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A Contingency Approach for Supply Chain Preparedness to Pursue Circular Economy Business Models

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A CONTINGENCY APPROACH FOR SUPPLY CHAIN PREPAREDNESS TO PURSUE CIRCULAR ECONOMY BUSINESS MODELS

A Dissertation

by

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A CONTINGENCY APPROACH FOR SUPPLY CHAIN PREPAREDNESS

TO PURSUE CIRCULAR ECONOMY BUSINESS MODELS

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ABSTRACT

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A growing stream in circular economy (CE) research is about circular economy business models (CEBM). It suggests how firms could learn to adopt unique material and product designs, newer business models, value chain networks and potential enablers that satisfies CE ideologies about economic, environment, and society. However, the understanding about how firms could integrate CEBM practices at internal, supply chain, and external levels is limited. In this dissertation, the first study provides an inclusive understanding of CE in a supply chain management context using bibliometric-network analysis. Using contingency theory lens, the second study identifies factors related to a focal firm's CEBM practice as the response, its contingencies as context, its supply chain preparedness as output, and its CEBM performance as a consequent outcome. Using multi-industry multi-tier supply chain case-study method, the study explores how "supply chain preparedness" is related to CEBM practices and CEBM performance, and the factors upon which this relationship is contingent.

DEDICATION

This dissertation is dedicated to my parents, my parents-in-laws, my aunt Bela, my extended families and my two daughters Shamitha and Keya. It is our sharing, caring and belief in hard work and perseverance that makes our lives meaningful. I will remain grateful to each one of you for your support, sacrifice, love, and making me feel important throughout this journey.

I dedicate this work to my wife Madhavi for convincing me that I too can achieve this moment and for understanding me throughout this journey. Your support is greatly appreciated.

I love you all.

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I would like to thank and acknowledge all respondent who volunteered to participate in this research. I would also like to thank my wife, Madhavi, and my daughters, Shamitha and Keya, in helping me out in several ways, including audio transcriptions. Finally, I would like to thank all my UTRGV professors, colleagues and friends for their boundless support in this scholarly journey.

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CHAPTER I

INTRODUCTION

"There's a new type of economy in town — and some businesses think it could change everything."

(Schulze, 2018)

"A new relationship with our goods and materials would save resources and energy and create local jobs."

— Walter R. Stahel, Swiss architect and industrial analyst
(Stahel, 2016, Nature News)

"The circular economy is in essence the way of moving forward from 200 years of linear value chains."

— Peter Lacy, Accenture
(Lacy & Rutqvist, 2015, Waste to Wealth)

In 2015, the United Nations reported that the present world's population (7.5 billion, 2017) is projected to become 9.7 billion by 2050 (UN DESA Report, 2015). This demographic growth must be thought-provoking not only to economists, but also to policy-makers, that the global economy must also grow at a similar pace, and sustain thereafter. The contradiction exists in the prevailing form of traditional "take-make-consume-dispose" economy model. Traditionally, only 20% of the material used for the first time goes back for reuse and remanufacturing (Sempels & Hoffmann, 2013). The faster pace of resource extraction and GDP than population growth (see figure 1-1) reflects that the traditional linear economy model may cause irreversible damage to the. Earth

It has been a long-known fact that Earth's resources are limited (Boulding, 1966; Ghisellini, et al., 2016). Much of the irreplaceable metals have been pervasively extracted since industrialization to meet human requirements and are becoming more and more constrained. In addition, the technically renewable life-supporting elements, such as air quality, water, and forests are ever more strained. Even worse, the linear economy model makes no or limited efforts to take ownership of the impact of waste it generates.

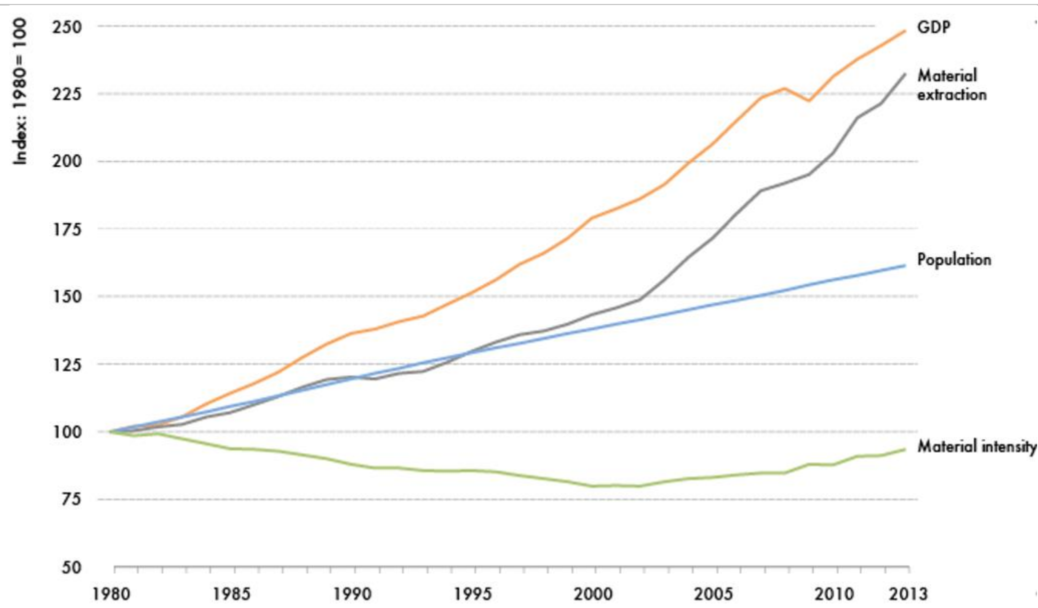

Figure 1 - 1 Trends in global resource extraction, GDP and material intensity (1980-2013); Source: Materialflows (2018)

Broadly, a longer prevalence of these phenomena may present survival challenges for the present and future generations, as reflected in figure 1-2. It displays the forecasted gap between resource supply and demand starting 2015 till 2050 that keeps growing if the linear economy model continues to prevail. Developed by Accenture Analysis, this forecasting model merges "population and economic growth data from 1961 to 2014 and forecasts to 2050, together with resource extraction data for biomass, fossil energy, ores, industrial minerals, and construction minerals, to predict future resource demand, adjusted for technological development scenarios" (Lacy & Rutqvist, 2015).

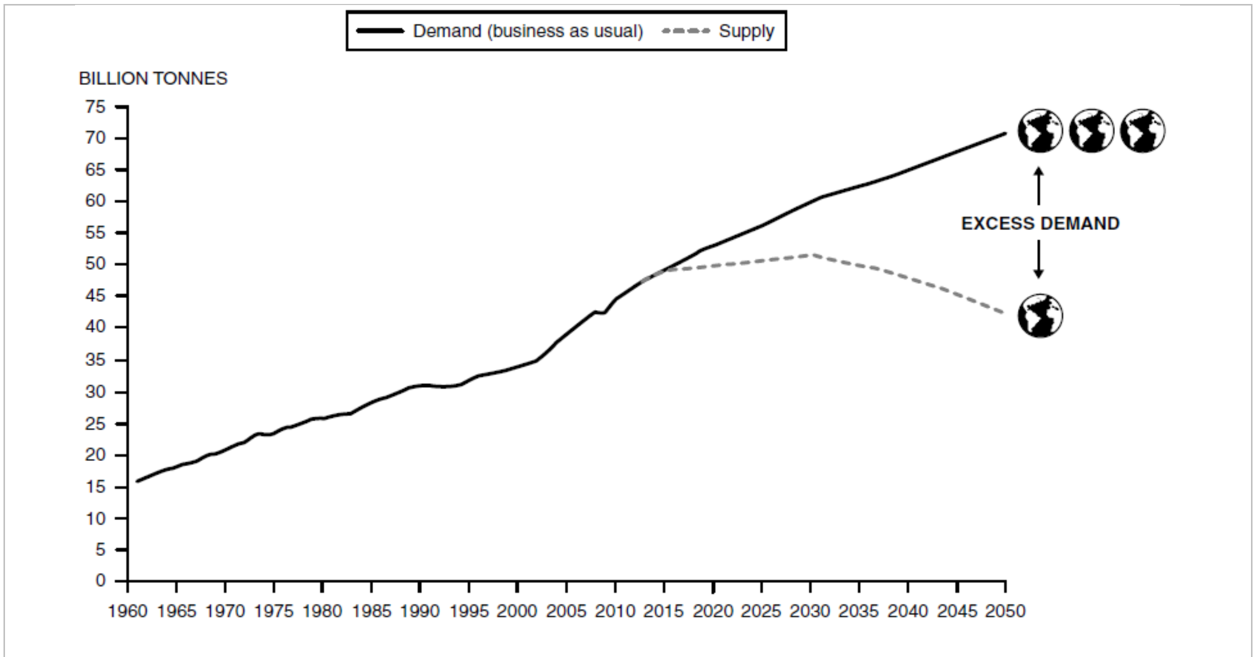

Figure 1 - 2: Resource supply and demand imbalance (1960–2050); Source: Lacy & Rutqvist (2015)

Apparently, our society is becoming aware of this conflict in the current linear production economy model. This economic misbalance due to growing surplus of people and scarcity of natural resources and ecological systems has emerged as a strong force to a drift away from the prevailing model and to find sustainable alternates. The EMAF 2014 report expressed that a shift towards sustainable means of production would not only save natural resources, but would also create an opportunity of over 1 trillion USD for the global economy (EMAF, 2014). More so, it has generated strong influence among large and small corporate firms to recover raw materials from post-usage products and finding other means for resource preservation and/or reutilization

(Planing, 2015). To resolve the contradictions of linear economy model, the concept of circular economy (CE) has gained global attention over the past few decades (See literature reviews by Homrich et al., 2018; Andersen, 2007; Ghisellini et al., 2016; Lieder & Rashid, 2016; Su et al., 2013). As shown in figure 1-3, ideologically CE promises to find ways to translate today's goods into tomorrow's resources (Stahel, 2016).

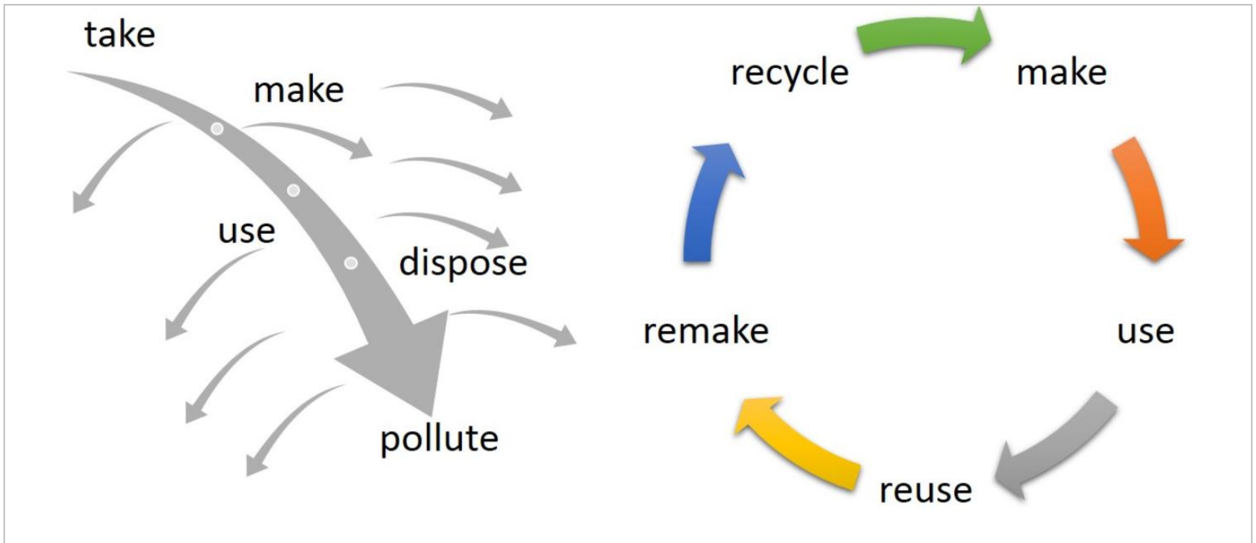

Figure 1 - 3. A Diagram to Contrast the "Take, Make, Waste" Linear Approach with the CE; Source: Weetman, 2016, www.wikimedia.org

A few decades ago, supply chain management (SCM) was a modest operations and economics focused field. Today, SCM can provide an integrated outlook of economic, environmental and social challenges that firms face in present times (Stevens & Johnson, 2016). In particular, SCM speaks on how firms could adopt and realize cyclical thinking along their add-value chains to synergize the three above-mentioned challenges (Govindan & Hasanagic, 2018). On the other hand, resource preservation concern of CE has fired the notion of circular economy business model (CEBM) for firms, i.e., how firms could introduce circularity in their respective business models. CEBM follows the traditional definitions of business models (BM) not only in terms of creating value for the firm and its customers (Zott & Amit, 2008; Osterwalder & Pigneur, 2010), but also for the society and ecological system it belongs to (Bocken et al., 2018; Linder & Williander, 2017). A growing stream in CE research is about CEBM in the context of material and product designs, newer business models, value chain networks, and potential enablers (Planing, 2015; Geissdoerfer et al., 2018). However, there exists a glaring disconnect in understanding about how firms integrate the CE principles into their business models at internal, supply chain, and external levels, no matter how much circularity they intend to achieve. The rising complexities in supply chain context and networks have been keeping firms wrestling with uncertainties about internal manufacturing processes, supply-side processes, or demand-side issues (Hult et al., 2010). These uncertainties are deemed to grow exponentially when firms decide to adopt a new practice, such as CEBM practice. Moreover, there is a growing interest in the related area of supply chain risk (e.g., Ritchie & Brindley 2007; Braunscheidel & Suresh 2009; Neiger et al., 2009; Simangunsong et al., 2016) that commonly suggested that inadequate "supply chain preparedness (SCP)" is a major deterring factor that leads firms towards failures in operational performance, thus causing severe impact on their business performance (Davis, 1993; Hult et al, 2010). That said, aspects of firms' preparedness, both internally and externally, that drive their respective business models in transitioning from a linear economy to a circular economy model are yet to be understood, and hence require further investigation (Ghisellini et al., 2016; Masi et al., 2017; Govindan & Hasanagic, 2018).

RESEARCH OBJECTIVES

The purpose of this dissertation is: (a) to understand the landscape of circular economy concepts within supply chain management context, and consequently (b) to comprehend how firms' preparedness, in terms of their internal, end-to-end supply chains and external environments, helps them in pursuing business models that are guided by CE principles.

First, there are several general and comprehensive literature reviews on circular economy (c.f., Homrich et al., 2018; Lieder & Rashid, 2016; Lewandowski, 2016; Pan et al., 2015; Su et al., 2013; Geng et al., 2009; Ghisellini et al., 2016) univocally demonstrating that the circular economy approach aims at reducing the consumption of new raw materials by reusing existing materials as opposed to the conventional "take-make-dispose" or linear economy approach. The problem with available literature is that each study uniquely captures the positive (or negative) impressions of circular economy strategies in general or on supply chains, but creates a divergent view about the relationship between circular economy and supply chain management. Therefore, the first objective of this dissertation is to provide converging insights about the CE stream of literature within supply chain relevance by answering the following research question:

RQ 1: What is the present state of the intellectual structures of circular economy within supply chain management literature?

Second, firms pursuing CEBM require a paradigm shift in their ways of managing supply chains (Geissdoerfer et al., 2018; Govindan & Hasanagic, 2018). Scholars have studied concepts, actors and linkages between environmental, societal, and economic systems of transitioning towards CE models in different geographic settings (e.g., Geng et al., 2009; Su et al., 2013; Ghisellini et al., 2016). The findings and recommendations from such studies have unearthed new knowledge about CE "applications" in isolation, but are constrained in explaining how firms could manage such CE "applications" internally, across their supply chains and externally. Regardless of the application in consideration, the importance of supply chain management cannot be ignored.

The simple fact is that firms and their supply chains perform better when they are better prepared to handle new or unanticipated dynamics or paradigm shifts (Spekman et al., 1998; Finch, 2004; Ahmad et al., 2017; Akkermans & Van Wassenhove, 2018). There is a scholarly gap in understanding about the art of "preparedness" (i.e., "supply chain preparedness") of firms practicing CEBM, and its influence on their CEBM performance. To address this gap in literature about "supply chain preparedness" of firms practicing CEBM, the second objective of this study is to answer the following two research questions:

RQ 2: How can CEBM practices be deployed in the supply chain context? What are the factors that firms pursuing CEBM should consider fostering "supply chain preparedness"?

RQ 3: How is "supply chain preparedness" related to the CEBM practices and the CEBM performance, and what are the factors upon which the relationships are contingent?

RESEARCH DESIGN

To adequately investigate and answer the research questions, the dissertation is organized to conduct two studies. The first study attempts to answer the RQ 1 stated above, and therefore, sets the tone for the second study. Using cues from first study, the second study answers RQ2 and RQ3.

CHAPTER II – STUDY 1

Given the nature of analysis required to answer the first research question (RQ 1), an inductive approach is adopted. It helps to make broad generalizations about the field based on the pattern discerned from specific observations of extant CE literature that is isolated or connected with supply chain management aspects in full or in parts. More specifically, a bibliometric and network analysis approach is deployed on a sample of 345 articles to present a comprehensive overview of the field of CE relevant to supply chain management, by objectively identifying impactful articles, their authors, their relationships, and their dominant areas of contributions. In addition, citation and co-citation analyses are performed to identify the major clusters of CE research, and to demonstrate their evolution by analyzing how each cluster has contributed to the field over time.

Findings of this study enlarge the current knowledge spectrum. First, CE ideologies are still distantly connected to the field of strategic and operations management, even though they are deeply embedded in prescriptive modelling approaches. Second, the rapid increase in interdisciplinary publications associated with cyclic thinking suggest that sub-disciplines of supply chain management, such as risk management and supply chain resilience, may soon start considering the role of CE. Third, the field of supply chain management has yet to deliver influential works related to the circular economy. Fourth, from a media perspective, CE phenomenon appears to be more concentrated in Europe and China, but geographic dispersion shows that North America is not far behind. Interestingly, the scholarly works by European authors tend to be more conceptual than empirical, unlike their Asian counterparts, thus suggesting the openness of Asian government policy-makers to adopt circularity concepts in their territories. Lastly, the hot topic analysis suggested that CEBM and the product-service system (PSS) are two promising themes with CE that remain significantly under-explored in supply chain management context. As such, this finding sets the path to explore the other research questions (i.e., study 2) of this dissertation, considering the “transdisciplinary” usefulness of CE ideologies and sustainability research.

CHAPTER III, IV, V AND VI – STUDY 2

This study begins as Chapter III. It builds upon an important finding from study 1 that CEBM is a promising theme within CE, but needs more understanding about its practice in the supply chain context. Accordingly, the second research question (RQ2) is answered by conducting a thorough literature review upon CEBM and supply chain preparedness concepts. Since CEBM is a relatively new field and yet to attain its "best practices" attributions, a contingency theory (Burns & Stalker, 1961; Lawrence & Lorsh, 1967; Thompson, 1967; Donaldson, 2001; Van de Ven et al., 2013) perspective is used to identify factors related to a focal firm's CEBM practice as response, its contingencies as context, its supply chain preparedness as outcome, and its CEBM performance as consequent outcome. At the end of Chapter III, a guiding contingency research framework is developed.

To answer the third research question (RQ3), in-depth understanding about unique experiences and settings (Simons, 2014) of firms CEBM practices and their supply chain preparedness is mandated. Given the exploratory characteristics, this study suits a multiple case study approach to provide strong methodological support and new theory generation (Eisenhardt, 1989). Moreover, the conditions of this study justify for a case study approach guided by Yin (2015) following these recommendations: (a) the emphasis of the research question is to answer "how" and "why" questions; (b) the study must not be affected by intentional or unintentional manipulation of the behavior of those involved; (c) researchers must be keen to study contextual conditions due to their relevance to the phenomenon under study; and (d) there may not be clear boundaries between the phenomenon and context. Accordingly, an exploratory qualitative research approach is proposed to explore the role of "supply chain preparedness" between the relationship of CEBM practices and their performance, and the factors upon which the overall relationship is contingent. In Chapter IV, the research methodology approach proposed, in terms of case selection approach, data collection and instrumentation, and data analysis techniques, are discussed. In Chapter V, the data analysis of the selected companies (within-case and cross-case analysis) is presented. Finally, Chapter VI presents a rich discussion of the study findings and concludes with a set of propositions and proposes a contingency framework for supply chain preparedness of CEBM practices for future research.

RESEARCH CONTRIBUTIONS

Engaged scholarship is achieved through the virtuous cycle of connecting theory with practice (Van de Ven, 2007). Three main contributions of engaged scholarly worthiness that this dissertation must serve are as follows. First, it presents a convergent view of the CE stream of literature within the supply chain context. Second, it identifies different factors that firms pursuing CEBM should consider fostering “supply chain preparedness”. Third, it promises to provide deeper understanding of the contingency relationship between firms’ CEBM practice, their “supply chain preparedness”, and their CEBM performance. The research implications shall benefit scholars of transdisciplinary interests. Practical implications shall serve as a guiding tool for practitioners and consultants presently acting upon CEBM implementation in their supply chain systems.

CONTRIBUTION TO RESEARCH

Research on CEBM practices is constrained in explaining about its applicability in the supply chain management context (Govindan & Hasanagic, 2018; Geissdoerfer et al., 2018). This dissertation is expected to overcome such constraints by posing several research implications. For example, the second study’s contingency perspective of CEBM practice to achieve supply chain preparedness indicates that different configurational scenarios (such as industry, type of product, and type of skills) are anticipated for firm's implementation of CEBM practices across their supply chains. In addition, this investigation should reveal different combinations of supply chain preparedness by highlighting key contingencies that may be unknown from scholarly perspective.

In Chapter II, the bibliometric study objectified the state of circular economy research in supply chain management literature. Although several review articles have been published in this area as well as associated areas in the past decade, the sheer lack of a systematic bibliometric and network analysis to objectively identify impactful articles, their authors, their relationships, and their contributions in characterization of research clusters (topical themes) has been a major disadvantage for the scholars, businesses and policy-makers. This study lessens this disadvantage by demonstrating the evolution of the research clusters, and by analyzing how each cluster has contributed to the field by comparing their relationships over time.

In Chapter III, the role of supply chain preparedness in CEBM practice is discussed with theoretical congruence that forms the basis for its subsequent qualitative investigation. For that reason, the dissertation's proposed framework, identified factors and operationalization strategy is of scholarly value. Scholars can explore this phenomenon further by adding new CEBM practice dimensions and under unique supply chain settings.

In Chapter IV, the qualitative inquiry approach proposed is aimed at providing useful insights about the study phenomena in unbiased naturalistic setting (Jones, 1995). Since the study is guided by a theoretical framework from extant literature of CE and supply chain management, observations and interpretations of CEBM implementation events and experiences of participants must augment theoretical development and bringing the two fields closer.

In Chapter V, the data analysis, in terms of within case and cross case analysis, may be useful for future researchers to educate upon CEBM level aspects of firms from an industry stand-point. Finally, the discussions and conclusions from the study findings expressed in Chapter VI as a set of propositions and proposed contingency framework may satisfy some of the research gaps about our present understanding of the supply chain preparedness of firms pursuing CEBM, their contingencies, and their CEBM performance. Moreover, it sets an agenda for future scholars to explore this phenomenon further.

CONTRIBUTION TO PRACTICE

The finding of this study can provide potentially valuable insights for practitioners and consultants associated with CEBM implementation from a supply chain perspective. Even though scholars, enterprises and policy-makers recognize the value of CEBM implementation, the literature struggles to provide managers with actionable and identifiable objects that can help them to implement and manage CEBM practices across supply chains and improve performance (Pagell & Wu, 2009). In Chapter II, important scholarly and industry reports are statistically drawn that managers must refer to increase their knowledge base about CEBM implementation challenges and concerns. In Chapter III, the contingency model approach may appeal to managers to describe their respective firms' contingency relationship between CEBM practice, its context, and supply chain preparedness. Upon qualitative validation using multi-industry cases as presented in Chapter IV, managers can easily relate the findings of this study with their business scenarios from several perspectives (such as industry, product, skills, and so on). Furthermore, the empirical analysis presented in Chapter V can help managers recognize types of CEBM practices that may suit their supply chains and also recognize the benefits that may accrue thereon. The findings in Chapter VI may even encourage managers to think out-of-box to innovate and implement new CEBM practices for their firms that can resist external and internal pressures and capture broader benefits for their individual firms and supply chains. Managers may find the study's findings useful to assess and clarify parts of CEBM practices are related and/or not related with their present sustainability initiatives and supply chain management practices. Lastly, managers may find the study useful to evaluate whether preparing supply chains for practicing CEBM is related to their higher-order strategic goals, such as sustainability firm performance, social recognition, and corporate branding.

RESEARCH STRUCTURE

The structure of the dissertation follows the structure of the research thinking. Figure 1-4 presents the research thinking applied to achieve this research study. The research conducted in this dissertation is only a beginning. While the study expects to uncover the "supply chain preparedness" aspect of CEBM practice, there is a long path that remains unexplored. The future of this research relies on solidifying the present scope and expanding it beyond the present one.

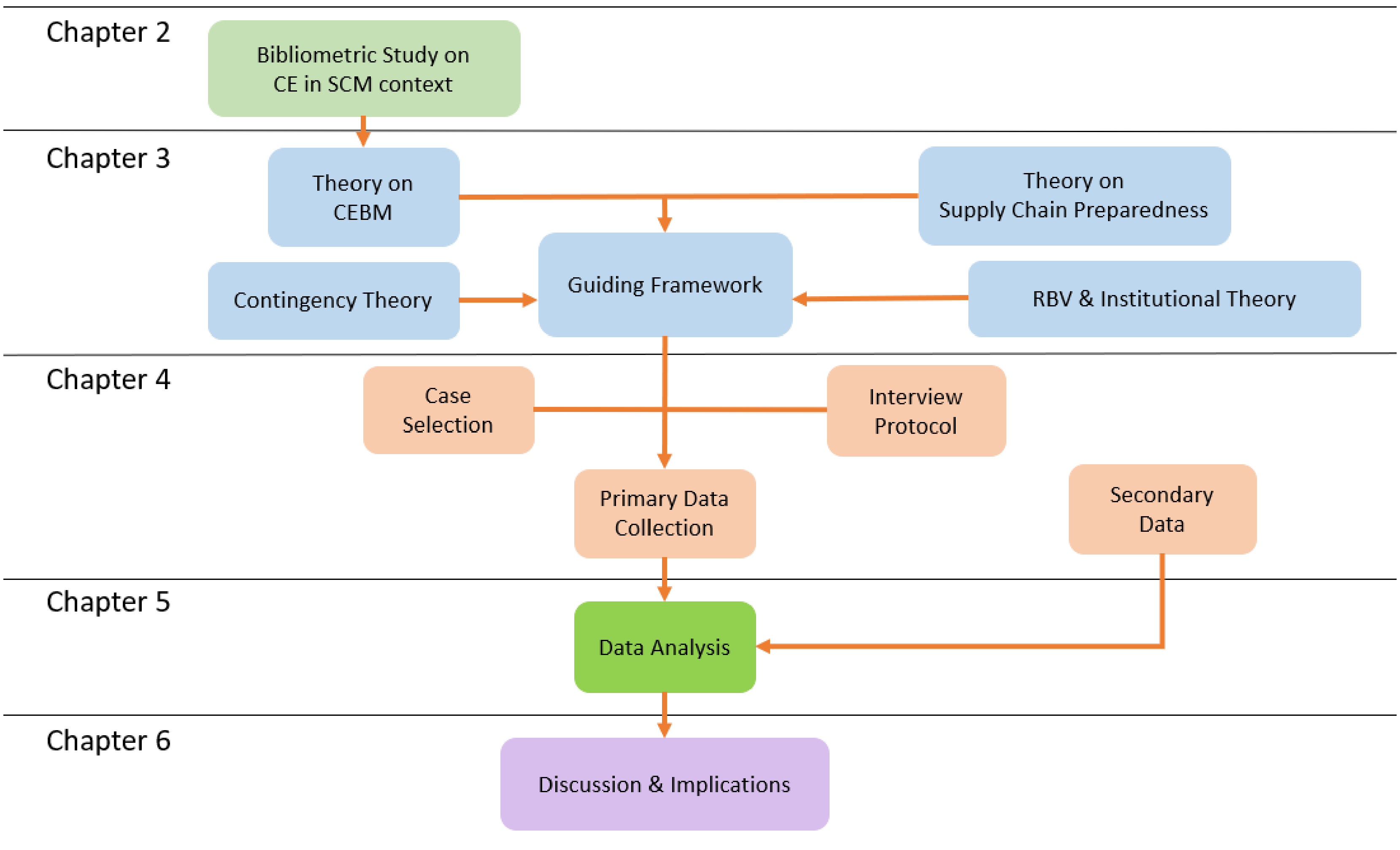

Figure 1 - 4. The structure of the dissertation

CHAPTER II

INTELLECTUAL STRUCTURES OF CIRCULAR ECONOMY WITHIN THE CONVERSATION OF SUPPLY CHAINS – A BIBLIOMETRIC REVIEW

INTRODUCTION

In the past three decades, supply chain management has emerged from a modest operations and economics focused field to a more comprehensive field that aims to provide an integrated outlook of economic, environmental and social challenges that firms face in present times (Stevens & Johnson, 2016). In the past decade, circular economy (CE) is an important global phenomenon that supply chain management has embraced. Specifically, supply chain management scholars do not hesitate to adopt CE's cyclical ideologies to synergize the three above-mentioned challenges of firms along their value chains (Govindan & Hasanagic, 2018). CE "in isolation" promises a new path of production and consumption for sustaining Earth's natural resources by focusing on the big-picture trends and configurations of elements, rather than the elements. However, such an isolated view of CE is analogous to one's desire to drive a pollution-free car, but not sufficiently keen to understand its complex engineering mechanisms.

A comprehensive understanding of circular economy from a supply chain perspective is more beneficial to uncover the inner workings of its elements. A surge of general and comprehensive literature reviews on circular economy has shown that the field is far from converging to a dominant one (c.f., Homrich et al., 2018; Lieder & Rashid, 2016; Lewandowski, 2016; Pan et al., 2015; Su et al., 2013; Geng et al., 2009; Ghisellini et al., 2016), and the term "closed-loop" is arguably the nearest parallel one (Bocken et al., 2016). These reviews have collectively demonstrated that the concept of circular economy is presently diluted among several competing streams, such as, cradle-to-cradle (McDonough & Braungart, 2002), industrial ecology (Graedel & Allenby, 1995), biomimicry (Benyus, 2002), blue economy (Pauli, 2010), life cycle assessment (Bakker et al., 2014), and performance economy (Stahel, 2010). At hindsight, these reviews have univocally demonstrated that circular economy approach is targeted to reduce the consumption of new raw materials by reusing existing materials as opposed to the conventional "take-make-dispose" or linear economy approach, by apprehending its positive impacts in a wide range of settings, such as manufacturing (Lieder & Rashid, 2016), product-service system (Tukker, 2015), construction industry (Smol et al., 2015), consumer durable goods (Asif et al., 2016), Chinese and Japanese manufacturing enterprises (Zhu et al., 2010), and so on. The problem with available literature is that each study uniquely captures the positive (or negative) impressions of circular economy strategies in general or on supply chains, but creates a divergent view about the relationship between circular economy and supply chain management. To address this gap in literature about lack of common understanding about the relationship between circular economy and supply chain management, the main objective of this study is to answer the following to research question:

RQ 1: What is the present state of the intellectual structures of circular economy within supply chain management literature?

To answer this research question, an inductive approach is adopted to make broad generalizations about the field based on the pattern discerned from specific observations of the large body of circular economy literature that addresses supply chain management concerns in full or parts. More specifically, a bibliometric and network analysis approach is used to present a comprehensive overview of the field of circular economy relevant to supply chain management, in terms of influences of authors, affiliations, and geographic distributions. In addition to it, the study performs citation and co-citation analyses to identify the major clusters of research and investigate further for topical classification. The statistically derived conclusions would form the basis to gain additional insights about present state of research and potential directions for future research.

The remainder of the study starts with an overview of circular economy and supply chain management to describe how the two concepts have been studied in the past. The next section describes the research methodology adopted to identify and organize the literature for finalizing the evaluation sample for this study. This section also describes how the data analysis is conducted using BibExcel bibliometric software and VOSviewer network analysis software. Thereafter, the bibliometric analysis results in terms of journals/conference, articles, authors, affiliations, geographic spread, and keyword statistics are described. The network analysis results, in terms of keyword network analysis and citation and co-citation network analyses of the articles, are presented next. The chapter ends with a summary of the key findings, the limitations and suggests future research opportunities.

AN OVERVIEW OF CIRCULAR ECONOMY AND SUPPLY CHAIN MANAGEMENT

The notion of sustainable development in supply chain management field has long been labeled as "theoretical dream [rather than] implementable reality" (Naudé, 2011, p.352) and "sustainababble" (Engelman, 2013, p.3) by their critics considering the vagueness of green economy and green growth concepts (UNEP, 2011; OECD, 2016). Contrarily, the expression of "circular economy" has gained sufficient traction among scholars, businesses and policy-makers as "an idea and ideal" (Gregson et al., 2015, p.218) for instrumenting sustainable supply chains for businesses (Ghisellini et al., 2016; Kirchherr et al., 2017; Murray et al., 2017) due to increasing scarcity of Earth's natural resources (Meadows et al., 1972). Literature shows that the introduction of the concept of circular economy can be traced back to the works of Pearce & Turner (1990), as an alternate for linear model of production system, to conserve natural resources of economic systems (Su et al., 2013; Ghisellini et al., 2016; Geissdoerfer et al., 2017; Homrich et al., 2018).

Among businesses, the Ellen MacArthur Foundation is seen as the most engaging proponents to spread the "circularity" concept as "an industrial system that is restorative or regenerative by intention and design" and is derived from the five core principles: (i) design out waste, suggesting creation of restorative loops, (ii) building resilience through diversity, (iii) creating energy from renewable resources, and (iv) thinking in systems, and (v) thinking in cascades (EMAF, 2015). Ellen MacArthur Foundation proposes two forms of closing loops: one for technical material recovery (right wing) and the other for biological nutrients recovery (left wing) in the forms of two wings of a butterfly diagram (EMAF, 2013). In supply chain management context, this cyclic thinking is broadly understood as prioritizing inputs reduction, reuse, and recycling waste, which needs firms to optimize their supply chain networks. Some of the exemplary forms of this circularity concept can be seen in the eco-industrial parks (Yu et al., 2015) across several industrial nations such as China, Brazil, Malaysia, and so on.

A surge in general and comprehensive literature reviews of circular economy field (c.f., Homrich et al., 2018; Lieder & Rashid, 2016; Lewandowski, 2016; Pan et al., 2015; Su et al., 2013; Geng et al., 2009; Ghisellini et al., 2016; Bocken et al., 2016) have shown the growth of the field and its potential areas of research interest, but have unknowingly diluted the core of “circular economy” into several competing streams of thoughts. Such themes include cradle-to-cradle (McDonough & Braungart, 2002), industrial ecology (Graedel & Allenby, 1995), biomimicry (Benyus, 2002), performance economy (Stahel, 2010), blue economy (Pauli, 2010), life cycle assessment (Bakker et al., 2014), zero waste economy (Mirabella et al., 2014), and so on. In addition, the definitions of circular economy and sustainable supply chains are not cohesive. Comically, two review papers focusing purely and separately on definitions of circular economy and sustainable supply chain management found at least 114 definitions of circular economy (Kirchherr et al., 2017) and at least 12 definitions of sustainable supply chain management (Ahi & Searcy, 2013). With so many definitions and conceptualizations, it is hard to interpret the boundaries of circular economy within supply chain management context. As such, CE implementation requires several re-adjustments of upstream and downstream supply chain activities at operational and/or strategic levels, which in turn, has compounding effects on the associated ecosystem and stakeholders.

To help understand the relationship between circular economy and supply chain management, the main intent of the study is to explore how the literature is presently linked across authors, themes, and interdisciplinary fields using thorough descriptive statistics, bibliometric and network analysis. In other words, the main objective of this study is to map the intellectual structures of circular economy within supply chain management literature to identify the most impactful articles and their connectedness, and to explore the prime clusters of the field. Through this thorough network analysis-based approach, the intention of the study is to reduce the subjective judgements about the field, and to objectively identify the clusters of research streams, their evolution patterns over time and potential directions for future research. This study makes an effort to complement the existing reviews on the circular economy and about its characterization in supply chain management context by offering a rigorous, robust and statistically drawn roadmap for further research.

RESEARCH METHODOLOGY

Literature reviews help scholars to chart, structure and analyze the present state of the literature, identify potential research questions, and make informed conclusions (Denyer & Tranfield, 2009). This study uses Rowley & Slack's (2004) recommendations for conducting a systematic literature review through "*scanning, making notes, structuring the literature review, writing the literature review, and building a bibliography*" (Rowley & Slack, 2004). Accordingly, this study uses an iterative approach of data collection and a multi-staged evaluation of the length and breadth of the selected data sample of publications to identify the most influential studies, to determine the most relevant topics for research, to provide deeper understanding of the current state of research, and to suggest directionality for advancing research in the field.

