upcoming circular economy.* Journal of Cleaner Production, 2016. **134**: p. 342-353.
47. Işıldar, A., et al., *Electronic waste as a secondary source of critical metals: Management and recovery technologies.* Resources, Conservation and Recycling, 2018. **135**: p. 296-312.
48. Richa, K., C.W. Babbitt, and G. Gaustad, *Eco-Efficiency Analysis of a Lithium-Ion Battery Waste Hierarchy Inspired by Circular Economy.* Journal of Industrial Ecology, 2017. **21**(3): p. 715-730.
49. Pialot, O., D. Millet, and J. Bisiaux, *"Upgradable PSS": Clarifying a new concept of sustainable consumption/production based on upgradablility.* Journal of Cleaner Production, 2017. **141**: p. 538-550.
50. Scheepens, A.E., J.G. Vogtländer, and J.C. Brezet, *Two life cycle assessment (LCA) based methods to analyse and design complex (regional) circular economy systems. Case: Making water tourism more sustainable.* Journal of Cleaner Production, 2016. **114**: p. 257-268.
51. Gorissen, L., K. Vrancken, and S. Manshoven, *Transition thinking and business model innovation-towards a transformative business model and new role for the reuse centers of Limburg, Belgium.* Sustainability (Switzerland), 2016. **8**(2).
52. Lieder, M., F.M.A. Asif, and A. Rashid, *Towards Circular Economy implementation: an agent-based simulation approach for business model changes.* Autonomous Agents and Multi-Agent Systems, 2017. **31**(6): p. 1377-1402.
53. Urbinati, A., D. Chiaroni, and V. Chiesa, *Towards a new taxonomy of circular economy business models.* Journal of Cleaner Production, 2017. **168**: p. 487-498.
54. Stål, H.I. and J. Jansson, *Sustainable Consumption and Value Propositions: Exploring Product–Service System Practices Among Swedish Fashion Firms.* Sustainable Development, 2017. **25**(6): p. 546-558.
55. Tukker, A., *Product services for a resource-efficient and circular economy - A review.* Journal of Cleaner Production, 2015. **97**: p. 76-91.

56. Spring, M. and L. Araujo, *Product biographies in servitization and the circular economy.* Industrial Marketing Management, 2017. **60**: p. 126-137.
57. Schulte, U.G., *New business models for a radical change in resource efficiency.* Environmental Innovation and Societal Transitions, 2013. **9**: p. 43-47.
58. Mendoza, J.M.F., et al., *Integrating Backcasting and Eco-Design for the Circular Economy: The BECE Framework.* Journal of Industrial Ecology, 2017. **21**(3): p. 526-544.
59. Todeschini, B.V., et al., *Innovative and sustainable business models in the fashion industry: Entrepreneurial drivers, opportunities, and challenges.* Business Horizons, 2017. **60**(6): p. 759-770.
60. Rizos, V., et al., *Implementation of circular economy business models by small and medium-sized enterprises (SMEs): Barriers and enablers.* Sustainability (Switzerland), 2016. **8**(11).
61. Lakatos, E.S., et al., *How supportive are Romanian consumers of the circular economy concept: A survey.* Sustainability (Switzerland), 2016. **8**(8).
62. Lewandowski, M., *Designing the business models for circular economy-towards the conceptual framework.* Sustainability (Switzerland), 2016. **8**(1): p. 1-28.
63. Niero, M., et al., *Combining Eco-Efficiency and Eco-Effectiveness for Continuous Loop Beverage Packaging Systems: Lessons from the Carlsberg Circular Community.* Journal of Industrial Ecology, 2017. **21**(3): p. 742-753.
64. Vogtlander, J.G., et al., *Combined analyses of costs, market value and eco-costs in circular business models: eco-efficient value creation in remanufacturing.* Journal of Remanufacturing, 2017. **7**(1).
65. Hobson, K., *Closing the loop or squaring the circle? Locating generative spaces for the circular economy.* Progress in Human Geography, 2016. **40**(1): p. 88-104.
66. Mativenga, P.T., et al., *Circular Economy Ownership Models: A view from South Africa Industry.* Procedia Manufacturing, 2017. **8**: p. 284-291.
67. Nußholz, J.L.K., *Circular business models: Defining a concept and framing an emerging research field.* Sustainability (Switzerland), 2017. **9**(10).
68. Linder, M. and M. Williander, *Circular Business Model Innovation: Inherent Uncertainties.* Business Strategy and the Environment, 2017. **26**(2): p. 182-196.
69. Roos, G., *Business model innovation to create and capture resource value in future circular material chains.* Resources, 2014. **3**(1): p. 248-274.
70. Bocken, N.M.P., et al., *Business model experimentation for circularity: Driving sustainability in a large international clothing retailer.* Economics and Policy of Energy and the Environment, 2017. **2017**(1): p. 85-122.
71. Whalen, K.A., L. Milios, and J. Nussholz, *Bridging the gap: Barriers and potential for scaling reuse practices in the Swedish ICT sector.* Resources, Conservation and Recycling, 2018. **135**: p. 123-131.
72. Vasantha, G.V.A., R. Roy, and J.R. Corney, *Advances in Designing Product-Service Systems.* Journal of the Indian Institute of Science, 2015. **95**(4): p. 429-447.
73. Esposito, M., T. Tse, and K. Soufani, *Reverse logistics for postal services within a circular economy.* Thunderbird International Business Review, 2018. **60**(5): p. 741-745.
74. Bernon, M., B. Tjahjono, and E.F. Ripanti, *Aligning retail reverse logistics practice with circular economy values: an exploratory framework.* Production Planning and Control, 2018. **29**(6): p. 483-497.

75. Wang, P., S. Kara, and M.Z. Hauschild, *Role of manufacturing towards achieving circular economy: The steel case.* CIRP Annals, 2018. **67**(1): p. 21-24.
76. Casarejos, F., et al., *Rethinking packaging production and consumption vis-à-vis circular economy: A case study of compostable cassava starch-based material.* Journal of Cleaner Production, 2018. **201**: p. 1019-1028.
77. Mao, Y. and J. Wang, *Is green manufacturing expensive? Empirical evidence from China.* International Journal of Production Research, 2018: p. 1-13.
78. Ghisellini, P., et al., *Evaluating the transition towards cleaner production in the construction and demolition sector of China: A review.* Journal of Cleaner Production, 2018. **195**: p. 418-434.
79. Ridaura, G., et al., *Equipment suppliers integration to the redesign for emissions reuse in industrial processes.* Resources, Conservation and Recycling, 2018. **131**: p. 75-85.
80. Moktadir, M.A., et al., *Drivers to sustainable manufacturing practices and circular economy: A perspective of leather industries in Bangladesh.* Journal of Cleaner Production, 2018. **174**: p. 1366-1380.
81. Sousa-Zomer, T.T., et al., *Cleaner production as an antecedent for circular economy paradigm shift at the micro-level: Evidence from a home appliance manufacturer.* Journal of Cleaner Production, 2018. **185**: p. 740-748.
82. Vimal, K.E.K., S. Rajak, and J. Kandasamy, *Analysis of network design for a circular production system using multi-objective mixed integer linear programming model.* Journal of Manufacturing Technology Management, 2018.
83. Gaur, J., et al., *Towards building circular economy: A cross-cultural study of consumers' purchase intentions for reconstructed products.* Management Decision, 2018.
84. Lakatos, E.S., et al., *Studies and investigation about the attitude towards sustainable production, consumption and waste generation in line with circular economy in Romania.* Sustainability (Switzerland), 2018. **10**(3).
85. Junnila, S., J. Ottelin, and L. Leinikka, *Influence of reduced ownership on the environmental benefits of the circular economy.* Sustainability (Switzerland), 2018. **10**(11).
86. Camacho-Otero, J., C. Boks, and I.N. Pettersen, *Consumption in the circular economy: A literature review.* Sustainability (Switzerland), 2018. **10**(8).
87. Gaustad, G., et al., *Circular economy strategies for mitigating critical material supply issues.* Resources, Conservation and Recycling, 2018. **135**: p. 24-33.
88. Zhong, S. and J.M. Pearce, *Tightening the loop on the circular economy: Coupled distributed recycling and manufacturing with recyclebot and RepRap 3-D printing.* Resources, Conservation and Recycling, 2018. **128**: p. 48-58.
89. Yang, S., et al., *Opportunities for industry 4.0 to support remanufacturing.* Applied Sciences (Switzerland), 2018. **8**(7).
90. Lopes de Sousa Jabbour, A.B., et al., *Industry 4.0 and the circular economy: a proposed research agenda and original roadmap for sustainable operations.* Annals of Operations Research, 2018. **270**(1-2): p. 273-286.
91. Rajala, R., et al., *How Do Intelligent Goods Shape Closed-Loop Systems?* California Management Review, 2018. **60**(3): p. 20-44.
92. Esmaeilian, B., et al., *The future of waste management in smart and sustainable cities: A review and concept paper.* Waste Management, 2018. **81**: p. 177-195.

93. Nascimento, D.L.M., et al., *Exploring Industry 4.0 technologies to enable circular economy practices in a manufacturing context: A business model proposal.* Journal of Manufacturing Technology Management, 2018.
94. Bressanelli, G., et al., *Exploring how usage-focused business models enable circular economy through digital technologies.* Sustainability (Switzerland), 2018. **10**(3).
95. Garmulewicz, A., et al., *Disruptive Technology as an Enabler of the Circular Economy: What Potential Does 3D Printing Hold?* California Management Review, 2018.
96. Bodova, E., *Tools of environmental management and EU circular economy.* MM Science Journal, 2017. **2017**(FEBRUARY): p. 1700-1706.
97. Winkler, H. and B. Kaluza, *Sustainable supply chain networks - A new approach for effective waste management.* WIT Transactions on Ecology and the Environment, 2006. **92**: p. 501-510.
98. Genovese, A., et al., *Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications.* Omega (United Kingdom), 2017. **66**: p. 344-357.
99. Masi, D., S. Day, and J. Godsell, *Supply chain configurations in the circular economy: A systematic literature review.* Sustainability (Switzerland), 2017. **9**(9).
100. O'Connor, M.P., et al., *A strategy for material supply chain sustainability: Enabling a circular economy in the electronics industry through green engineering.* ACS Sustainable Chemistry and Engineering, 2016. **4**(11): p. 5879-5888.
101. Pan, S.Y., et al., *Strategies on implementation of waste-to-energy (WTE) supply chain for circular economy system: A review.* Journal of Cleaner Production, 2014. **108**.
102. Ghisellini, P., C. Cialani, and S. Ulgiati, *A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems.* Journal of Cleaner Production, 2016. **114**: p. 11-32.
103. Accorsi, R., et al., *On the design of closed-loop networks for product life cycle management: Economic, environmental and geography considerations.* Journal of Transport Geography, 2015. **48**: p. 121-134.
104. Di Maio, F., et al., *Measuring resource efficiency and circular economy: A market value approach.* Resources, Conservation and Recycling, 2017. **122**: p. 163-171.
105. Zeng, H., et al., *Institutional pressures, sustainable supply chain management, and circular economy capability: Empirical evidence from Chinese eco-industrial park firms.* Journal of Cleaner Production, 2017. **155**: p. 54-65.
106. Clark, J.H., *From waste to wealth using green chemistry: The way to long term stability.* Current Opinion in Green and Sustainable Chemistry, 2017. **8**: p. 10-13.
107. Mohamed Abdul Ghani, N.M.A., et al., *From green buildings to green supply chains: An integrated input-output life cycle assessment and optimization framework for carbon footprint reduction policy making.* Management of Environmental Quality: An International Journal, 2017. **28**(4): p. 532-548.
108. Zhu, Q., Y. Geng, and K.H. Lai, *Environmental supply chain cooperation and its effect on the circular economy practice-performance relationship among Chinese manufacturers.* Journal of Industrial Ecology, 2011. **15**(3): p. 405-419.
109. Park, J., J. Sarkis, and Z. Wu, *Creating integrated business and environmental value within the context of China's circular economy and ecological modernization.* Journal of Cleaner Production, 2010. **18**(15): p. 1492-1499.
110. Borrello, M., et al., *Consumers' perspective on circular economy strategy for reducing food waste.* Sustainability (Switzerland), 2017. **9**(1).

111. Nasir, M.H.A., et al., *Comparing linear and circular supply chains: A case study from the construction industry.* International Journal of Production Economics, 2017. **183**: p. 443-457.
112. Winkler, H., *Closed-loop production systems-A sustainable supply chain approach.* CIRP Journal of Manufacturing Science and Technology, 2011. **4**(3): p. 243-246.
113. Zhu, Q., Y. Geng, and K.H. Lai, *Circular economy practices among Chinese manufacturers varying in environmental-oriented supply chain cooperation and the performance implications.* Journal of Environmental Management, 2010. **91**(6): p. 1324-1331.
114. Franco, M.A., *Circular economy at the micro level: A dynamic view of incumbents' struggles and challenges in the textile industry.* Journal of Cleaner Production, 2017. **168**: p. 833-845.
115. Jiliang, Z. and Z. Chen, *Building and application of a circular economy index system frame for manufacturing industrial chain.* Research Journal of Applied Sciences, Engineering and Technology, 2013. **5**(24): p. 8646-8651.
116. Sihvonen, S. and J. Partanen, *A survey of perceived prevalence of selected environmental topics in product development, and their relationships with employee's ecological concern.* Journal of Cleaner Production, 2018. **199**: p. 1116-1129.
117. Subramanian, N., et al., *Role of traditional Chinese philosophies and new product development under circular economy in private manufacturing enterprise performance.* International Journal of Production Research, 2018.
118. Sumter, D., C. Bakker, and R. Balkenende, *The role of product design in creating circular business models: A case study on the lease and refurbishment of baby strollers.* Sustainability (Switzerland), 2018. **10**(7).
119. Pinheiro, M.A.P., et al., *The role of new product development in underpinning the circular economy: A systematic review and integrative framework.* Management Decision, 2018.
120. Bovea, M.D., et al., *Options for labelling circular products: Icon design and consumer preferences.* Journal of Cleaner Production, 2018. **202**: p. 1253-1263.
121. Bovea, M.D., et al., *Incorporation of circular aspects into product design and labelling: Consumer preferences.* Sustainability (Switzerland), 2018. **10**(7).
122. Bovea, M.D. and V. Pérez-Belis, *Identifying design guidelines to meet the circular economy principles: A case study on electric and electronic equipment.* Journal of Environmental Management, 2018. **228**: p. 483-494.
123. Lofthouse, V. and S. Prendeville, *Human-Centred Design of Products And Services for the Circular Economy – A Review.* Design Journal, 2018: p. 1-26.
124. Haines-Gadd, M., et al., *Emotional durability design Nine-A tool for product longevity.* Sustainability (Switzerland), 2018. **10**(6).
125. Steenis, N.D., et al., *Effects of sustainable design strategies on consumer preferences for redesigned packaging.* Journal of Cleaner Production, 2018. **205**: p. 854-865.
126. Golev, A. and G.D. Corder, *Quantifying metal values in e-waste in Australia: The value chain perspective.* Minerals Engineering, 2017. **107**: p. 81-87.
127. Linder, M., S. Sarasini, and P. van Loon, *A Metric for Quantifying Product-Level Circularity.* Journal of Industrial Ecology, 2017. **21**(3): p. 545-558.
128. Winans, K., A. Kendall, and H. Deng, *The history and current applications of the circular economy concept.* Renewable and Sustainable Energy Reviews, 2017. **68**: p. 825-833.