SAMPLING PROCEDURE

To locate studies, two scientific data sources with quality coverage for research topic in the fields of science, technology, medicine, social sciences, and arts and humanities were identified: Thomson ISI's "Web of Science (Core Collection)" and Elsevier's "Scopus". Both data sources collectively provide coverage of tens of millions of peer-reviewed articles from over 22,000 journals, 400,000 proceedings from worldwide events, 30,000 editorially selected books, and hundreds of trade publications. In addition, both data sources allow sorting results by parameters, citation searching, and most importantly, exporting to the commonly used bibliometric tools such as Mendeley, Endnotes and RefWorks (Fingerman, 2006). Both data sources are equally competent for conducting rigorous bibliometric analysis based on the extracted metadata containing the articles' respective abstracts, keywords, citations, authors, institutions, countries, and so on (Carvalho et al., 2013). Some studies have argued for the superiority of Scopus over Web of Science for its better curation by experts, completeness of data records, neat interface for search refinement, document discovery and data extraction (Yong-Hak, 2013; Chicksand et al., 2012; Fahimnia, et al., 2015). After comparing facts sheets of both data sources, the Scopus database is adopted as primary tool and Web of Science as supplementing tool for the bibliographic data extraction process. This strategy satisfied the aim of the study to capture rich and accurate metadata from relevant articles without compromising on journal reputation and influence.

The search string used for data collection from both Scopus and Web of Science include "Supply Chain", "Circular Economy", "Economic Sustainability" and "Circular Business Model". The combinations of these keywords used include (1) Circular Economy AND Supply Chain, (2) Economic Sustainability AND Supply Chain, (3) Circular Business Model AND Supply Chain, and (4) Circular Economy AND Business Model. In sustainable supply chain literature, circular economy is conceptualized as an alternate to the linear economy model for industrial production. There are at least three dominant perspectives to identify circular economy literature – the core conceptualization, its associated understandings, and its application perspective. The selection of keywords must ensure that these three perspectives are significantly covered. For example, in the fields of Environmental Science and/or Agricultural and Biological Sciences, "Economic Sustainability" commonly refers to an understanding for related efforts to abandon the traditional linear economy model of industrial production. An apt example would refer to viable methods for re-purposing waste generated from rice production process. Similarly, the aspects of implementing circular economy models would fall under “Circular Business Model”. It must be noted that those terms of sustainability that do not “directly” refer to idea of abandon traditional linear economy model are excluded. Such terms include Waste management, Closed Loops, Industrial Ecology, Environmental Sustainability, Green, and so on. This allowed us to tighten the focus of the data sample to those articles that are solely focused on studying circular economy with supply chain management context.

The filter used in searching articles was “title, abstract, keywords” in Scopus and “topic” in Web of Science data sources. Only, “articles”, “article in press” and “conference articles” are stored. The “reviews” were excluded to avoid inflation of citation counts from the analysis (Opthof, 2013). The initial search attempts performed on March 14, 2018 found 391 articles in total from Scopus and Web of Science. After matching for articles found from both data source, the Scopus results were retained, resulting into a total of 365 unique articles. The search results were stored in Research Information Systems (RIS) file format with all required bibliographic information such as article title, authors' names and affiliations, year of publication, journal or conference name, abstract, keywords and references. The RIS datasets were then imported to Mendeley software (Butros & Taylor, 2011) for the initial screening to eliminate non-refereed articles, commercial articles, unknown authored articles were removed as they may have scientific contributions of little significance. In the next screening process, the authors conducted qualitative evaluation of each article by separately studying article title and abstract to confirm its fitment with the research question (Carvalho et al., 2013). Articles that did not meet agreement of both authors were excluded. This screening process resulted in a refined sample of 345 articles, published during a 20-year period, between 1999 and 2018. Table 2-1 shows statistics of journal articles and full conference proceedings using the four set of keywords. The resulting RIS file was used for further data analysis.

Table 2 - 1. Terms and Search Results

Terms	Search results (journal articles)	Search results (full conference proceedings)	Search results (total)
"Circular Economy" AND "Supply Chain"	129	70	199
"Economic Sustainability" AND "Supply Chain"	77	10	87
"Circular Business Model" AND "Supply Chain"	2	2	4
"Circular Economy" AND "Business Model"	74	27	101
Total articles (before refinement)	282	109	391
Total articles (after refinement)	245	100	345

DATA ANALYSIS

The inductive approach chosen for this study requires data analysis to follow "the specific to the general" strategy of knowledge discovery– a strategy of gathering several observations, recognizing the patterns, suggesting a generalization, and finally, logical explanations for advancement of the field (Piateski & Frawley, 1991). Accordingly, the literature is classified before carrying out the data analysis in three parts – a "descriptive analysis", a "bibliometric analysis" and a "network analysis" respectively. The open-source BibExcel (Persson et al., 2009) software is deployed to conduct the bibliometric analysis for creating data statistics regarding author, affiliation, geographic dispersion and keyword. Bibexcel software was chosen over other bibliometric analysis software, such as Sitkis (Schildt & Mattsson, 2006), Publish or Perish (Harzing, 2007), HistCite (Garfield, 2009), CiteSpace (Chen, 2006) and so on, largely for its flexibility in preprocessing large bibliographic datasets extracted from data sources including Scopus and Web of Science, its data format (the .OUT file format) compatibility with Microsoft Excel for additional data adjustment and analysis, and its network file (the .Net file) creation/extraction feature. BibExcel accepts RIS data format extracted from Mendeley Software as the input data. The input RIS data contained the bibliographic information regarding authors, title, year of publication, journal and conference, affiliation of authors, author keywords, and references. In BibExcel, the input RIS is passed through a series of steps to create an OUT-file for conducting required data analyses including descriptive and bibliometric analyses (Pilkington, 2006; Persson et al., 2009). The .Net file extracted from BibExcel is the input data for network analysis. For network data analyses, the open-source VOSviewer (Van Eck & Waltman, 2010) software was chosen over other popular ones such as Pajek (Batagelj & Mrvar, 2011), Gephi (Bastian et al., 2009), Ucinet (Borgatti et al., 2002), for its interactive options of probing large bibliometric network data and flexibility in making visually appealing network maps.

BIBLIOMETRIC ANALYSIS

DESCRIPTIVE STATISTICS OF THE INTELLECTUAL STRUCTURE: TRENDS, SOURCES, AND MOST CITED ARTICLES

The year-wise publication trend of articles published in journals and in conferences as full paper proceedings between the year 1999 and 2017 are shown in Figure 2-1. The field evolved with a slow and linear rate for the initial fourteen years (1999 to 2012), but has grown at an exponential rate since 2013. 79% of the articles of the data sample of 345 articles were published in the last six years (2013-2018), demonstrating profound interest of scholars, practitioners and policy makers in last few years. Interestingly, the first (oldest) article of the sample appeared as a conference proceeding at *1999 IEEE International Symposium on Electronics and the Environment Conference*. The article studied how small and medium enterprises (SME) supply chains could eliminate recycling cost and generate end-of-life value from wastes through product design (Bollinger et al., 1999). It was only after a gap of seven years (until 2006) that four articles addressing sustainable supply chain issues were published in journals. Further data analyses revealed that 6 journals collectively have published 95 articles (28%), whereas, 5 conferences together make 24 articles (7%). Table 2-2 lists the journals and Table 2-3 lists the conferences, in which these articles were published. It was also observed that these journals/conferences have highest self-citation rates in the sample of articles. In other words, scholars carry an impression about these publishing journals/conferences as the most reliable scholarly sources, and hence cited most by others too.

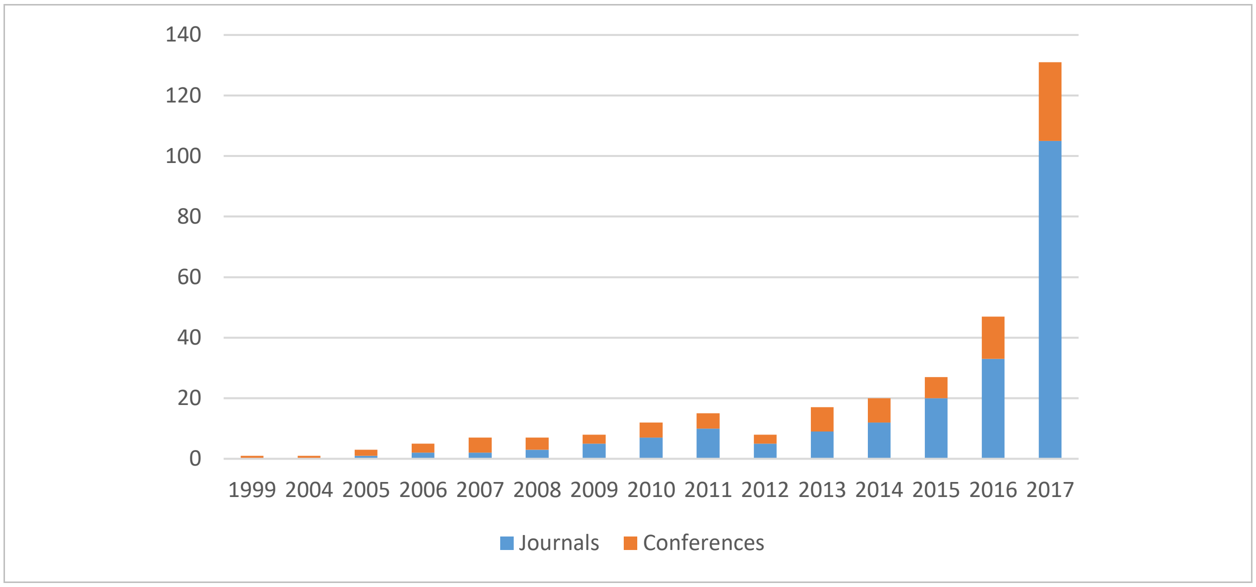

Figure 2 - 1. Year-wise publication trend of journals and conference proceedings

In analyzing the focus and quality of the top six journals that represented 28% of the total sample, it was found that these journals commonly share the repute of being high-quality peer-reviewed international transdisciplinary scholarly journals with varying degree of focus on sustainable development and supply chain issues. For example, The Journal of Cleaner Production, which tops the list with 37 articles (11%), is an outlet for researches on wide variety of theoretical/practical issues related to environmental and sustainability issues of institutional, government, and societal interests. The second one in the list with 25 articles (7%), The Sustainability Journal, is an open access journal that is more focused on addressing industrial and socio-economic challenges related sustainable development issues, such as eco-industrial parks and industrial symbioses discussions in supply chain context. The third one with 14 articles (4%), Resources Conservation and Recycling, is geared towards resource management research and practices for sustainable development in the context of technological, economic, institutional and policy-making issues. The fourth one with 7 articles (2%), The Supply Chain Management –

An International Journal, is more inclined towards extending supply chain boundaries. It may be noted that this journal made considerable contributions during the early stage (2006 -2010), but, is no more an active outlet. One possible explanation could be attributed to the journal's myopic view towards "sustainable" supply chain issues, in its quest to keep pace in capturing other impactful supply chain issues, such as data analytics, risk management and so on. The last two journals are the Journal of Industrial Ecology with 6 articles (2%) each are aligned in disseminating environmental/ecological issues related knowledge at both firm and industry levels.

Table 2 - 2. Dissertation Structure and Research Activities

Source	Publication Year													
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total (%)
Journal of Cleaner Production	-	-	-	-	1	-	-	-	-	-	6	16	14	37 (11%)
Sustainability (Switzerland)	-	-	-	1	-	2	-	-	2	1	8	7	4	25 (7%)
Resources, Conservation and Recycling	-	-	-	-	-	-	-	-	-	1	3	10	-	14 (4%)
Supply Chain Management	1	1	1	1	2	-	-	-	-	1	-	-	-	7 (2%)
Journal of Industrial Ecology	-	-	-	-	-	2	-	-	-	-	-	4	-	6 (2%)
Resources	-	-	-	-	-	-	-	-	2	1	-	3	-	6 (2%)
Total	1	1	1	2	3	4	0	0	4	4	17	40	18	95 (28%)

In speaking about the conference, it was observed that these five conferences are typically hosting scholars from production engineering/operations management domain wherein "sustainability" or "sustainable supply chain" is recognized as one among several themes in operations management/supply chain area. Apparently, CIRP international conferences have earned its coverage due to its unique arrangement of publishing the conference proceedings on Procedia-CIRP (https://www.sciencedirect.com/journal/procedia-cirp), a website hosted by Elsevier/ScienceDirect. The other three conferences are also international, but have significant recognition in Europe (Electronics Goes Green), Asia (International Conference on Innovation & Management), and Australia (International Conference on Sustainable Design and Manufacturing). Therefore, these five international conferences have played a significant role in bringing out trending topics into the scholarly minds and institutions/policy-makers' attention about the circular economy in supply chain context.

Table 2 - 3. Top 5 conferences publishing full paper proceedings

Conference	Frequency (%)
CIRP Conference on Manufacturing Systems	10 (3%)
Electronics Goes Green	4 (1%)
International Conference on Sustainable Design and Manufacturing	4 (1%)
CIRP Conference on Life Cycle Engineering	3 (1%)
International Conference on Innovation & Management	3 (1%)

The list of top 25 most influential articles in the sample is presented. In literature road mapping, an article's influence (article impact factor) must consider the journal impact factor (JCRIF), which can be extracted from the latest Journal Citation Report along with the number of times the article has been cited by others (Carvalho et al., 2013). However, the yearly average citation (AYC) of an article may be more appropriate measure to reduce variations otherwise accounted for using the total number of citations only (Homrich et al., 2018). Accordingly, the article impact factor (AIF) of an article can be calculated using the Equation (1).

AIF = AYC * (JCRIF + 1) ………………………………………………………………… (1)

Table 2-4 lists the top twenty-five (25) articles drawn from the sample ranked by their article impact factor (AIF). These set of 25 articles may be considered as the most influential studies based on the relevancy of research content and source of publication (journal) that other studies use as the basis extend the field further.

Table 2 - 4. Top 25 most influential articles ranked by article impact factor (AIF)

Authors	Year	Article Title	Journal	Average Citations	JCR/IF (2016)	AIF
Carter, C.R.; Rogers, D.S.	2008	A framework of sustainable supply chain management: moving toward new theory	International Journal of Physical Distribution & Logistics Management	88.00	2.577	314.776
Cucchiella, F.; D'Adamo, I.; Lenny-Koh, S.C.; Rosa, P.	2015	Recycling of WEEEs: An economic assessment of present and future e-waste streams	Renewable and Sustainable Energy Reviews	34.33	8.05	310.717
Geissdoerfer, M.; Savaget, P.; Bocken, N.M.P.; Hultink, E.J.	2017	The Circular Economy - A new sustainability paradigm?	Journal of Cleaner Production	34.00	5.715	228.310
Carter, C.R.; Liane-Easton, P.	2011	Sustainable supply chain management: evolution and future directions	International Journal of Physical Distribution & Logistics Management	52.57	2.577	188.048
Genovese, A.; Acquaye, Adolf A.; Figueroa, Alejandro; Koh, S. C.Lenny	2017	Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications	Omega (United Kingdom)	33.00	4.029	165.957
Andersen, M.; Skjoett-Larsen, T.	2009	Corporate social responsibility in global supply chains	Supply Chain Management: An International Journal	24.11	4.072	122.292
Seuring, S.A.	2008	Assessing the rigor of case study research in supply chain management	Supply Chain Management: An International Journal	14.30	4.072	72.530
Svensson, G.	2007	Aspects of sustainable supply chain management (SSCM): conceptual framework and empirical example	Supply Chain Management: An International Journal	14.27	4.072	72.391
Witjes, S.; Lozano, R.	2016	Towards a more Circular Economy: Proposing a framework linking sustainable public procurement and sustainable business models	Resources, Conservation and Recycling	16.00	3.313	69.008
Mathews, J.A.; Tan, H.	2011	Progress toward a circular economy in China: The	Journal of Industrial Ecology	13.43	4.123	68.795

Authors	Year	Article Title	Journal	Average Citations	JCR/IF (2016)	AIF
		drivers (and inhibitors) of eco-industrial initiative				
Park, J.; Sarkis, J.; Wu, Z.	2010	Creating integrated business and environmental value within the context of China's circular economy and ecological modernization	Journal of Cleaner Production	9.13	5.715	61.274
Chiaroni, D.; Chiesa, V.; Colasanti, L.; Cucchiella, F.; D'Adamo, I.; Frattini, F.	2014	Evaluating solar energy profitability: A focus on the role of self-consumption	Energy Conversion and Management	8.50	5.589	56.007
de-Santoli, L.; Mancini, F.; Nastasi, B.; Piergrossi, V.	2015	Building integrated bioenergy production Economic sustainability analysis of Bari airport CHP (combined heat and power) upgrade fueled with bioenergy from short chain	Renewable Energy	10.33	4.357	55.356
Markley, M.J.; Davis, L.	2007	Exploring future competitive advantage through sustainable supply chains	International Journal of Physical Distribution & Logistics Management	15.09	2.577	53.980
Zhu, Q.; Geng, Y.; Sarkis, J.; Lai, K.H.	2011	Evaluating green supply chain management among Chinese manufacturers from the ecological modernization perspective	Transportation Research Part E: Logistics and Transportation Review	12.29	2.974	48.823
Lewandowski, M.	2016	Designing the business models for circular economy-towards the conceptual framework	Sustainability (Switzerland)	15.50	1.789	43.230
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	8.50	4.01	42.585
Alvarez, G.; Pilbeam, C.; Wilding, R.	2010	Nestle Nespresso AAA sustainable quality program: an investigation into the governance dynamics in a multi-• stakeholder supply chain network	Supply Chain Management: An International Journal	6.00	4.072	30.432
Winkler, H.	2011	Closed-loop production systems-A sustainable supply chain approach	CIRP Journal of Manufacturing Science and Technology	6.86	2.76	25.783
Zhu, Q.; Geng, Y.; Lai, K.H.	2011	Environmental supply chain cooperation and its effect on the circular economy practice-	Journal of Industrial Ecology	5.00	4.123	25.615

Authors	Year	Article Title	Journal	Average Citations	JCR/IF (2016)	AIF
		performance relationship among Chinese manufacturers				
Green, K.W.; Zelbst, P.J.; Bhadauria, Vi.S.; Meacham, J.	2012	Do environmental collaboration and monitoring enhance organizational performance?	Industrial Management & Data Systems	7.83	2.205	25.106
Flint, D.J.; Golicic, S.L.	2009	Searching for competitive advantage through sustainability	International Journal of Physical Distribution & Logistics Management	6.56	2.577	23.449
Vasileiou, K.; Morris, J.	2006	The sustainability of the supply chain for fresh potatoes in Britain	Supply Chain Management: An International Journal	4.58	4.072	23.247
Bocken, N.M.P.; de-Pauw, I.; Bakker, C.; van-der-Grinten, B.	2016	Product design and business model strategies for a circular economy	Journal of Industrial and Production Engineering	16.50	0.395	23.018
Xia, Y.; Li-Ping-Tang, T.	2011	Sustainability in supply chain management: suggestions for the auto industry	Management Decision	6.14	1.396	14.718

AUTHOR PRODUCTIVITY

In BibExcel, the frequency of occurrence of texts within a field can be created by segregating that data field from the bibliographic data. To analyze the contributions by author, the author field from the main RIS data file and generated the frequency of occurrence of all authors is extracted. Table 2-5 shows the authors in the data sample who have authored or co-authored at least three or more articles, their affiliations and the frequency of articles authored or co-authored.

Table 2 - 5. Authors contributing three or more articles

Author	Affiliation	Frequency
Sarkis, J.	Worcester Polytechnic Institute, MA, USA	6
Bocken, N.M.P.	Lund University, Sweden	5
Geng, Y.	Chinese Academy of Science, China	5
Zhu, Q.	JiaoTong University, China	5
Zheng, J.L.	Kunming University of Science & Technology, China	4

Author	Affiliation	Frequency
Lai, K.H.	Hong Kong Polytechnic University, Hong Kong	4
Aminoff, A.	VTT Technical Research Centre, Finland	4
Li, J.	Tianjin University of Technology, China	4
Charnley, F.	Cranfield University, UK	4
Milios, L.	Lund University, Sweden	3
Lieder, M.	KTH Royal Institute of Technology, Sweden	3
Cucchiella, F.	University of L'Aquila, Italy	3
Zeng, H.	Central South University, China	3
Pascucci, S.	University of Exeter, UK	3
D'Adamo, I.	University of L'Aquila, Italy	3
Rosa, P.	Politecnico di Milano, Italy	3
Shen, B.	Donghua University, China	3
Niero, M.	Technical University of Denmark, Denmark	3
Chen, X.	National Research Institute for Environmental Studies, Japan	3
Krystofik, M.	Rochester Institute of Technology, USA	3
Kettunen, O.	VTT Technical Research Centre, Finland	3
Hauschild, M.Z.	Technical University of Denmark, Denmark	3
Rashid, A.	KTH Royal Institute of Technology, Sweden	3
Zhao, F.	Tsinghua University, China	3

It may be noted that Sarkis, Bocken, Geng, and Zhu top the list with at least five or more contributions each. Incidentally, Sarkis, Geng and Zhu have co-authored a few articles together. Bocken appears to the other dominating author who have co-authored a few with Aminoff. Most of the researchers appearing in this list are belong to the field of operations research/management with focus on sustainability and/or environmental engineering. The articles published by these researchers fall under two categories. One set of researchers tend to use management theories and a wide variety of methodologies ranging from sophisticated analytical modeling techniques to broader empirical studies. The other set of scholars are more inclined towards descriptive case studies approaches. In general, the theoretical and methodological approaches of these productive researchers commonly illustrate the interdisciplinary characteristics of the circular economy and supply chain management research.

INSTITUTIONAL CONTRIBUTION

The purpose of conducting institutional contribution analyses of the authors is to identify the top contributing institutions and to understand the geographic spread of the institutions. To conduct these analyses, the institutional affiliations of the authors were extracted from the RIS files and sorted within BibExcel software. The data represented 902 unique authors representing 302 institutions in total. Table 2-6 shows the top contributing institutions by their names and countries whose affiliated authors have collectively contributed at least four or more articles. The list makes important revelations. In comparing this table 2-6 with the top authors productivity table (table 2-5), it was observed that some of the top contributing institutions, namely, Worcester Polytechnic Institute (USA), Lund University (Sweden), JiaoTong University (China), Kunming University of Science & Technology (China), Hong Kong Polytechnic University (Hong Kong), VTT Technical Research Centre (Finland), Tianjin University of Technology (China), and Cranfield University (UK), are represented by some of the most productive authors, Sarkis, Bocken, Zhu, Zheng, Lai, Aminoff, Li, and Charnley respectively. However, institutions, such as Delft University of Technology (Netherlands), University of Cambridge (UK), University of São Paulo (Brazil), Dalian University of Technology (China), Purdue University (USA), National Taiwan University (Taiwan) and so on, also have aggressive publication record even though they are not represented by any highly prolific authors. Upon further investigation, it was found that these institutions share a common attribute. They have active research centers for sustainability/sustainable causes, or higher level (masters/doctoral) programs of similar focus or both. For example, Delft University of Technology, Netherlands (TU-Delft, 2018) owns an active research center for electrical sustainable power and an intense doctoral program whose candidates possess strong industry experiences. Prior bibliometric studies in sustainability domain, such as Fahimnia et al. (2015), have claimed that the works of one or two prolific researcher may be the sole reason for an institution to become the top performer. Rather, it may be argued that the reasons for better publication performance of an institution may depend on other factors, such as active participation with industries, educational programs, grants and funding, industry participation, which facilitates their researchers to collectively conduct experiments with real-time data, and thus, make stronger publication records.

Table 2 - 6. The top contributing institutions

Institutions	Freq.	Institutions	Freq.
Delft University of Technology, Netherlands	17	Wuhan University of Technology, China	5
Lund University, Sweden	11	Kunming Univ. of Science & Tech., China	5
Cranfield University, UK	9	Central South University, China	5
University of Cambridge, UK	8	KTH Royal Institute of Technology, Sweden	4
University of São Paulo, Brazil	8	Tsinghua University, China	4
Dalian University of Technology, China	7	JiaoTong University, China	4
University of Manchester, UK	7	China University of Geosciences, China	4
London South Bank University, UK	7	National Taiwan University, Taiwan	4
Hong Kong Polytechnic University, China	6	Donghua University, China	4
Politecnico di Milano, Italy	6	Wageningen University, Netherlands	4
Technical University of Denmark, Denmark	6	VTT Technical Research Centre, Finland	4
Purdue University, USA	6	Utrecht University, Netherlands	4
Worcester Polytechnic Institute, USA	6	Yale University, USA	4

In the next step, the locations (i.e., city names with country) of each affiliation were extracted in Bibexcel and geocoded using GPSVisualizer.com, an open-source online mapping utility website, and plotted on Google Maps. Figure 2-2 shows the geographic distribution of all 302 institutions that contributed to circular economy in supply chain literature. The red circles depict the location of the institution and their sizes depict the relative frequency of contributions of each institution. It was clear from this visual map that the field of circular economy in supply chain context attracts institutions across the world, but, more concentrated in Europe, USA and China.

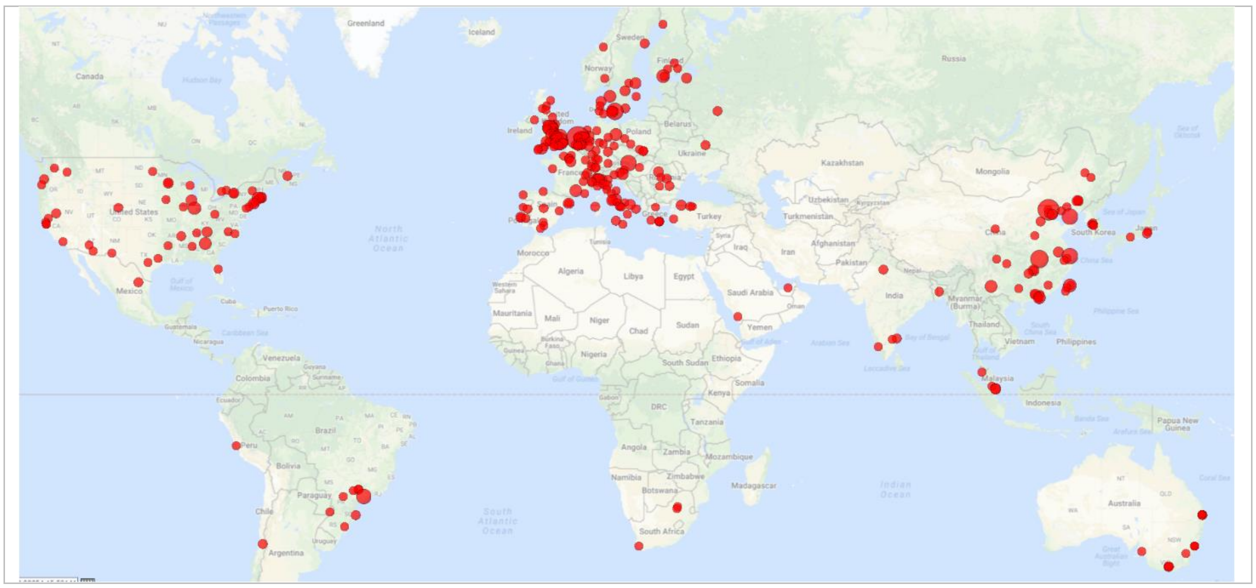

Figure 2 - 2. Geographical locations of (302) organizations represented by (928) contributing authors

To analyze the geographic distribution more precisely, the globe is divided into different geographic regions using references drawn from geopolitical categorizations of United Nations (https://unstats.un.org/unsd/methodology/m49/) and U.S. Department of Homeland Security (https://www.dhs.gov/geographic-regions). Table 2-7 shows the break-down of all 302 institutions per region to this growing body of research within supply chain management. It must be noted that geographic distribution analysis records an article being co-authored by researchers from multiple institutions into multiple regions. Figure 2-3 shows the percentage chart of contributions by institutions based on their geographical regions.

Table 2 - 7. Contribution of institutions based on their geographical regions

Geographic region	Institution Authorships (%)
Europe	178 (59%)
North America	48 (16%)
East Asia	41 (14%)
Oceania	10 (3%)
South America	8 (3%)
Southeast Asia	8 (3%)
Middle East	6 (2%)
Africa	3 (2%)
Total	302 (100%)

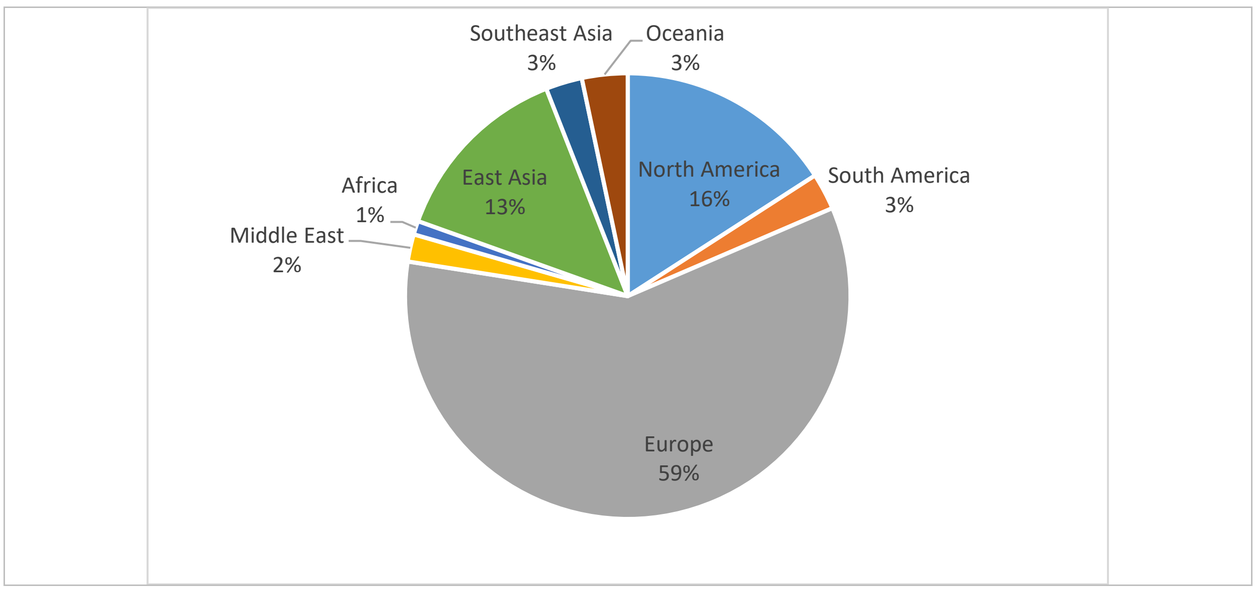

Figure 2 - 3. Percentage chart of contributions by institutions based on their geographical regions

KEYWORDS AND HOT TOPIC TREND ANALYSIS

In order to get identify the most frequently used words, terms or phrases, two set of the analysis (i.e., keyword frequency analysis and hot topic trend analysis) are conducted. The keyword frequency analysis was done in Bibexcel by extracting and counting the keywords from article titles and assigned keywords columns drawn from 345 articles independently. Table 2-8 summarizes the list of words with their frequencies that appeared in the article titles of 345 articles, at least six times or more, in the collection of 465 unique words. Table 2-9 summarizes the list of keywords along with their frequencies that appeared as assigned keywords by the authors to their articles, at least five times or more, in the collection of 1,119 unique keywords or phrases. In comparing the two tables, it was found that the words used in the article titles and the keywords by authors are consistent in their rankings. The top two keywords - “circular economy” and “supply chain/s” – are the obviously most prevalent ones in both tables since they reflect the core of the study. However, the other key words that frequented the two lists generates the inquisitiveness about their implications for the growing circularity concept in supply chain context. For example, “industrial economics” is a keyword that has known implications on circular economy within the context of supply chain management, whereas, “value creation” may be an upcoming term in describing circular economy from the supply chain perspective.

Table 2 - 8. The words in article titles at least 6 times or more

Keyword	Freq.	Keyword	Freq.	Keyword	Freq.
Circular economy	130	Food	13	Strategies	8
Supply chain	90	Development	12	Construction	8
Business model(s) / integration / strategies / opport.	46	Reverse	12	Application	8
Sustainable / sustainability	45	China	11	Sector	7
Management	45	Systems	11	Enterprises	7
Green	33	Practices	11	Cost-efficiency	7
Case study	31	Material	11	Technology	7
Industry/Industrial	27	Remanufacturing	11	Reuse	7
Economic	24	Innovation	11	Steel	7
Manufacturing	21	Policy	10	Network	7
Environmental	20	Logistics	10	Future	7
Assessment	19	Integrated	10	Barriers	6

Design	18	Global	9	Service	6
Product(s)	17	Recycling	9	Assessing	6
Waste	17	Production	9	Resource	6
Analysis	16	Closed-loop	9	Concept	6
New	16	Theory	8	Strategy	6
Value	16	Challenges	8	Implementation	6
Approach	16	Transition	8	Recovery	6
Research	15	Exploring	8	Symbiosis	6
Framework	14	Performance	8	Information	6
Life-cycle	14	Fashion	8		
System	14	Chinese	8		

To understand the most promising keywords and their future trends, the hot topic trend analysis is conducted on the list of the keywords by authors. In doing so, the first step involved creating a list of top 20 reoccurring terms by combining both tables and their most current HB indexes (Hirsch, 2005) were extracted from the Web of Science database. In the next step, the M indexes (Banks, 2006) were estimated as the proportional relationship between HB index and the number of years (here, n equals to 19 years, that is the total number of years passed since the first article of the data sample and/or the keyword was published). The proportional relationship is represented as Equation (2).

M ~ HB/n …………………………………………………………………………………… (2)

Table 2 - 9. The keywords assigned by the authors to their articles at least 5 times or more

Author-Keyword	Freq.	Author-Keyword	Freq.
Circular economy (CE)	161	Reuse	14
Supply chain(s)/Supply chain management	97	End of life returns / data management / design strategy / flow / manufacturing	13
Sustainable development / business / consumption / manufacturing / innovation / practices	66	Circular (economy) business model(s)	12

Author-Keyword	Freq.	Author-Keyword	Freq.
Industrial ecology / economics / modeling / symbiosis / wastes / metabolism	60	China	10
Sustainability (analysis / assessment / dimensions / driver / principles / reporting)	55	Forest bioenergy / management / plantation / production	10
Environmental accounting, benefits, costs, demands, footprints, life-cycle, performance, policy, sustainability	53	Global climate / economies / material / reporting / emissions / trade / value-chain / warming	10
Green supply chain / management / practice / risk / virtual enterprises / innovation / chemistry / economy / infrastructure	48	Business model innovation	9
Economic sustainability	35	Product-service systems (PSS)	9
Resource efficiency / management / potential / productivity / recovery / allocation	35	Product design	8
Closed-loop supply chain(s) / manufacturing / economy / system / recycling	34	Waste	8
Business model(s)	28	Manufacture	6
Recycling (systems / products / materials)	28	Waste management	6
Social sustainability / enterprise / entrepreneurship / investment / structures / value creation	26	Agriculture	5
Life cycle assessment (LCA) / costing / development / inventory / thinking	23	Economics	5
Sustainable supply chain(s)	21	LCA	5
Remanufacturing	17	Logistics	5
Reverse logistics	17	Manufacturing	5
Food industry / policy / re-localization / safety / supply / waste / sustainability	15		

Figure 2-4 represents the derived M indexes (Banks, 2006) for the top 20 reoccurring keywords. It can be clearly interpreted that “reverse logistics” and “food waste” have the highest M index estimates and may be considered as the two most recognized topics, and probably, most known and/or adequately researched topics in the stream of interest. On the other hand, the theme of “circular business model” holds the lowest M index estimate of 0.3 and is presently not being considered as a hot topic. Thus, it may also be interpreted that the concept of “circular business model" represents a gap that requires more research to gain adequate understanding in the context of circular economy and supply chain management.