129. Kalmykova, Y., M. Sadagopan, and L. Rosado, *Circular economy - From review of theories and practices to development of implementation tools.* Resources, Conservation and Recycling, 2017. **135**: p. 190-201.
130. Scheel, C., *Beyond sustainability. Transforming industrial zero-valued residues into increasing economic returns.* Journal of Cleaner Production, 2016. **131**: p. 376-386.
131. Densley Tingley, D., S. Cooper, and J. Cullen, *Understanding and overcoming the barriers to structural steel reuse, a UK perspective.* Journal of Cleaner Production, 2017. **148**: p. 642-652.
132. Salemdeeb, R., A. Al-Tabbaa, and C. Reynolds, *The UK waste input-output table: Linking waste generation to the UK economy.* Waste Management and Research, 2016. **34**(10): p. 1089-1094.
133. Golev, A. and G.D. Corder, *Typology of options for metal recycling: Australia's perspective.* Resources, 2016. **5**(1).
134. Krystofik, M. and G. Gaustad, *Tying product reuse into tying arrangements to achieve competitive advantage and environmental improvement.* Resources, Conservation and Recycling, 2018. **135**: p. 235-245.
135. Manomaivibool, P. and J.H. Hong, *Two decades, three WEEE systems: How far did EPR evolve in Korea's resource circulation policy?* Resources, Conservation and Recycling, 2014. **83**: p. 202-212.
136. Gu, Y., et al., *To realize better extended producer responsibility: Redesign of WEEE fund mode in China.* Journal of Cleaner Production, 2017. **164**: p. 347-356.
137. Diener, D.L. and A.M. Tillman, *Scrapping steel components for recycling - Isn't that good enough? Seeking improvements in automotive component end-of-life.* Resources, Conservation and Recycling, 2016. **110**: p. 48-60.
138. Hazen, B.T., D.A. Mollenkopf, and Y. Wang, *Remanufacturing for the Circular Economy: An Examination of Consumer Switching Behavior.* Business Strategy and the Environment, 2017. **26**(4): p. 451-464.
139. Van Schaik, A. and M.A. Reuter, *Recycling indices visualizing the performance of the circular economy.* World of Metallurgy - ERZMETALL, 2016. **69**(4): p. 201-216.
140. Parajuly, K. and H. Wenzel, *Product family approach in e-waste management: A conceptual framework for circular economy.* Sustainability (Switzerland), 2017. **9**(5).
141. Atlason, R.S., D. Giacalone, and K. Parajuly, *Product design in the circular economy: Users' perception of end-of-life scenarios for electrical and electronic appliances.* Journal of Cleaner Production, 2017. **168**: p. 1059-1069.
142. Ueberschaar, M., et al., *Potentials and Barriers for Tantalum Recovery from Waste Electric and Electronic Equipment.* Journal of Industrial Ecology, 2017. **21**(3): p. 700-714.
143. Parajuly, K. and H. Wenzel, *Potential for circular economy in household WEEE management.* Journal of Cleaner Production, 2017. **151**: p. 272-285.
144. Gaspari, L., et al., *Modularization in material flow simulation for managing production releases in remanufacturing.* Journal of Remanufacturing, 2017. **7**(2-3): p. 139-157.
145. Botelho, A., et al., *The market of electrical and electronic equipment waste in Portugal: Analysis of take-back consumers' decisions.* Waste Management and Research, 2016. **34**(10): p. 1074-1080.
146. Hartwell, I. and J. Marco, *Management of intellectual property uncertainty in a remanufacturing strategy for automotive energy storage systems.* Journal of Remanufacturing, 2016. **6**(1).
147. Cong, L., F. Zhao, and J.W. Sutherland, *Integration of dismantling operations into a value recovery plan for circular economy.* Journal of Cleaner Production, 2017. **149**: p. 378-386.

148. Jiménez-Rivero, A. and J. García-Navarro, *Indicators to Measure the Management Performance of End-of-Life Gypsum: From Deconstruction to Production of Recycled Gypsum.* Waste and Biomass Valorization, 2016. **7**(4): p. 913-927.
149. Polzer, V.R., M.A.J. Pisani, and K.M. Persson, *The importance of extended producer responsibility and the national policy of solid waste in Brazil.* International Journal of Environment and Waste Management, 2016. **18**(2): p. 101-119.
150. Jiang, Z., et al., *A hybrid approach of rough set and case-based reasoning to remanufacturing process planning.* Journal of Intelligent Manufacturing, 2016: p. 1-14.
151. Marlet, C., *GtoG Life + Project: First step towards gypsum circular economy.* ZKG International, 2014. **67**(4): p. 48-55.
152. Gauffin, A., et al., *The global societal steel scrap reserves and amounts of losses.* Resources, 2016. **5**(3).
153. Richter, J.L. and R. Koppejan, *Extended producer responsibility for lamps in Nordic countries: Best practices and challenges in closing material loops.* Journal of Cleaner Production, 2016. **123**: p. 167-179.
154. Favot, M., R. Veit, and A. Massarutto, *The evolution of the Italian EPR system for the management of household Waste Electrical and Electronic Equipment (WEEE). Technical and economic performance in the spotlight.* Waste Management, 2016. **56**: p. 431-437.
155. Jensen, J.P. and A. Remmen, *Enabling Circular Economy Through Product Stewardship.* Procedia Manufacturing, 2017. **8**: p. 377-384.
156. Zhang, T., et al., *Development pattern and enhancing system of automotive components remanufacturing industry in China.* Resources, Conservation and Recycling, 2011. **55**(6): p. 613-622.
157. Tolio, T., et al., *Design, management and control of demanufacturing and remanufacturing systems.* CIRP Annals - Manufacturing Technology, 2017. **66**(2): p. 585-609.
158. Niero, M. and S.I. Olsen, *Circular economy: To be or not to be in a closed product loop? A Life Cycle Assessment of aluminium cans with inclusion of alloying elements.* Resources, Conservation and Recycling, 2016. **114**: p. 18-31.
159. Mo, H., Z. Wen, and J. Chen, *China's recyclable resources recycling system and policy: A case study in Suzhou.* Resources, Conservation and Recycling, 2009. **53**(7): p. 409-419.
160. Wübbeke, J. and T. Heroth, *Challenges and political solutions for steel recycling in China.* Resources, Conservation and Recycling, 2014. **87**: p. 1-7.
161. Jiménez-Rivero, A. and J. García-Navarro, *Best practices for the management of end-of-life gypsum in a circular economy.* Journal of Cleaner Production, 2017. **167**: p. 1335-1344.
162. Zhang, J.H. and M. Chen, *Assessing the impact of China's vehicle emission standards on diesel engine remanufacturing.* Journal of Cleaner Production, 2015. **107**: p. 177-184.
163. van Loon, P. and L.N. Van Wassenhove, *Assessing the economic and environmental impact of remanufacturing: a decision support tool for OEM suppliers.* International Journal of Production Research, 2017: p. 1-13.
164. Gumley, W., *An analysis of regulatory strategies for recycling and re-use of metals in Australia.* Resources, 2014. **3**(2): p. 395-415.
165. Krystofik, M., et al., *Adaptive remanufacturing for multiple lifecycles: A case study in office furniture.* Resources, Conservation and Recycling, 2018. **135**: p. 14-23.

166. Cherry, C.E. and N.F. Pidgeon, *Why is ownership an issue? Exploring factors that determine public acceptance of product-service systems.* Sustainability (Switzerland), 2018. **10**(7).
167. Nasiri, M., et al., *Transition towards sustainable solutions: Product, service, technology, and business model.* Sustainability (Switzerland), 2018. **10**(2).
168. Hobson, K., et al., *Systems of practice and the Circular Economy: Transforming mobile phone product service systems.* Environmental Innovation and Societal Transitions, 2018. **26**: p. 147-157.
169. van Loon, P., C. Delagarde, and L.N. Van Wassenhove, *The role of second-hand markets in circular business: a simple model for leasing versus selling consumer products.* International Journal of Production Research, 2018. **56**(1-2): p. 960-973.
170. Khan, M.A., et al., *Review on upgradability – A product lifetime extension strategy in the context of product service systems.* Journal of Cleaner Production, 2018. **204**: p. 1154-1168.
171. Lüdeke-Freund, F., S. Gold, and N.M. Bocken, *A Review and Typology of Circular Economy Business Model Patterns.* Journal of Industrial Ecology, 2018.
172. Copani, G. and S. Behnam, *Remanufacturing with upgrade PSS for new sustainable business models.* CIRP Journal of Manufacturing Science and Technology, 2018.
173. Yang, M., et al., *Product-service systems business models for circular supply chains.* Production Planning and Control, 2018. **29**(6): p. 498-508.
174. Kjaer, L.L., et al., *Product/Service-Systems for a Circular Economy: The Route to Decoupling Economic Growth from Resource Consumption?* Journal of Industrial Ecology, 2018.
175. Perey, R., et al., *The place of waste: Changing business value for the circular economy.* Business Strategy and the Environment, 2018. **27**(5): p. 631-642.
176. Wells, P. and P. Nieuwenhuis, *Over the hill? Exploring the other side of the Rogers' innovation diffusion model from a consumer and business model perspective.* Journal of Cleaner Production, 2018. **194**: p. 444-451.
177. Levänen, J., T. Lyytinen, and S. Gatica, *Modelling the Interplay Between Institutions and Circular Economy Business Models: A Case Study of Battery Recycling in Finland and Chile.* Ecological Economics, 2018. **154**: p. 373-382.
178. Chamberlin, L. and C. Boks, *Marketing approaches for a circular economy: Using design frameworks to interpret online communications.* Sustainability (Switzerland), 2018. **10**(6).
179. Hopkinson, P., et al., *Managing a Complex Global Circular Economy Business Model: Opportunities and Challenges.* California Management Review, 2018. **60**(3): p. 71-94.
180. Ünal, E., A. Urbinati, and D. Chiaroni, *Managerial practices for designing circular economy business models: The case of an Italian SME in the office supply industry.* Journal of Manufacturing Technology Management, 2018.
181. Sarasini, S. and M. Linder, *Integrating a business model perspective into transition theory: The example of new mobility services.* Environmental Innovation and Societal Transitions, 2018. **27**: p. 16-31.
182. Appelgren, S., *History as business: Changing dynamics of retailing in Gothenburg's second-hand market.* Business History, 2018: p. 1-15.
183. Kjaer, L.L., et al., *Guidelines for evaluating the environmental performance of Product/Service-Systems through life cycle assessment.* Journal of Cleaner Production, 2018. **190**: p. 666-678.

184. Chen, C.W., *Guidance on the conceptual design of sustainable product-service systems.* Sustainability (Switzerland), 2018. **10**(7).
185. Núñez-Cacho, P., et al., *Family businesses transitioning to a circular economy model: The case of "Mercadona".* Sustainability (Switzerland), 2018. **10**(2).
186. Sousa-Zomer, T.T., et al., *Exploring the challenges for circular business implementation in manufacturing companies: An empirical investigation of a pay-per-use service provider.* Resources, Conservation and Recycling, 2018. **135**: p. 3-13.
187. Bocken, N.M.P., C.S.C. Schuit, and C. Kraaijenhagen, *Experimenting with a circular business model: Lessons from eight cases.* Environmental Innovation and Societal Transitions, 2018. **28**: p. 79-95.
188. de Mattos, C.A. and T.L.M. de Albuquerque, *Enabling factors and strategies for the transition toward a circular economy (CE).* Sustainability (Switzerland), 2018. **10**(12).
189. Veleva, V. and G. Bodkin, *Emerging drivers and business models for equipment reuse and remanufacturing in the US: lessons from the biotech industry.* Journal of Environmental Planning and Management, 2018. **61**(9): p. 1631-1653.
190. Dentchev, N., et al., *Embracing the variety of sustainable business models: A prolific field of research and a future research agenda.* Journal of Cleaner Production, 2018. **194**: p. 695-703.
191. Poppelaars, F., C. Bakker, and J. van Engelen, *Does access trump ownership? Exploring consumer acceptance of access-based consumption in the case of smartphones.* Sustainability (Switzerland), 2018. **10**(7).
192. Manninen, K., et al., *Do circular economy business models capture intended environmental value propositions?* Journal of Cleaner Production, 2018. **171**: p. 413-422.
193. Heyes, G., et al., *Developing and implementing circular economy business models in service-oriented technology companies.* Journal of Cleaner Production, 2018. **177**: p. 621-632.
194. Wastling, T., F. Charnley, and M. Moreno, *Design for circular behaviour: Considering users in a circular economy.* Sustainability (Switzerland), 2018. **10**(6).
195. Lahti, T., J. Wincent, and V. Parida, *A definition and theoretical review of the circular economy, value creation, and sustainable business models: Where are we now and where should research move in the future?* Sustainability (Switzerland), 2018. **10**(8).
196. Stål, H.I. and H. Corvellec, *A decoupling perspective on circular business model implementation: Illustrations from Swedish apparel.* Journal of Cleaner Production, 2018. **171**: p. 630-643.
197. Ranta, V., L. Aarikka-Stenroos, and S.J. Mäkinen, *Creating value in the circular economy: A structured multiple-case analysis of business models.* Journal of Cleaner Production, 2018. **201**: p. 988-1000.
198. Veleva, V. and G. Bodkin, *Corporate-entrepreneur collaborations to advance a circular economy.* Journal of Cleaner Production, 2018. **188**: p. 20-37.
199. Sinclair, M., et al., *Consumer intervention mapping-A tool for designing future product strategies within circular product service systems.* Sustainability (Switzerland), 2018. **10**(6).
200. Lieder, M., et al., *A conjoint analysis of circular economy value propositions for consumers: Using "washing machines in Stockholm" as a case study.* Journal of Cleaner Production, 2018. **172**: p. 264-273.
201. Singh, P. and E. Giacosa, *Cognitive biases of consumers as barriers in transition towards circular economy.* Management Decision, 2018.