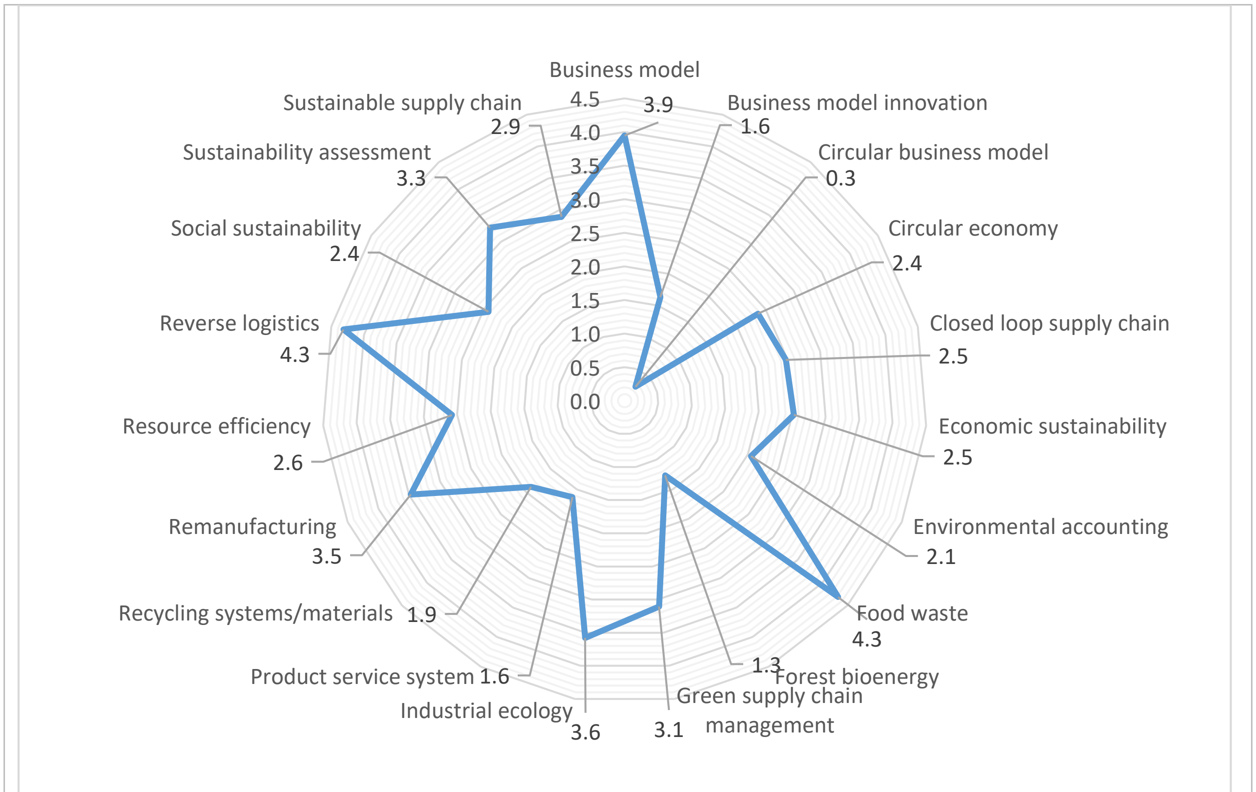

Figure 2 - 4. Hot topics trend map

NETWORK ANALYSIS

This section describes the purpose, the process and types of bibliometric network analyses. The purpose of this network analysis is to "*painting a big picture of scientific knowledge*" (Borner et al., 2003, p. 180) by conducting interactive data-analysis and information visualization of the available bibliographic structures of the selected 345 articles of the sample. Prior to conducting such analysis, it requires two important steps - the construction of network maps and the graphical visualization of such maps (Van Eck & Waltman, 2010). In this case, the network maps were created in Bibexcel and exported as .NET and .corresponding .MAP files. These two files are related and can be expressed as matrix files representing the relationships and networks/maps between citations or phrases initially extracted from Scopus and Web of Science bibliographic data for the selected articles (Pilkington, 2006). Next, the network maps were graphical visualized in VOSviewer (www.vosviewer.com), an open source software for bibliometric network mapping. Apart from VOSviewer, there are a few similar tools, such as Pajek, HistCite Graph Maker, Gephi and so on, each having a varying degree of functionalities and/or rendering capabilities, that can provide a similar output for data analysis and information visualization. The VOSviewer was chosen over others for its easy-to-use interface and interactive high-quality map-making capabilities of the bibliometric network arcs/nodes. Also, VOSviewer can display large bibliometric network maps (i.e., co-citation map of up to 5,000 scientific journals) and interactive clustering of data (Van Eck & Waltman, 2010). To complement the understanding of the selected 345 publication samples, three types of network analyses (i.e., keyword network analysis, citation of publications analysis and co-citation of publications analysis) were conducted.

KEYWORD NETWORK ANALYSIS

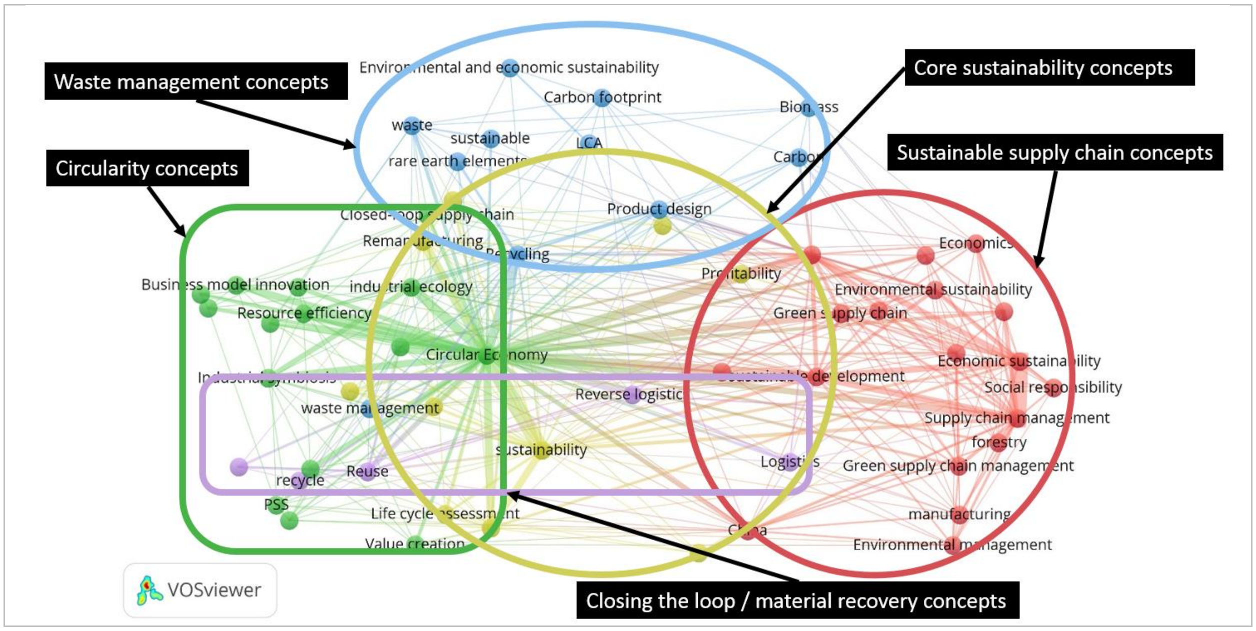

Figure 2 - 5. Keyword network for CE in SCM

The keywords network generated from the pool of 1,119 unique keyword assigned by authors is presented in Figure 2-5. Based on this visual representation, it was found that the keywords may be thematically classified under five groups: (a) circularity concepts representing key concepts for achieving “circular economy”, such as industrial ecology, closed-loop supply chain, resource efficiency, business model innovation, value creation and similar ones; (b) sustainable supply chain concepts corresponding to those themes that result into sustainable forms of supply chains in terms of performance, challenges and outcomes, upon adoption of the “circularity” path. Such themes include environmental sustainability, social responsibility, green supply chain, forestry management, manufacturing management, sustainable development, eco-parks, and even China as a location where such implementations are dominantly seen; (c) core sustainability concepts referring to broader and known themes such as sustainability, life-cycle assessment, remanufacturing and so on. It was interesting to note that this group has the largest spread but least concentrated among the five groups. Indeed, this observation leaves an impression about the state of research, more so, in reflecting that core sustainability concepts are known and well-researched issues, and therefore, do not require further emphasis in discussions related to inclusion of circular economy concepts in supply chain context; (d) material recovery concepts representing those themes that pertain to recovery of material. Such themes include the reuse, recycle, reverse-logistics, and so on. It is evident from the network map that this is an under-researched area in the study context. However, the themes in this group are showing proximity to both "circularity" and "sustainable supply chain" groups, thus indicating about its potential for future area of research as a mediating variable in the relationship between two earlier stated concepts; and (e) waste management concepts representing those themes that speaks about waste management concepts, such as carbon footprint, biomass, rare-earth elements, emission and similar ones. It may be noted that this group shows a significant representation that confirms about its singularity in purpose, but appears to act as a moderator towards the relationship between "circularity" and "sustainable supply chain" concepts. In addition, it was observed that the last two groups (i.e., "material recovery" and "waste management") finds similarity with the seminal framework of adding circularity in business models/production system by Ellen MacArthur Foundation (EMAF, 2013) wherein "material recovery" resembles to the loops for "technical material" recovery and "waste management" resembles the loops for "biological material" recovery into the production system.

In analyzing the strength of the ties between the nodes, varying intensities of the relationships between keywords from all groups were found (Carvalho et al., 2013). To do this, the filtering criteria was fixed at five occurrences per keyword before making interpretations. First and foremost, the network map supports that “circular economy” and “supply chain management” and the two main concepts that are connected to each other through other related concepts directly or indirectly. It was found that the two concepts are connected through “sustainable development”. Also, “profitability” and “economic sustainability” mediates the connection between “circular economy” and “supply chain management”. In addition, it was observed that “recycling”, “reverse logistics” and “product design” are the three most proximal mediators for the relationship between the two main concepts. In another instance, “China” acts as a mediator between the above stated relationship that may be reasoned to the significant record of publications studying performance and issues related to Chinese eco-industrial park.

CITATION ANALYSIS

A citation analysis is a method to measure the relative importance of an article (or an author) by counting the number of times that article (or author) has been cited by other articles. In technical terms, it means an examination of the degree of relatedness between all possible pairs generated from the citations available in the entire sample. At the end, it charts (also, ranks) the most relevant and impactful articles. This analysis was conducted in Bibexcel software.

Table 2-10 lists the 8 major technical reports, and Table 2-11 lists the top 40 scholarly articles based on based on the local citation counts. For the ease of reporting of the industry reports (table 2-11), the individual technical reports released by the agencies were not separately classified, rather, they were grouped as a single agency to create a singular data-point. For example, the publications released between 2013 and 2017 by Ellen MacArthur Foundation were summed up as “EMAF Reports (2013 – 2017)”, which totaled as 95 local citations. “Local citation” is the count of citations that an article has been cited by other papers in the 345 node network. In addition, the “global citation” counts were extracted for the listed set of scholarly articles from Scopus database.

Table 2 - 10. Top 8 industry reports ranked by local citation measure

Authors (Year)	Article Title	Journal/Source	Local citation	Global citation	Yearly average citation
EC Reports (2000-17)	European Commission Releases	EU Science Hub (https://ec.europa.eu/jrc/en)	95	-	-
EMAF Reports (2013-17)	Ellen MacArthur Foundation Publications	https://www.ellenmacarthur foundation.org/publications	76	-	-
Brundtland Commission (1987)	Presentation of the Report of the World Commission on Environment and Development to UNEP’s 14th Governing Council Session. June 8, 1987, Nairobi, Kenya	World Commission on Environment and Development	26	2957	95.39
UN Reports (1992 - 2016)	United Nations Department of Economic and Social Affairs (UNDESA)	Sustainable Development Knowledge Platform (https://sustainabledevelopment.un.org/)	24	-	-
OECD Reports (1997-2016)	Organization for Economic Co-operation and Development Publications	http://www.oecd-ilibrary.org/	15	-	-
World Economic Forum (2010-15)	Global Competitiveness Reports	https://www.weforum.org /reports/global-competitiveness -report-2014-2015	15	-	-
US Reports (2000-16)	United States Government Releases	www.USA.gov	12	-	-
WRAP (2006-17)	Waste & Resources Action Programme (WRAP) Releases	WRAP (http://www.wrap.org.uk/ category/what-we-offer/reports)	10	-	-

Much of the credit in progressing thoughts/application of circular economy principles in today's supply chains can be attributed to the industrial/government agencies listed in Table 2-10. The EC Reports cited in the study sample are related to the sustainable development policies of the European Union members. In a similar vein, the Ellen MacArthur Foundation, since established in 2010, has relentless focused on accelerating the circularity wheel for businesses and governments. The EMAF reports present several frameworks for adopting/transitioning to circular economy model that has been challenged or propagated for empirical examination by other scholars. The Brundtland Commission report (1987), popularly known as World Commission on Environment and Development's (WCED) "*A global agenda for change*" is ground-breaking policy framework that defines shared perceptions of long-term environmental issues, suggests methods for developing/developed countries to co-operate, and proposes long-term environmental strategies for sustainable development. This report is no less than a seminal consideration for scholars in making arguments favorable/against their research goals. Correspondingly, UN Reports (1992 - 2016), OECD Reports (1997-2016), World Economic Forum (2010-15), US Reports (2000-16) and WRAP (2006-17) are the notable ones that acts as policy references to make the argument of circularity stronger in supply chain management.

Table 2 - 11. Top 40 scholarly articles ranked by local citation measure

Authors (Year)	Article Title	Journal/Source	Local citation	Global citation	Yearly average citation
McDonough W., Braungart M., (2002)	Cradle to cradle: Remaking the way we make things	North Point Press	37	5082	317.63
Ghisellini P., Cialani C., Ulgiati S., (2016)	A review on circular economy: the expected transition to a balanced	Journal of Cleaner Production	34	371	185.50

Authors (Year)	Article Title	Journal/Source	Local citation	Global citation	Yearly average citation
	interplay of environmental and economic systems				
Bocken N.M.P., Short S., Rana P., Evans S., (2014)	A literature and practice review to develop sustainable business model archetypes	Journal of Cleaner Production	27	667	166.75
Tukker A., (2015)	Product services for a resource-efficient and circular economy – a review	Journal of Cleaner Production	27	374	124.67
Yin R.K., (1994)	Case study research: Design and Methods	Sage Publications, London	27	2665	111.04
Lieder M., Rashid A., (2016)	Towards circular economy implementation: a comprehensive review in context of manufacturing industry	Journal of Cleaner Production	24	184	92.00
Yuan Z., Bi J., Moriguichi Y., (2006)	The circular economy: A new development strategy in China	Journal of Industrial Ecology	24	379	31.58
Seuring S., Müller M., (2008a)	From a literature review to a conceptual framework for sustainable supply chain management	Journal of Cleaner Production	23	2972	297.20
Bocken N.M.P., de Pauw I., Bakker C., van der Grinten B., (2016)	Product design and business model strategies for a circular economy	Journal of Industrial and Production Engineering	19	132	66.00
Andersen M.S., (2007)	An introductory note on the environmental economics of the circular economy	Sustainability Science	18	236	21.45
Bakker C., Wang F., Huisman J., Den Hollander M., (2014)	Products that go round: exploring product life extension through design	Journal of Cleaner Production	18	151	37.75

Authors (Year)	Article Title	Journal/Source	Local citation	Global citation	Yearly average citation
Osterwalder A., Pigneur Y., (2010)	Business model generation: a handbook for visionaries, game changers, and challengers	John Wiley & Sons	18	5638	704.75
Tukker A., (2004)	Eight types of product–service system: eight ways to sustainability? Experiences from SusProNet	Business strategy and the environment	18	1345	96.07
Chertow M.R., (2000)	INDUSTRIAL SYMBIOSIS: Literature and Taxonomy	Annual review of energy and the environment	16	1193	66.28
Lewandowski M., (2016)	Designing the business models for circular economy—Towards the conceptual framework	Sustainability	16	83	41.50
Mont O.K., (2002)	Clarifying the concept of product–service system	Journal of Cleaner Production	16	1659	103.69
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	16	232	46.40
Elkington J., (1998)	Cannibals with forks: the triple bottom line of twenty-first century business	Oxford	15	164	7.81
Geng Y., Doberstein B., (2008)	Developing the circular economy in China: Challenges and opportunities for achieving 'leapfrog development'	International Journal of Sustainable Development and World Ecology	15	224	22.40
Pearce D.W., Turner R.K., (1990)	Economics of natural resources and the environment	JHU Press	15	5142	183.64
Sarkis J., Zhu Q., Lai K.H., (2011)	An organizational theoretic review of green supply chain management literature	International Journal of Production Economics	15	1024	93.09

Authors (Year)	Article Title	Journal/Source	Local citation	Global citation	Yearly average citation
Carter C.R., Rogers D.S., (2008)	A framework of sustainable supply chain management: moving toward new theory	International Journal of Physical Distribution & Logistics Management	14	2135	213.50
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	14	184	30.67
Allwood J.M., Ashby M.F., Gutowski T.G., Worrell E., (2011)	Material efficiency: A white paper	Resources, Conservation and Recycling	13	396	56.57
Boons F., Lüdeke-Freund F., (2013)	Business models for sustainable innovation: state-of-the-art and steps towards a research agenda	Journal of Cleaner Production	13	724	144.80
Braungart M., McDonough W., Bollinger A., (2007)	Cradle-to-cradle design: creating healthy emissions–a strategy for eco-effective product and system design	Journal of Cleaner Production	13	561	51.00
Frosch R.A., Gallopoulos N.E., (1989)	Strategies for manufacturing	Scientific American	13	1922	66.28
Hart S.L., (1995)	A natural-resource-based view of the firm	Academy of Management Review	13	5284	220.17
Zumwinkel K., Stuchtey M.R., (2015)	Growth within: a circular economy vision for a competitive Europe	Ellen MacArthur Foundation	13	21	7.00
Hatcher G.D., Ijomah W.L., Windmill J.F.C., (2011)	Design for remanufacture: a literature review and future research needs	Journal of Cleaner Production	12	198	28.29
Linton J.D., Klassen R., Jayaraman V., (2007)	Sustainable supply chains: An introduction	Journal of Operations Management	12	1342	122.00

Authors (Year)	Article Title	Journal/Source	Local citation	Global citation	Yearly average citation
Östlin J., Sundin E., Björkman M., (2008)	Importance of closed-loop supply chain relationships for product remanufacturing	International Journal of Production Economics	12	249	24.90
Preston F., (2012)	A Global Redesign?: Shaping the Circular Economy	London: Chatham House	12	156	26.00
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	12	132	16.50
Stahel W.R., (2010)	The performance economy	Springer	11	279	34.88
Tukker A., Tischner U., (2006)	Product-services as a research field: past, present and future. Reflections from a decade of research	Journal of Cleaner Production	11	687	57.25
Zhu Q., Sarkis J., Geng Y., (2005)	Green supply chain management in China: pressures, practices and performance	International Journal of Operations & Production Management	11	922	70.92
Boulding K., (1966)	The economics of the coming spaceship earth	Environmental Quality Issues in a Growing Economies	10	2975	57.21
Chertow M.R., Ehrenfeld J., (2012)	Organizing Self-Organizing Systems	Journal of Industrial Ecology	10	222	27.75
Chesbrough H., (2010)	Business model innovation: opportunities and barriers	Long Range Planning	10	2374	296.75
Eisenhardt K.M., (1989)	Building theories from case study research	Academy of Management Review	10	45670	1574.83
Genovese A., Acquaye A.A., Figueroa A., Koh S.C.L., (2017)	Sustainable supply chain management and the transition towards a circular economy:	Omega	10	88	88.00

Authors (Year)	Article Title	Journal/Source	Local citation	Global citation	Yearly average citation
	Evidence and some applications				
Srivastava S.K., (2007)	Green supply-chain management: a state-of-the-art literature review	International Journal of Management Reviews	10	2734	248.55

A closer look at the articles listed in Table 2-11 reveals that the patterns of citation and global citation values per article vary significantly. In other words, the ranking the articles by local citation and the same by global citation would differ significantly. This indicates that the articles that hold a greater global citation value attracts researchers from other fields too. For example, Pearce & Turner (1990) ranks 20th by local citation counts, but would rank in the top 5 if ranked by global citation counts (5,142). This is clear evidence for Pearce & Turner (1990) to be an important consideration for researchers, such as agriculture, which is totally unrelated to the concept of circular economy in supply chains. Similar other articles include Yin (1994) and Eisenhardt (1989) as these two papers are valued for their guidance about case-based methodical approaches in conducting inductive studies that applies to other research areas too.

Another interesting observation seen in table 2-12 when compared with author productivity table (table 2-4) is about the representation of authors in both lists. Only 8 of the 25 most productive authors (table 2-4) have their articles listed in the top 40 most influential scholarly articles list ranked by local citation (table 2-11). Those authors include Zhu (20 articles), Sarkis (18 articles), Geng (14 articles), Lai (8 articles), Bocken (5 articles), Lieder (3 articles), Rashid (3 articles) and Aminoff (2 articles). Accordingly, it may be appropriate to argue that these eight authors may be considered not only as productive (as per table 2-4), but also, influential (as per table 2-11) in the study context. In addition, it was found that four authors represent European institutions, three authors represent Chinese institutions, and one author represents US institution. This finding agrees with earlier observation about the geographic distribution of institutional contributions (Table 2-7). One reason that explains why other productive authors did not appear in this citation list may be attributed to the newness of the circularity concept in supply chain management. As a thumb rule, it takes several years for articles to earn enough citations, unless, the article embraces sufficient seminal value in term of content, context or both. This is apparent from the fact that only six out of forty articles that appeared as most cited were published in last three years. As a matter of fact, these six articles belong to "review" typology of scholarly studies. The articles include Ghisellini et al. (2016), Tukker (2015), Bocken et al. (2016), Lewandowski (2016), Genovese et al. (2017) and Zumwinkel & Stuchtey (2015). A major disadvantage about citation analysis based on local citation is that it does not capture the more recent papers articles since they have not yet been sufficiently cited by other articles in the sample. However, this disadvantage can be neutralized to some extent by converting the "global citation" counts into "yearly average citation" (i.e. global citation counts of the article divided by the number of years since published) and re-rank them. In the re-ranking analysis, it was found that twelve articles still maintained their position in the upper half of table, thus allowing eight articles from the lower part to move up the rank order. Of which, four articles were published in 2015 or later. This new re-ranking revealed that McDonough & Braungart (2002) and Seuring & Muller (2008a) are the most influential articles directly related to the study context.

CO-CITATION ANALYSIS

In a bibliometric study, co-citation analysis is the method to structurally detect the homogenous parts of the study network (Zitt & Bassecoulard, 1996). It involves counting of the number of times a pair of articles (or authors) are cited jointly in the study network with the aim of identifying clusters of closely related articles (or authors), where each cluster may represent a "type" with the study network (Price, 1965). This follows the logic that a pair of articles (or authors) are cited together by others only when both pair members are closely related to each other by their study content/context. While this relatedness guarantees that the pair of articles (or authors) may be addressing the same broad questions, but not necessarily be agreeing with each other (Acedo et al., 2006). These co-citation counts are then statistically analyzed, and represented in the form of a co-citation network map based on the relative distances between all the articles (or authors) in the study network. Further in-depth analysis of the articles delineated by clusters provides an objective understanding of the field's state of diffusion, its main trends, and its linkages within the clusters (Small & Griffith, 1974).

While the appropriateness to use articles or authors is still arguably inconclusive (White & Griffith, 1981; Culnan, 1986), the study appeared more appropriate to use articles instead of authors, since the goal is to identify the intellectual structures by their specificities and not by interests of the authors. In this case, a co-citation analysis based on authors may produce misleading patterns if some authors have studied different themes within the study scope (Garfield, 1979, Acedo et al., 2006). The co-citation analysis also assumes that the most cited papers of the sample as the relevancy criteria for forming the core of the study. In this case, it may be intuitively derived that there are two cores, the circular economy and the supply chain management, since the study makes an effort to bibliometrically review the relationship between circular economy and supply chain management. However, this assumption about "more citations as relevant" suffers from two limitations. First, it would favor older highly cited articles and overlook more recent articles that may be more impactful in explaining the field's newer trend. Second, although the analysis does not include journals in its co-citation counting consideration, it is well known fact that some journals are considered more reliable, and hence articles from those journals are cited more than other journal. This may be incorporate unexpected journal biases to the overall results. These two limitations may, however, be restricted through consultation with domain experts (Culnan, 1986). The sample of 345 articles extracted a total of 9543 unique documents (cited articles). Of which, 1374 documents (14%) were cited two times or more. To increase the effectiveness in the citation analysis, a filtering criterion of 10 counts of citations (total link strength) or more was used to recreate a 191-nodes with 6295-edges network. Accordingly, the co-citation network topologies (.NET file) were generated in Bibexcel, which were then processed in VOSviewer to create co-citation network clusters. Three variants of co-citation analyses (i.e., cluster analysis, joint author-cluster analysis and dynamic co-citation analysis) were conducted with the article network to assert objectivity in the findings.

Co-citation clustering analysis

In bibliometric network analysis, co-citation mapping and clustering is often used to classify main topics (clusters) within a specific scientific domain, and to understand how these topics (clusters) related to each other. In addition, it also guides in explicating how the scientific domain has evolved over time (Waltman et al., 2010). As stated earlier, the VOSviewer software was deployed as the main toolset for co-citation analyses. VOSviewer uses a unified approach for mapping and clustering. This approach enhances the interactivity and transparency while conducting this analysis, thus helps in avoiding unwanted technical complexity (Van Eck & Waltman, 2010). The clustering technique in VOSviewer is based on a weighted and parameterized variant of the well-known modularity algorithm originally developed by Newman & Girvan (2004).

The co-citation matrix file (.NET file) created from the filtered 191-node network was loaded in VOSviewer to conduct the co-citation cluster analysis. Five clusters were created. Each cluster contained articles ranging from 20 articles in the smallest cluster (cluster 5) to 57 articles in the largest cluster (cluster 1). Figure 2-6 shows the final version of the co-citation map with the five clusters being represented in five different colors.

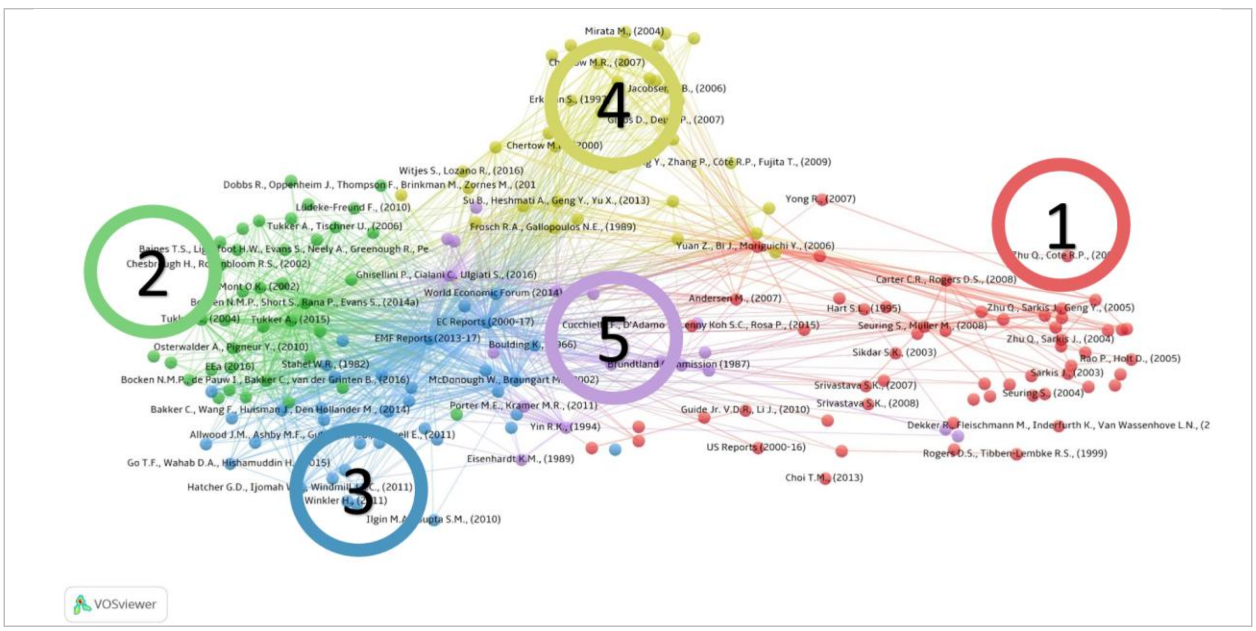

Figure 2 - 6. The co-citation network of five clusters

This co-citation network presents the big picture of the state of circular economy within supply chain management domain. The clusters represent the “school of thoughts” based on how the articles are cited together within each cluster and in the entire network (Leydesdorff, 2011). Table 2-12 presents the break-down of articles per cluster from the co-citation network (Figure 2-6).

Table 2 - 12. Articles in each cluster (co-citation network analysis)

Cluster 1	**Cites**	**Cluster 3**	**Cites**
Yuan Z., Bi J., Moriguichi Y., (2006)	24	EC Reports (2000-17)	95
Seuring S., Müller M., (2008a)	23	EMAF Reports (2013-17)	76
Andersen M.S., (2007)	18	McDonough W., Braungart M., (2002)	37
Zhu Q., Sarkis J., Lai K.H., (2007)	15	Lieder M., Rashid A., (2016)	24
Carter C.R., Rogers D.S., (2008)	14	Bakker C., Wang F., Huisman J., Den Hollander M., (2014)	18
Hart S.L., (1995)	13	World Economic Forum (2014)	15
Linton J.D., Klassen R., Jayaraman V., (2007)	12	Allwood J.M., Ashby M.F., Gutowski T.G., Worrell E., (2011)	13
US Reports (2000-16)	12	Braungart M., McDonough W., Bollinger A., (2007)	13
Zhu Q., Geng Y., Lai K.H., (2010)	12	MacArthur E., Zumwinkel K., Stuchtey M.R., (2015)	13
Zhu Q., Sarkis J., Geng Y., (2005)	11	Hatcher G.D., Ijomah W.L., Windmill J.F.C., (2011)	12
Srivastava S.K., (2007)	10	Stahel W.R., (2010)	11
Guide Jr. V.D.R., Van Wassenhove L.N., (2009)	9	Boulding K., (1966)	10
Kleindorfer P.R., Singhal K., Van Wassenhove L.N., (2005)	9	WRAP (2006-17)	10
Sarkis J., (2003)	9	Benyus J.M., (1997)	9
Seuring S., (2004)	9	Graedel T.E., Allenby B.R., (1995)	9
Thierry M., Salomon M., van Nunen J., van Wassenhove L.n (1995)	9	Bakker C., Den Hollander M., Van Hinte E., Zijlstra Y., (2014)	8
Georgiadis P., Besiou M., (2008)	8	Pauli G., (2010)	7
Rao P., Holt D., (2005)	8	Rashid A., Asif F.M.A., Krajnik P., Nicolescu C.M., (2013)	7
Zhu Q., Sarkis J., (2004)	8	Boons F., Montalvo C., Quist J., Wagner M., (2013)	6
Ahi P., Searcy C., (2013)	7	Go T.F., Wahab D.A., Hishamuddin H., (2015)	6
Beamon B.M., (1999)	7	Ijomah W.L., McMahon C.A., Hammond G.P., Newman S.T., (2007)	6

Cucchiella F., D'Adamo I., Lenny Koh S.C., Rosa P., (2015)	7	Lacy P., Rutqvist J., (2015)	6
French M.L., Laforge R.L., (2006)	7	Lyle J.T., (1994)	6
Liu Q., Li H.m., Zuo X.l., Zhang F.f., Wang L., (2009)	7	Mirabella N., Castellani V., Sala S., (2014)	6
Matos S., Hall J., (2007)	7	Stahel W.R., (1997)	6
Michaud C., Llerena D., (2011)	7	Wells P., Seitz M., (2005)	6
Rogers D.S., Tibben-Lembke R.S., (1999)	7	Winkler H., (2011)	6
Rogers D.S., Tibben-Lembke R.S., (2002)	7	Allwood J.M., (2014)	5
Vachon S., Klassen R.D., (2006)	7	Binnemans K., Jones P.T., Blanpain B., Van Gerven T., Yang Y., Walton A., Buchert M., (2013)	5
Zhu Q., Sarkis J., Lai K.H., (2012)	7	Hawken P., Lovins A., Lovins L.H., (1999)	5
Ageron B., Gunasekaran A., Spalanzani A., (2012)	6	Ilgin M.A., Gupta S.M., (2010)	5
Carter C.R., Easton P.L., (2011)	6	Jackson T., (2009)	5
Choi T.M., (2013)	6	Ongondo F.O., Williams I.D., Cherrett T.J., (2011)	5
Dekker R., Fleischmann M., Inderfurth K., Van Wassenhove L.N., (2004)	6	Parfitt J., Barthel M., MacNaughton S., (2010)	5
Guide Jr. V.D.R., Li J., (2010)	6	Reuter M.A., Hudson C., Van Schaik A., Heiskanen K., Meskers C., Hagelüken C., (2013)	5
Lai K.H., Cheng T.C.E., Tang A.K.Y., (2010)	6	Stahel W.R., (1982)	5
Sarkis J., Zhu Q., Lai K.H., (2011)	6	Stahel W.R., (2013)	5
Srivastava S.K., (2008)	6	Stahel W.R., Reday-Mulvey G., (1981)	5
Zhu Q., Geng Y., (2001)	6	**Cluster 4**	**Cites**
Zhu Q., Sarkis J., (2006)	6	Chertow M.R., (2000)	16
Barney J., (1991)	5	Su B., Heshmati A., Geng Y., Yu X., (2013)	16
Blackburn J.D., Guide Jr. V.D.R., Souza G.C., Van Wassenhove L.N., (2004)	5	Geng Y., Doberstein B., (2008)	15
Chen I.J., Paulraj A., (2004)	5	Geng Y., Fu J., Sarkis J., Xue B., (2012)	14
Geyer R., Jackson T., (2004)	5	Frosch R.A., Gallopoulos N.E., (1989)	13
Guinée J.B., (2002)	5	Preston F., (2012)	12
Hair J.F., Anderson R.E., Tatham R.L., Black W.C., (1995)	5	Chertow M.R., Ehrenfeld J., (2012)	10

Krikke H., Le Blanc I., Van De Velde S., (2004)	5	Genovese A., Acquaye A.A., Figueroa A., Koh S.C.L., (2017)	10
Miller R.E., Blair P.D., (2009)	5	Chertow M.R., (2007)	9
Pagell M., Wu Z., (2009)	5	Jacobsen N.B., (2006)	9
Prahinski C., Kocabasoglu C., (2006)	5	Mathews J.A., Tan H., (2011)	9
Savaskan R.C., Bhattacharya S., Van Wassenhove L.N., (2004)	5	Ashton W.S., (2008)	8
Seuring S., (2013)	5	Ehrenfeld J., Gertler N., (1997)	8
Shrivastava P., (1995)	5	Geng Y., Zhu Q., Doberstein B., Fujita T., (2009)	8
Walton S.V., Handfield R.B., Melnyk S.A., (1998)	5	Gibbs D., Deutz P., (2007)	8
Yong R., (2007)	5	Moriguchi Y., (2007)	8
Zhu Q., Cote R.P., (2004)	5	Gregson N., Crang M., Fuller S., Holmes H., (2015)	7
Zhu Q., Sarkis J., (2007)	5	Chertow M.R., Lombardi D.R., (2005)	6
Cluster 2	**Cites**	Erkman S., (1997)	6
Baines T.S., Lightfoot H.W., Evans S., Neely A., Greenough R., Peppard J., Roy R., Shehab E., Braganza A., Tiwari A., Alcock J.R., Angus J.P., Basti M., Cousens A., Irving P., Johnson M., Kingston J., Lockett H., Martinez V., Michele P., Tranfield D., Walton I.M., Wilson H., (2007)	7	Mirata M., (2004)	6
Bocken N.M.P., Short S., Rana P., Evans S., (2014)	27	Peck D., Kandachar P., Tempelman E., (2015)	6
Tukker A., (2015)	27	Van Berkel R., Fujita T., Hashimoto S., Geng Y., (2009)	6
Bocken N.M.P., de Pauw I., Bakker C., van der Grinten B., (2016)	19	Witjes S., Lozano R., (2016)	6
Osterwalder A., Pigneur Y., (2010)	18	Wu H.Q., Shi Y., Xia Q., Zhu W.D., (2014)	6
Tukker A., (2004)	18	Geng Y., Zhang P., Côté R.P., Fujita T., (2009)	5
Lewandowski M., (2016)	16	Haas W., Krausmann F., Wiedenhofer D., Heinz M., (2015)	5
Mont O.K., (2002)	16	Heeres R.R., Vermeulen W.J.V., De Walle F.B., (2004)	5
Boons F., Lüdeke-Freund F., (2013)	13	Jiao W., Boons F., (2014)	5
Linder M., Williander M., (2017)	13	Korhonen J., (2001)	5

Östlin J., Sundin E., Björkman M., (2008)	12	Ma S.H., Wen Z.G., Chen J.N., Wen Z.C., (2014)	5
Tukker A., Tischner U., (2006)	11	Mirata M., Emtairah T., (2005)	5
Chesbrough H., (2010)	10	Park H.S., Rene E.R., Choi S.M., Chiu A.S.F., (2008)	5
Scheepens A.E., Vogtländer J.G., Brezet J.C., (2016)	9	Sterr T., Ott T., (2004)	5
Stubbs W., Cocklin C., (2008)	9	Van Beers D., Corder G., Bossilkov A., Van Berkel R., (2007)	5
Teece D.J., (2010)	9	Zhijun F., Nailing Y., (2007)	5
Zott C., Amit R., Massa L., (2011)	9	Zhu Q., Lowe E.A., Wei Y.A., Barnes D., (2007)	5
EEA (2016)	7	**Cluster 5**	**Cites**
Moreno M., De los Rios C., Rowe Z., Charnley F., (2016)	7	Ghisellini P., Cialani C., Ulgiati S., (2016)	34
Chesbrough H., Rosenbloom R.S., (2002)	6	Yin R.K., (1994)	27
Govindan K., Soleimani H., Kannan D., (2015)	6	Brundtland Commission (1987)	26
Lüdeke-Freund F., (2010)	6	UN Reports (1992 - 2016)	24
Magretta J., (2002)	6	Elkington J., (1998)	15
Mont O., Dalhammar C., Jacobsson N., (2006)	6	Pearce D.W., Turner R.K., (1990)	15
Osterwalder A., Pigneur Y., Tucci C.L., (2005)	6	OECD Reports (1997-2016)	15
Planing P., (2015)	6	Eisenhardt K.M., (1989)	10
Vezzoli C., Ceschin F., Diehl J.C., Kohtala C., (2015)	6	Porter M.E., Kramer M.R., (2011)	9
Besch K., (2005)	5	Geissdoerfer M., Savaget P., Bocken N.M.P., Hultink E.J., (2017)	8
Dobbs R., Oppenheim J., Thompson F., Brinkman M., Zornes M., (2011)	5	Dyllick T., Hockerts K., (2002)	7
Elia V., Gnoni M.G., Tornese F., (2017)	5	Eisenhardt K.M., Graebner M.E., (2007)	6
Fletcher K., (2008)	5	Freeman R.E., (1984)	6
Goedkoop M.J., Van Halen C.J.G., Te Riele H.R.M., Rommens P.J.M., (1999)	5	Sikdar S.K., (2003)	6
Zott C., Amit R., (2010)	5	Hopwood B., Mellor M., O'Brien G., (2005)	5
Lovins A.B., Lovins L.H., Hawken P., (1999)	5	Meadows D.H., (1972)	5

Reim W., Parida V., Örtqvist D., (2015)	5	Murray A., Skene K., Haynes K., (2017)	5
Sauvé S., Bernard S., Sloan P., (2016)	5	Porter M.E., Kramer M.R., (2006)	5
Schaltegger S., Lüdeke-Freund F., Hansen E.G., (2012)	5	Smol M., Kulczycka J., Henclik A., Gorazda K., Wzorek Z., (2015)	5
Winans K., Kendall A., Deng H., (2017)	5	Lee D.H., (2016)	5

In the next step, the content analysis is conducted to analyze the contribution of each article in terms of purpose, research question, key findings, and research methods. This exercise allows for characterization (i.e., labeling of research focus) from the available themes for each cluster. Table 2-13 presents the areas of research focus for each of the five clusters.