202. Goyal, S., M. Esposito, and A. Kapoor, *Circular economy business models in developing economies: Lessons from India on reduce, recycle, and reuse paradigms.* Thunderbird International Business Review, 2018. **60**(5): p. 729-740.

203. Zucchella, A. and P. Previtali, *Circular business models for sustainable development: A "waste is food" restorative ecosystem.* Business Strategy and the Environment, 2018.

204. Frishammar, J. and V. Parida, *Circular Business Model Transformation: A Roadmap for Incumbent Firms.* California Management Review, 2018.

205. Nußholz, J.L.K., *A circular business model mapping tool for creating value from prolonged product lifetime and closed material loops.* Journal of Cleaner Production, 2018. **197**: p. 185-194.

206. Oghazi, P. and R. Mostaghel, *Circular business model challenges and lessons learned-An industrial perspective.* Sustainability (Switzerland), 2018. **10**(3).

207. Geissdoerfer, M., et al., *Business models and supply chains for the circular economy.* Journal of Cleaner Production, 2018. **190**: p. 712-721.

208. Aboulamer, A., *Adopting a circular business model improves market equity value.* Thunderbird International Business Review, 2018. **60**(5): p. 765-769.

209. Zink, T., R. Geyer, and R. Startz, *Toward Estimating Displaced Primary Production from Recycling: A Case Study of U.S. Aluminum.* Journal of Industrial Ecology, 2018. **22**(2): p. 314-326.

210. Kunz, N., K. Mayers, and L.N. Van Wassenhove, *Stakeholder Views on Extended Producer Responsibility and the Circular Economy.* California Management Review, 2018. **60**(3): p. 45-70.

211. Coughlan, D., C. Fitzpatrick, and M. McMahon, *Repurposing end of life notebook computers from consumer WEEE as thin client computers – A hybrid end of life strategy for the Circular Economy in electronics.* Journal of Cleaner Production, 2018. **192**: p. 809-820.

212. Tran, H.P., et al., *Recycling portable alkaline/ZnC batteries for a circular economy: An assessment of natural resource consumption from a life cycle and criticality perspective.* Resources, Conservation and Recycling, 2018. **135**: p. 265-278.

213. Brouwer, M.T., et al., *Predictive model for the Dutch post-consumer plastic packaging recycling system and implications for the circular economy.* Waste Management, 2018. **71**: p. 62-85.

214. Hahladakis, J.N., et al., *Post-consumer plastic packaging waste in England: Assessing the yield of multiple collection-recycling schemes.* Waste Management, 2018. **75**: p. 149-159.

215. Tsiliyannis, C.A., *Markov chain modeling and forecasting of product returns in remanufacturing based on stock mean-age.* European Journal of Operational Research, 2018. **271**(2): p. 474-489.

216. Low, J.S.C. and Y.T. Ng, *Improving the Economic Performance of Remanufacturing Systems through Flexible Design Strategies: A Case Study Based on Remanufacturing Laptop Computers for the Cambodian Market.* Business Strategy and the Environment, 2018. **27**(4): p. 503-527.

217. Wang, P. and A.T.H. Kuah, *Green marketing cradle-to-cradle: Remanufactured products in Asian markets.* Thunderbird International Business Review, 2018. **60**(5): p. 783-795.

218. Bag, S., S. Gupta, and C. Foropon, *Examining the role of dynamic remanufacturing capability on supply chain resilience in circular economy.* Management Decision, 2018.

219. Liu, B., et al., *The effect of remanufacturing and direct reuse on resource productivity of China's automotive production.* Journal of Cleaner Production, 2018. **194**: p. 309-317.

220. Rentizelas, A., A. Shpakova, and O. Mašek, *Designing an optimised supply network for sustainable conversion of waste agricultural plastics into higher value products.* Journal of Cleaner Production, 2018. **189**: p. 683-700.
221. Sabbaghi, M. and S. Behdad, *Consumer decisions to repair mobile phones and manufacturer pricing policies: The concept of value leakage.* Resources, Conservation and Recycling, 2018. **133**: p. 101-111.
222. Marconi, M., et al., *Applying data mining technique to disassembly sequence planning: a method to assess effective disassembly time of industrial products.* International Journal of Production Research, 2018: p. 1-25.
223. Mishra, J.L., P.G. Hopkinson, and G. Tidridge, *Value creation from circular economy-led closed loop supply chains: a case study of fast-moving consumer goods.* Production Planning and Control, 2018. **29**(6): p. 509-521.
224. Masi, D., et al., *Towards a more circular economy: exploring the awareness, practices, and barriers from a focal firm perspective.* Production Planning and Control, 2018. **29**(6): p. 539-550.
225. Govindan, K. and M. Hasanagic, *A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective.* International Journal of Production Research, 2018: p. 1-34.
226. De Angelis, R., M. Howard, and J. Miemczyk, *Supply chain management and the circular economy: towards the circular supply chain.* Production Planning and Control, 2018. **29**(6): p. 425-437.
227. Dubey, R., et al., *Supplier relationship management for circular economy: Influence of external pressures and top management commitment.* Management Decision, 2018.
228. Jain, S., N.K. Jain, and B. Metri, *Strategic framework towards measuring a circular supply chain management.* Benchmarking, 2018. **25**(8): p. 3238-3252.
229. Habibi, M.K.K., et al., *Sample average approximation for multi-vehicle collection–disassembly problem under uncertainty.* International Journal of Production Research, 2018.
230. Howard, M., P. Hopkinson, and J. Miemczyk, *The regenerative supply chain: a framework for developing circular economy indicators.* International Journal of Production Research, 2018.
231. Kazancoglu, Y., I. Kazancoglu, and M. Sagnak, *A new holistic conceptual framework for green supply chain management performance assessment based on circular economy.* Journal of Cleaner Production, 2018. **195**: p. 1282-1299.
232. Yılmaz Balaman, Ş., et al., *Network design and technology management for waste to energy production: An integrated optimization framework under the principles of circular economy.* Energy, 2018. **143**: p. 911-933.
233. Laso, J., et al., *Introducing the Green Protein Footprint method as an understandable measure of the environmental cost of anchovy consumption.* Science of the Total Environment, 2018. **621**: p. 40-53.
234. Batista, L., et al., *In search of a circular supply chain archetype–a content-analysis-based literature review.* Production Planning and Control, 2018. **29**(6): p. 438-451.
235. Lapko, Y., et al., *In Pursuit of Closed-Loop Supply Chains for Critical Materials: An Exploratory Study in the Green Energy Sector.* Journal of Industrial Ecology, 2018.
236. Lin, Y., et al., *An improved artificial bee colony for facility location allocation problem of end-of-life vehicles recovery network.* Journal of Cleaner Production, 2018. **205**: p. 134-144.
237. Larsen, S.B., et al., *How the reverse supply chain contributes to a firm's competitive strategy: a strategic alignment perspective.* Production Planning and Control, 2018. **29**(6): p. 452-463.

238. Liu, J., et al., *Green supply chain management and the circular economy: Reviewing theory for advancement of both fields.* International Journal of Physical Distribution and Logistics Management, 2018. **48**(8): p. 794-817.
239. Ghisellini, P., M. Ripa, and S. Ulgiati, *Exploring environmental and economic costs and benefits of a circular economy approach to the construction and demolition sector. A literature review.* Journal of Cleaner Production, 2018. **178**: p. 618-643.
240. Botezat, E.A., et al., *An exploration of circular economy practices and performance among Romanian producers.* Sustainability (Switzerland), 2018. **10**(9).
241. Brown, P.J. and C. Bajada, *An economic model of circular supply network dynamics: Toward an understanding of performance measurement in the context of multiple stakeholders.* Business Strategy and the Environment, 2018. **27**(5): p. 643-655.
242. Vlajic, J.V., R. Mijailovic, and M. Bogdanova, *Creating loops with value recovery: empirical study of fresh food supply chains.* Production Planning and Control, 2018. **29**(6): p. 522-538.
243. Hahladakis, J.N. and E. Iacovidou, *Closing the loop on plastic packaging materials: What is quality and how does it affect their circularity?* Science of the Total Environment, 2018. **630**: p. 1394-1400.
244. Batista, L., et al., *Circular supply chains in emerging economies–a comparative study of packaging recovery ecosystems in China and Brazil.* International Journal of Production Research, 2018.
245. Tsolakis, N., M. Kumar, and W. Bam, *Circular supply chains and renewable chemical feedstocks: a network configuration analysis framework.* Production Planning & Control, 2018. **29**(6): p. 464-482.
246. Leising, E., J. Quist, and N. Bocken, *Circular Economy in the building sector: Three cases and a collaboration tool.* Journal of Cleaner Production, 2018. **176**: p. 976-989.
247. Stewart, R. and M. Niero, *Circular economy in corporate sustainability strategies: A review of corporate sustainability reports in the fast-moving consumer goods sector.* Business Strategy and the Environment, 2018. **27**(7): p. 1005-1022.
248. Bressanelli, G., M. Perona, and N. Saccani, *Challenges in supply chain redesign for the Circular Economy: a literature review and a multiple case study.* International Journal of Production Research, 2018.
249. Braun, A.T., et al., *Case study analysing potentials to improve material efficiency in manufacturing supply chains, considering circular economy aspects.* Sustainability (Switzerland), 2018. **10**(3).
250. Braz, A.C., et al., *The bullwhip effect in closed-loop supply chains: A systematic literature review.* Journal of Cleaner Production, 2018. **202**: p. 376-389.
251. Mangla, S.K., et al., *Barriers to effective circular supply chain management in a developing country context.* Production Planning and Control, 2018. **29**(6): p. 551-569.
252. Faussone, G.C., *Transportation fuel from plastic: Two cases of study.* Waste Management, 2018. **73**: p. 416-423.
253. Nowakowski, P. and B. Mrówczyńska, *Towards sustainable WEEE collection and transportation methods in circular economy - Comparative study for rural and urban settlements.* Resources, Conservation and Recycling, 2018. **135**: p. 93-107.
254. Kourmentza, C., et al., *Spent coffee grounds make much more than waste: Exploring recent advances and future exploitation strategies for the valorization of an emerging food waste stream.* Journal of Cleaner Production, 2018. **172**: p. 980-992.

255. Cobo, S., A. Dominguez-Ramos, and A. Irabien, *From linear to circular integrated waste management systems: a review of methodological approaches.* Resources, Conservation and Recycling, 2018. **135**: p. 279-295.

256. Milios, L., et al., *Plastic recycling in the Nordics: A value chain market analysis.* Waste Management, 2018. **76**: p. 180-189.

257. Maaß, O. and P. Grundmann, *Governing transactions and interdependences between linked value chains in a circular economy: The case of wastewater reuse in Braunschweig (Germany).* Sustainability (Switzerland), 2018. **10**(4).

258. Laso, J., et al., *Finding an economic and environmental balance in value chains based on circular economy thinking: An eco-efficiency methodology applied to the fish canning industry.* Resources, Conservation and Recycling, 2018. **133**: p. 428-437.

259. Ranta, V., et al., *Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe.* Resources, Conservation and Recycling, 2018. **135**: p. 70-82.

260. Lokesh, K., L. Ladu, and L. Summerton, *Bridging the gaps for a 'circular' bioeconomy: Selection criteria, bio-based value chain and stakeholder mapping.* Sustainability (Switzerland), 2018. **10**(6).

261. Huybrechts, D., et al., *Best available techniques and the value chain perspective.* Journal of Cleaner Production, 2018. **174**: p. 847-856.

Appendix A

Table A1: Distribution of sample by geographic region

Region	**Sample Size**	**Percentage**	**Province/Region**	**Sample Size**	**Percentage**
North China	157	61.6%	Beijing	21	8.2%
			Tianjin	97	38.0%
			Hebei	26	10.2%
			Shanxi	8	3.1%
			Inner Mongolia	5	2.0%
Northeast China	24	9.4%	Liaoning	15	5.9%
			Jilin	6	2.4%
			Heilongjiang	3	1.2%
East China	40	15.7%	Shanghai	7	2.8%
			Jiangsu	13	5.1%
			Zhejiang	1	0.4%
			Anhui	4	1.6%
			Fujian	2	0.8%
			Jiangxi	3	1.2%
			Shandong	10	3.9%
South Central China	28	11.0%	Henan	11	4.3%
			Hubei	2	0.8%
			Hunan	5	2.0%
			Guangdong	10	3.9%
Southwest China	4	1.6%	Chongqing	3	1.2%
			Sichuan	1	0.4%
Northwest China	2	0.8%	Gansu	1	0.4%
			Ningxia	1	0.4%
Total	**255**	**100.0%**	**23**	**255**	**100.0%**

Table A2: Other demographic characteristics of the sample.