Table 2 - 13. The five major research clusters and their areas of research focus

Cluster	**No. of papers**	**Area of research focus**
1	57	Empirical evidences of strategies and efforts of the circular economy (CE), closed-loop supply chains, green, product-service system and sustainability practices to achieve sustainable supply chain management (SSCM).
2	39	Scholarly conceptualizations for applying circularity, sustainable, product-service systems, closed-loop supply chain-based business models (BM) into practice, and their barriers/facilitators. Also, includes core BM papers.
3	38	Industrial policy-making and public awareness structures supporting new/conceptual CE elements, designs, strategies. E.g., EMAF Reports, EC Reports.
4	36	Prescriptive approaches for problem solving using mathematical modeling and optimization.
5	20	Conceptual/theoretical foundations, sense-making, and skeletal basing to develop CE and sustainability researches. E.g., Brundtland Commission (1987), Porter & Kramer (2011).

The summarized classifications of the research topics in Table 2-13 presents the research in circular economy in supply chain management is currently passing through an interesting cross-section. It was found that most of the scholarly conceptualizations of applying circularity conceptualization (cluster 2) requires to lean upon industrial/policy-making/public-awareness structures of circular economy models (cluster 3) in presenting its viability and relevance to improve as environmental, social and economic performance of supply chains. The cluster 2 represents those conceptual designing, planning, business modeling, and supporting attributes as antecedents that policy-making structures (cluster 3) have not appropriately clarified in making recommendations for sustainable supply chains. However, an interesting cluster (cluster 4) composed of prescriptive articles (e.g., mathematical modeling) was found that seems intricately connected with sustainable supply chains (cluster 1) and policy-making structures (cluster 3). This may be interpreted as a practice-focused stream that efforts to develop its reputation an independent prescriptive stream, far from the core supply chain domain. This finding is quite tangential to some of the recent reviews that suggests lack of normative, prescriptive and quantitative modeling efforts that enriches applicability of circular economy model in driving sustainability (Seuring, 2013; Masi et al., 2017). Additionally, it was observed that new strategic concepts within cluster 2, such as circular economy business models (Bocken et al., 2014; Planing, 2015; Lewandowski, 2016), have earned enough recognition in terms of industrial and policy relevance, but, require more attention in terms of sense-making, prescriptive, and empirical validations. This insight about the relationship between cluster 1 and 2 is so important that it call for additional research of both scholarly and practical importance that may drive and convince scholars, business and policy-makers about the benefits of adding circularities in their supply chains. Finally, it was not very surprising to find that the central core of the co-citation network was taken by a set of articles (cluster 5), which sustainability researchers do not oversight while making theoretical arguments, sense-making, or skeletal basing in defining circularity argument for sustainable supply chain. Some of the noticeable ones in this cluster 5 include Brundtland Commission, 1987; Yin, 1994; Eisenhardt, 1989; Porter & Kramer, 2011. The logic of sense-making also explains why cluster five overlaps with other seemingly delineated four clusters.

Joint author-cluster analysis

The purpose of the joint author-cluster analysis is to understand how authors influence and contribution in different themes of the research area. To a great extent it speaks about the richness of each cluster by reflecting how authors collaborate across clusters to conduct their research studies. It is measured by counting the number of articles that authors of the lead co-cited articles have published in each of the identified clusters (i.e., themes). Table 2-14 presents the lead authors and their contributions in each of the five clusters of the research study. It may be noticed that some of the lead authors (i.e., Geng and Zhu) in cluster 1 (sustainable supply chain management) have also contributed in clusters 4 (prescriptive circularity), but not in other clusters. This indicates about similarities between cluster 1 and 4 in terms of their research variables, empirical methods or data context, but also speaks about its overall disjointedness with other related clusters. For example, Sarkis is an ardent operation management/supply chain professional who is frequently seen as a co-author in articles first-authored by Geng and/or Zhu whose are more oriented towards operations modelling. However, it was also noticed that lead authors in cluster 2 (circular economy concepts) restrict themselves to the same cluster. These two observations reflect in togetherness that the field needs more research to demonstrate the fruitfulness of adding circularity in supply chain management.

Table 2 - 14. Joint author-cluster analysis (at least three contributions per author)

Author	Counts of articles contributed per cluster					
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Total
Zhu, Q.	10			2		12
Geng, Y.	3			6		9
Sarkis, J.	8					8
Van Wassenhove, L.N.	6					6
Lai, K.H.	5					5
Stahel, W.R.			5			5
Chertow, M.R.				4		4
Guide Jr., V.D.R.	3					3
Rogers, D.S.	3					3
Seuring, S.	3					3
Lüdeke-Freund, F.		3				3
Tukker, A.		3				3
Fujita, T.				3		3
Bocken, N.M.P.		2			1	3
Bakker, C.		1	2			3
Boons, F.		1	1	1		3

Dynamic co-citation analysis

A dynamic co-citation brings objectivity to the inherent problem of “immediacy” concerns that a bibliometric study would generally face (Acedo et al., 2006). Immediacy is related to identification of patterns to conservatively label themes (clusters) as promising and/or recurrent research topics, which is solely based on the trends of citations that a set of articles have gathered over a time span (Zitt & Bassecoulard, 1996). To help understand how the notion of circularity in supply chains research has evolved over time, a dynamic co-citation analysis was conducted over the articles of the five clusters in the study.

Table 2-15 presents the publication record of the articles in each cluster over years (>= 2000, 2001-2005, 2006-2010, 2011-2015 and 2016 – present). In comparing the two prime clusters, namely conceptual circularity (cluster 1) and sustainable supply chains (cluster 2), it is not very surprising to see that the field is still evolving by playing a balancing role between the two clusters. Nevertheless, it also provides enough cues about the growing dominance of cluster 2. This in fact reveals that management scholars have not kept enough pace with empirical groundings, while developing the conceptual/theoretical bases about the field, which may be needed to demonstrate its concrete value to scholars, businesses and policy-makers. Rather, production engineering scholars has embraced the field by demonstrating sufficient contribution of high-quality practice-focused modeling research (cluster 4) since early 2000s. Figure 2-7 graphically reinforces these findings by showing the sharp decline of influential publications in cluster 1 starting 2006, when compared with the steady rise of such works cluster 2 and 4. As for cluster 4, it was found that the industrial/policy-making publications showed seasonality trends rather than stability in showing their influence. For example, the influence of the initial Ellen MacArthur report published in 2012 started gaining less citations when follow-up publication appeared in the subsequent years.

Table 2 - 15. Dynamic co-citation – counts of articles per cluster (research areas) over time

Year span	**Counts of articles contributed per cluster**					
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Total
>=2000	9	2	8	4	8	31
2001 - 2005	16	6	4	6	4	36
2006 - 2010	23	11	7	13	2	56
2011 - 2015	9	11	16	11	2	49
2016 - 2018	0	9	3	2	4	18
Total	57	39	38	36	20	

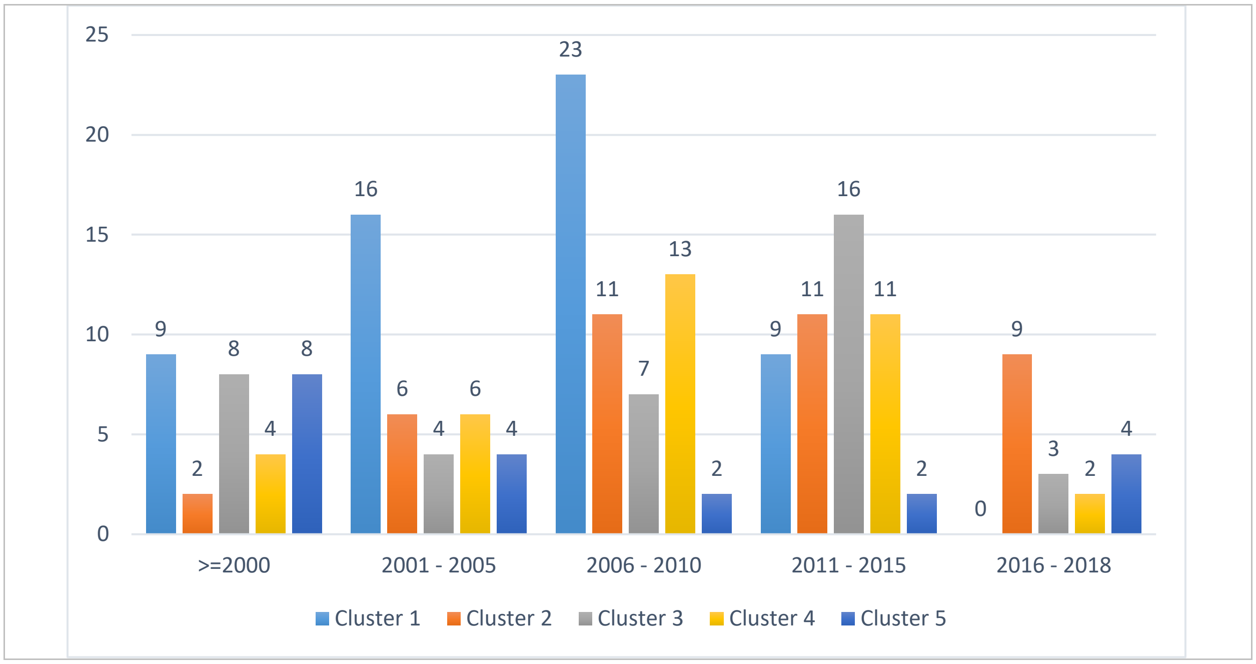

Figure 2 - 7. Dynamic co-citation – evolution of clusters (research areas) over time

CONCLUSION, LIMITATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

This study objectified the state of circular economy research in supply chain management literature. Although several review articles have been published in this area as well as associated areas in the past decade, the sheer lack of a systematic bibliometric and network analysis to objectively identify impactful articles, their authors, their relationships, and their contributions in characterization of research clusters (topical themes) has been a major disadvantage for the scholars, businesses and policy-makers. This study lessens this disadvantage by demonstrating the evolution of the research clusters, and by analyzing how each cluster has contributed to the field by comparing their relationships over time. For example, the study found that a cluster dominated with prescriptive modeling research (cluster 4) embraces conceptualizations of circular economy concepts such as circular business models (cluster 2) and the policy making efforts (cluster 3) more than relying on sustainable supply chain management theme (cluster 1).

This is a clear indication of the fact that circular economy concepts are still far reach from making significantly convincing impressions about its implication in the field of strategic and operations management, even though it has gained complex understanding in terms of prescriptive approaches. One way to reconcile this gap is to use organizational theories, such as contingency theory, as guiding theoretical framework to explore why and how firms may use certain contextual factors to their own advantage to implement circular strategies in their supply chains.

Findings also suggest that a handful of scholars may be considered most prolific based on their co-authorship arrangements in contributing more impactful articles. Yet, as the field appears to be aggressively expanding, some institutions (e.g., TU Delft, Netherlands) appeared have collectively contributed more articles even though they do not possess prolific authors from the field. Moreover, this trend is enough to convincingly argue that sub-disciplines of supply chain management, such as risk management and supply chain resilience, may find interest in the exploring how cyclic thinking may influence their outcomes. While it was expected that prolific works in circular economy themes would be more recent, it was quite surprising to observe that the field of supply chain management slowed down outputting influential works related to circular economy in the last 3-4 years. However, it may also be true that those works have not gained much traction (i.e. citations are yet to accrue) because research works in the field of management and business research a longer than other fields to build reputation.

In addition, findings suggested that the overall impression the notion of circularity in supply chains in more concentrated in Europe and China is partially incorrect. The geographic dispersion of authors did show that Europe presently leads the field, but it also showed that scholars from North America are spotted second and the same from South East Asia (includes China) are closely behind at the third spot. However, it was found that the works by European authors tend to be more conceptual than empirical, whereas, it appeared opposite for Asian authors. As a matter of fact, this reveals about the openness of Asian government policy-makers to adopt circularity concepts in their territories, thus, enable scope for diffusion of the cyclical thinking into Asia and providing opportunities for Asian scholars to conduct empirical studies. A balance between conceptual and empirical studies for all themes (clusters) is much needed for the field to appear more established as it grows with time. Moving forward, this may be an appropriate direction for future research, more so using practical real data and/or modeling. For example, studies need to reflect how those firms that have adopted circularity concepts in full/parts have influence their value-chain partners.

In terms of scholarly research agenda, the study identified more recent articles, their connectedness and their relevance for labeling into categorical clusters. A set of hot-topics were identified that have not been sufficiently researched (such as circular economy business model, product-service system). Future studies may consider these pointers for careful monitoring and studying in associated and sub-disciplinary themes. For example, some of the recent works have focused on identifying supply chain configurations for circular economy, but, the barriers, enablers and challenges of such configurations in implementing sustainable supply chains remains unexplored. Also, the study accounted for an important aspect of including works from scholars, practitioners as well as policy-makers since the field of sustainability research needs "transdisciplinary" attention. This allowed us account for the views of all three disciplines by including conceptual/theoretical studies by scholars, industry-focused releases as standards by practice focused entities such as Ellen MacArthur, and policy framework reports such as European Union reports. This study addresses the scope of "transdisciplinary" usefulness in terms of theoretical, practical and environmental policy-making aspects brought into question.

While the study makes unique contributions, it suffers from several weaknesses in terms of findings due to the newness of the field per se. First, the field is relatively new and has a handful of influential scholars. It was noticed that the subsequent works by these influential authors are somewhat repetitive in nature. As such, this may bring in stagnation to the overall circular economy thinking in sustainable supply chain management content. The future scholars are expected to influence the field by making innovative and interesting contributions. Second, despite the global impact of field, it was noticed that out findings are compilations of voices of scholars from a handful number of countries. For example, the entire sample from South America contained few authors from only two universities in Brazil. Therefore, lack of voices from scholars across a larger set of developed and developing nations is essentially nullifying the multi-cultural and other global aspects related to the study context.

Overall, the study finds that the intellectual structures of circular economy in supply chain management literature is currently in the rising trend. However, it is yet to reach a stage to be called significantly matured, and thus, present ample room for future research, considering the trivial number of influential articles identified from a considerably small sample of 345 articles. Given the strong foundation of supply chain discipline and global policy-making attention, it is bound to leapfrog in coming times. In short, scholars have ample opportunities to conduct research of operations management focus as well as formal modeling methods of circularity implementations in supply chain contexts with practical applications. For example, it is hard to interpret how green purchasing could be a viable option for firms to develop circular business model. Similarly, the study seems inconclusive about the theme of “reverse-logistics” to be a considered as a part of circular supply chain discussion. Additional future research in similar direction would enlarge the spectrum as well as potentially shift the present core further. It is further suggested that the scope of the study must be expanded by including more keywords (such as economic sustainability, closed-loop supply chain) and/or by conducting in-depth analysis of the identified clusters to find promising patterns of interdisciplinary interests that may have been unintentionally ignored. Additional keywords would essentially mean larger sample, thus, providing an opportunity to conduct more innovative bibliometric and network reviews. This would create scope for additional content analysis that may lead to identify useful gaps and research directions. In addition, longitudinal co-citation network analysis is also suggested to conclude evolutionary patterns beyond the observations noted in this study.

CHAPTER III

A CONTINGENCY APPROACH FOR SUPPLY CHAIN PREPAREDNESS TO PURSUE CIRCULAR ECONOMY BUSINESS MODELS

INTRODUCTION

The traditional "take-make-consume-dispose" model is no longer seen as a sustainable production system but considered as a threat to mankind. This linear model of production system not only extracts Earth's resources, but also pollutes its environment, much faster than they can be restored (Meadows & Randers, 2012; Murray et al., 2017). The model creates environmental concerns, such as air, water and soil pollutions, that have negative impact on the Earth's life-support systems (WWF, 2015), and fails to meet societal expectations in term of providing quality employment, healthy working conditions, societal equality (Prahalad, 2004). A recent study claimed that the linear production model presently accounts for about 1.3 billion *tonnes* of solid waste per year globally and will surge to 2.2 billion *tonnes* by 2025 (Masi et al., 2017). In addition, it creates economic distractions within and across firms and economies by means of faster product obsolescence, shorter resource supplies, resource price volatility, competition, and flawed market structures (Sachs, 2015). Clearly, the linear model of production system disregards all three elements - economic, environmental, and social - of sustainable development to meet the aspirations of mankind towards a better life without risking the natural ecosystem "over time" (Kates et al., 2005).

To counter this linear trend of production system and related sustainable development issues, the concept of Circular Economy (CE) has gained traction in the recent years among scholars to describe a range of circularity topics (See literature reviews by Homrich et al., 2018; Andersen, 2007; Ghisellini et al., 2016; Lieder & Rashid, 2016; Su et al., 2013), among enterprises to apply circular strategies (See Webster, 2017; EMAF, 2015, for example), among consulting firms to guide for circular opportunities (e.g., Lacy & Rutqvist, 2015), and also in the larger schema of policymakers at different levels across the globe (Nugent & Rhinard, 2015). The sole aim of circular economy (CE) model is to enable thinking upon how to close the production loops that decrease the need of new raw materials by means of reusing existing materials and reducing waste generation (Govindan & Hasanagic, 2018). Some of the promising themes within circular economy (CE) include closed-loop supply chains (e.g., Guide Jr. et al., 2003; Govindan et al., 2015), circular economy business models (Bocken et al., 2016; Linder & Williander, 2017), circular product design (Bakker et al., 2014), and circular supply chains (Geissdoerfer et al., 2018). While each of these themes individually address unique aspects of circular economy, circular economy business model (CEBM) appears theoretically competent to act as a key strategic tool for firms in analyzing, structuring, planning, communicating, configuring and implementing the needful changes from the perspectives of resource efficiency and business model innovation (Osterwalder & Pigneur, 2010). Circular economy business models (CEBM) provide a unified understanding about value proposition, value creation and delivery, and value capturing process (Zott et al., 2011) for a firm's business system as whole, or in parts, that are guided by the circular economy (CE) principles through incorporation of suggested levels of circular strategies, such as refuse, reduce, re-design, reuse, repair, refurbish, remanufacture, re-purpose, recycle, and recover (Geissdoerfer et al., 2018).

The growing awareness of CE and its business models (CEBM) has pushed scholars to consider its organizational role in the field of supply chain management. Practicing CEBM require a paradigm shift when moving from a traditional to a sustainable supply chain. For instance, scholars have reviewed CE concepts, practices, assessment tools and scope of implementation in Chinese context (e.g., Geng et al., 2009; Su et al., 2013). Scholars have also performed studies upon concepts, actors and linkages between environmental, societal and economic systems of transitioning towards CE models (e.g., Ghisellini et al., 2016). The findings and recommendations from these studies have unearthed important aspects of CE "applications", such as product and business model designs (Tukker, 2015), reverse supply chains (Murray et al. 2017; Zhu et al., 2010; Genovese et al., 2017), closed-loop supply chains, product stewardship (Jensen & Remmen, 2017), integrated secondary markets (Dhakal et al., 2016), eco-industrial parks (Mathews & Tan, 2011), green and environmental supply chains (Rizos et al., 2016; Zhu et al., 2011; Ferreira et al., 2015), but they have limited suggestions about CE's applicability in the supply chain management context. The suggestions are limited to descriptions of several supply chain related barriers and enablers that may come in the path of firm's CEBM practices (e.g., Pan et al., 2015; Govindan & Hasanagic, 2018; Masi et al., 2017). At hindsight, prior studies from mainstream supply chain management have established that the effectiveness of supply chain management is an important "strategic" attribute for firm performance, regardless of the application in consideration (e.g., Lambert & Cooper, 1998; Bechtel & Jayaram, 1997; Gunasekaran et al., 2004; Meyr & Stadtler, 2015). As such, firms and their supply chains tend to respond more effectively when they are better prepared to handle new or unanticipated dynamics or paradigm shifts (Spekman et al., 1998; Finch, 2004; Ahmad et al., 2017; Akkermans & Van Wassenhove, 2018).

Take the case of Tesla (www.tesla.com), the all-electric car maker. Its future is filled with optimism and skepticism due to its inexperience in the auto industry. Given its background, Tesla is more valued as a rapid-growth technology company than an automotive company. Presently, its "supply chain *un*preparedness" is reflected in its shortcomings on the fundamentals of automotive business, such as failure to meet its ambitious production goal of 5,000 Model 3 cars per week at its *only* factory in California. In attempts to redesign Tesla's production process for the Model 3 sedan, it has hastily invested in automation anticipating producing 100,000 - 200,000 vehicles per year. However, it has struggled to increase both automation and production capacities since launching the sedan in May 2017. Until July 2018, Tesla has met its self-imposed 5,000 per week target just once, and has produced only about 50,000 Model 3 vehicles in total (Tesla Model 3 Tracker, 2018). Tesla's "supply chain *un*preparedness" is explicitly visible in the agonizingly slow pace of delivering the cars to its customers (Debord, 2018). In today's times, the rising complexities in supply chain context and networks has been keeping firms wrestling with uncertainties in internal manufacturing processes, supply-side processes, or demand-side issues (Hult et al., 2010). These uncertainties are deemed to grow exponentially when firms decide to adopt a new practice, such as CEBM practice. There is a growing interest in the related areas of supply chain risk (e.g., Ritchie & Brindley 2007, Braunscheidel & Suresh 2009, Neiger et al., 2009; Simangunsong et al., 2016) that commonly suggest that inadequate "supply chain preparedness" (SCP) is a major deterring factor that leads firms towards failures in operational performance, thus causing severe impact on their business performance (Davis, 1993; Hult et al, 2010). Inadequate “supply chain preparedness” could cause major impact upon firms’ practice-performance relationship (Davis, 1993). Therefore, firms practicing CEBM must work to achieve deeper understanding about the state of “preparedness” (i.e., “supply chain preparedness”) of their internal, end-to-end supply chains and external structures, and its subsequent influence on the performance of such CEBM practice. To address this gap in literature about “supply chain preparedness” of firms practicing CEBM, the main objective of this study is to answer the following to research questions:

RQ 1: How can CEBM practices be deployed in the supply chain context? What are the factors that firms pursuing CEBM should consider fostering “supply chain preparedness”?

To answer this research question, a thorough review of the literature on concepts of CEBM and “preparedness” in supply chain management context is conducted through the lens of contingency theory (Burns & Stalker, 1961; Lawrence & Lorsh, 1967; Thompson, 1967). The uniqueness of the contingency theory approach exists in its notion to disprove the “one size fits all” or “best practices” approach, and to highlight related contingency and efficiency factors that have influence on performance (Sousa & Voss, 2008). CEBM is a relatively new field and yet to attain its “best practices” attributions. While CE encompasses all related to sustainability at planet level, its implementation challenges may differ significantly (Guide Jr. & Van Wassenhove, 2005). For instance, acquisition of used cellphones is harder than that of used jet engines, whereas, their respective remanufacturing/refurbishing is just opposite. Thus, a contingency perspective seems appropriate to answer this research study. The constituent factors, in terms of practices, contingencies, and preparedness and performance outcomes are identified accordingly.

*RQ**2:** How is "supply chain preparedness" related to the CEBM practices and the CEBM performance, and what are the factors upon which the relationships are contingent?*

To answer the research question, a guiding contingency research framework is developed to conduct a qualitative investigation of the relationships given the exploratory characteristic of this study. The conceptual framework shall guide to explore the role of "supply chain preparedness" between the relationship of CEBM practices, their contingencies, and their performance.

The remainder of this chapter is organized as follows. The present state of literature on circular economy business models and contingency theory in the context of SCM is explored first. The literature on institutional theory and resource-based view are discussed with an intention to address those questions that cannot be entirely answered using a contingency theory lens only (Cairney, 2013; Mayer & Sparrowe, 2013). The study builds further to identify the related factors for the three key variables of – context, response, performance – of this contingency model. In this study, context refers to set of contingencies, response refers to CEBM initiative, and outcome refers to supply chain preparedness as intermediary outcome and CEBM performance as succeeding outcome. Toward the end, a guiding contingency framework is proposed to continue upon qualitative investigation given the exploratory characteristic of this study. The literature reviewed consists of dissertations, peer reviewed journal articles, white papers, and books published between 1960 and 2018. Annual company, government, and other organizational documents have also been included.

LITERATURE REVIEW, THEORETICAL CONCEPTS, AND RESEARCH FRAMEWORK

The purpose of this section is to set the foundation for the main premise of this study that the focal firm's supply chain preparedness (outcome) of circular economy initiatives (response) is contingent upon several upstream and downstream contextual factors (context). Accordingly, theoretical backgrounds of circular economy and its business models are described first. Next, contingency theory and complementary roles of institutional theory and resource-based view in supply chain context are described. Further, the concept of supply chain preparedness is derived from mainstream and sustainable supply chain literature. Thereafter, the discussion moves on to develop a fit-based relationship between the constructs of CEBM practices (as response), contextual factors, supply chain preparedness (as outcome), and the CEBM performance. The key constituents for each of the four constructs extracted from prior literature and described accordingly. Finally, a summary of the entire chapter is presented.

CIRCULAR ECONOMY BUSINESS MODELS

This section introduces to the concepts of the Circular Economy and the Circular Economy Business Models. Starting with the former and concluding with the latter, this section provides a review of the literature in terms of conceptual origination, selected definitions, scholarly articulation, and relevant discussions about the two related concepts.

Circular Economy

Since the industrial revolution, the linear "Take-Make-Consume-Waste" economy model has dominated our society, but, is increasingly becoming obsolete and unsustainable (Antikainen & Valkokari, 2016). It has become an apparent revelation that the model favors economic objectives in solidarity and pays little to no attention to societal and environmental concerns. Social concerns include growing population, rising unemployment, poor working conditions, socio-economic inequality, inter- and intra-generational gaps, whereas environmental concerns include bio-diversity damage, water, air, and soil pollution, resource depletion, and excessive land use. The world has also realized that the earth has finite key resources, and landfilling or dispersion of wastes generated by linear economy model brings no good, but keeps contaminating our ecological system, thus constraining healthy survival of the present and future generations. As a response, the concept of circular economy (CE) has burgeoned in the last few decades as an alternate flow model for cyclic production and consumption among researchers, enterprises and policy-makers (See Brundtland Commission, 1987; McDonough & Braungart, 2002; Stahel, 2010; EMAF, 2012; EMAF, 2013; EMAF, 2015; Ghisellini et al., 2016; Bocken et al., 2016; Lieder & Rashid, 2016; Geissdoerfer et al., 2017). Figure 3-1 is a visual demonstration to compare liner economy with circular economy model.

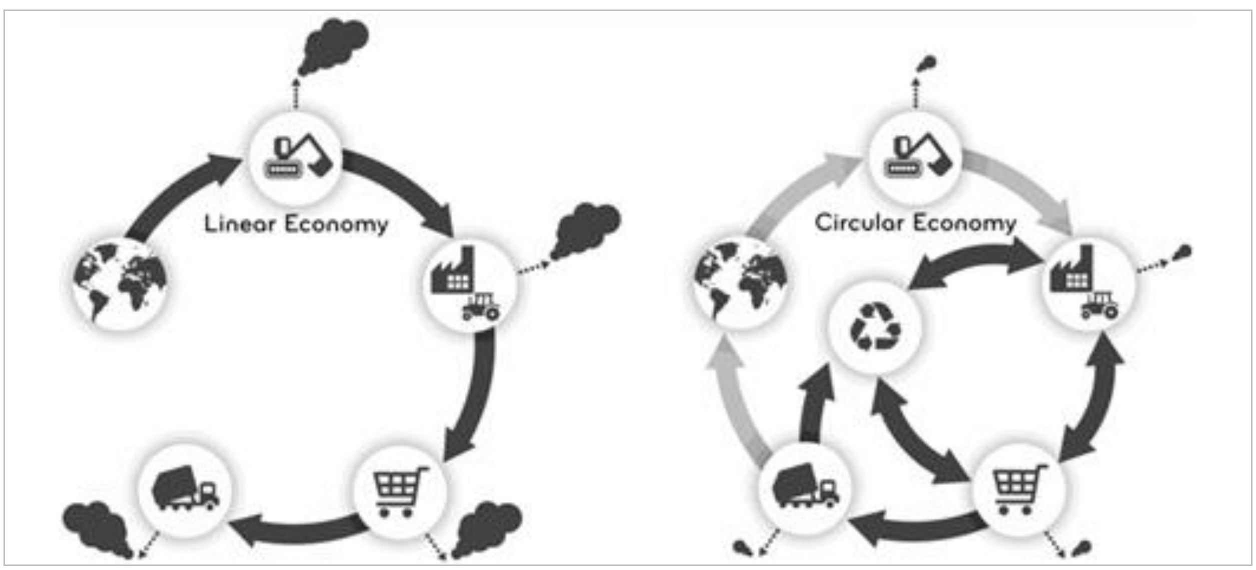

Figure 3 - 1. Contrasting linear and circular economy concepts (Source: Sauvé et al., 2016)

Although circular economy has existed and evolved organically since the 1970s (EMAF, 2013), the first methodical conceptualization of the circular economy model is credited to the seminal work by Pearce and Turner in 1990, as mentioned in numerous comprehensive literature reviews (See Su et al., 2013, Ghisellini et al., 2016; Geissdoerfer et al., 2017; Homrich et al., 2018). In their seminal work (Pearce & Turner, 1990), they present a framework to shift from linear economic to circular economic system to limit the overuse and depletion of natural resources. The consequences of overuse are explained by relying on the second law of thermodynamics (also referred as “Entropy”; Georgescu-Roegen, 1971). The entropy law can be illustrated through the simple example of rechargeable batteries such that even they degrade over time. Accordingly, their model suggests for price (or market) for environmental usage, such as provision of resources, life support system, and sink for waste and emissions, in the production system. Their work supports an earlier foundational work of Boulding (1966) about Earth’s ecological limits that compares linear economy as equivalent to a “cowboy” model, and closed economy as that of a “spaceman” model of sustainable efforts of living by practically making no exchanges of matter with the outside environment (Boulding, 1966; Ghisellini et al., 2016). These two works commonly propound that the circular economy paradigm is vital for sustainability of human life on Earth.

The circular economy model ensures closing of production loops at each stage to avoid extraction of new resources for production and to prevent landfilling or dispersion of generated wastes (EMAF, 2014; Lewandowski, 2016). The concept of CE resembles the closed-loop supply chains (CLSC) system in its production process, but actualizes fulfillment of the larger goal related to the economic, environment, and social aspects of sustainability – at planet level, as opposed to CLSC's emphasis on economic and environment at firm level (Despeisse et al., 2012; Govindan et al., 2015; Leigh & Li, 2015; Tonanont et al., 2008). In addition, CE suggests a method to reduce dependencies on new raw material by creating substitutes through reuse and recycling. It is an accelerating mission that allows us to secure a better tomorrow for ourselves and our future generations by improving our abilities for sustainability (Sauvé et al., 2016). Table 3-1 presents some of the most commonly cited definitions of CE.

Table 3 - 1. Definitions of circular economy (CE) in chronological order

Definition	Source
"realization of [a] closed loop material flow in the whole economic system"	Geng & Doberstein (2008, p.231)
"the core of [the Circular Economy] is the circular (closed) flow of materials and the use of raw materials and energy through multiple phases"	Yuan et al. (2006, p.5)
"an industrial economy that is restorative or regenerative by intention and design"	EMAF (2013, p.14)
"[one] that is restorative by design, and which aims to keep products, components and materials at their highest utility and value, at all times"	Webster (2017, p.16)
"design and business model strategies [that are] slowing, closing, and narrowing resource loops"	Bocken et al. (2016, p.309)
"[a] regenerative system [in which] resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. [This] can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling"	Geissdoerfer et al. (2017, p.759)
"[an] economy constructed from societal production-consumption systems that maximizes the service produced from the linear nature-society-nature material and energy throughput flow. [This] is done by using cyclical material flows, renewable energy sources and cascading-type energy flows. Successful [Circular Economy] contributes to all three dimensions of sustainable development"	Korhonen et al. (2018, p.39)

The circular economy (CE) model follows five principles for its realizations – (a) Design out waste, (b) Build resilience through diversity (i.e., balance efficiency with adaptability), (c) Shift to renewable energy sources, (d) Think in systems, and (e) Think in cascades ((EMAF, 2013). The CE principles are derivatives of prior “circularity” conceptualizations, such as extension of product life by treating products as services (Stahel, 1997), treating waste as value-adding resource (McDonough et al., 2003), industrial symbiotic ecosystem (Graedel & Allenby, 1995) and so on (Homrich et al., 2018). In the past decade, these principles have gained acceptance among enterprises, consulting firms, policymakers, academicians and governments across the globe, but mostly in Europe and China (Sauvé et al., 2016). The principles of "Design out waste" and "Thinking in systems" refers to idea of performance-based or use-based systems or regenerative processes for products to minimize consumption of scarce material and energy (Stahel & Reday-Mulvey, 1981), or to renew its source of energy and material (Lyle, 1996). An example would be to re-furbish and resale of used cars or electronic products. "Building resilience" refers to the idea of development of sustainable and self-sufficient ecosystems such as permaculture (i.e., agricultural ecosystems intended to be sustainable and self-sufficient) (Mollison & Holmgren, 1978). "Shift to renewable energy sources" is not a part of transition to CE, but is about using renewable energy, such as wind mills or photo-voltaic panels, at earliest possible juncture. "Think in cascades" refers to the principles of Blue Economy such as developing innovative ways to use one’s waste as another’s income (Pauli, 2010).

Although CE allows us to vision a world without any waste, a fully circular economy is far from reach with our current patterns of consumption, and need for input material, both raw and technical. There are several reasons to claim that is not possible to create a 100% CE at least in near future. First and foremost, 100% CE requires fully closed rings to avoid material loss. Ideally, this would require sophisticated recollection mechanisms, not only at appropriate junctions of the product value chain and beyond that to recollect last mile wastes. For example, is it economically viable to aim to recollect every coke can dumped by ignorant adventurers in the Rocky Mountains? Such a system would become unnecessarily cost and labor intensive as well as technologically complex to implement. An alternate option would be to suggest methods to generate ecologically degradable waste and or avoid generating waste at all (e.g., coke vending machines in the Rocky Mountains), which is again far from reality. Second, the notion of fully closed rings for 100% CE suggests there is no need of any input material. In other words, it suggests that all forms of output material must become input material. Contrastingly, the alarm rate of population growth (UN DESA Report, 2015) indicates no remorse but continued need for more input material to meet global production demand, unless scientists make miraculous innovations to normalize input requirements. Third, the notion of fully closed rings suggests rings within rings to balance input and output materials. However, there is a lifespan for any physical material on its number of reuse and/or recycle. For example, drink-safe re-usable glasses/bottles also become unusable after a while and need replacement (i.e., need for new input material arises even when the intent is to achieve 100% circularity). Four, the energy requirements to manage fully closed ring are unexpectedly high. An argument in support of renewable energy may not be economically viable to deploy. Lastly, there are other forms of possible limits such as system, temporal and physical space related boundaries, limits due to path-dependence and/or lock-in factors, governance and management related limits, and socially and culturally constructed boundaries that may pose significant challenges for the CE concept (Korhonen et al., 2018).