Variable	Sample size	Percentage
Type of firm		
Raw-material supplier	34	13.3%
Component supplier	37	14.5%
OEM	159	62.4%
Contract manufacturer	25	9.8%
Firm sales		
< 1 million RMB	2	0.8%
1-4.9 million RMB	7	2.7%
5-9.9 million RMB	11	4.3%
10-49.9 million RMB	38	14.9%
50-99.9 million RMB	15	5.9%
100-499.9 million RMB	64	25.1%
500-999.9 million RMB	31	12.2%
1-4.9 billion RMB	40	15.7%
5-9.9 billion RMB	18	7.1%
> 10 billion RMB	29	11.4%
Designation (Management Level)		
Senior Management (i.e., CEO, COO etc.)	44	17.3%
Middle Management (i.e., Director, Dept Head etc.)	161	63.1%
Junior Management (i.e., Supervisor, Accountant etc.)	50	19.6%
Total	**255**	**100.0%**

Appendix B

Table B1: EFA results

Construct	Variable(s)	Measurement Items	Loading
CSCM Practices	**KMO = 0.873, Cumulative % of Variance = 68.52**		
	Circular Product Design	Design of products for re-contextualizing, re-purposing, repair, refurbishing, remanufacturing	0.86
		Design of products for recycling	0.83
		Design of products for ease of disassembly	0.83
		Design of products to use recycled materials	0.71
	Circular procurement	Require your main suppliers to use materials that are used (non-virgin), repaired, refurbished, remanufactured or recycled	0.54
		Require your main suppliers to use environmentally friendly packaging (e.g., non-hazardous and recycled etc.)	0.65
		Consider the impact of transportation emissions when selecting suppliers	0.78
		Require suppliers to have an environmental management system (e.g. ISO 14001)	0.73
	Cleaner Production	Improve employee environmental consciousness through training and evaluation	0.80
		Improve processes to reduce/eliminate waste	0.88
		Improve processes to increase energy efficiency through the use of clean technologies	0.81
		Increase investment in equipment for environmental protection	0.78
		Environmental issues are considered in the processes of production planning and technology innovation	0.81
	End-of-Life Product and Waste Management	Collect expired/unsold products from distribution network	0.84
		Collect used/end of life products from customers	0.82
		Return products to suppliers	0.66
		Require your main suppliers to collect their packaging materials from your firm (i.e., packaging materials of supplied materials or components)	0.82
		Collect packaging from customers	0.79
	KMO = 0.853, Cumulative % of Variance = 76.38		

Firm Performance	**Environmental Performance**	Emission of greenhouse gases (e.g. CO2, SOx, NOx...)	0.85
		Waste water (e.g. sewage)	0.89
		Other wastes (e.g. oily waste, sludge and rubbish)	0.90
		Total amount of hazardous and toxic waste	0.87
		Consumption of hazardous/harmful/toxic materials	0.83
	Resource Circularity Performance	Usage of renewable energy Sources	0.89
		Percent of materials reused, refurbished, remanufactured, recycled	0.90
	Cost Performance	Cost of purchased materials	0.79
		Operational cost	0.83
		Energy consumption cost	0.80
		Waste treatment fee	0.74
		Waste discharge/disposal fee	0.73
	Financial Performance	Growth in sales revenue	0.84
		Return on sales	0.91
		Growth in profit	0.93
		Net Profit Margin	0.92
		Return on investment (ROI)	0.88
		Growth in market share	0.73

Manuscript 3

Appendix 1

Details of evaluators

Product Type	Frequency	Percentage
Flour	5	16%
Beverage	4	13%
Confectionery	4	13%
Dairy	4	13%
Meat	4	13%
Liquor	2	6%
Others*	9	28%
Annual Revenue** (million RMB）	Frequency	Percentage
1-4.9	1	2%
5-9.9	10	17%
10-49.9	10	17%
50-100	11	19%
100-300	8	14%
>300	18	31%
Overall industry experience***	Frequency	Percentage
1-3 years	2	3%
4-7 years	22	31%
8-12 years	32	46%
Over 13 years	14	20%
Designation*** (Management level)	Frequency	Percentage
Mid-level	27	39%
Top-level	43	61%

*one respondents each (Cereal, Edible Oil, Eggs, Fast food, Frozen food, Sauces, Seeds, Tea, Water)

**excluding government officials, customers & unreported

***excluding customers

Appendix 2

An example of pairwise comparison and importance ranking

Evaluators' importance ranking	Barrier	Pairwise comparison							
		B1	B2	B3	B4	B5	B6	B7	B8
8	B1	0	1	0	0	0	0	0	4
4	B2	1	0	0	4	4	2	0	0
3	B3	1	1	0	4	4	2	0	0
1	B4	1	4	0	0	4	4	4	4
2	B5	1	2	0	4	0	2	2	0
7	B6	0	0	0	4	4	0	2	0
6	B7	1	0	0	4	2	2	0	2
5	B8	1	0	0	4	4	2	2	0

Note: Evaluators' importance ranking ranges from highest rank (1) to lowest rank (8).
For pairwise comparison, 0 = no Influence, 1 = very low Influence, 2 = low Influence, 3 = high Influence, 4 = very high Influence

Appendix 3

The total direct relation matrices (T)

Food processors

Barrier	B1	B2	B3	B4	B5	B6	B7	B8
B1	0.79	**0.95**	0.86	0.81	0.73	0.74	0.71	**0.98**
B2	0.90	0.81	0.87	0.81	0.74	0.73	0.71	**0.98**
B3	0.84	0.87	0.73	0.79	0.72	0.72	0.68	**0.93**
B4	0.84	0.86	0.80	0.67	0.68	0.69	0.68	0.90
B5	0.88	**0.91**	0.86	0.80	0.64	0.75	0.70	**0.93**
B6	0.81	0.84	0.78	0.73	0.68	0.59	0.65	0.86
B7	0.88	0.90	0.85	0.82	0.73	0.73	0.62	**0.92**
B8	**0.98**	**1.02**	**0.94**	0.88	0.79	0.78	0.79	**0.91**

Ø= 0.90

Sales and distribution channels

Barrier	B1	B2	B3	B4	B5	B6	B7	B8
B1	1.43	1.59	1.59	1.55	1.46	1.57	**1.69**	**1.70**
B2	1.38	1.33	1.44	1.44	1.32	1.42	1.54	1.52
B3	1.62	1.64	1.55	1.64	1.54	**1.66**	**1.79**	**1.76**
B4	1.46	1.53	1.51	1.39	1.40	1.49	1.63	1.59
B5	1.48	1.50	1.53	1.50	1.31	1.51	1.64	1.59
B6	1.54	1.57	1.58	1.55	1.47	1.46	**1.69**	**1.67**
B7	1.45	1.48	1.50	1.48	1.39	1.49	1.49	1.58
B8	1.56	1.60	1.60	1.59	1.49	1.60	**1.73**	1.58

Ø= 1.64

Customers

Barrier	B1	B2	B3	B4	B5	B6	B7	B8
B1	0.42	0.56	0.52	0.47	0.32	0.40	**0.59**	**0.62**
B2	0.49	0.40	0.52	0.45	0.31	0.38	0.57	0.56
B3	0.56	0.52	0.44	0.47	0.33	0.44	**0.64**	**0.63**
B4	0.49	0.51	0.49	0.35	0.30	0.38	**0.59**	0.55
B5	0.53	0.53	0.55	0.48	0.28	0.47	**0.63**	**0.60**
B6	0.52	0.54	0.55	0.50	0.37	0.36	**0.65**	**0.62**
B7	0.46	0.47	0.49	0.42	0.29	0.40	0.45	0.55
B8	0.53	0.51	0.52	0.44	0.32	0.41	**0.60**	0.47