Despite these challenges, the academic community, businesses and policy-makers have shown increasing interest due to the opportunities promised by CE, and have begun to realize its value potential for themselves and their stakeholders by including the CE principles in their business models (EMAF, 2013). The CE initiatives are recognizably seen in the form of eco-industrial parks and industrial symbiosis networks, value-chains and cross-linkages of prioritized material flows such as water, land, wood, agricultural products, plastics, metals and energy sectors, and as technological enablers, eco-design and business strategies and social innovations (Winnans et al., 2017). The governmental recognitions of CE are noteworthy too. In 1996, Germany integrating CE in their legal system by enacting the “Closed Substance Cycle and Waste Management Act” (Su et al., 2013). In 2002, Japan introduced the “Basic Law for Establishing a Recycling-Based Society” (METI, 2004). Later in 2009, China introduced the “Circular Economy Promotion Law of the People's Republic of China” (Lieder & Rashid, 2016). In UK, Denmark, Switzerland and Portugal, businesses have adopted business models for material circularity and waste management (Costa et al., 2015). In North America and Europe, major businesses such as Unilever, Google and similar others have explicitly embraced the CE concepts to enhance reduce, reuse, and recycling, life-cycle assessments and other environmental footprint reduction methods in their production processes (EMAF, 2016). More recently, the European Union formulated the “Circular Economy Strategy” to actively support the CE concepts to its participation members (European Commission, 2015). This multi-stakeholder interest in CE strongly reflects that the opportunities and challenges of CE concepts are geared towards making pathways for sustainable development.

Circular Economy Business Model

While circular economy (CE) offers countless business opportunities by creating closed loops for both current and new players, an unresolved dynamism persists in the patterns of consuming and role of consumers (Antikainen & Valkokari, 2016). CE has the potential to disrupt the present "consumptive" lifestyle of consumers towards a "conservative" lifestyle for products and services (Goodwin et al., 2008). For example, Netflix has changed the concept of buying physical media of music and videos (i.e., pay-for-ownership) to the concept of buying access and performance (i.e., pay-per-use). Such transformation in production systems and consumerism can not only accelerate CE, but also, incentivize firms to co-create products with users that have longer service life and lesser impact on ecological system (Tukker & Tischner, 2006). It is therefore, argued that this notion of CE forms the basis for developing circularity in the business model of a firm, product or network; hence originates the terms "circular economy business models" (CEBM). CEBM is more of a micro-level phenomenon since it deals with circularity factors related to products and businesses, but has its influence on meso and/or macro level phenomena in terms of profitability, job creation, and environmental impact (Linder & Williander, 2017). As such, CEBM is largely seen in micro-level systems dealing with circularity elements at product and firm-level. It can also exist in meso- and macro-level systems. For instance, Helsinki Metropolitan Area's (Finland) "Smart & Clean" (www.smartclean.fi) project exports clean-technology solutions related to housing, air-quality, mobility, food and waste materials to other countries that are developed, tested and made to perfection first within its regional cities (Smart & Clean Foundation, 2016).

Research overview on business models. A business model can be defined as "*a conceptual tool that contains a set of elements and their relationships and allows expressing a company's logic of earning money. It is a description of the value a company offers to one or several segments of customers and the architecture of the firm and its network of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and sustainable revenue streams*" (Osterwalder, 2004, p. 43). The above definition speaks about two noticeable aspects of business model. First, it acts as a template for the firm to describe its business activities and how it distributes value to its stakeholders" (e.g., the focal firms, customers, partners, etc.), and second, about how it connects production and markets (Zott et al., 2011; Aspara et al., 2013). The choice of an appropriate business model is a crucial business decision as firms develop new products and services or reposition their existing products and services into new markets. Firms regularly require novel business models to readjust their structures and processes in order to refuel their products, services, or market strategy (Chesbrough & Rosenbloom, 2002). A firm's business model can serve as an important point of innovation and a vital source of value creation for the firm and its stakeholders (Chesbrough, 2011; Teece, 2006). Scholars and business practitioners are increasingly recognizing the design and execution of business model as a potential source of competitive advantage and a central factor in explaining firm performance (Markides & Charitou, 2004). In this background, business model can be interpreted as a mediating construct between a firm's capabilities and its performance (Osterwalder, 2004). As a unit of analysis, business model can explain not just the product, firm, industry, or network. Rather, it may be a construct that is centered on a focal firm with broader boundaries than those of the firm. Thus, business model proves to be valuable construct for firms to design (Zott & Amit, 2010), generate (Osterwalder & Pigneur, 2010), configure (Kulins et al., 2016), innovate (Foss & Saebi, 2017); modify (Velu, 2017), transform (Aspara et al., 2013), reintroduce (Chesbrough, 2010), tryout (Sosna et al., 2010), shift (McNamara et al., 2013), co-create (Dahan et al., 2010), cannibalize (Velu & Stiles, 2013), and unlearn/relearn (Mehrizi & Lashkarbolouki, 2016) their business activities. At the very least, it is strategic planning and management tool that provides a system-level, holistic approach to explaining how firms "do business" by organizing their structure and value creation processes (Zott et al., 2011).

Research on circular economy business models (CEBM). A circular economy business model can be defined as "*a business model in which the conceptual logic for value creation is based on utilizing the economic value retained in products after use in the production of a new offerings. Thus, a circular business model implies a return flow to the* <u>*producer*</u> *from* <u>*users*</u>*, though there can be* <u>*intermediaries*</u> *between the two parties [. . . and] always involves recycling, remanufacturing, reuse or of their sibling activities (e.g., refurbishment, renovation, repair*" (Linder & Williander, 2017, p. 2–3). A closer look into the above definition suggests that the involvement of producers, users and intermediaries allows circular flows to occur at three levels – the main production system, internal to the main production system (i.e., reuse by itself), and external to the main production system (i.e., reused by another business model as input material). Thus, CEBM has the potential to extend the boundaries of business models. This sort of complex thinking suggests that the field of CEBM is still evolving to create a common understanding about how to design stable business system in time, space or industry (Nussholz, 2017). Extant literature suggests for a cluttered set of ideas for adding circularity in business models – all targeted for efficiency enhancement, longer use, recovery, energy recovery or their combinations upon the product or its parts. Figure 3-2 (adapted from EMAF, 2013) is an illustrative depiction of how (and at what stage) circularity can be introduced to create closed material cycles in business models to the greatest possible extent (EMAF, 2013). To demonstrate how some of the suggested circularities in figure 3-2 (adapted from EMAF, 2013) can be incorporated into a firm's business model, a hypothetical example of a firm's CEBM activities for value proposition, creation and distribution, and capturing processes is presented in table 3-2.

Table 3 - 2. A demonstrative circular economy business model (CEBM) by adapting value dimension of Osterwalder & Pigneur's (2010) Business Model Canvas

Value Dimensions	What does "value" refer to?	A hypothetical example of a firm's CEBM
Value proposition	The offerings by the firm, and for whom?	An innovative a buy-back scheme (or a service-contract) for after-use product (such as cars, phones, or luxury goods) to serve a target segment that is interested to buy or continue to use post-use products
Value creation and distribution	How does the firm generate and distribute these offerings?	Setting up collection points and appropriate channels to enable reverse logistics
Value capture	How does the firm benefit from such offerings?	Direct profit from selling "certified" post-use products at lower prices by adopting remanufacturing, repairing, redistributing, and reselling processes. Indirect gains in terms of brand image for bringing resource efficiency and creating secondary market leading to larger economic, environmental and societal benefits

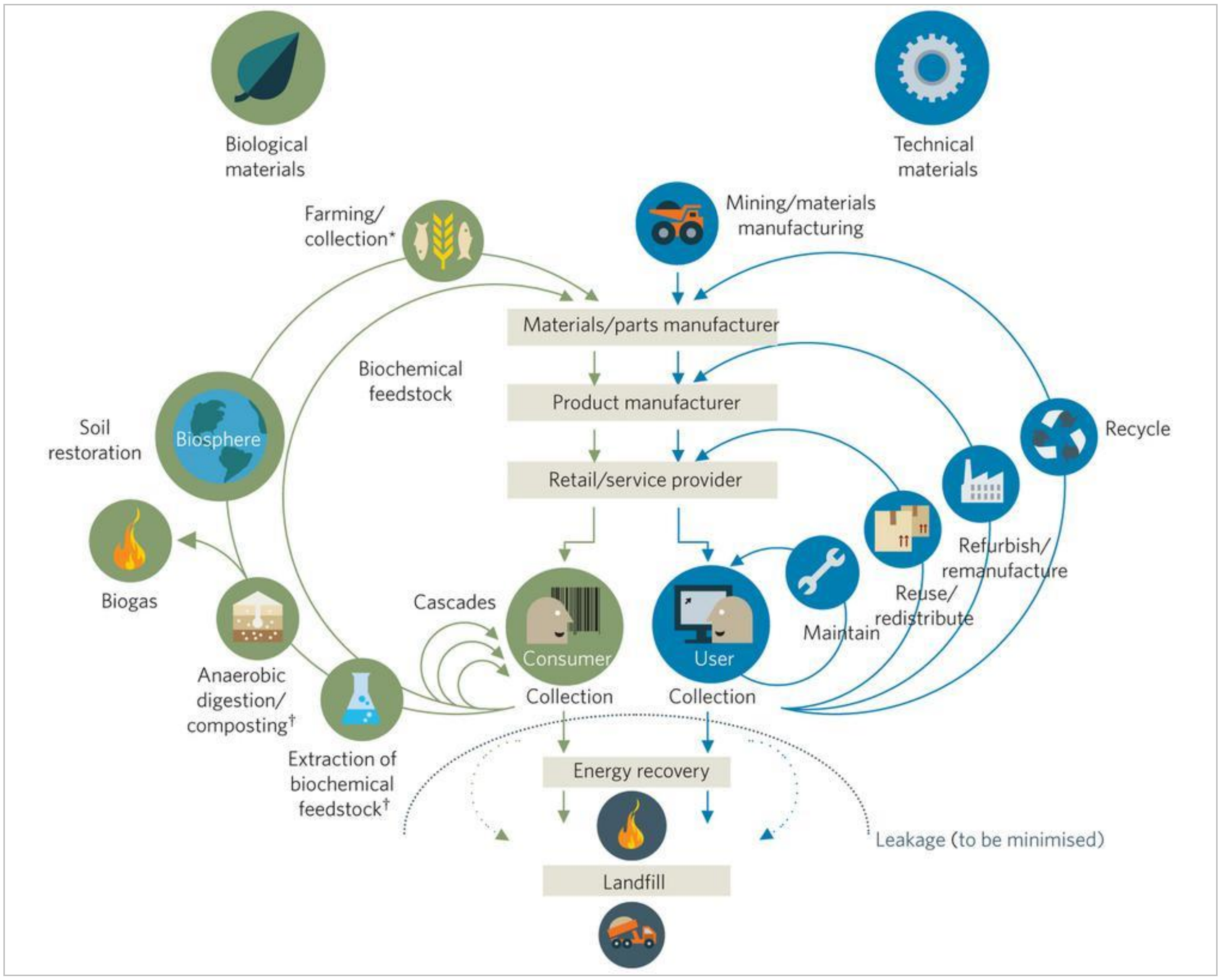

Figure 3 - 2. Overview of adding circularity in business models (Adapted from EMAF, 2013)

Table 3 - 3. Major studies addressing circular economy business model (CEBM) practices in circular economy (CE)			
Study	**Purpose**	**Research type *(Aspects)***	**CEBM related findings**
Stahel & Reday, 1976	To report to the European Commission about industrial strategies to create manpower-based jobs.	Technical report *(Supply chain activities; Value proposition)*	Industrial strategies for waste prevention, regional job creation, resource efficiency, and de-materialization of the industrial economy.
Stahel, 1982	To demonstrate about why and how to involve private sectors to pursue product use life extension for gradually transiting towards a sustainable society.	Conceptual *(Supply chain activities; Value proposition; Customer interaction; Revenue flow)*	Selling "utilization" instead of "ownership" of goods as a sustainable business model that allows industries to profit without depleting resources and generating industrial wastes.
Lyle, 1994	To discuss upon how to integrate the principles of ecological designs with practical realities	Conceptual and narrative with life examples *(Supply chain activities; Value proposition; Customer interaction)*	Regenerative practices for water-use, land-use, energy use, and building designs that yields reconnection between people and nature, art and science and technology and daily life.
Graedel & Allenby, 1995	To describe issues in industrial ecology, its long-term impacts and alternate strategies.	Conceptual and narrative with life examples *(Supply chain activities; Value proposition)*	Sustainability focused product-design techniques for "sustainability scientists".
Benyus, 2002	To introduce the concept of "biomimicry" as an innovative approach inspired by natural processes such as photosynthesis.	Conceptual and narrative with life examples *(Supply chain activities; Customer interaction; Revenue flow)*	Business models that are geared towards low-maintenance agricultural processes.
McDonough & Braungart, 2002	To propose a radically different philosophy and practice of manufacturing and environmentalism	Conceptual and narrative with life examples *(Supply chain activities; Value proposition)*	"Cradle to cradle" - How to design products from waste (i.e., after their useful life) as input - either as "biological nutrients" that can safely re-enter in the environment or as "technical nutrients" that

Table 3 - 3. Major studies addressing circular economy business model (CEBM) practices in circular economy (CE)			
Study	**Purpose**	**Research type *(Aspects)***	**CEBM related findings**
			circulate within closed-loop industrial cycles without being "downcycled" into low-grade uses.
Geng & Doberstein, 2008	To present the situation of circular economy practice in China.	Conceptual *(Supply chain activities; Customer interaction; Revenue flow; Circular typology; Implementation)*	Suggest three levels of closed-loop material flow system of practices at micro (firm/product), meso (eco-industrial parks), and macro (region / country), how they co-exist and their legal, technical and public barriers/challenges in China.
Pauli, 2010	To propose to the United Nations a model that uses core competence to create a portfolio of evolutionary and symbiotic businesses generating benefits for business, society and environment.	Conceptual and narrative with life examples *(Supply chain activities; Value proposition; Customer interaction; Revenue flow; Circular typology)*	Business models capable of making "total" use of all its available resources (including wastes), can cluster activities, and can form cascades to gain higher levels of efficiency. E.g., Growing coffee, mushroom and animal feed in the same field.
EMAF 2012	To express the limits of linear system and examine the potential of circular business models to drive value creation.	Technical report *(Supply chain activities; Value proposition; Customer interaction; Revenue flow; Circular typology)*	Four strategies for redistribution efficiency and material productivity – decrease production cost; product life extension; cascading use (waste-is-input); keep source material uncontaminated
Schulte, 2013	To present the conditions for developing circular business models due to growing resource scarcity.	Conceptual *(Supply chain activities; Value proposition)*	Key principles in terms of waste minimization, reflecting total ecosystem of the business, maximizing flexibility, using renewable energy, and maximizing energy efficiency.

Table 3 - 3. Major studies addressing circular economy business model (CEBM) practices in circular economy (CE)			
Study	**Purpose**	**Research type *(Aspects)***	**CEBM related findings**
Stahel, 2013	To argue that a tax system based on the principles of sustainability (i.e., not taxing renewable resources and human labor but taxing non-renewable resources instead) will promote low-carbon and low-resource solutions.	Conceptual with life examples *(Supply chain activities; Value proposition; Revenue flow)*	Strategies to implement "sustainable tax policy" to secure future resources, create more jobs at all skill levels and reduce greenhouse gas emissions, which leads to reduction in resource consumption, leading to increase in material efficiency.
Bakker et al., 2014	To describe methods to develop and exploit goods in such a way that it helps in reducing material and energy consumption over time.	Conceptual and narrative with life examples *(Supply chain activities; Value proposition)*	Crafting product designs and their business models to make "products that last".
Bocken et al., 2014	To develop sustainable business model archetypes by reviewing literature and industrial practices.	Qualitative cases *(Value proposition; Customer interaction; Revenue flow; Circular typology)*	Eight distinct sustainable business model archetypes concerned with technological, social or organizational innovations.
Pan et al., 2015	To propose strategies for implementing waste-to-energy supply chain from technological, financial, institutional and regulatory perspective.	Conceptual *(Supply chain activities; Value proposition; Revenue flow; Circular typology)*	Strategies include (a) establishing policy and government responsibility, (b) internalizing externalities, social acceptance and investor mobilization, (c) providing economic incentives (d) establishing performance evaluation program.
Lacy & Rutqvist, 2015	To propose a framework for circular economy.	Technical report (Accenture) *(Supply chain activities; Value proposition; Customer*	Five archetypes – Sharing platforms, product as a service, product life extension, resource recovery, and circular supplies.

Table 3 - 3. Major studies addressing circular economy business model (CEBM) practices in circular economy (CE)			
Study	**Purpose**	**Research type *(Aspects)***	**CEBM related findings**
		interaction; Revenue flow; Circular typology)	
Tukker, 2015	To propose the concept of product-services system for resource-efficiency and circular economy	Conceptual *(Supply chain activities; Value proposition; Customer interaction; Revenue flow; Circular typology)*	Three product-service system-based business models – result-oriented, use-oriented and product-based services.
Webster, 2017	To describe how circular economy works.	Technical report *(Supply chain activities; Value proposition; Customer interaction; Revenue flow; Circular typology)*	Methods of designing out waste, enabling access over ownership, favoring radical resources productivity and rebuilding natural resources.
Bocken et al., 2016	To propose a framework of strategies to guide upon transitioning from a linear to a circular economy.	Conceptual with life examples *(Supply chain activities; Value proposition; Circular typology)*	Circular product design and business model strategies – slowing and closing (and narrowing) resource loops.
Lewandowski, 2016	To fit circular economy characteristics into the Osterwalder's business model canvas.	Conceptual with life examples *(Supply chain activities; Value proposition; Customer interaction; Revenue flow; Circular typology)*	The ReSOLVE framework to translate opportunities into business actions of CE, and a template to analyze such actionable CEBM.
Moreno et al., 2016	To explore upon design for resource conservation, design for slowing resource loops and whole systems design, and suggest fit for circular business models.	Conceptual *(Supply chain activities; Value proposition; Customer interaction; Revenue flow; Circular typology)*	Mapping five circular design strategies according to five business model archetypes and their value creation aspects, and a set of ten circular design practice recommendations.

Table 3 - 3. Major studies addressing circular economy business model (CEBM) practices in circular economy (CE)			
Study	**Purpose**	**Research type *(Aspects)***	**CEBM related findings**
Scheepens et al., 2016	To analyze environmental impacts of business initiatives at the system level, and to provide a framework for designing sustainable business models using costs, eco-costs and market value dimensions.	Empirical case method *(Supply chain activities; Value proposition; Customer interaction; Revenue flow; Circular typology)*	Strategies to design sustainable circular systems that could satisfy double objective of "eco-efficient value creation" (i.e., lower eco-costs and at the same time higher value for product/business model designs.
Witjes & Lozano, 2016	To explicate the procurement and supply practices process, and to propose a collaborative framework to promote reductions in raw material utilization and waste generation.	Conceptual *(Supply chain activities; Value proposition; Circular typology)*	Insights to formulate product / service combinations in procurement processes aimed at improving resource usage efficiency through recovery.
Elia et al., 2017	To evaluate the existing environmental assessment methodologies, and to propose a framework to monitor CE.	Conceptual *(Supply chain activities; Value proposition; Measurement)*	Measuring a CE model adopt requires evaluation of processes to monitor, the actions involved, the requirements to be measured, and, the implementation levels.
Frenken, 2017	To define the sharing economy as a practice of consumer's granting temporary access of their assets to each other, and its variants.	Conceptual *(Supply chain activities; Value proposition; Customer interaction; Revenue flow)*	Identified variants of sharing economy include peer-to-peer exchange, temporary access either by borrowing or renting, and better use of underutilized physical assets.
Gaustad et al., 2017	To study how firms assess and monitor for critical material supply chain vulnerabilities in their circularity strategies	Empirical/ Qualitative case *(Supply chain activities; Value proposition)*	Identified risk reduction circular strategies include: Recycle-remanufacture-reuse, collection, lean principles, de-materialize, and diversify.

Table 3 - 3. Major studies addressing circular economy business model (CEBM) practices in circular economy (CE)			
Study	**Purpose**	**Research type *(Aspects)***	**CEBM related findings**
Geissdoerfer et al., 2017	To investigate how circular economy paradigm is represented in sustainability in terms of similarities and differences.	Bibliometric review *(Supply chain activities; Value proposition; Circular typology)*	Long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.
Linder & Williander, 2017	To examine the reasons for industry reluctance in adopting circular business models despite its economic and environmental promises.	Empirical - action research *(Supply chain activities; Value proposition; Customer interaction; Revenue flow; Measurement; Implementation)*	Contingencies include customer suitability, technical expertise, return predictability, remanufactured product's price sensitivity, risk of cannibalization, restricted aesthetic attributes, seller-producer's financial and operational risks, and regulatory issues.
Masi et al., 2017	To argue that "one size fits all" approach can jeopardize CE adoption to due unique challenges in supply chains.	Conceptual/ literature review *(Supply chain activities; Value proposition; Customer interaction; Implementation)*	Identified drivers, inhibitors and enablers of meso-level CE supply chain structure. Also, three supply chain configurations are presented.
Murray et al., 2017	To elaborate upon circular economy roots, meanings, its antecedents, and how has it been operationalized in business and policy-making so far.	Conceptual *(Supply chain activities; Value proposition; Customer interaction)*	Suggest that redesigning of processes and (re)cycling of materials are the two key elements of developing more sustainable business models
Abbey & Guide Jr., 2018	To propose typology of remanufacturing based on a firm's strategic focus and product design philosophy	Conceptual *(Supply chain activities; Value proposition; Circular typology)*	Four remanufacturing variants – durability and reparability; multiple lifecycle products; commercial returns; third-party remanufacturing.

Although the notion of CE was introduced several decades ago (e.g., Pearce & Turner, 1990; Stahel & Reday-Mulvey, 1981; McDonough & Braungart, 1992), the patterns revealed from the literature review conducted and presented in table 3-3 shows that the understanding about structuring circular economy business models (CEBM) to effectively transform the CE principles into an appropriate economic system is still facile and fragmented. One might argue that the notion of CEBM is relatively new. But such an argument brings along more complexities for CEBM research due to its juxtaposed relationship with two well-established notions, namely, business model from organizational/strategic management domain and circular economy from sustainable development domain. While the concept of business models describes the strategic approaches that firms apply for value proposition, creation and delivery, and capturing (Zott et al., 2011; Osterwalder & Pigneur, 2010), circularity concepts are derived from a far-apart area of sustainable development, which mainly stresses upon studying resource efficiency models by altering directionality in resource and energy flows to achieve the ultimate objective of balancing environmental and societal values for economic gains (Moreno et al., 2016). As shown in table 3-3, the research seems to point five dominant aspects of CEBM that firms consider in transitioning from a linear to circular economy based business models or developing new circular economy business models. These four aspects include directionality of supply chain activities, value proposition, customer interaction, revenue flows and circularity typologies. However, research seems inadequate in addresses two important aspects of CEBM, namely, measuring circularity (Elia et al., 2017) and implementation challenges (Linder & Williander, 2017; Murray et al., 2017). These seven aspects of CEBM needs better understanding, hence described further in the following sub-sections.

Directionality of supply chain activities. A typical supply chain consists varying levels of forward-looking production planning, purchase of input materials, production processes, marketing, distribution, sales, and after-sales support activities. Accordingly, firms configure their business models. However, in CEBM initiatives, the changes in directionality of supply chains pushes firms to introduce reverse flows in supply chain (also, termed as reverse logistics), devise means to evaluate their products' quality of sustainability promise, instrument reuse and redistribution systems, and establishing new supply chain networks for remanufacturing and recycling (Bakker et al., 2014). It is, therefore, very unlikely that firms cannot reap in the benefits of such CEBM practices without applying newer innovative technologies, equipment and managerial/technical skills. At a strategic level, it implies that firms must adopt systemic approach to clarify how their re-configured supply chains would create value for the firm and their forward and downward supply chain networks. At tactical and operational level, firms must own enough knowledge and skills to righteously apply Life Cycle Assessment (LCA) (Geng et al., 2013), long-life and product-life extension (Bocken et al., 2016), product-service systems (PSS) (WRAP, 2017), Sharing platform (Moreno et al., 2016) and other methods to improve their CEBM performance.

Value proposition. In practicing CEBM, firms are expected to stay on with their customers by means of adding intangible components to their tangible products (Tukker & Tischner, 2006). Typically, this sort of value propositions may be noted in CEBM supporting the notion of product-service systems (PSS) depending on the degree of mix required in the product and service part that fulfills their customers' needs and allows value capturing for the firms and their supply chain network. Thus, value proposition aspect in CEBM requires firms to satisfy their customer needs by means of lower degree of ownership (such as product leasing) thereby maintaining higher ownership of the product by the firm (Urbinati et al., 2017). In doing so, firms have more control on the components of the product that makes it easier for firms to appropriate CE principles (such as re-use, re-manufacture, or recycle) while maintaining the status of producers as well as service providers. This aspect of CEBM aspect allows firm to propose flexible pricing for their product not based on the cost of production, but, based on the functional value it can generate for their customers. Further, it allows firms with an incentive to innovative products with longer life-cycle that can be repaired, re-upgraded, re-assembled with lesser amount of inputs and energy (Mont, 2002). As for customers, it increases their affordability for a better product without owning the responsibility of disposing at the end of life of such product. This form of win-win proposition for both producers and customers in an inherent characteristic of CEBM.

Customer interaction. In practicing CEBM, firms are expected to interact differently with their customers and prospective buyers both in terms of quality and quantity. As firms increase their levels of interactivity with customers, their CEBM would gain more perfection in terms of better insights on customer preferences and buying rationality. This would allow firms to improve customer experiences leading to higher retention, co-operation and superior maintenance over time. (Zhu et al., 2011). In addition, customer interaction will also allow firms influence new customers to adopt CEBM driven products. For instance, customers who are socially unaware of the benefits of CE have developed their own rationality about how to choose, protect, use, and dispose products, services, experiences, or ideas to satisfy their needs and wants (Kuester, 2012). More than often, they are willing to pay a price for a product that can satisfy their immediate requirement, and reject the more expensive alternate even if it is more durable. Also, customers show inclination towards owning the product even if they understand that the product may not be used quite often or extensively. This sort of rationality develops due to inadequacy in social diffusion/awareness caused by differential economic environments across economic strata, communities, cultures and nations. For example, American apparel firms manufacture in China to make apparels available at lower prices, but the consumer in the US is unaware of the social harm it may or may not have caused while producing it in China. Therefore, it becomes a responsibility of the firms to educate their prospective buyers about how could customers contribute and benefit by becoming a part of the CE mechanism to help balancing ecological harms.

Revenue flows. In CEBM transforms, the revenue flow is an important economic consideration that keeps firms alive and/or provide ability to survive. It speaks about how revenues should flow across the entire value chain. Since, a CEBM assumes that the supply chains are closed, it allows for significant decrease in the use of virgin material and energy required in the production process, thus following a consequent reduction in input cost. In addition, by means of recovery and recycling of material and used products, firm and its supply chain network are also expected to cut costs of disposal and landfill as per environmental regulations (Stahel, 2016; EMAF, 2013). As such, this allows firms to devise affordable pricing models to earn larger customer bases depending on “pay-per-use” model for use-oriented products and “pay-per-own” for result-oriented products (Tukker, 2004; Urbinati et al., 2017). An apt example to demonstrate successful flow of revenues is that of the ride-share company “Uber” (www.uber.com) that has crafted its business model in such a way that it enables its user, drivers, and car makers to directly satisfy their economic interests and indirectly contribute to the company’s environmental and social priorities.

Skewness in circularity typologies. CEBM research is holistically expected to appropriately address economic viability aspect of a business system by adding circularity techniques in terms of recollection, restoration, reuse or similar techniques with the material chain. However, the present state of CEBM appears to address only one part of a product's life cycle – the "use" part by applying circularity techniques, and seems elusive in addressing the other parts, such as material extraction and processing, production processes, and material recycling post-use (Nussholz, 2017). Table 3-4 provides a list of suggested circularity techniques (also terms as resource efficiency strategies) for CEBM. Apparently, the listed circularity techniques are loosely related to input material extraction and processing parts, which is an important consideration to curb new input resource demand or encourage input resource sufficiency.

Table 3 - 4. Overview of literature and suggestions to add circularity in business models

Authors (Year)	**Suggested circularity techniques in business models**
Stahel & Reday-Mulvey (1981)	Product Life extension (through re-use, re-manufacturing, Maintenance); Recycling (through reusing materials at micro-level)
Damen (2012)	Maintenance; Repair; Reuse; Refurbishment; Remanufacturing; Recycling; Energy recovery
Evans & Bocken (2013)	Product as a Service; Design, Manufacture and Distribute; Usage; Maintain/ Repair; Reuse/ Redistribute; Refurbish/Remanufacture; Product Recycling
Lacy et al. (2014)	Products as services; Next life sales; Product transformation; Recycling 2.0; Collaborative consumption
Bakker et al. (2014)	Classic long-life model; Hybrid model (combine durable product with short-lived consumables); Gap-exploiter model (components of products that last longer than the rest); Access model (customer pays for access to product); Performance model (customer pays for performance instead of product)
Mentink (2014)	Maintenance; Repair; Redistribution (or reuse without treatments); Upgrading; Remanufacturing; Recycling; Energy recovery; Disposal
Van Renswoude et al. (2015)	Short cycle; Long Cycle; Cascades; Pure circles; Dematerialized services; Produce on demand
Bocken et al. (2016)	Access and performance model; Classic long-life; Extending product value; Extending resource value; Encourage sufficiency, Industrial symbiosis

Moreno et al. (2016)	Product life-extension; Extending product value; Sharing platform; Resource value; Circular supplies
Wrap (2017)	Product Service System; De-materialized services; Hire & leasing; Collaborative consumption; Incentivized return & re-use; Asset management; Collection of used products; Long life; Made to order; Bring your own device

Measurement of circularity. To make CEBM approaches manageable, there must exist standardized or well-established forms of circularity measurement indexes to evaluate robustness, reliability, legitimacy, and effects of circularity decisions considered based on theoretical justifications (Geng et al., 2012). The measurement indexes help determining the circularity values generated within a business system through aggregation of different types of resource and energy flow circulations. Presently, at macro- and meso-levels, there are available methodologies and approaches to measure circularity, in terms of measuring disassociation of economic progress from environmental (such as material footprint of consumption, water and energy depletion and pollution) and social (such as job creation, human health safety) concerns, and for making appropriate recommendations to the change actors (Schandl et al., 2016). These metrics include material circularity indicator (EMAF & Granta, 2015), eco-efficient value ratio (Scheepens et al., 2016), circular economy index (Di Maio & Rem, 2015), remanufacturing product profile (Gehin et al., 2008), material reutilization part (C2C, 2014) and ratio-based recirculated economic value (Linder & Williander, 2017). As in the case of micro-level CEBM, these metrics can aptly collect a wide range of environmental information about the product/service (i.e., material wastage, energy depletion, water contamination, air pollution, and so on), but they fail to appropriately interpret economic and social value factors of CEBM performance, such as market equilibrium, price sensitivity, job-creation aspects, and other similar ones,. Thus, the field is still in lacking in standardizing circularity indexes and product policies to the requirement of different stakeholders, such as industry, academics, policy makers, non-governmental organizations and similar others (Tecchio et al, 2017). In short, these indexes have low-to-high construct validity, reliability, transparency and aggregation logic, but, high generalizability (Linder & Williander, 2017; Elia et al., 2017).

Challenges in implementation. In implementing CEBM, firms face significant challenges that seeks managerial interventions to make dynamic iterations in the business and related sub-systems (Sousa-Zomer et al., 2018)). CE research shows that firms need to tackle with several external and internal factors that may come in their ways of CEBM implementation. Such factors include management structure, capital structure, contextual factors (government regulations, markets), cultural factors (leadership, risk aversion), stakeholder relations and inter-firm collaboration (Fischer & Pascucci, 2017; Scheepens et al., 2016), customer irrationality and conflict of interest within supply chain network (Planing, 2015; Linder & Williander, 2017); technological, professional and institutional barriers (Roos, 2014; van Buren et al., 2016). To counter these CEBM implementation challenges, firms tend to necessitate organizational innovations (Lewandowski, 2016). This in turn leads firms address issues related to intra/inter-organizational collaboration by means of aligning interests (Planing, 2015), organizational processes by improving design, sourcing/manufacturing, technical and sales capabilities (Lacy et al., 2014), cultural aspects by means of adaptation (Lewandoski, 2016) and business and operational risks (Linder & Williander, 2017). Since, these challenges may interact complexly, and thus, needs firms to keep abreast in their CEBM practices.

ORGANIZATIONAL THEORIES

Organizational theories help understanding how organizations are constructed for purposes and managed within bounds (Shafritz et al., 2015). Contingency theory (Lawrence & Lorsch, 1967) is used as the primary theoretical lens to explain the possible patterns of selection and deviation of CEBM to achieve supply chain preparedness. However, institutional theory (DiMaggio & Powell, 1983) and resource-based view of the firm (Barney, 1991) are additionally employed to address those questions that cannot be entirely answered using a contingency theory lens only (Cairney, 2013; Mayer & Sparrowe, 2013). This multi-theory approach is expected to accomplish a deeper understanding of the research questions of the study (Erkul et al., 2015; Hales, 2010; Webster & Trevino, 1995; Simons, 2014). Accordingly, this section provides a review of the literature of the contingency theory, the institutional theory and the resource based view of firm, in terms of conceptual origination, selected definitions, and relevant scholarly articulations.

Contingency Theory

Contingency theory (CT) is one of the leading theories in the organizational as well as supply chain literature for past several decades. In its simplest form, the theory asserts that there is no “one best way to manage” for organizations, and therefore, must match their actions with their contexts to perform better. In other words, firms can successfully co-exist within an industry by applying different structures and strategies, and their individual performances would depend on how well each of them could adjust their structures and strategies with their contextual factors. These contextual factors (as contingencies) would otherwise affect their performances if they fail to match their strategies choices with the contextual changes. To illustrate, an organization’s choice to pursue a business decision, such as, acquiring its competitor, starting a corporate social responsibility program, is influenced and defined by several contextual factors such as firm size, market and/or technological uncertainty and so on. The organization's ability to align its decision-making structure with the contingency variables is essential for positive outcome. The theory assumes organizations are more open than closed, and hence, fit between context and structure is the assumed premise to achieve higher performance. Tosi & Slocum (1984) cite two reasons for contingency theory's immediate acceptance in management research.

> *"First, the logic underlying them was compelling. It makes good sense that there is not one best way to manage. Second, the early research of Burns and Stalker (1961), Chandler (1962), Fieldler (1964), Woodward (1965) and Lawrence and Lorsch (1967) produced, at first glance, seemingly convergent results. Later theoretical developments by Thompson (1967) and Galbraith (1977) provided theoretical foundations within which these early findings could be explained. (p.9)"*

The traditional model of Contingency theory explains the relationship between three firm level variables - the context, the response, and the performance (e.g., Chandler, 1962; Lawrence & Lorsch, 1967; Woodward, 1965; Thompson, 1967). The context refers to those variables that exist out of the firm's control, such as technological changes or demand uncertainty, and has effect of the firm's response or action (Van de Ven & Drazin, 1984). The response variables refer to the firm's internal factors that are within its control. The theory explains how to achieve a fit between the context and response by varying response factors, such as internal resources and management decisions, according to varying contextual factors, in anticipation of high performance (Drazin & Van de Ven, 1985). In terms of response, structure specifies the means to divide several tasks and balance between related or unrelated tasks, whereas strategy refers to whole form of the structures, such as corporate strategy or business unit strategy, which evolves to respond to contextual changes (Donaldson, 2001). In contingency theory research, the term context is interchangeably used with environmental dynamism (Hambrick, 1983). The performance variable refers to the amount of goals that a firm could achieve, and can therefore be characterized as efficiency and/or effectiveness (Drazin & Van de Ven, 1985; Venkatraman, 1989; Donaldson, 2001).

Some of the later works by management researchers, such as Fry & Smith (1987), Schoonhoven (1981), Drazin & Van de Ven (1985), Venkatraman (1989) and Donaldson (2001), found several of its conceptual and empirical weaknesses because of the major assumptions of CT. Although incorrectly, scholars often confuse "contingency" with "congruency" and the same transpires in its empirical applications. "To continue using congruence and contingency in various undefined or vaguely defined ways perpetuates the confusion to which such uses lead" (Fry & Smith, 1987, p.118). The logic of congruent proposition suggests that a direct unconditional relationship exists between the variables of a contingency model; for example, greater task uncertainty would imply more complex structure, thus leading to poor performance. On the other hand, a contingent proposition is supposedly more complex because when two or more independent variables that are conditionally associated with a dependent outcome, it requires empirical validation before making any conclusion. For example, when task uncertainty interacts with structural complexity, it might impact performance in either direction (Drazin & Van de Ven, 1985). In another instances, Donaldson (2001) suggests that:

> *"Critics of structural contingency theory sometimes argue that it is not sensible for organizations to move into fit with their contingencies, because while the organization is changing its structure to fit the contingencies, the contingencies themselves change, so that*

the organizational structural change does not produce fit. Nevertheless, by moving towards the fit, the organization is decreasing misfit, and thereby increasing its performance relative to what it would be if it were to make no structural change (Donaldson, 2001, p. 23).

Another major challenge that researchers faced for at least initial two decades was about accurate depiction of fit-based relationship between the three variables of contingency model. Based on how the relationships between contextual, response and performance variables are investigated, three most prominent forms of fit are selection, interaction and system approach (Drazin & van de Ven, 1985). In investigating this notion of fit-based relationship further, Venkatraman (1989) found six distinct archetypes of fit - fit as moderation, fit as mediation, fit as matching, fit as gestalts, fit as profile deviation, and fit as covariation – based on degree of specificity (or strength) of the functional form and choice of anchoring (or direction) the specification of any particular fit-based relationship as shown in figure 3-3.

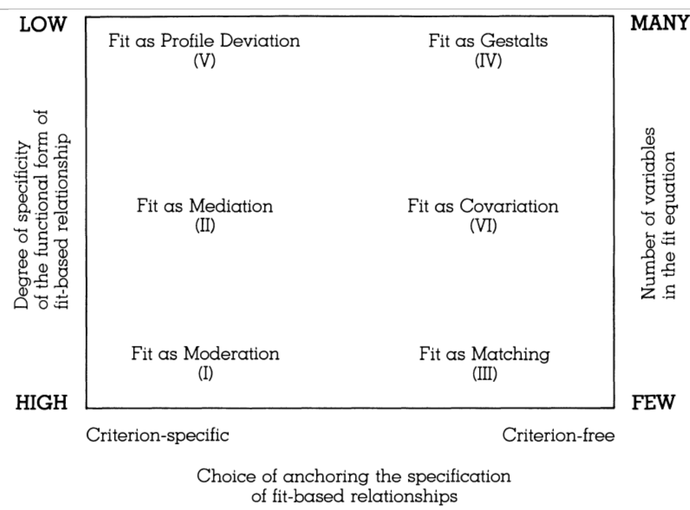

Figure 3 - 3. Framework for mapping the six perspectives of fit (Source: Venkatraman, 1989)

His work explained that while both fit as moderation and as mediation highlight the interaction effect of context and response on performance in a contingency model, fit as moderation observes when certain contingency factors would strengthen/weaken the relationship between response and performance, whereas fit as mediation observes why and how certain responses are necessitated to maintain a constructive relationship between context and performance (Venkatraman, 1989). Fit as matching is simple selection form of fit-relationship between context and response variables without concerning about performance (Drazin & Van de Ven, 1985). As shown in figure 3-3, the other three forms of fit perspectives – as profile deviation, as co-variation, and as gestalts – apply for the system form of fit relationship, which essentially suggests that a contingency model with several contingencies, response alternates, and performance criteria and is likely to suggest equifinal fit-relationship, i.e., there can be multiple, equally effective methods to achieve fit (Drazin & Van de Ven, 1985). The system perspective of contingency model is expected to gain more traction in supply chain management research, especially, in practice-performance stream, due to its advantage to address equifinality conditions, since several studies, such as Kaynak (2003) and Shah & Ward (2007), have adequately demonstrated that superior performance is often attributed as consequence of mutual interfacing between bundles of management practices (Soussa & Voss, 2008).

Nonetheless, the greatest strength of contingency theory lies in the "largely descriptive in nature" approach that amplifies its prescriptive value to critically examine and determine effective designs of organizations. Apart from providing logical adequacy in explain relationships between adoption of best practice and performance, the contingency theory also provides strong rational bases to closely identify the contexts in which they may transpire. Based on this critical evaluation, the contingency theory has been chosen as the primary theoretical lens to understand and develop the contingency model of this study.

Institutional Theory

Why does the structures (organization chart, policies, norms, etc.) of large corporations, universities, military, hospitals, insurance, national offices, wage market, (and even marriage, and sometimes products too) look so similar? Almost four decades ago, two sociologists from Stanford University, John Meyer and Brian Rowan, explained this phenomenon in their seminal work as "*Institutionalized Organizations: Formal Structure as Myth and Ceremony (1977)*". The institutional theory argues that organizations incorporate socially rational structure in order to achieve legitimacy, resources, stability, and survival, whereas, tasks and processes are controlled and coordinated according to their symbolic structure. Six years later (in 1983), DiMaggio and Powell of Yale University, extended this theory further by visualizing organizations as iron cage, by arguing how and why organizations imitate, by conceptualizing isomorphism (by highlighting coercive, normative, and mimetic approaches of reproduction). The core idea of institutional theory is to suggest that organizational practices and structures are often either reflections or responses to rules, beliefs, and norms created by the external environment (Meyer & Rowan, 1977). The unit of analysis is either at organizational level or at societal level. Per se, institutional theory assumes that most organizations do not perform rationally, rather, they are influenced by their environment (i.e., made to believe about how things have been done before and how should be done). Meyer & Rowan (1977) argues that formal structures of organizations are designed to reflect myths of their institutional environments (i.e., how their structure should look like), instead of what their work activities demand. In doing so, the authors first describe the pre-existing theories of formal structures (e.g., Weber's (2015) concept of bureaucracy) and confront their approaches as myths, in terms of coordination and control. Accordingly, the forces (such as gaining legitimacy, resources, survival, etc.) that pushes organizations to create such formal structures are argued. Further, they argue that organizations reflecting institutionalized environments maintain purposive gaps between their formal structures and their ongoing work activities (e.g., administrative units in universities), and the performance/existence of those structures are evaluated by external agencies (e.g., Nobel Prize committee, safety boards, etc.). Thus, rationalized institutions create myths of formal structure which shape organization ((Meyer & Rowan, 1977).

The concept of isomorphism and collective rationality of organizations, which is briefly summarized by Meyer & Rowan (1977), was later broadened by Maggio & Powell (1986). From an institutional perspective, stable organizations exert pressure on others to become similar to their structure (i.e., to isomorph) as that enables them with better connectedness. Isomorphic processes occur in three forms – coercive isomorphism (e.g., banking, health, schools, etc.), mimetic processes (e.g., automobile, smartphone, police, postal, courts, etc.), and normative pressure (e.g., CPAs, AACSB, teaching certification, etc.). Such isomorphic changes lead firms towards increased resource centralization and dependencies in/between organizations, goal ambiguity and technical uncertainty in organizations, and professionalization and structural formation (such as medical certifications, AACSB certification, etc.). In addition to economic efficiency, such isomorphism leads firms to gain "organizational legitimacy" (Suchman, 1995; Haunschild & Miner, 1997; Scott, 2015). Organizational legitimacy is defined as follows: "Legitimacy is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995, p. 574). As such, Suchman's (1995) work is pivotal in bringing a consistent understanding upon "organizational legitimacy" that explains strategic and institutional approaches to legitimacy, suggest typology to legitimacy - pragmatic, moral, and cognitive, and challenges of legitimacy management (i.e., developing, maintaining, and repairing legitimacy).

Later scholarly works by Tolbert & Zucker (1983), Singh et al. (1986), Deephouse (1996), and Pollock & Rindova (2003) have empirically validated and expanded the concepts of organizational legitimacy, isomorphism and institutional. First, Tolbert & Zucker (1983) empirically study upon diffusion and institutionalization of change in formal organization structure, using time-series data of 5 years (from 1880-1930) on the adoption of civil service reform by cities in US. Their study shows that when civil service compliances are legitimized by the state, they have faster than when they are not so legitimated. It demonstrates that early adoption of civil service by cities is related to internal organizational requirements, while late adoption is related to institutional definitions of legitimate structural form. Overall, the findings support their argument that the adoption of a policy or program by an organization is determined by the extent to which the measure (requirement) is institutionalized - whether by law or by gradual legitimation. Second, Singh, Tucker, & House (1986) explores whether external legitimacy or internal coordination contribute more towards the liability of newness (for survival of newer/younger organizations which are yet to gain legitimacy). The authors studied a Canadian population of voluntary social service organizations on three indicators of legitimacy – community directory listing, charitable registration numbers, and board size at initial stage, and found that external legitimacy significantly increases the likelihood of the organization to survive. Additionally, they found that chief executive change has consequences upon the organization's survival. Therefore, it can be inferred that the lack of institutional support in newer organizations has a causal relationship with their liability of newness. Third, Deephouse (1996) test a core element of institutional theory that organizational isomorphism increases organizational legitimacy, using a data sample of commercial banks in the Minneapolis-Saint Paul metropolitan area from 1985 to 1992. Their results show that strategic isomorphism (i.e., strategic conformity; one organization imitating another successful organization during uncertainty) of commercial banks is highly correlated to the legitimacies conferred by bank regulators (as regulatory endorsements) and media (as public endorsements), even when other organizational attributes (such as age, size, and performance) were included in the model. Fourth, Pollock & Rindova (2003) examine media legitimation effect by examining the effect of media-provided information on underpricing and stock turnover of a dataset of 225 newly public firms. Their findings suggest that the volume of media-provided information decreases underpricing and increases stock turnover (both at diminishing rate) on the first day of trading, and that the proportion (by time-weeks-months) of media-provided information increases underpricing and decreases stock-turnover (both at a nonlinear rate). Their findings infer that publicly available information not only reflects IPOs' legitimacy, but also adds to their legitimacy and influences investor behavior.

In contrast to the above studies, Sherer & Lee (2002) made an exceptional contribution to the literature by integrating Resource dependency (RDT) and institutional theory by arguing that resource scarcity generates, and legitimacy enables, institutional changes. Using a data sample of over 200 large law firms with high legitimacy/prestige, they examine the causes of innovation (new ways of doing a task) when departing from standard human resource practices (standard ways of doing that task). Their findings suggest that human resource scarcity and prestige (legitimacy) increased the likelihood of adoption. It may be interesting to note that their findings are completely at odds with Tolbert & Zucker's (1983) findings that early adopters of civil service were motivated to reform by technical-competitive pressures (resource scarcity), and late adopters, by institutional pressures (legitimacy reasons). However, they can be partly reconciled for the early adopter by assuming that early adopters have both technical-competitive and institutional (prestige) pressures.

In supply chain management literature, institutional theory describes "institutionalized practices" as those practices by firms that are perceived as economically viable even if there is a lack of empirical evidence of such economic effectiveness (Ketokivi & Schroeder, 2004). These practices include, but not limited to, quality management practices, lean manufacturing practices, JIT practices, integrated manufacturing practices, and sustainability practices. For instance, Toyota's success in its manufacturing system and upstream supply network management was a clear motivation for US manufacturing firms to mimic lean manufacturing practices, without consideration about its impact on economic performance. In supplier certification context, large firms coerce their suppliers to mimic certain practices (such as ISO 9000 and ISO 14000), that suppliers have no choice but to comply. The so-called "industry best practices" is an out loud application of institutional theory in operations and supply chain management context. Perhaps, the growing trend of adopting sustainability practices makes a strong case for institutional isomorphism argument as a "rubrics of fashion" (Abrahamson, 1996).

Resource-based View

Resource-based view (RBV) explains how firms gain competitive advantages, such as unique resources and capability that have an influence on their performance. It suggests that firms need to focus on their internal resources rather than their external environment to achieve for achieving competitive advantages (Barney, 1991; Peteraf, 1993). In its simplest form, RBV speaks primarily about the resourcefulness and application of a bundle of valuable tangible or intangible resources of the firm as a source of competitive advantage (Barney, 1991; Wernerfelt, 1984; Penrose, 1959). RBV stands on two key assumptions: (a) resource heterogeneity, i.e., firms within an industry (or group) may be heterogeneous with respect to the set of strategic resources and capabilities they control, and (b) resource immobility, i.e., these resources and capabilities may not be perfectly mobile (tradable) across firms, and thus maintains long-lasting heterogeneity of resources.

Barney (1991) defines a firm's 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). This definition about a firm's resources appears vague and draws sharp criticisms among management scholars for its unbounded limits of a firm's resources, and thus questioning what a resource is not then. (Priem & Butler, 2001; Kraaijenbrink et al., 2010). A simpler approach to explain resources is to classify resources as tangible and intangible (Grant, 1999; Allee, 2009). The former means tangible assets such as financial, land, and building, physical assets and the latter means intangible assets such as reputation, patents, and technology. While tangible assets are efficient in a stable environment, intangible assets are effective in an uncertain environment. Therefore, intangible assets can be considered as those strategic resources that ensures competitive advantages of firms and hold higher importance than tangible assets in environmental uncertainty.

According to RBV, not all firm's resources have the potential of sustained competitive advantage. To have this potential of sustained competitive advantage, the firm's resource must satisfy the VRIO condition (i.e., valuable, rare, inimitable, and non-substitutable). A firm's valuable and rare resources may become the sources of sustained competitive advantage when other firms cannot perfectly imitate it. It can happen due to one or a combination of three reasons: (a) unique historical conditions/path dependence of the firm (e.g., unique scientific foundation) (b) existence of causal ambiguity about the firm's resources and its sustained competitive advantage that is not/partially understood by its competitors (e.g., Toyota's TQM) (c) complex social phenomena that cannot be fully/partially understood by its competitors (e.g., organization culture of South West Airlines). Lastly, even if a resource is rare, potentially value-creating and imperfectly imitable, an equally important aspect is lack of substitutability (Dierickx & Cool, 1989) to have sustained competitive advantage. For example, if competitors can counter the firm’s value-creating strategy with a substitute, profits may dip significantly.

Despite its circularity in definition, RBV can sufficiently explain how a firm’s internal attributes (such as products that it produces) are linked with the market. While Barney’s (1991) seminal work provides the VRIO framework to assess the firm’s competitive or sustained competitive advantage, Wernerfelt’s (1984) groundbreaking work explicitly highlights the linkage between product and market strategy. By examining the direct/indirect resource positions of a firm, Wernerfelt identifies the type of resources required (and can be re-used in different strategic/product settings) by a firm that can make firm achieve its profitability. RBV suggests that first mover advantages (resource position barriers), resources attractiveness (e.g., machine capacity, customer loyalty, experience, etc.), resource recombination, mergers and acquisitions (as purchase of resource in imperfect market by firms such as GE) are the unique means that a firm should dynamically manage resources to attain competitive advantage and /or sustained competitive advantage.

One of the initial and critical challenges of RBV was to operationalize and empirically validate the key tenets of the proposed framework. Miller & Shamsie (1996) study is one noteworthy example on empirically defining and testing RBV of the firm in a study of the major US film studios from 1936 to 1965. Their findings suggest that property-based resources (e.g., exclusive long-term contracts with stars and theaters) supported financial performance during stable environment (i.e., during the period between 1936 and 1950), whereas, knowledge-based resources (e.g., production, coordinative and technical talents) helped financial performance during uncertain post-television environment (i.e., during the period between 1951 and 1965).

Several studies have critically examined the worthiness of RBV. For instance, Priem & Butler (2001) questions the usefulness of Barney's (1991) RBV as a theory for strategic management research by criticizing the vagueness of its definition (what is/is not resources; law-like generalization), its boundary conditions (assumed stability in market conditions), tautological approach (circular reasoning/nomic necessity – how do you know that a resource is valuable ex-ante?) between valuable resources and (sustained) competitive advantage, empirical testifiability criterion, and its static-ness (inability to explain where does the firm's resources come from – "blackbox"?). In response to this criticism, Barney (2001) positive response enriches RBV's usability and contextuality for strategic management research. In a similar effort, Kraaijenbrink et al. (2010) review and assess the principal critiques that surfaced from the extant RBV literature (of past 20 years). Together, they argue that some of the criticism can be countered within RBV framework of variables, boundaries and applicability, whereas, other criticisms (that arise due to the unspecified limits of resource and narrow conceptualization of a firm's sustained competitive advantage) require further theorizing and research. In yet another instance, Armstrong & Shizimu (2007) discuss about empirical approaches and challenges in RBV studies (from 1991-2005) in terms of operationalization issues, sustainability (DV), confounding factors, and non-significant findings. As such, some scholars support RBV as a theory that explains about role of managers, resource functionality, resource recombination), whereas critics of RBV disqualify it to be considered as a theory due to its methodological issues (Lockett et al., 2009).

Basing on RBV of the firm, Miles & Snow (2007) interpreted how firms develop capabilities through acts of trust and mutual co-operation between firms, in terms of knowledge sharing and expertise. RBV asserts that such resources and capabilities of firms may become their core competencies (i.e., competitive advantages) which explains for the differences in performance among firms even within a single industry (Wernerfelt, 1984; Barney, 1991; Peteraf, 1993). From a supply chain perspective, it may be argued that RBV can help in identifying and sustaining those core competencies of a firm that can form the basis of achieving efficiency in their supply chain structure and processes, such as integration capabilities, information sharing capabilities, supply chain flexibility, and so on (Bowersox et al., 2002; Subramani, 2004). In addition. Dyer & Singh (1998), expressed that valuable resources and practices often exist within diverse memberships of a supply chain. This study relies on RBV as a theoretical lens for two reasons: (a) to explain the assets, knowledge, capabilities, and organizational processes (Grant, 1999) related CEBM activities of supply chains that contingency theory (i.e., the main theoretical lens) may not sufficiently describe, and (b) to explain how those CEBM activities may be organized and leveraged to become the source of competitive advantage of the focal firm and its supply chains (Peteraf, 1993; Henderson & Cockburn, 1994; Wiklund & Shepherd, 2003).

CONTINGENCY RESEARCH IN SUPPLY CHAIN MANAGEMENT

The field of supply chain management has noted an explosion of new management practices ranging from quality management to sustainable supply chains (Furlan Matos Alves et al., 2017; Caniato et al., 2014). While these new practices have typically undertaken a stance of “the best practice paradigm” (Voss, 1995) to achieve superior performance based on their proof of applicability on few large/small firms and their processes, limitations have also been identified about such generalizations (Sousa & Voss, 2008; McAdam et al., 2016; Prajogo et al., 2018). Research has provided enough evidence that the claim of best practices can be severely flawed due to anecdotal evidences from cases studies approaches or lack of empirical richness in “contextuality”, and even, due to lack of emphasis on uncertainties at different levels (Flynn et al., 2016). Incidentally, this “contextuality” reasoning finds additional support in sustainable supply chain management domain where studies have adopted contingency approach as primary planning tool for production planning/controlling for material/resource recovery and reuse (e.g., Guide Jr. et al., 2003; Srivastava, 2007; Zhu et al., 2007; Walker & Jones, 2012). As such, the contextual elements of supply chain practices play an important role in driving firms to find a form of “fit” between the proposed form of practice (e.g., CEBM practice in this study) and its organizational relevance to achieve better performance (Sousa & Voss, 2008; Ketokivi & Schroeder, 2004). Table 3-5 presents a review of relevant literature in supply chain management that uses contingency theory (e.g., Lawrence & Lorsch, 1967; Thompson, 1967; Woodward, 1958) to answer the research questions. Given the practice-oriented nature of supply chain domain, studies cover the subdomains of quality and innovation management (e.g., Hult et al., 2007; Caniato et al., 2014), production process management (e.g., Ketokivi, 2006; Trkman & McCormack, 2009; Gold et al., 2017), supplier network management (Kajuter & Kulmala, 2005; Rosenzweig, 2009; Iyer et al., 2009), supply chain risk management (Simangunsong et al., 2016; Grostch et al., 2013; Eckstein et al., 2015), and sustainable supply chain management (Guide Jr. et al., 2003; Walker & Jones, 2012; Formentini & Taticchi, 2016; Furlan Matos Alves et al., 2017; Zhang et al., 2017). Since sustainable supply chain domain describes the core of this study, further investigation showed that contingency approach seems suitable to this sub-field due the countless exogenous and endogenous uncertainties that it faces for practicing sustainable development (and CEBM, for its circularity approach, qualifies as one of those practices).

Table 3 - 5. Major studies addressing contingency factors (CT) affecting supply chain management (SCM)

Study	**Purpose**	**Research type (Form of fit)**	**Main findings**
David et al., 2002	To examine longitudinally about the performance contingency effect between product competitive strategy (production differentiation vs. cost leadership) and organization design.	Quantitative statistical (Interaction)	A contingency relationship exists between product competitive strategies, purchasing design characteristics, and overall firm financial performance.
Guide Jr. et al., 2003	To explore contingency factors that have influence on production planning and control in the process of product recovery in closed-loop supply chains	Qualitative case (System)	Remanufacturing requires different environments for effective production planning and controlling due to uncertainties in returns volume, returns timing, returns quality, product complexity and remanufacturing complexity
Stonebraker & Afifi, 2004	To examine and classify distinct supply chain strategies (differentiation vs. integration) appropriate for four evolving phases of supply chain development.	Qualitative case (Selection)	Supply chain integration effort are realized through variance in strategies and tactics by means of balancing differentiation and integration efforts of supply chain activities
Kajuter & Kulmala, 2005	To study upon how to make open-book accounting work towards improving the cost efficiency of supply chains and building trust into buyers & suppliers.	Qualitative case (System)	A contingency framework for open-book accounting in networks.
Ketokivi, 2006	To understand task-environmental contingencies influencing firm's strategic flexibility, more specifically in terms of plant-level	Qualitative case; not inductive (System)	Demand uncertainty and variability, technology, and competitive strategy qualify as the key contingencies.

Table 3 - 5. Major studies addressing contingency factors (CT) affecting supply chain management (SCM)

Study	Purpose	Research type (Form of fit)	Main findings
	actions deliberated to gain manufacturing flexibility.		
Hult et al., 2007	To examine the influence of a firm's culture of supply chain competitiveness and knowledge development on supply chain performance in varied market turbulence conditions (contingency)	Quantitative statistical (Interaction)	The interaction of competitiveness and knowledge development has positive influence on performance, and market turbulence positively moderates the relationship between knowledge development and performance and negatively for that between culture of competitiveness and performance.
Sousa & Voss, 2008	To examine practice contingencies in operation management (OM PCR) using several dimensions of contingency theory (CT), such as contingency variables, performance variables, measurement, research design and the form of fit.	Conceptual (n/a – Seminal article)	To increase contingency patterns, scholars need to study the selection process of OM best practices by organizations using integrated approach to CT with other theoretical perspectives, such as institutional theory, resource-based view and so on.
Iyer et al., 2009	To study the relationship between B2B e-commerce supply chain integration and performance by applying the contingency theory "fit" concept.	Quantitative statistical (Interaction)	The effect of B2B supply chain integration on firm's performance (financial, market, and operational) decreases when product turbulence and demand unpredictability increases.
Rosenzweig, 2009	To study how varying product and market characteristics influence the nature of the expected positive	Quantitative statistical (Interaction)	The influence of electronic-collaboration on operational performance of manufacturing firms is contingent upon perceived level of

Table 3 - 5. Major studies addressing contingency factors (CT) affecting supply chain management (SCM)

Study	**Purpose**	**Research type (Form of fit)**	**Main findings**
	relationship between e-collaboration and performance.		environmental munificence, but not upon product complexity or market variability.
Trkman & McCormack, 2009	To analyze and assess supplier risk of disruption based on how turbulence influences their strategy, structure, performance and other attributes.	Conceptual (System)	A conceptual framework for predicting supply chain risks by analyzing environmental turbulence based on their classification (exogenous vs. endogenous) against supplier attributes and SC strategies/structure
Caridi et al., 2010	To study the relationship between supply chain configuration (i.e., virtuality and complexity contexts), supply chain visibility (response) and their impact on focal firm's performance	Qualitative case (System)	A focal firm whose supply chain is complex is required to invest more on increasing visibility. Also, focal firms have lesser visibility on their second and beyond tier suppliers, irrespective of supply chain complexity.
Boon-itt & Wong, 2011	To evaluate the moderating effects of technological and demand uncertainties on the relationship between supply chain integration and customer delivery performance.	Quantitative statistical (Interaction)	Internal and supplier (but not customer) integration on customer delivery performance vary under different levels of technological and demand uncertainties. Also, technical and demand uncertainties are exogenous factors.
Wong et al., 2011	To study situational factors under which information integration between a firm's internal functions and across partner firms contribute to gain competitiveness.	Quantitative statistical (Interaction)	Information integration improves firms' ability to perform during less uncertain conditions, and, when they offer stable and complex products.
Walker & Jones, 2012	To explore sustainable supply chain management (SSCM) issues that leading firms in their sectors	Qualitative case (System)	A typology of firm responses (Internal focusers, Reserved players, External responders, and Agenda setters) to practice

Table 3 - 5. Major studies addressing contingency factors (CT) affecting supply chain management (SCM)

Study	Purpose	Research type (Form of fit)	Main findings
	presently face, and investigate upon factors that have influence on their SSCM practices.		SSCM in future, based on internal/external enablers and barriers.
Grotsch et al., 2013	To investigate for antecedents that raises pro-activeness in risk management implementation.	Quantitative statistical (Interaction)	Mechanistic management, rational cognitive style and relational buyer–supplier relationships are identified.
Caniato et al., 2014	To investigate the integration of new product development process and international retail in fashion industry.	Qualitative case (System)	A fit model, identified contingency and contextual variables, practices, and their relationships in terms of propositions.
Engelseth, 2016	To study how food producers network for supplying goods through short supply chains ("local foods" distribution).	Qualitative case (Selection)	"Local foods" distributions are transparent and interdependent (pooled/reciprocal) due to human perception/local knowledge of operations.
Flynn et al., 2016	To develop a theoretical analogy between a supply chain and an organization based on organizational theories and identify characteristics of micro-, meso- and macro-levels of supply chain uncertainty.	Quantitative statistical (Interaction)	The micro-level and meso-level uncertainty are positively related to supply chain integration, whereas macro-level uncertainty is inversely related to it. Also, the organization structure variables of centralization and formalization moderate the above relationship.
Formentini & Taticchi, 2016	To provide empirical and theoretical evidence about of how firms apply sustainability-based strategies into practice and their alignment with governance mechanisms.	Qualitative case (System)	Identification of sustainability profiles (sustainability leaders, sustainability practitioners and traditionalists), governance mechanisms categories by levels of collaboration and formalization, governance mechanisms enablers.

Table 3 - 5. Major studies addressing contingency factors (CT) affecting supply chain management (SCM)

Study	**Purpose**	**Research type (Form of fit)**	**Main findings**
Simangunsong et al., 2016	To investigate effective management strategies that involve unethical approaches to manage supply chain uncertainties.	Qualitative case (System)	Three ethical issues surfaced - collusion amongst suppliers, government lobbying and power "abuse". Joint purchasing strategy is suggested to counter supplier collusion issue.
Furlan Matos Alves et al., 2017	To explore how climate-change based supply chain-related contingencies affect organizational structure of firms, and influence towards adoption of low-carbon operations management practices.	Qualitative case (System)	Low-carbon management structure/initiative improves the organizations' perceptions of potential benefits. Also, controlling and monitoring climate contingencies at the supply chain level must be permanent and systematic.
Gold et al., 2017	To investigate manufacturing capabilities development process by comparing top management's competitive priorities, plants' manufacturing strategies, and plants' manufacturing performances between old and new EU member firms.	Quantitative statistical (Interaction)	Extends "sand cone model" by showing that old and new EU member firms take different paths due to differing labor costs, impositions, and pressure from stakeholders.
Zhang et al., 2017	To investigate how green supply chain management practices and social control interact in complex and dynamic environments.	Quantitative statistical (Interaction)	Joint effect of social control and green supply chain management practices is positive and significant under conditions of environmental dynamism.
Castillo et al., 2018	To study why and how "crowdsourced logistics" deliver	Quantitative modeling (Interaction)	Contingency variables that firms can apply to gain strategic benefit using "crowdsourced logistics".

Table 3 - 5. Major studies addressing contingency factors (CT) affecting supply chain management (SCM)

Study	**Purpose**	**Research type (Form of fit)**	**Main findings**
	sooner better than traditional ones in dynamic conditions.		
Dubey et al., 2018	To study when and how firms must develop capability in big data analytics to improve supply chain agility.	Quantitative statistical (Interaction)	Information systems capability increases a firm's supply chain agility, and is contingent upon its organizational flexibility.

In addition, the contingency approaches employed in extant literature (See table 3-6) appears to examine the influence of contextual factors, which can be subjective and inertial, on supply chain related practices and their related outcomes. This response-context-performance relationship requires deeper understanding on four aspects - the response construct, the contingency construct, the performance contract, and finally, the forms of the fit between the three constructs.

Response construct. The response construct explains the actions taken by the focal firms or their managers in response to present or anticipated contingency factors. The response construct includes a wide variant of practices. These actions can be broadly qualified into strategic, operational, and environment level concerns, but possible overlaps are unwarranted depending on the research in questions. An example of strategic level action can be found in the by study by Hult et al. (2007) that statistically examines the influence of an organization's culture of supply chain competitiveness and knowledge development on supply chain performance in varied market turbulence conditions. Another example of strategic action can be expressed through the study by Simangunsong et al. (2016) that qualitatively investigate effective management strategies that involve unethical approaches to manage supply chain uncertainties. Similarly, actions at operational level can be represented in the study by Kajuter & Kulmala (2005) that how open-book accounting can improve the cost efficiency of supply chains and build trust in customer–supplier relationships. An apt example of environment related action can be found in the study by Furlan Matos Alves et al. (2017) that explores the fit between adoption of low-carbon operations initiatives and climate-change based supply chain-related contingencies in improving organizations' perceptions of potential benefits.

Contingency construct. The contingency construct characterizes the contextual factors that the focal firms or their managers consider for their response. Typically, such factors are exogenous, meaning the ability to directly manage these factors are limited (e.g., interest rates, political shifts, climatic changes). For some highly inertial exogenous case, such as socio-cultural preferences of customers, firms may be able to manage in the long-term based on their continuance of efforts. Endogenous factors, such as employee skills, plant processes, etc., are the ones that firms or managers can directly controllable. Exogenous factors appear to be the predominant set of contingencies among studies of strategic and environmental importance. For example, the study by Caniatio et al. (2014) addresses strategic stability in terms of developing new products for international markets by addressing exogenous factors such as climatic conditions, seasonality, economic potential, religious beliefs, and people's stylistic nature and fitting patterns of different countries. Similarly, Zhang et al. (2017) addresses environmental aspects in adopting green supply chain practices by selecting exogenous conditions related to complex social behaviors. However, consideration for both exogenous and endogenous contingency factors are also found in several studies, such as the one by Flynn et al. (2016) that studies influence of micro-, meso- and macro-levels of supply chain uncertainties on centralization, formalization and flatness of organizational structure and their impact on downward and upward supply chain integration. The objective of those studies considering exogenous factors effect appeared to be looking for applicability of supply chain practices for different strategic outcomes.

Performance construct. The performance construct represents the desired outcome and its appropriateness as a result of the examined fit between response and contextual factors under consideration. The performance objectives are typically rooted in the contingency models (Sousa &

Voss, 2008). As such, the firms' performance (or outcome) for this stream of research has wide variety, which included business performance (e.g., Kajuter & Kulmala, 2005; Rosenzweig, 2009), supply chain performance (e.g., Hult et al., 2007; Iyer et al., 2009), product performance (Caniato et al., 2014; Guide Jr. et al., 2003), risk management (e.g., Trkman & McCormack, 2009), market performance (e.g., Rosenzweig, 2009; Iyer et al., 2009), supplier collaboration (e.g., Fawcett et al., 2010), logistics effectiveness (e.g., Castillo et al., 2018), supply chain agility (e.g., Dubey et al., 2018) and sustainable supply chain performance (e.g., Walker & Jones, 2012; Zhang et al., 2017). Thus, it can be concluded that this form of research provides prescriptive knowledge required to achieve traditional operational performance (also known as competitive priorities, i.e., cost, quality, delivery and flexibility; Ferdows & Meyer, 1990), which in turn becomes the source of gaining other forms of organizational performance.

Forms of fit. Contingency research scopes for several forms of fit model (See Drazin & van de Ven, 1985; Venkatraman, 1989, Doty et al., 1993, Sousa & Voss, 2008). Based on the how the relationships between contextual, response and performance variables are investigated, three distinct forms of fit are selection, interaction and system approach (Drazin & Van de Ven, 1985). In yet another effort, Venkatraman (1989) re-examines these alternate forms and proposes six different forms of fit based on purpose of such form of fit and the associated number of variables considered in the fit model. These six forms include moderation, mediation, matching, gestalts, profile-deviation and co-variation. Nonetheless in their seminal article, Sousa & Voss (2008) calls for a parsimonious reconciliation as shown in figure 3-4. All the three forms of fit were commonly observed in the contingency research literature (See table 3-6).

First, the selection form of fit suggests congruence between response and contextual factors, without any concern about performance (Sousa & Voss, 2008). Table 3-6 shows that the selection approach is not commonly observed. This reason can be attributed to the fact that the scopes of supply chain management studies are typically questioned if practice-performance outcomes are excluded. Not surprisingly, Stonebraker & Afifi (2004) aptly ignores to measure performance, since their research question points at qualitative investigate the contingencies related to application of two distinct supply chain strategies (i.e., differentiation or integration) during the four complexly evolving phases of supply chain development. Similarly, Engelseth (2016) adopt selection approach to find fit between local food networks (i.e. supplier and producers) for increasing short-supply chain situation as a pre-condition. Second, the interaction for of fit evaluates the interaction between a paired set of response and contextual factors that affects performance (Sousa & Voss, 2008).

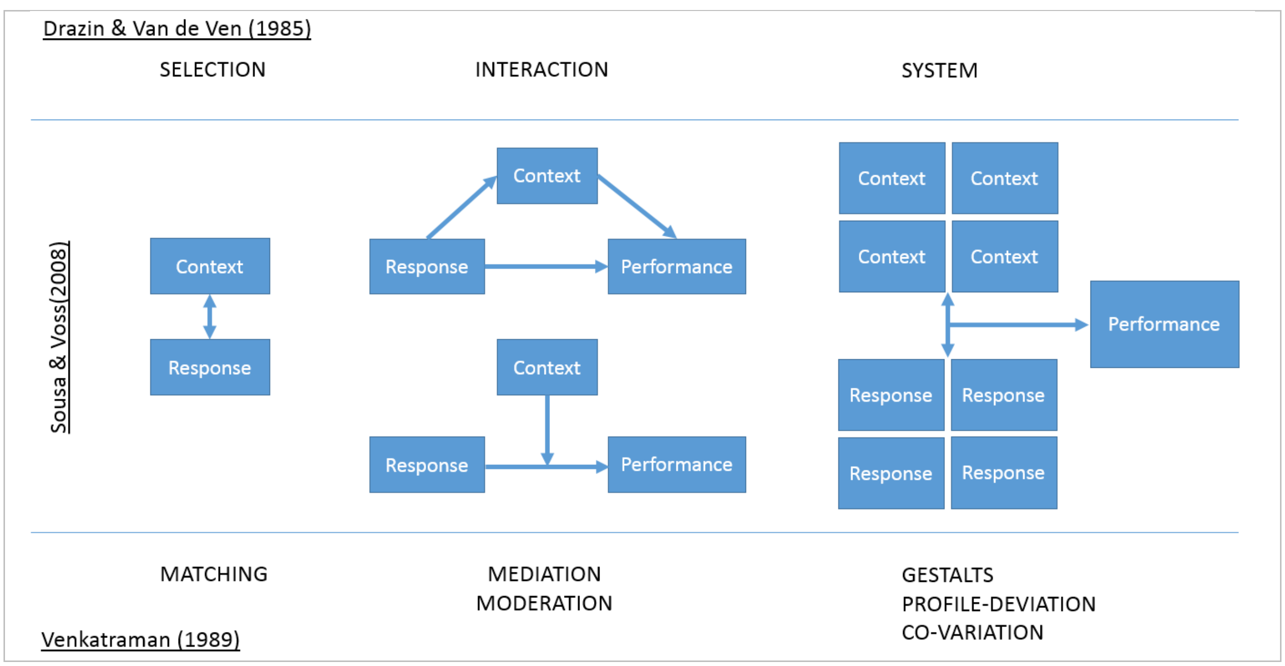

Figure 3 - 4. Venkatraman's (1989) six forms of fit in Drazin & Van de Ven's (1985) categorization. Source: Sousa &Voss (2008)

Table 3-6 shows that the interaction approach is commonly observed in studies that uses quantitative methods to aggregate and infer upon larger sample dataset. The interaction approach suits for studies that the one-to-one interaction between certain individual action and its related contingency significantly affect performance of a supply chain practice. Therefore, this approach suits for well-established fields, such as manufacturing practices (e.g., Gold et al., 2017), supplier management (e.g., Flynn et al., 2016), and supply chain risk management (e.g., Grotsch et al., 2013), that draws deeper understanding about unfound practice related aberrations. In general, both selection and interaction approaches are tuned to study how one contextual factor affects one response type. Third, the system form of fit allows holistic understand of an organizational design by forming a system for simultaneous reasoning about how several contingencies can interact with alternate responses and their expected performance outcomes (Sousa & Voss, 2008). Interestingly, the system approach allows firms to find "equifinal" configurations, means, more than one equally effective alternate designs (Van de Ven & Drazin, 1985). Table 3-6 shows system approach as the most obvious choice for qualitative studies in promising areas, such as sustainable supply chains (e.g., Guide Jr. et al., 2003; Walker & Jones, 2012; Formentini & Taticchi, 2016; Furlan Matos Alves et al., 2017). Although supply chain management is not explicitly attached to any distinct form of fit, the system approach become an inherent form of fit for this CEBM study, since "one size fits all" approach can jeopardize CE adoption due to the unique challenges in supply chains (Masi et al., 2017; Gaustad et al., 2017).