Ø= 0.58

Government officials

Barrier	B1	B2	B3	B4	B5	B6	B7	B8
B1	0.87	0.95	0.87	0.94	0.62	0.59	**1.00**	**1.05**
B2	0.90	0.75	0.81	0.89	0.56	0.58	0.91	0.95
B3	0.91	0.83	0.69	0.84	0.57	0.53	0.89	0.87
B4	0.84	0.81	0.73	0.70	0.52	0.51	0.86	0.88
B5	**0.98**	0.91	0.88	0.92	0.56	0.64	**1.01**	**1.00**
B6	0.83	0.77	0.74	0.81	0.61	0.46	0.83	0.85
B7	0.91	0.83	0.79	0.82	0.58	0.55	0.78	0.90
B8	**1.00**	0.89	0.88	0.93	0.63	0.57	**0.97**	0.87

Ø= 0.96

Ethics Approval

AUTEC Secretariat

Auckland University of Technology
D-88, WU406 Level 4 WU Building City Campus
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

17 October 2017

Abraham Zhang
Faculty of Business Economics and Law

Dear Abraham

Re Ethics Application: **17/305 Drivers, barriers and performance of circular supply chain management: A comparative study of Agri-food businesses in New Zealand and China**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 17 October 2020.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. If the research is undertaken outside New Zealand, you need to meet all locality legal and ethical obligations and requirements. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries, please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: muhammad.farooque@aut.ac.n

Auckland University of Technology Ethics Committee (AUTEC)

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14 February 2019

Abraham Zhang
Faculty of Business Economics and Law

Dear Abraham

Ethics Application: **17/305 Circular supply chain management: An empirical investigation of performance and barriers in China**

At their meeting of 11 February 2019, the Auckland University of Technology Ethics Committee (AUTEC) received the report on your ethics application. AUTEC noted your report and asked me to thank you.

On behalf of AUTEC, I congratulate the researchers on the project and look forward to reading more about it in future reports.

When communicating with us about this application, we ask that you use the application number and study title to enable us to provide you with prompt service. Should you have any further enquiries regarding this matter, you are welcome to contact me by email at ethics@aut.ac.nz or by telephone on 921 9999 at extension 6038.

Yours sincerely

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: muhammad.farooque@aut.ac.nz

Auckland University of Technology Ethics Committee (AUTEC)

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E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

7 May 2019

Abraham Zhang
Faculty of Business Economics and Law
Dear Abraham

Re: Ethics Application: **17/305 Circular supply chain management: An empirical investigation of performance and barriers**

Thank you for your request for approval of amendments to your ethics application.

The minor amendment to the title and scope (to include Australia) is approved.

I remind you of the **Standard Conditions of Approval**.

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/research/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/research/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/research/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. If the research is undertaken outside New Zealand, you need to meet all locality legal and ethical obligations and requirements.

For any enquiries please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: muhammad.farooque@aut.ac.nz

Participant Information Sheet

This information sheet is for general manager, operations or supply chain manager supply chain executives and financial controller, senior manager in accounting and finance of their respective organizations.

Date Information Sheet Produced:

1st May 2019

Project Title

Circular supply chain management: An empirical investigation of performance and barriers

An Invitation

My name is Muhammad Farooque. I am a doctoral student at Auckland University of Technology (AUT). I invite you to participate in this survey which is being conducted as a part of academic research in fulfilment of a doctoral degree requirements. Your participation is at your discretion. You can withdraw from participating in this study at any point during data collection process.

As we realize that due to increasing resource and environmental issues, the Chinese government has developed policies and regulations to promote the implementation of circular economy in China. In response, manufacturers have implemented various kinds of circular economy practices and achieved performance improvements. For circular economy practices to be successfully implemented, manufacturers have to cooperate with upstream and downstream companies along their supply chains.

This study aims to understand the current status of implementing circular economy practices in supply chains (circular supply chain practices) in China as well as the environmental and economic performance implications of implementing such practices in the manufacturing industry. Towards achieving these objectives, we developed measurement scales for evaluating circular supply chain practices, and enterprise performance. Please evaluate the situations in your company using the questions developed below on the basis of given measurement scales.

Please note that the questionnaire consists of two parts. Part I should be completed by a general manager, operations or supply chain manager who is familiar with operations activities. Part II should be completed by the financial controller or someone who is familiar with the financial accounting. The two parts must be completed by two different people before the questionnaire is returned.

What is the purpose of this research?

The purpose of this research is twofold. The proposed study will benefit the participants' in improving their sustainability performance as they get to learn how manufacturing industry has progressed towards circular economy and how various circular supply chain practices impact the economic and environmental performance.

Overall, the researcher is doing this research as part of PhD requirement (including academic publications). However, there is great learning opportunity for the researcher as he will be able to interact with senior executives during the course of the research and this is likely to improve researcher knowledge and practical insights on the research topic.

Largely the research is directed toward sustainability issues, which are of greater importance to the larger community. The research results are likely to encourage businesses to adapt circular supply chain practices to improve economic and environmental performance which is of benefit to the whole community.

How was I identified and why am I being invited to participate in this research?

The project research team has used several channels including support from local government, scholars and post graduate students help us with data collection. Manufacturing industry is one of most important economic pillars of any country however; the industry's contribution to sustainability and circularity is less known. Your participation in the research will help us understand how has the circular economy concept been integrated into supply chain management and what is the impact of such integration on performance in the manufacturing industry.

How do I agree to participate in this research?

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

This research involves a survey in order to assess the impact of circular supply chain management practices on organization performance in terms of economic and environmental performance. As a potential participant, by completing the survey, you will share the circular supply chain practices being adopted by your organization and rate your organization's economic and environmental performance in comparison with a similar sized firm in the industry. This information will be used for academic purposes only including research publications.

How will my privacy be protected?

This anonymous survey does not collect any personal information about the participants. Moreover, the information required is commercially insensitive thereby a minimal risk is involved in participation. It is ensured to participants that all the obtained information/data will remain confidential both during and proceeding the project.

What are the costs of participating in this research?

Participation in this research requires an investment of around 20 minutes of your valuable time.

What opportunity do I have to consider this invitation?

You are requested to respond within 3 weeks of receiving this invitation.

Will I receive feedback on the results of this research?

A copy of the executive summary of this research will be posted on the AUT website Thesis Link (Thesislink.aut.ac.nz) and it can be publically accessed.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Abraham Zhang, E-mail: abraham.zhang@aut.ac.nz; Tel: 09 921 9999 Extension # 5327

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Muhammad Farooque

E-mail: muhammad.farooque@aut.ac.nz

Project Supervisor(s) Contact Details:

1. Dr. Abraham Zhang

Senior Lecturer in Supply Chain Management,

Auckland University of Technology (AUT), New Zealand

E-mail: abraham.zhang@aut.ac.nz

2. Liu Yanping

Associate Professor, Management Science & Engineering

Nankai University, P.R. China.

Email: nkliuyp@nankai.edu.cn

Approved by the Auckland University of Technology Ethics Committee on *14th February 2019* AUTEC Reference number *17/305.*