Table 3 - 6. The "response-context-performance" relationship in supply chain management (SCM) literature

Study	Response	Context	Performance	Form of Fit
David et al., 2002	Product competitive strategies (cost leadership vs. differentiation)	Organization design (decentralization vs. coordination), operational efficiency	Organizational performance	Interaction
Guide Jr. et al., 2003	Production planning and control	Volume, timing, quality of returns; Complexities in terms of product features, testing & evaluation, and remanufacturing processing	Product recovery	System
Stonebraker & Afifi, 2004	Four evolving phases of supply chain development.	Supply chain strategies (differentiation vs. integration)	N/A	Selection
Kajuter & Kulmala, 2005	Open-book Accounting in networks	Exogenous, endogenous, network-specific	Organizational performance	System
Ketokivi, 2006	Strategic (manufacturing) flexibility	Task-environmental contingencies (demand uncertainty/variability, technology, competitive strategy)	Manufacturing flexibility	System
Hult et al., 2007	Organizational culture (i.e., supply chain competitiveness; knowledge development)	Market turbulence	Supply chain performance	Interaction
Iyer et al., 2009	B2B e-commerce supply chain integration	Demand unpredictability ; product turbulence	Financial, operational, market performance	Interaction
Rosenzweig, 2009	e-collaboration	Product complexity, environment, market	Operational and business performance	Interaction
Trkman & McCormack, 2009	Supplier attributes & SC strategy/structure	Endogenous (Market, technology),	Supplier disruption	System

Table 3 - 6. The “response-context-performance” relationship in supply chain management (SCM) literature

Study	Response	Context	Performance	Form of Fit
		Exogenous (interest, terror, etc.)		
Caridi et al., 2010	Supply chain visibility (response)	Supply chain configuration (i.e., virtuality, complexity)	Supply chain performance	System
Fawcett et al., 2010	Collaboration strategy	Inadequate training, policies, and social dilemma	Supply chain collaboration	System
Boon-itt & Wong, 2011	Supply chain integration	Technological and demand-based uncertainties	Customer delivery performance	Interaction
Wong et al., 2011	Information integration (internal & across)	External (munificence, uncertainty); Operating (product type/complexity)	Supply chain’s business performance	Interaction
Ashenbaum et al., 2012	Firm-level trait preferences in personnel hiring and promotion decisions	Organizational structure and entrepreneurial culture	N/A	Selection
Chavez et al., 2012	Supply chain management practices	Industry clockspeed	Supply chain performance	Interaction
Bellingkrodt & Wallenburg, 2013	External relations (with logistics service providers)	Innovation	Business performance	Interaction
Walker & Jones, 2012	Sustainable supply chain practices	External (NGO, customer requirement, supplier, media, sectorial, and global) Internal (strategic, reputation, size, performance management, functional, purchasing, integration	Sustainable supply chain performance	System

Table 3 - 6. The “response-context-performance” relationship in supply chain management (SCM) literature

Study	Response	Context	Performance	Form of Fit
Grotsch et al., 2013	Supply chain management practices (mechanistic control, rational cognitive, buyer-supplier relationship	Past supplier insolvency	Supply chain risk management	Interaction
Caniato et al., 2014	New product development process and practices; International retailing	Country Variable (Climatic, seasonality, economic potential, religious, stylistic, fitting); Firm variables	Time-to-market; Number of collections	System
Eckstein et al., 2015	Supply chain agility and adaptability – capabilities	Product complexity	Cost and operational performance	Interaction
Engelseth, 2016	Developing efficient “short supply chains” in local food chains	Improved intensive technology vs. pooled interdependency (standardization)	N/A	Selection
Formentini & Taticchi, 2016	Sustainability-based strategies	Governance mechanisms	Sustainability practices	System
Simangunsong et al., 2016	Ethical management strategies (reducing and coping with uncertainty), such as parallel interaction with similar firms and government (i.e., collusion), abuse of power	Environmental uncertainties	Supply chain performance	System
Furlan Matos Alves et al., 2017	Low carbon management practices	Supply chain Level Climate-related factor (e.g., scarce	Perceived benefits	System

Table 3 - 6. The “response-context-performance” relationship in supply chain management (SCM) literature

Study	Response	Context	Performance	Form of Fit
		resources, regulation, extra cost due to bad weather)		
Gold et al., 2017	Plants' manufacturing strategies	Top management's competitive priorities	Plants' manufacturing performances	Interaction
Zhang et al., 2017	Green supply chain management practices	Complex and dynamic environment	Social control	
Dubey et al., 2018	Big data capability	Organizational flexibility	Supply chain agility	Interaction
Castillo et al., 2018	Crowdsourced logistics (vehicle supply vs. dedicated logistics)	Task environment (time to deliver, daily demand)	Logistics effectiveness (on-time, total delivery)	Interaction

SUPPLY CHAIN PREPAREDNESS

The rising complexities in supply chain context and networks has been keeping firms wrestling with uncertainties internal manufacturing processes, supply-side processes, or demand-side issue (Hult et al., 2010). These uncertainties are deemed to grow exponentially when firms decide to adopt new practices, such as CEBM practices. There is a growing interest in the related areas of supply chain risk (e.g., Ritchie & Brindley 2007, Braunscheidel & Suresh 2009, Neiger et al., 2009; Simangunsong et al., 2016) that commonly suggested that inadequate "supply chain preparedness" (SCP) is a major deterring factor that leads firms towards failures in operational performance, thus causing severe impact on their business performance (Davis, 1993; Hult et al., 2010). In the following sub-section, the notion of "supply chain preparedness" is discussed based upon its relevance in mainstream and sustainable supply chain management domains.

Origin and sense-making of the term "Preparedness". In behavioral science, the term "preparedness" finds subsequence to Pavlov's (1927) and Thorndike's (1905) laws of learning. Both Pavlov's dog-meat experiment and Thorndike's cat-puzzle box experiment are archetypes to demonstrate how "*organism can be either prepared, unprepared, or contraprepared for learning about the events*" (Seligman, 1970, p.408). Likewise, the term "supply chain preparedness (SCP)" is approached in this study as a focal firm's supply chain readiness in pursuing, planning and implementing CEBM practices, as well as its ability to appropriately respond to contingencies in its strategic, structural and institutional conditions. Strategic contingencies comprise of those factors that the focal firm may strategically address in pursuing their circular business models. Structural contingencies include those factors related to external business and internal task environment that have structurally relevant for a firm in pursuing their circular business models. Institutional contingencies represent those factors influencing a firm's circular business models, which are guided by isomorphic mechanisms (mimetic, normative, or coercive) in their formation, as per institutional theory (Meyer & Rowan, 1977; DiMaggio & Powell, 1983).

Agility, Resilience, Adaptability and Preparedness. In supply chain management literature, the concepts of supply chain agility (e.g., Christopher & Peck, 2004; Carvalho et al., 2012) and supply chain resilience (e.g., Rice & Caniato, 2003; Christopher & Peck, 2004; Tang, 2006) have significant overlaps with the concept of supply chain preparedness. While agility characterizes a supply chain's ability to deal with unanticipated fluctuations in business environment and take advantage from such fluctuations, both in terms of volume and variety (Christopher, 2000), resilience refers to a supply chain's ability to rebound from a disruption to its normalcy (Sheffi & Rice, 2005). Thus, both concepts require different set of capabilities to address the uncertainty problem. Agility requires capabilities to gain market sensitive knowledge, shared information on demand and leveraging on partner's integrated capabilities to resolve the crisis (Agarwal et al., 2007; Swafford et al., 2008). On the other hand, resilience requires rebounding capabilities in terms of supply chain re-engineering, supply chain collaboration and business continuity planning. Since the purpose of resilient supply chains is to cope with the uncertainties in the business environment, they are not necessarily the lowest cost. Agility approaches are not related to internal supply chain events, since they tackle only the changes in environment factors (as threats or opportunities). On the other hand, resilience tackles both internal task and external business environments. However, major disruptions in the supply chain can also bring unexpected opportunities (Sheffi, 2005). For example, car manufacturers with resilient supply chains may exploit a crude oil crisis to popularize electric cars with more agility. Thus, agility approaches can become a major advantage for resilient supply chains (Lenort & Wicher, 2012). However, both approaches have commonalities in flexibility, visibility and collaboration capabilities, which in turn has positive influence on supply chain performance and competitiveness related attributes, such as time to market, quality and customer service (Carvalho et al., 2012). Adaptability is yet another closely related term (to supply chain preparedness) that refers to a firm's willingness to re-organize its supply chains as needed, and with no linkage to its past issues (Ketchen & Hult, 2007). Adaptable supply chains learn shifts from markets and apply appropriate actions such as moving facilities, changing suppliers, and outsourcing. For example, the American car manufacturer, Ford, sources its cars for African markets from its Indian production facility, although it could do so from its equivalent European facilities, to help differentiate the brands (e.g., Ford Ecosport), and to exploit costs and capabilities of suppliers from India. In this study context, the notion of "supply chain preparedness" serves for a larger purpose by combining the three approaches (i.e., agility, resilience and adaptability) in three different scopes, as shown in figure 3-5.

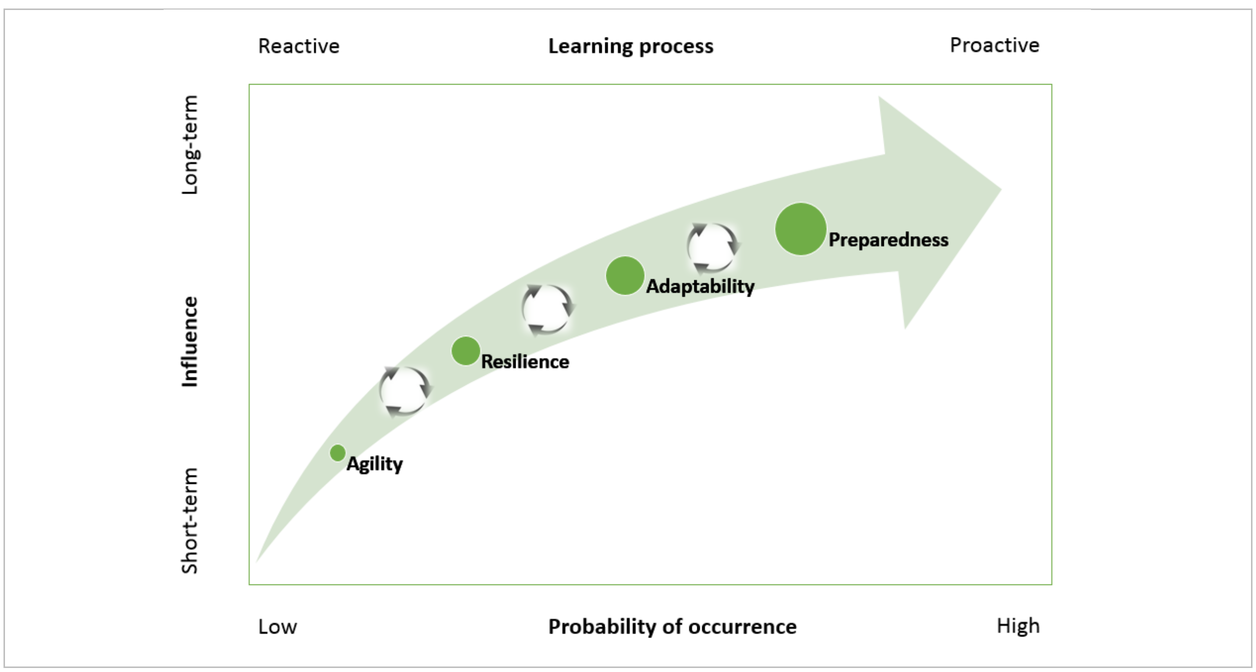

Figure 3 - 5. Matrix of Supply chain preparedness

The first scope is related to probability of occurrence. The likelihood of occurrence of unexpected events (such as demand mismatch and supply chain disruptions) that require agile and resilience approaches are typically low, and that for adaptability approaches may be for more profound medium. However, supply chain preparedness is seen as an outcome of a planned initiative (CEBM initiative), it is deemed to be an expected event. The second scope is associated with the learning process (i.e., proactive or reactive learning) of the four capabilities. While the proactive approach means taking a prior position to prevent or resist from getting affected by an unexpected event, the reactive approach looks to respond only after being affected by an event (Valikangas, 2010). In event of an unexpected event, a proactive agile approach of a supply chains becomes a learning precursor for its resilience capability (Neiger et al., 2009; Li et al., 2017). This process of one capability becoming a learning precursor for the next capability in the continuum shows path-dependence and historicity as described in the resource-based view (Barney, 1991). As such, each capability reactively learns from each other's response. Thus, a supply chains' scope to attain maximum supply chain preparedness depends upon its iterative and incremental learning process that grows step-by-step by working in cyclic iterations (Larman & Basili, 2003). The third scope relates to potential influence of the approaches. In the continuum, the short-term character of agile approaches has least influence, and the long-termed character of fully prepared approaches have highest influence on the supply chain performance (Charles et al., 2010).

Table 3-7 shows that the notion of "supply chain preparedness" has been richly discussed in several supply chain context, such as supply chain disruption (e.g., Chopra & Sodhi, 2004), humanitarian relief operations and disaster preparedness (e.g., Taskin & Lodree Jr., 2011), logistics planning (e.g., Closs et al., 2005), bio-terrorism preparedness (e.g., Bravata et al., 2006), business continuity planning (e.g., Zsidisin et al., 2005). These preparedness notions fall under three supply chain levels: upstream, internal (to the focal firm), and downstream.

At upstream level. These notional readinesses are related with interfaces between the focal firm and their suppliers. Examples include interest alignment across supply chains members (Li et al., 2017), coordinating and integrating with suppliers for designing and development, procurement, order quantification, cycle and delivery time planning (Agarwal et al., 2007; Swafford et al., 2008), creating switching and contracting methods with suppliers for flexible sourcing and material supplies (Rice & Caniato, 2003), increasing visibility of upstream inventories and supply conditions (Christopher & Peck, 2004).

At internal level. These notional readinesses are the ones that are deployed by focal firms in their daily internal operations. Examples include facility and stock prepositioning (Manopiniwes & Irohara, 2017), developing contingency plans to prevent damage of core business values (Li et al., 2017), coordinating, integrating, reconfiguring and batch-processing activities in manufacturing and production processes (Naylor et al., 1999), planning for reducing manufacturing throughput times, development cycle times, setups times and product changeovers (Swafford et al., 2008), designing production systems to accommodate multiple products and real-time changes (Rice & Caniato, 2003), provisioning multi-skilled workforce, capacity requirements, postponement and batch sizing (Tang, 2006), strategic stocking, make-and-buy trade-off structuring, strategic disposing of additional capacity and/or inventory, increasing visibility in production and purchasing schedules, knowledge creation, collaborative and risk management culture (Christopher & Peck, 2004; Iakovou et al., 2007).

At downstream. These notional readinesses are concerned with the types of material, information or financial flows that occur between the focal firm and their downstream partners in delivering their products or services to their end-customers. Examples include coordinating and integrating activities in logistics and distribution, delivery scheduling, new product releases (Manopiniwes & Irohara, 2017; Liu et al., 2006), adjusting and improving delivery capability and reliability, customer service quality, market responsiveness, levels of product customization, and demand information (Agarwal et al., 2007; Swafford et al., 2008), maintaining flexibility in logistics operations, managing product rollover, developing visibility of downstream inventories and demand conditions (Christopher & Peck, 2004; Tang, 2006).

Not surprisingly, this preparedness notion is anecdotally found in a handful of studies from sustainable supply chain domain. For instance, Ahmad et al. (2017) studied the influence of firm's commitment and management preparedness (i.e., relevant internal factors) upon sustainable practices in up/downstream supply chain of oil & gas industry - an industry that is closely related to our economic, environment and social needs. Similarly, Linton et al. (2007) studied upon factors that supports for convergence of supply chains with sustainability concepts such as product design, manufacturing by-products, by-products produced during product use, product life extension, product end-of-life, and recovery processes at end-of-life. Wolf (2011) uses four German cases to qualitatively identify critical success factors that enable or impede the integration of sustainability into supply chains. Svensson (2007) studied how corporate efforts of sustainable supply chains can be enhanced in business practices of first, second and n-order supply chains in clothing industries. Lastly, Golicic & Smith (2013) meta-analytically showed a positive and significant link between environmental supply chain practices and market-based, operational-based and accounting-based forms of firm performance. These studies act as collective evidence to suggest that a firm's readiness for pursue sustainable practices is a critical dimension for superior supply chain management outcomes, which in turn leads to increased firm performance.

Table 3 - 7. Major studies addressing supply chain preparedness (SCP) in supply chain management (SCM) literature

Study	Purpose	Research type	Concept of supply chain preparedness
Hendricks & Singhal, 2003	To assess effects of supply chain glitches on shareholder wealth.	Quantitative statistical	Supply chain glitches (unpreparedness) as factors that adversely affect the short/long-term net cash flows (from both revenue and cost side) of the firm.
Rice & Caniato, 2003	To propose a set of initiatives to build a secure and resilient supply network.	Conceptual	Supply chain resilience as a set of actions in supply, transportation, production facilities, communication, and human resources.
Zsidisin et al., 2005	To identify and analyze effective practices for business continuity planning in supply chain management.	Quantitative statistical	Business continuity planning as comprised of four factors - awareness, prevention, remediation, and knowledge management.
Chopra & Sodhi, 2004	To elaborate risks, their drivers and managing such risks to avoid supply chain breakdown.	Conceptual	Several types of risk mitigation approaches and its tailored strategies to avoid supply chain breakdown.
Christopher & Peck, 2004	To propose a framework to build resilient supply chains by describing the strategies and challenges of doing so.	Conceptual	Supply chain resilience comprises supply chain re-engineering, collaboration, agility and risk management culture
Closs et al., 2005	To define logistics flexibility constructs (i.e., flexible logistics programs and information connectivity), and test the mediating role of information connectivity in the relationship between flexible logistics programs and asset performance.	Quantitative statistical	Proactive preparedness as firm's planning, co-ordination and execution ability to adjust (flexibility) to changing customer requirement (i.e., shifting demand characteristics) and to modify its service delivery by making structural and system level changes.
Hale & Moberg, 2005	To propose a framework for building a network of secure site location to support multiple supply chain facilities.	Conceptual	Disaster preparedness as contingency plans in terms of disaster logistics planning in supply chains to store emergency supplies, equipment, and vital documents needed in times of crisis.

Table 3 - 7. Major studies addressing supply chain preparedness (SCP) in supply chain management (SCM) literature

Study	Purpose	Research type	Concept of supply chain preparedness
Bravata et al., 2006	To evaluate costs and benefits of alternate strategies respond to anthrax bioterrorism.	Quantitative statistical	Bioterrorism preparedness as alternate strategies/efforts to improve both local dispensing capacity and local inventories.
Cassivi, 2006	To analyze the effectiveness of e-collaboration tools on supply chain partners, and classify firms by their levels of collaboration planning.	Quantitative statistical	Collaboration planning as sequential approach of key actions (i.e., planning, forecasting, and replenishing) to be carried out to draft collaboration initiatives (e.g., joint process /product /relational innovation) in a supply chain.
Tang, 2006	To present strategies for mitigating supply chain disruptions (i.e., manage inherent fluctuations efficiently and increase more resilience).	Conceptual	Supply chain resilience as an exhaustive set of supply chain strategies
Van Wassenhove, 2006	To explore how private sector logistics can be applied to improve performance of humanitarian disaster logistics.	Qualitative case	Closer collaboration between humanitarians and businesses to achieve effective supply chains to respond to the complexities in both private sector and/or disaster logistics.
Iakovou et al., 2007	To propose taxonomy of supply chain risks and solutions to improve resiliency, and to outline an analytical model to design/operate supply chains efficiently.		Supply chain resilience as a set of interventions (flexible sourcing, demand-based management, strategic emergency stock, supply chain visibility, and process/knowledge back-up).
Chick et al., 2008	To demonstrate why/how production risks undermined by vaccine producers led to insufficient vaccine supply during times of epidemic.	Quantitative modeling	Supply chain co-ordination as function of cost-sharing contracts aligned to earn incentive for both buyer (govt. public health services) and supplier (vaccine producer).

Table 3 - 7. Major studies addressing supply chain preparedness (SCP) in supply chain management (SCM) literature

Study	Purpose	Research type	Concept of supply chain preparedness
Blos et al., 2009	To identify supply chain risks involved in automotive/electronic sectors in Brazil, and about supply chain risk management implementation.	Qualitative case	Supply chain risk management practices (better supply chain communication, business continuity planning, and creating chief risk officer position).
Faisal, 2009	To examine and categorize supply chain risks.	Conceptual	Risk mitigation variables as those variables that have positive impact on the overall risk mitigation environment.
Richey Jr., 2009	To propose a theoretical framework for understanding preparedness of and recovery from supply chain crisis.	Conceptual	Preparedness as interconnection between collaboration, communication, and contingency planning for better resource management.
Tomasini & Van Wassenhove, 2009	To discuss upon evolution of humanitarian supply chain (i.e., disaster relief) and public private partnerships	Conceptual	Preparedness as ability to focus on supply chain structures and processes to respond to disasters and to cope with uncertainty.
Czinkota et al., 2010	To provide theoretical grounding on the dimensions and effects of terrorism in global supply chain context	Conceptual	Organizational preparedness as advance preparation by virtue of flexibility and redundancy to ensure normal operations during and after terrorist events.
Taskin & Lodree Jr., 2011	To propose a Bayesian decision forecast model based on trade-off between forecast accuracy and cost efficiency of supplies in a hurricane situation.	Quantitative modeling	Disaster preparedness for potential humanitarian relief operations as a decision problem of finding balance between the conflicting goals of private (for profit) and humanitarian sectors (for time).
Kumar & Banerjee, 2012	To investigate influence of collaborative culture on collaboration, and moderating effect of preparedness on the relationship between collaboration and supply chain performance.	Quantitative statistical	Preparedness as set of tasks to be accomplished prior to initiation of collaborative relationship. It depends on how partners plan to collaborate and considered actions to ensure goals.

Table 3 - 7. Major studies addressing supply chain preparedness (SCP) in supply chain management (SCM) literature

Study	Purpose	Research type	Concept of supply chain preparedness
Cao & Zhang, 2011	To elaborate supply chain collaboration of a focal firm, and explore its impact on the firm performance based on the mediating role of collaborative advantage and firm size	Quantitative statistical	Supply chain collaboration as the concept of combining process focus and relationship focus of firms across the supply chain to plan and execute the operations together for achieving common goals and mutual benefits.
Carvalho et al., 2012	To propose a conceptual framework to explore how agile and resilient supply chain practices improves performance and competitiveness of supply chains.	Conceptual	Supply chain resilience as the ability of supply chains to cope with unexpected disturbances. Set of resilient practices developed upstream, internal and downstream.
Nagurneya & Qiang 2012	To provide an overview of network vulnerability assessment tools used in quantification of network efficiency in humanitarian operations/logistics/merger & acquisitions context	Quantitative modeling	Scenarios of centralized/decentralized user-optimized or network equilibrium designs of nodes and links of supply chain importance.
Kumar & Havey, 2013	To propose a decision support risk assessment and mitigation framework for disaster relief supply chain.	Quantitative event study	Preparedness as comprised of assessment, planning and training/education to prepare for supplying in anticipation of a demand. Also, differentiates Demand(s) ← Supply in normalcy vs. Suppli(es) → Demand in relief operations.
Bhattacharya et al., 2014	To examine asset transfer mechanism efficacies, and make recommendations for designing humanitarian supply chains	Quantitative modeling	Resource preparedness as the coordination and collaboration of humanitarian aids programs targeted at resource procurement and allocation.
Gualandris & Kalchschmidt, 2015	To develop a mathematical model of fit to manage supply risk, and evaluate the relationship between misfit and competitive advantage	Quantitative statistical	Balanced resilience as a (misfit) weighted distance between real adoption of practices SRM (such as flexibility in sourcing, anticipation,

Table 3 - 7. Major studies addressing supply chain preparedness (SCP) in supply chain management (SCM) literature

Study	Purpose	Research type	Concept of supply chain preparedness
			visibility, and recover) and vulnerability profile of the focal firm in a supply chain.
Ahmad et al., 2017	To analyze firm's commitment and preparedness of sustainable practices in their upstream and downstream supply chains.	Quantitative statistical	Management preparedness as a composition of macro-environmental and operational risk management, cross-functional integration and performance management
Manopiniwes & Irohara, 2017	To develop an integrated decision-making for effective relief operations -.	Quantitative modeling	Facility and stock prepositioning; evacuation planning; relief vehicle planning
Li et al., 2017	To study the impact of supply chain resilience dimensions (supply chain preparedness, supply chain alertness and supply chain agility) to increase firm's financial performance.	Quantitative statistical	Development of contingency plans to prevent damage of core business values; interest alignment across supply chains members to resist risks and optimize value creation.
Akkermans & Van Wassenhove, 2018	To present a dynamic model to predict and prevent grey swan events (destructive but somewhat predictable events caused due to inadequate managerial sense-making and decision making) in supply networks.	Qualitative case	Managerial preparedness as the prerequisite ability to actively "search for the grey swans" to prevent destructive impact on production supply networks (i.e., business tsunami).

CEBM AND SUPPLY CHAIN PREPAREDNESS THROUGH THE LENS OF CONTINGENCY THEORY

The main premise of this study is that a focal firm's supply chain preparedness (outcome) to pursue CEBM initiatives (response) is contingent upon several upstream and downstream contextual factors (contingencies), and such preparedness would lead firms for superior CEBM performance for the focal firm. This section outlines the factors to operationalize the four research constructs – the CEBM initiatives, the contextual factors, the supply chain preparedness, and the CEBM performance.

Factors of CEBM initiatives (Response Construct)

The concept of CE forms the basis for developing CEBM of a firm, product or network. CEBM is typically practiced at micro-level since it deals with circularity factors related to products and businesses, but can be practiced and has its influence on meso- and/or macro- levels, in terms of revenue-sharing, job creation, and environmental impact (Linder & Williander, 2017).The CE and CEBM literature reflects that a CEBM practice can be fully explained through interpreting the following four factors: (a) Rationality of pursuing CEBM practice, (b) Scope to pursue CEBM practice, (c) Degree of task complexity of CEBM practice, and (d) Level at which CEBM is practiced. In explaining a CEBM practice, these four factors may have significant overlaps and would make more sense when worked together. For instance, the rationality of certain CEBM practice might be to preserve natural resource (e.g., preserve trees by discouraging paper-based tax filing), but to do so, it must apply slowing loop (i.e., altering/reducing paper supply and size) as well as encouraging sufficiency (i.e., incentivized e-filing software) scopes. Figure 3-6 is a diagrammatically describe the CEBM practice factors and inter-relationships. Table 3-8 summarizes the descriptions of the above stated (four) factors.

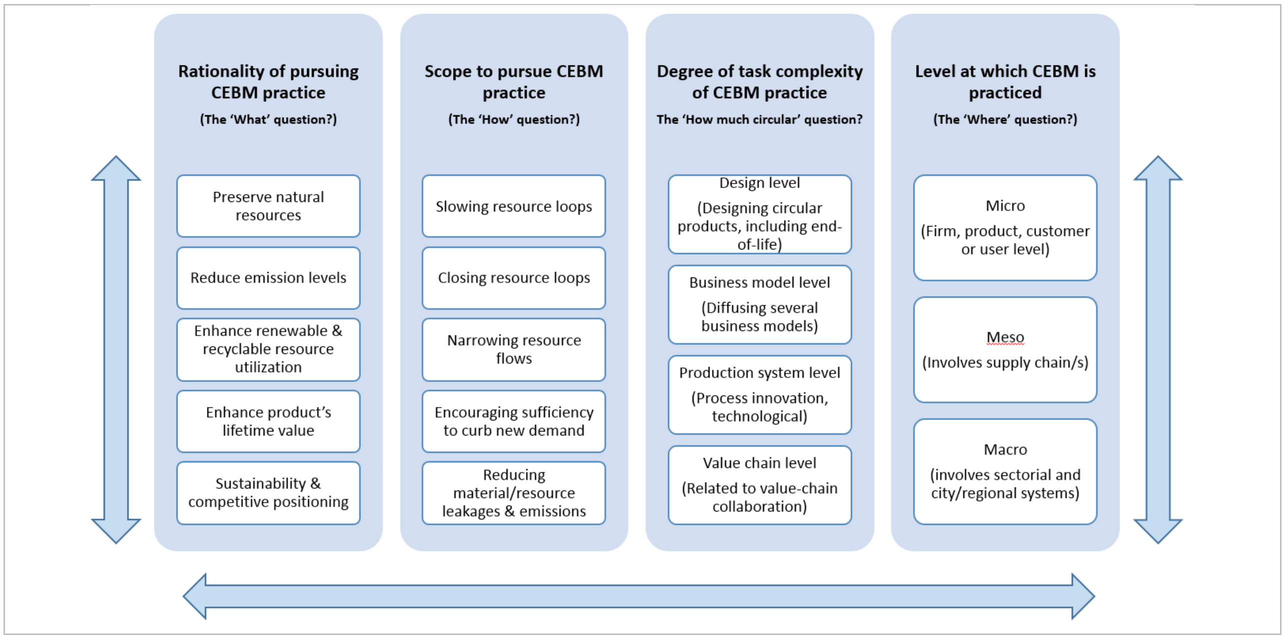

Figure 3 - 6. Factors of CEBM practice

Rationality of pursuing CEBM practice. The rationale to pursue CEBM practices answers the "What" question. It originates from the rise in awareness and proficiencies among businesses and society about the core CE principles that can be practiced as an opportunity for "*improved economic growth, substantial net material cost savings, the creation of employment opportunities, and increased innovation*" (EMAF, 2015). Therefore, firms must clearly define their CEBM, in terms of "what it can do" or "what it intends to do". A CEBM practice can be provisioned to satisfy one of more of the follow five elements: (a) preserve natural resources, (b) reduce emission levels, (c) reduce material losses, (d) enhance renewable and recyclable resource utilization, and (e) enhance product's lifetime value (EEA, 2016; EMAF, 2015; Elia et al. 2017).

First, a CEBM can be directed to *preserve natural resources* through efficient (lesser) use of raw materials, water and energy, which in turn can dismantle prevailing linear model practices of eroding the natural ecosystem (EMAF, 2015). Second, a CEBM can aim at *reducing emission levels* by adjusting production processes to release lower levels of hazardous chemicals and greenhouse gases, which in turn stabilizes earth's environment (greenhouse effect) (EMAF, 2015). Third, a CEBM can act to *reduce material losses* by adopting reverse flow techniques (i.e., recover and recycle) in production processes to prevent wastage of rare elements, minimize/ incineration/ landfilling, and reduce biological/technical material losses (EMAF, 2015). Fourth, a CEBM can *enhance renewable and recyclable resource utilization* through cleaner material cycles and renewable energy installations in production processes (EEA, 2016). Fifth, a CEBM can *enhance product's lifetime value* by crafting product life extension models (such as leasing, pooling, subscribing, etc.) to extract more value from products and their parts (i.e., re-use/ remanufacture) (EEA, 2016). To illustrate this rationality notion, Tesla's (www.tesla.com) business model to specialize in electric vehicles, energy storage and solar panel manufacturing may allude to as an apt example. The Tesla car as a resultant product satisfies all five rationality elements, i.e., preserves fossil fuel, enables reduction of carbon emission, reduces material losses through repurchasing used cars, enhances renewable energy (i.e., sunlight utilization), and lastly, aims to enhance the car's lifetime value claims by promising zero maintenance costs to the customer.

Scope to pursue CEBM practice. The scope of pursue CEBM practice describes the "How" question". It suggests firms with relevant strategies for resource and material efficiency to support throughout the life-cycle stages of the circular product system (Nussholz, 2017). Based on available CEBM literature, the technological and biological scope to improve resource efficiencies (includes material efficiencies) can be achieved by (a) slowing resource loops, (b) closing resource loops, (c) narrowing resource loops (e.g., Bocken et al., 2016; Willskytt et al., 2016; Stahel, 2010; McDonough & Braungart, 2002; Braungart et al., 2008; Allwood et al., 2011), and the strategic scope (i.e., to go beyond technological scope) to improve resource efficiency can be reached by (d) encouraging sufficiency to curb new demand and (e) reducing material/resource leakages and emissions (e.g., European Commission, 2018; Chertow, 2000; Zhu et al., 2007; Bocken et al., 2016; Nussholz, 2017).

First, *slowing resource loops* scopes for slowing down the flow of resources and materials by prolonging the utilization period of products (i.e. productivity of product), such as producing more durable products, repair/ remanufacturing to extend product's lifetime through life extension and designing emotionally durable products (Chapman, 2015; Bocken et al., 2016). Interestingly, this scope is sub-optimally related to circularity concept as it does not explain the "circling" purpose of resource loops. Examples may include car leasing models, re-furbished electronics, luxury green products, and no-fee upgradable products. Second, *closing resource loops* creates circular flow of both technical and biological resources (and materials) for their re-use by means of primary, secondary, tertiary or quaternary recycling (i.e., to achieve both upcycling and down cycling) of product or its parts post-use (Commoner, 1971; Ayres & Simonis, 1994; McDonough & Braungart, 2002). Examples include value-chain enhanced products such as computer peripherals and eco-industrial parks. Third, *narrowing resource flows* increases resource efficiency (i.e. productivity of resources) by using fewer resources to make products. In principle, this scope does not address circularity directly, but can co-exist with both slowing and closing resource flows in a circular system. Example include cloud-computing services, such as Microsoft Azure, that supports firms to lease redundant computing hardware devices to host their enterprise software application on pay-per-use basis. Another apt example is that of digital fabrication laboratories (also known as Fablab) that supports higher usage of technologies and facilities by start-up firms, entrepreneurs, students, artists, and other businesses to build new products cheaply (See www.fablabs.io). Fourth, *encouraging sufficiency to curb new demand* provides strategic scoping to reduce new demands for material extraction by applying encouraging a sense of sufficiency in the minds of producers and consumers (Bocken et al., 2016; Nussholz, 2017). For example, a self, community or city-driven initiative to use public transportation could reduce new demand for cars. Fifth, *reducing material/resource leakages and emissions* scopes to reduce both material losses and emission level from the production system by applying stricter norms (Nussholz, 2017). Example includes a Europe-wide strategic initiative to monitor consumption of 27 critical raw materials (European Commission, 2018 https://ec.europa.eu/docsroom/documents/27327).

Degree of task complexity of CEBM practice. Task complexity describes the relationships between task inputs (i.e., required actions and information cues in the form of knowledge, skills, and resources required for need for successful task performance (Woods, 1986). In CEBM context, tasks and their relationships occur at four levels – design, business model, production system, and value chain – whose performances are important for the success of such practices (EMAF, 2013; Elia et al., 2017). The degree of task complexity refers to the "How much circular" question.

At *design level*, task complexities are associated with designing circular products, their end-of-life planning, and their production processes, in terms of material flow, energy flow, ecological consumption, and other potential concerns of production (EMAF, 2013; Elia et al., 2017). Examples include variants of eco-design approaches to qualify product re-use, remanufacturing and recycling, use of less hazardous materials in production processes. At *business model level*, task complexities involve diffusing several business models to improve efficiency of the resulting business models by introducing product-service systems, collaborative consumption models and so on (EMAF, 2013; Elia et al., 2017). Examples include variants of asset and platform sharing models including Netflix, Uber, AirBnB, and Amazon cloud service. At *production system level*, task complexities involve how to apply innovative technologies and newer processes to avoid degrading of input resources, perform better recycling of used resources, and create cascading use of waste materials when recycling is not a viable option (EMAF, 2013; Elia et al., 2017). An ideal example of cascading use is about Google and Unilever's initiative of using grind-milled post-use glass (which otherwise is landfilled) as a substitute for fly-ash in concrete that reduces both carbon footprints and exposure to potentially toxic materials. At *value chain level*, task complexities may exist in formulating value chain collaborations for higher value creations, such as making efficient use of by-products generated from the core production process, thus reducing wastages while following circularity principles (EMAF, 2013; Elia et al., 2017). Example includes inclusion of agricultural firms in value chain of a bio-ethanol based electric plant to become buyers of wastes to make fertilizer, waste heat, recycled-water for farmland (also, known as industrial symbiosis).

Level at which CEBM is practiced. A CEBM practice should also be informed its levels of involvement at micro-, meso-, or macro-level of the entire supply chain system (Ghisellini et al., 2016). It explains the "Where" question in terms of asserting its influence on the overall system. The *micro-level* refers to involvement at firm, customer or user level. Example include firm's practice of cleaner production, greener consumption, green procurement, product recycling and reusing, and thereof. The *meso-level* refers to involvement at supply chain level impact, such as creation of eco-industrial systems, industrial symbiosis networks, waste trade markets, and thereof. The macro-level refers to involvement at sectorial and city/region/nation level Ghisellini et al., 2016; Elia et al., 2017). Example include creation of regional eco-cities, urban symbiosis, collaborative consumption, sharing platforms, municipal waste management initiatives, and thereof.

The above discussions underpin the overarching factors of CEBM practice that scholars are expected to investigate to fully characterize a CEBM practice that a firm may be pursuing or intend to pursue. These four factors are independent enquiries, but, may interact within and between factors. For instance, as a micro-level CEBM practice, the biodegradable and reusable "Desso carpet tiles" is mainly motivated to enhance renewable and recyclable resource utilization, but it also peripherally aims at preserving natural resource. To do so, Desso's CEBM scopes both slowing and narrowing resource loops, and acquires certain levels of task complexities at design, business model, and production system levels.

Table 3 - 8. Factors of circular economy business models (CEBM) identified in sustainability literature

CEBM factors	Meaning in circular economy (CE) context	Articles in sustainability literature
Rationality of pursuing CEBM practice (The "What" question?) --- "*The goal of this CEBM is to:*"		
Preserve natural resources	To challenge linear model practices of eroding the natural ecosystem through efficient (lesser) use of raw materials, water and energy.	EMAF, 2015; EEA, 2016; Elia et al., 2017
Reduce emission levels	To adjust production processes for releasing lower levels of hazardous chemicals and greenhouse gases in efforts to stabilize earth's environment (greenhouse effect).	EMAF, 2015; EEA, 2016; Elia et al., 2017
Reduce material losses	To prevent wastage of rare elements, minimize incineration/landfilling and reduce biological/technical material losses by adopting reverse flow techniques (i.e., recover and recycle) in production processes.	EMAF, 2015; EEA, 2016; Elia et al., 2017
Enhance renewable and recyclable resource utilization	To enable reduction in environmental pollution through cleaner material cycles and renewable energy installations in production processes.	EMAF, 2015; EEA, 2016; Elia et al., 2017
Enhance product's lifetime value	To extract more value from products and their parts (i.e., re-use/ remanufacture) by crafting product life extension models, such as leasing, pooling, subscribing, etc.	EMAF, 2015; EEA, 2016; Elia et al., 2017
Scope to pursue CEBM practice (The "How" question?) --- "*This CEBM meets its objective by:*"		
Slowing resource loops (e.g., Car leasing models; Re-furbished electronics;	This scope can slow down of the flow of resources by prolonging the utilization period of products (i.e. productivity of product), such as producing more durable products and repair/ remanufacturing to extend product's lifetime through life extension. Interestingly, this scope is partly related to circularity concept as it does not explain circling of resource loops.	Bocken et al., 2016 [Use phase related]

Table 3 - 8. Factors of circular economy business models (CEBM) identified in sustainability literature

CEBM factors	Meaning in circular economy (CE) context	Articles in sustainability literature
Luxury green products; No-fee upgradable products)		
Closing resource loops (Value-chain enhanced products; Eco-industrial parks)	This scope can create circular flow of resources for re-use of materials by means of primary, secondary, tertiary or quaternary recycling of product or its parts post-use.	Bocken et al., 2016 [Use and End-of-life phase related]
Narrowing resource flows (Cloud-computing services)	This scope is aimed at increasing resource efficiency (i.e. productivity of resources) by using fewer resources to make products. In principle, this scope does not address circularity directly, but can co-exist with both slowing and closing resource flows in a circular system.	Bocken et al., 2016 [Production phase related]
Encouraging sufficiency to curb new demand	This scope is aimed at reducing demand for material extraction by applying encouraging a sense of sufficiency in the minds of producers and consumers. For example, a self, community or city-driven initiative to use public transportation could reduce new demand for cars.	Nussholz, 2017 [Material extraction phase related]
Reducing material/resource leakages and emissions	This scope targets means to reduce both material losses and emission level from the production system by applying stricter norms.	Nussholz, 2017 [Material processing phase related]

Table 3 - 8. Factors of circular economy business models (CEBM) identified in sustainability literature

CEBM factors	Meaning in circular economy (CE) context	Articles in sustainability literature
Degree of task complexity of CEBM practice (The "How much circular" question?) --- "*This CEBM's degree of complexity at:*"		
Design level	Complexities in designing circular products, their end-of-life planning, and their production processes in terms of material flow, energy flow, ecological consumption, and other potential concerns of production. Examples include variants of eco-design approaches to qualify product re-use, remanufacturing and recycling, use of less hazardous materials in production processes.	EMAF, 2012, 2013
Business model level	Complexities in diffusing several business models to improve efficiency of the resulting business models by introducing product-service systems, collaborative consumption models and so on. Examples include variants of asset and platform sharing models including Netflix, Uber, AirBnB, and Amazon cloud service.	EMAF, 2016
Production system level	Complexities of applied innovations, technologies and processes that are targeted to avoid degrading of input resources, perform better recycling of used resources, and create cascading use of waste materials when recycling is not a viable option. An ideal example of cascading use is about Google and Unilever's initiative of using grind-milled post-use glass (which otherwise is landfilled) as a substitute for fly-ash in concrete that reduces both carbon footprints and exposure to potentially toxic materials.	Stahel, 2013; EMAF, 2016
Value chain level	Complexities in value chain collaboration that involves addition of new symbiotic value chain partners who can make efficient use of by-products generated from the core production process that reduces wastage as well as circularity principles. Example includes inclusion of agricultural firms in value chain of a bio-ethanol based electric plant to become buyers of wastes to make fertilizer, waste heat, recycled-water for farmland (also, known as industrial symbiosis).	Kalundborg Symbiosis, 2016

Table 3 - 8. Factors of circular economy business models (CEBM) identified in sustainability literature

CEBM factors	Meaning in circular economy (CE) context	Articles in sustainability literature
Level at which CEBM is practiced (The "Where" question?) --- "*This CEBM practice requires involvement at:"*		
Micro level	Involvement at firm, customer or user level. Example include firm's practice of cleaner production, greener consumption, green procurement, product recycling and reusing, and thereof.	Ghisellini et al., 2016
Meso level	Refers to involvement at supply chain level, such as creation of eco-industrial systems, industrial symbiosis networks, waste trade markets, and thereof.	Ghisellini et al., 2016
Macro level	Refers to involvement at sectorial and city/region/nation level. Example include creation of regional eco-cities, urban symbiosis, collaborative consumption, sharing platforms, municipal waste management initiatives, and thereof.	Ghisellini et al., 2016

Factors of Contingency (Context Construct)

In this study, the factors of contingency (i.e. contextual relevance) represent those situational factors of CEBM practice that the focal firm have limited control (Burns & Stalker, 1961; Lawrence & Lorsh, 1967; Thompson, 1967), or may also be able to change (Miller, 1992). Based on the review of contingency research on broader supply chain management (SCM) and sustainable supply chain management (SSCM) literature, the identified contingency factors are first classified from an organizational standpoint: strategic factors, structural factors, and institutional factors. Contingences as strategic factors refer to those situational factors that may arise due to strategic choices made by the firm to pursue CEBM practices (Child, 1972; Guide Jr. et al., 2003; Ketokivi & Schroeder, 2004). Structural factors represent those factors that that may arise based on how firms' external and internal structures are configured to operate CEBM practices (Donaldson, 2001; Sousa & Voss, 2004; Simangunsong et al., 2016). Institutional factors mean those factors that firms do not directly control, but has impact on their CEBM practices (Ketokivi & Schroeder, 2004; Simangunsong et al., 2016). Such factors are typically guided by isomorphic mechanisms (mimetic, normative, or coercive) in their formation, as per institutional theory (Meyer & Rowan, 1977; DiMaggio & Powell, 1983; Van de Ven et al., 2013). Using the above grouping, table 3-9 further classifies the contingency factors, along with an appropriate description in circular economy context for each contingency factor. Figure 3-7 draws a relational depiction of the contingency factors.

Strategic factors. Strategy plays a critical role in a firm's practice-performance relationship (e.g., Skinner, 1969; Hayes, 1985; Parthasarthy & Sethi, 1992; Dean & Snell, 1996; Ketokivi & Schroeder, 2004; Seuring & Mueller, 2008a; Seuring & Mueller, 2008b). Accordingly, strategic contingencies in CEBM practice scenarios include uncertainties that may arise due to strategic decisions made by the firm for pursuing CEBM practices. Such uncertainties, related to strategic aspects of product planning, facilities and logistics planning, manufacturing process, conformance and quality, organization design and supplier configurations, human resource policies, and sustainability policies, may act in favor or against a firm's CEBM practices. Therefore, firms must strategically align their CEBM practices to gain competitive advantage (Swamidass & Newell, 1987).

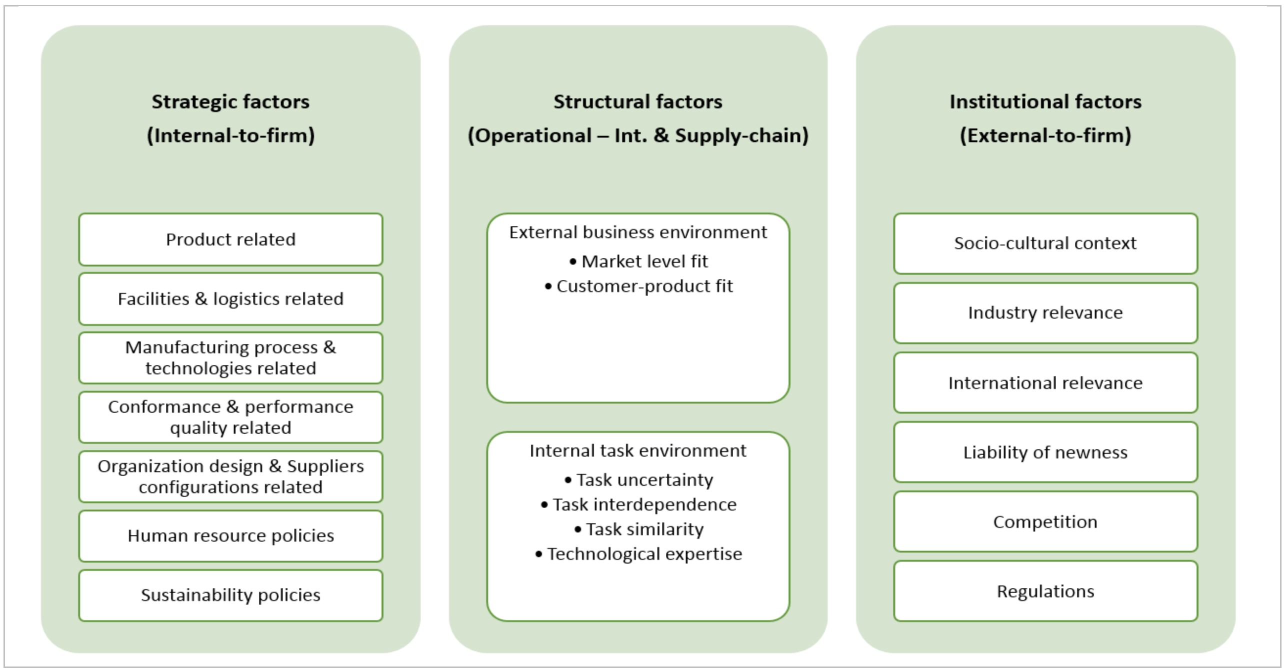

Figure 3 - 7. Factors of Contextual relevance

Product related contingencies describe unanticipated manifestations related to the product/ service offerings, such as volume and quality uncertainties, availability of skilled staffing, product designs, input materials and resources, upon which product's unit cost, overhead cost, inventory management costs, ancillary costs hinges upon (Hayes & Wheelwright, 1984; Ketokivi &

Schroeder, 2004; Simangunsong et al., 2016). *Facilities and logistics related contingencies* describe uncertainties related to size, location and other specific factors of setting up factory, warehouses and other infrastructures that may influence logistics costs, speed of delivery and similar ones (Hayes & Wheelwright, 1984; Sousa & Voss, 2008; Ketokivi & Schroeder, 2004; Simangunsong et al., 2016). *Manufacturing process, equipment & technologies related contingencies* describe uncertainties related to manufacturing processes that have implications upon scaling-up, design or volume flexibility, interconnectedness / traceability, information flows with supply chain partners (Hayes & Wheelwright, 1984; Ketokivi & Schroeder, 2004; Guide Jr. et al., 2003; Walker & Jones, 2012). *Conformance & performance quality related contingencies* describe uncertainties related to quality conformance that has influence of the overall business performance (Hayes & Wheelwright, 1984; Sousa & Voss, 2008; Ketokivi & Schroeder, 2004). *Organization design and supplier configurations related contingencies* describe uncertainties related to organizational and supplier relationships (i.e., arm-length transactional, trust-based partnership, or vertically integrated/joint-venture control-based) (Spekman et al., 1988; Gunasekaran et al., 2008; Ketokivi & Schroeder, 2004; Simangunsong et al., 2016). *Human resources policies related contingencies* describe uncertainties related to employee selection, training, compensation, rewards, health and safety policies, and similar ones (Gowen et al., 2003; Carter & Rogers, 2008; Simangunsong et al., 2016). Lastly, *Sustainability policies related contingencies* describe uncertainties related to sustainability/circularity knowledge and capacities of the focal firm, and its upward and downward partners in material/resource utilization, energy reductions, and other CE elements (Carter & Rogers, 2008; Linder & Williander, 2017; Walker & Jones, 2012).

Structural factors. The performance of an organizational practice (such as CEBM practice) is contingent upon its organizational structure (Burns & Stalker, 1961; Lawrence & Lorsch, 1967; Drazin & Van de Ven, 1985; Ketokivi & Schroeder, 2004; Sousa & Voss, 2008). As per structural contingency argument, the structure of a firm and its practices must fit its context (i.e., characteristics of the organization's culture, environment, technology, size, or task) to survive or to be effective (Drazin & Van de Ven, 1985). Accordingly, structural contingencies in CEBM practice scenarios include uncertainties that may arise based on how firms' external and internal structures are configured to operate CEBM practices (Drazin & Van de Ven, 1985). Such uncertainties in a firm's external business and internal task environment, may act in favor or against a firm's CEBM practices.

External business environment of a firm comprises of market-level fit and customer-product fit. Market-level fit resolves uncertainties related to customer development processes that firms undertake to iteratively refine and test their business models (in smaller markets to prepare for larger investments) in making of offerings to compete with or substitute previous ones. (Blank & Dorf, 2012; Linder & Williander, 2017). Customer-product fit resolves uncertainties related to finding product-customer fit based customer preference, usage, price-sensitivity, perception of environment and thereof (e.g., fully vs. partly re-manufactured computer) (Pearce, 2009; Linder & Williander, 2017).

Internal task environmental of a firm comprises of the following components: task uncertainty, task interdependence and similarity in product-process system, and technological expertise. Task uncertainty reflects factors that may contribute towards agreement/disagreement between units in applying certain production procedures, causing divergence in perceived operational goals (Ketokivi & Schroeder, 2004). Task interdependence for product-process system reflects the degree to which operations can be linked with the production processes and product life cycles, such as stocking, assembling, ordering (Hayes & Wheelwright, 1979; Guide Jr. et al., 2003). Task similarity in product-process system reflects the degree to which parts of operations can be mimicked (isomorphed) by other units for economic efficiency. As such, suppliers may also be coerced (isomorphed) using certification norms (e.g., ISO certification) (Haveman, 1993; Ketokivi & Schroeder, 2004). Technological expertise reflects situations that may arise based on levels of expertise and knowledge within organizational structure and suppliers about product remanufacturing, redesigning, restoration, life-cycle planning, return flow prediction, and similar thereof (Berchicci & Bodewes, 2005; Sundin et al., 2009; Pearce, 2009; Ostlin et al., 2009; Linder & Williander, 2017)

<u>Institutional factors</u>. Firms adopt and implement practices that are institutional perceived as economically valuable without reasonable validation of their economic effectiveness in their business system (Ketokivi & Schroeder, 2004). In a CEBM practice scenarios, such institutional contingencies are linked with socio-cultural context, industry relevance, international relevance, liability of newness, market competition, and regulation (e.g., Sousa & Voss, 20008; Simangunsong et al., 2016; Linder & Williander, 2017).

Socio-cultural context describes uncertainties related to customer's cultural perceptions about product's attractiveness in terms of customer's role in usage, aesthetic attributes, pricing model (renting vs. buying) and thereof (Kuo et al., 2010; Besch, 2005; Mont et al., 2006; Linder & Williander, 2017). *Industry relevance* describe uncertainties in an industry requires appropriate in terms of engaging/incentivizing partners (such as retailers or service partners) about their willingness or compatibility to associate with the initiating firm (Mont et al., 2006; Ketokivi & Schroeder, 2004). *International relevance* describes uncertainties related to product's potential to sell in other markets or geographies (international markets) (Caniato et al., 2014). *Liability of newness* describe concerns that may arise based on age of firm, size of firm, and market power, which are important to build confidence across the value chains in difficult situations (e.g., inexperience about new product releases) (Singh, Tucker & House, 1986). *Market competition* describe uncertainties related to factors of competition, such as price-war leading to risk of cannibalization by established firms pursuing linear economy systems (Guiltinan, 2009; Michaud & Llerena, 2011). Lastly, *regulations* play an important contingency role that are related to unanticipated changes in policies, laws, regulations and taxes, which in turn impacts the overall CEBM performance. For example, firms see certain forms of CEBM as unviable due to the present taxation systems/norms (Stahel, 2010; Simangunsong et al., 2016).

Table 3 - 9. Factors of contextual relevance in CEBM practice identified in supply chain management (SCM) literature

Contextual factors	Sub-factors	Description in sustainable supply chain context	Articles in mainstream and sustainable SCM literature
Strategic factors (Internal-to-firm)			
Uncertainties that may arise due to strategic decisions made by firms for pursuing CEBM practices.			
Product related		Related to product/service offerings, in terms of volume uncertainties, availability of skilled staffing, product designs, input materials and resources	Hayes & Wheelwright, 1984; Sousa & Voss, 2008; Ketokivi & Schroeder, 2004; Simangunsong et al., 2016
Facilities and logistics related		Related to size, location and other specific factors of setting up factory, warehouses and other infrastructures that may influence logistics costs, speed of delivery, etc.	Hayes & Wheelwright, 1984; Sousa & Voss, 2008; Ketokivi & Schroeder, 2004; Simangunsong et al., 2016
Manufacturing process, equipment & technologies related		Related to manufacturing processes that have implications upon scaling-up, design or volume flexibility, interconnectedness / traceability, information flows with supply chain partners	Hayes & Wheelwright, 1984; Ketokivi & Schroeder, 2004; Guide Jr. et al., 2003; Walker & Jones, 2012
Conformance & performance quality		Related to quality conformance that has influence of the overall business performance	Hayes & Wheelwright, 1984; Sousa & Voss, 2008; Ketokivi & Schroeder, 2004
Organization design and supplier configurations		Related to organizational and supplier relationships (arm-length transactional, trust-based partnership, or vertically integrated/joint-venture control-based)	Spekman et al., 1988; Gunasekaran et al., 2008; Ketokivi & Schroeder, 2004; Simangunsong et al., 2016
Human resources policies		Related to employee selection, training, compensation, rewards, health and safety policies, etc.	Gowen et al., 2003; Carter & Rogers, 2008; Simangunsong et al., 2016
Sustainability policies		Related to sustainability/circularity knowledge and capacities of the focal firm, and its upward and	Carter & Rogers, 2008; Linder & Williander, 2017; Walker & Jones, 2012; Liner & Williander, 2017

		downward partners in material /resource utilization, energy reductions, etc.	
Structural factors (Operational – internal and supply chain)			
Uncertainties that may arise based on how firms' external and internal structures are configured to operate CEBM practices.			
External business environment	Market level fit related	Related to customer development processes that firms undertake to iteratively refine and test their business models (in smaller markets to prepare for larger investments) in making of offerings to compete with or substitute previous ones.	Blank & Dorf, 2012; Linder & Williander, 2017
	Customer-product fit related	Related to finding product-customer fit based customer preference, usage, price-sensitivity, perception of environment and thereof (e.g., fully vs. partly re-manufactured computer)	Pearce, 2009; Linder & Williander, 2017
Internal task environmental	Task uncertainty	Related to agreement/disagreement between units in applying certain production procedures, causing divergence in perceived operational goals	Ketokivi & Schroeder, 2004
	Task interdependence for product-process system	Related to operations are linked with the production processes and product life cycles. E.g., stocking, assembling, ordering	Hayes & Wheelwright, 1979; Guide Jr. et al., 2003
	Task similarity in product-process system	Related to operations can be mimicked (isomorphed) by other units for economic efficiency; Suppliers may also be coerced (isomorph) using certification norms (e.g., ISO)	Haveman, 1993; Ketokivi & Schroeder, 2004
	Technological expertise	Related to expertise and knowledge of the product for remanufacturing, redesigning, restoration, life-cycle planning, return flow prediction, and similar thereof.	Berchicci & Bodewes, 2005; Sundin et al., 2009; Pearce, 2009; Ostlin et al., 2009; Linder & Williander, 2017

Institutional factors (External-to-firm)			
Uncertainties that firms do not directly control, but may have impact on CEBM practices. Such factors are typically guided by isomorphic mechanisms (mimetic, normative, or coercive) in their formation, as per institutional theory (Meyer & Rowan, 1977; DiMaggio & Powell, 1983).			
Socio-cultural context		Related to customer's cultural perceptions about product's attractiveness in terms of customer's role in usage, aesthetic attributes, pricing model (renting vs. buying) and thereof.	Kuo et al., 2010; Besch, 2005; Mont et al., 2006; Linder & Williander, 2017
Industry relevance		Related to perceived understanding and incentives of key partners (such as retailers or service partners) about their willingness or compatibility to associate with the initiating firm	Mont et al., 2006; Ketokivi & Schroeder, 2004
International relevance		Related to product's potential to sell in other markets or geographies (international markets).	Ketokivi & Schroeder, 2004
Liability of newness	Age of firm, size of firm, market power	Related to customer confidence and firm's size and/or inexperience about new product releases	Singh, Tucker & House, 1986
Competition		Related to factors of competition such as price-war leading to risk of cannibalization by established firms pursuing linear economy systems	Guiltinan, 2009; Michaud & Llerena, 2011
Regulations		Related to policies, laws, regulations and taxes that may affect the performance of the product. For example, the present taxation system upsets circular business models due to higher taxes on labor, rather than on raw materials.	Stahel, 2010; Simangunsong et al., 2016

Factors of Supply Chain Preparedness (SCP) (Outcome Construct)

In this study, supply chain preparedness (SCP) is conceptualized as an outcome of the focal firm's pursuit to carry out circular business models (CEBM) by harmonizing with its several contingencies. Such preparedness makes pathway for the focal firm to gain superior CEBM performance. Based on the review of broader supply chain management (SCM) and sustainable supply chain management (SSCM) literature, the identified constituents of supply chain preparedness are classified into three broad groups: industry level (external), end-to-end supply chain (multi-tiered), and focal firm (internal) factors. Whereas industry level factors express those attributes that are externally linked to the focal firm (i.e., out of firm's boundary) (e.g., Aguilar, 1967; Wagner & Armstrong, 2010; Porter, 1991; Seuring & Mueller, 2008a; Seuring & Mueller, 2008b), focal firm level factors refers to those preparedness attributes that the focal firm can master and/or control internally (e.g., Zhu et al., 2007; Pagell & Wu, 2009; Ahmad et al., 2017), and supply chain level factors are associated with preparedness attributes related to their end-to-end supply chain boundaries (e.g., Colicchia et al., 2011; Carter & Rogers, 2008; Walker & Jones, 2012). Table 3-10 uses the above classification to present the exhaustive list of identified supply chain preparedness (SCP) factors, along with an appropriate description in circular economy context for each preparedness factor. Figure 3-8 draws a relational depiction of the preparedness factors.

Industry level. Both strategic and operations management literature has shown the external environment (industry level) of a firm is enacted through a complex interaction of various governmental, socio-economic and environmental influences (Porter, 1985; Porter, 1991; Wagner & Armstrong, 2010). Researchers have conceptualized the external environment in several ways.

While some studies show more inclination to the widely held PESTEL (i.e., political, economic, social/geographical, technology, environmental and legal) model (Aguilar, 1967), others consider macro-level unpredictable heterogeneous environmental characteristics to describe firm's organic or mechanistic behaviors for survival (Burns & Stalker, 1961; Swamidass & Newell, 1987; Pagell & Krause, 2004). From the perspective of operationalizing circular economy business models, four scopes for supply chain preparedness were identified that are external to the firm, namely governmental factors, business factors, consumer factors, and natural forces.

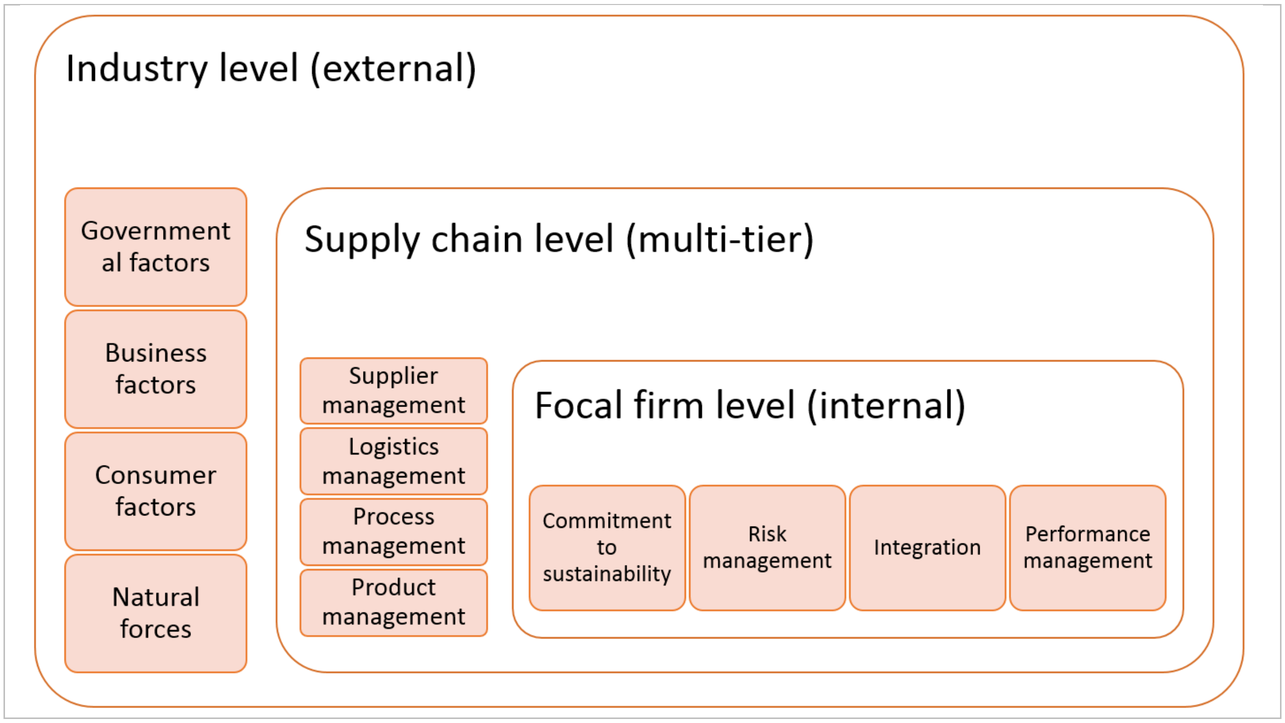

Figure 3 - 8. Factors of supply chain preparedness (SCP)

Governmental factors encompass interactions of political crises, legal and regulatory constraints, and social conditions that a firm must learn to cope with in pursuing their circular business strategies. For example, it is quite common that changes in political leadership at national level requires large and medium firms to rebalance their environmental and social priorities surrounding their business models. Imagine a hypothetical scenario of a focal firm that might have once earned tax applauds from a pro-environmental government for making, say, carpets from recycled fibers is presently be pushed by a pro-societal/less-environmental government to create more jobs to save those tax benefits. This is possible only when the firm's supply chain preparedness is reflected in their political and/or legal power of controlling such political behests from interfering their supply chain performances. As a matter of fact, it is related to a firm's ability to management conflict of interests within the firm and across the supply chains while satisfying such national, social, legal and political interests (Wolf, 2009). In addition, the variances in regulatory frameworks and requirements present a reason for circularity model firms to pro-actively handle issues related to legal, fiscal, safety and environmental matters and corporate governance (Repsol, 2011). For example, even if the safety, legal and environmental standards are seemingly low in the United States when compared to, Europe and Brazil (Lin-Hi & Blumberg 2011), it presents a learning opportunity for firms to pro-actively prepare their own governance mechanism by comparing both geographies. In the long-run, such preparedness would help the firm, its supplying partners and the industry to avoid damages and prevent undesirable and un-rectifiable events (Ahmad et al., 2017).

Business factors incorporates dealings with economic viability, stakeholder pressure, competition and technological changes that may be relevant for a firm to preserve continuance in pursuing circular economy business models. Economic uncertainties can not only create financial risks (i.e., liquidity and bankruptcy) for itself and its partners, but also add legal risks for its contractual obligations across its value chain (Repsol, 2011). A firm's ability to accomplish economic viability of their circular economy business model reflects in their interactive approaches of handling borrowing rates, market trends, taxes and duties, overall demand-supply fluctuations to avoid both supply chain performance disruptions and profitability reductions. It speaks about how firms may afford to keep itself as well as suppliers committed to the centrality of circularity initiatives for during the swings of economic trends (Halldórsson et al., 2009). Firms owning such superior capabilities are often rewarded through huge capital investments to pursue growth models. In addition, they also tend to become showcase models for flag-shipping socio-economic development within their host communities, a phenomenon known as “by “creating shared values” (Porter & Kramer, 2011). Yet another business factor is about the stakeholder pressure from a firm’s suppliers, employees, competitors, and distributors that may put strains on costs, quality and overall success of a viable business operation (Gillespie, 2014). In sustainability literature, a firm’s ability to respond to stakeholder pressure is considered as one of the most crucial drivers of such implementation. A firm’s ability to alter market dynamism and socio-environmental risks depends on the quality of endurance, mutuality and conflict avoidance it preserves with its stakeholders’ expectations (Seuring & Muller, 2008b) in terms of climate change, health safety, environmental management, human rights, social impact, ethics, and so on. Lastly, factors of competition due to market, geography or technological eccentricities affect businesses most when firms overlook their present and future competitors (Kumar & Putnam, 2008). Since the field of circular economy is passing through its infancy, firms are more likely to adopt co-operative measures to increasing their market shares in terms of resource capabilities, alliance formulation, and brand reputation, as a collective effort to counter traditional linear models, especially, due to lack of appropriate policy frameworks, governmental support, private investment, scalable technology, and infrastructure (Farrell & Brandt, 2006).

Consumer factors poise firms with the overwhelming challenge of convincing consumers to switch from their existing preference and socio-economic traits of using linear economy based products to circular economy based greener products. The linear economy-based production model has empowered consumers to exercise unrestricted consumerism in choosing products and services. Research shows that, most often, consumers do not make good choice due to factors such as choice making in isolation or over considerations, or in balancing between utility and pleasure (Kahneman, 1994). An illustrative example could be about selecting a meal at a restaurant that requires consumer to make a decision that requires consideration for health or taste or balance of both. As a phenomenon, it enables a society's economic system to thrive but only at the cost of the environmental damage. Thus, the ability to change the present perception of consumerism, which is based on consumers' irrationality and unawareness about economic, environmental, and social aspects (Elkington, 1998), is a major preparedness factor that firms pursuing circular production system are expected to learn from their circularity model implementations.

Lastly, *natural forces* may be witnessed as those factors that circularity model firms require to demonstrate aggressive preparedness of practicing/adopting low carbon energy systems, saving energy and avoiding/tackling environmental hazards. Since, the present means and technologies to generate alternate clean energy (such as wind, solar, thermal) is both slower and costlier than the traditional ones (coal, oil and gas) (Lior, 2010), it presents a circularity model firms and their supply chains take the risk of making bold investments to maintain its market competitiveness. However, the field of sustainability has sufficiently demonstrated that formulation of eco-industrial parks is one proven method that firms may learn to apply for bringing conventionality as well as turning a major external discourse to their favor (Chertow, 1998; Zeng et al., 2017; Zhang et al., 2017).

Supply chain level (multi-tiered). Research has shown that firms that have considered proactive approaches in developing and integrating their supplier have also demonstrated success in developing both sustainable products and sustainable supply chains (Seuring & Muller, 2008b). In reality, a firm's reactive approaches to fix their supplier's incongruences a strong indicator about their failure to meet sustainability goals. Such possible incongruences may be seen as unanticipated delays, increased input costs, quality issues, and so on. This notion of proactivity may shape into variety of supply chain preparedness attributes (such as clean technology solutions, environmental auditing and supplier training on environmental issues) that environmentally responsible firms can uniquely develop to build innovative approaches to collaborate with their multi-tiered suppliers (Kovacs, 2008). Four scopes were identified where firms can demonstrate their pro-activeness in managing their end-to-end supply chains, namely supplier management, logistics management, operations management and product management that plays an instrumental role in improving their supply chain competitiveness to operationalize circular business models (Gold et al., 2017).

Supplier management preparedness is a process perspective that environmentally responsible firms must keep learning from their involvements of selecting appropriate suppliers, adapting with their supply partners, auditing and certifying environmental requirements periodically, developing methods to share information with their partners, training and upscaling partners, and thus, reducing institutional distances (Wilhelm et al., 2016) and supporting their supplier's business continuity (Kovacs, 2008) while pursuing circular business models. Retrospectively, firms tend to favor those suppliers who could (or are willingness to) collaborate for supporting their environmental and social objectives, even during uncertain economic times. Such collaborations are important in implementing circular business model because it allows firms to avoid supply chain disruptions due to input cost escalation, market fluctuations/price reduction and delays in delivery, and may act as positive indicator about better supplier management preparedness of a firm, thus help firms to gain competitive advantage over their traditional economy model competitors.

Logistics management preparedness is yet another factor that the sustainable supply chain management commonly refers as green logistics. It explains how firms can include sustainable means of transportation, green warehousing, packaging using recycled products, and other possible logistics activities from an environmental viewpoint (Min & Kim, 2012). In addition, environmentally responsible firms are also expected to advance their logistics management preparedness by improving their energy efficiency and emission standards (Halldorsson & Kovacs, 2010). As such, it is an integral capability linked to supply chain planning because the risks associated with a logistics management decision (in terms of materials, means and locations) has direct implications not only on the cost of delivering new product, but also on the firm's business model (i.e., distribution mechanism) for reusing, reselling, recovering, remanufacturing, and recycling of used products (Tsoulfas & Pappis, 2008).

Process management preparedness of firms has a major influence on sustainable supply chain performances in terms of improvement in quality of both inputs and outputs, and overall process efficiency (Sarkis, 2003). As firms acquire superior operations management preparedness, they tend to innovate newer methods of using scarce resources, develop modularity in improve reusability and remanufacturing, and avoid wastage of material (Tsoulfas & Pappis, 2008). In fact, this particular preparedness can positively moderate other supply chain level factors. For example, if a dining table produced using modular design parts made from recycled wood can also be converted into a television console, it becomes economically more efficient in terms of sourcing, production, distribution and logistics handling, and managing supply/demand, while meeting its environmental and societal promises.

Product management preparedness is yet another capability that firms must continue to learn as they pursue circular business strategies. Sustainability research has sufficiently shown that life cycle of product is one of the most important consideration of product design as it optimizes the scope for polluting the environment. Life cycle assessment (LCA) is one such decision making tool that helps firms to integrate environmental concerns with their end-to-end supply chain (Hendrickson et al., 2006). The scope of improving product management preparedness is so dynamic that individual firms can differently learn to apply life cycle assessment/product management methods internally and make their supply chains to participate for varying degree of circularity approaches that would fit for their sustainability goals (Sanchez & Mahoney, 1996; Pehnt, 2006).

Focal Firm level (internal). Sustainable supply chain management literature advocates organizational and managerial behaviors, in terms of "*assumptions, norms, institutions, measures, and methods*" as an important factor that could synergies (or even impede) firms to systematically engage their processes and supply chains in achieving their sustainability goals (Pagell & Shevchenko, 2013, p.52). Since these organizational/managerial behaviors are "iron-caged" by the environment in which they perform (DiMaggio & Powell, 1991; Larrinaga, 2007), it may become a "double-edged" sword for the firms. Four factors were identified that are internal to the firms in their preparation to pursue circular business strategies. These factors include firm's managerial commitment, ability to manage risks, its cross-functional integration capabilities and its practices for measuring/rewarding performance.

Managerial commitment to sustainability strengthens firms to chart "*internally consistent set of goals and functional policies*" for their sustainability goals. As such, top leaders' commitment and leadership aids firm's to integrate their cross-functional activities and makes them align their strengths and weaknesses to counter possible threats and opportunities from external environment (Porter, 1991). This sort of preparedness is related to a firm's promptness in planning and execution of circular business initiatives while withstanding pressures from external and/or internal contingencies. In addition, it encourages firms to communicate, embrace and develop an organizational culture that is filled with trust, co-operation and transparency, and may become "*unique and inimitable*" strength of the firm over time (Barney, 1991). In sustainable supply chain context, transparency refers to vertical integration across supply chain and horizontal integration across networks required for convergence in reporting/engaging its stakeholders to minimize related risks and improve supply chain performance (Carter & Rogers 2008). Further, managerial commitment reassures employees to take righteous decisions in tackling implementation hurdles of their sustainable/circular business model initiatives (Pagell & Wu, 2009).

Risk management refers to a focal firm's capability to anticipate and minimize any form of economic, environmental and social risks related to its supply chain performance (Carter & Rogers, 2008). For example, a firm may fail meet its supply/demand expectations due to possible supply chain disruption factors, such as machine failure, inclement weather, war and so on. Therefore, a firm's preparedness for reduction and/or avoidance of supply chain risks by means of alignment and collaboration with its supply chain partners contributes significantly towards supply chain performance of their circularity missions (Kleindorfer & Saad, 2005).

Preparedness of the focal firm, in terms of *integration* within the firm, explains the firm's ability to handle complexities through strategic alignment of sustainability goals and cross-functional integration within the firm and across firms (supply chains) (Pagell & Wu 2009; Walker & Jones 2012). In essence, this preparedness arises from the fact that interconnected/intertwined requirements of circular economy business models are such that it does not allow a firm, or its departments or its supply chain partners to perform in isolation, rather, it needs coordinated and integrated efforts at horizontal and vertical levels (Chen & Paulraj, 2004). Along with managerial cognition, a firm's inclination to invest in technology (such as traceability information systems, resource and material planning tools) is a good indicator about its readiness to improve its co-ordination capabilities, which in turn, is likely to improve its supply chain performance.

Lastly, a firm's capacity to apply *performance metrics* encourages the sustainability culture internally and across its value chain. This sort of preparedness enables firms to quantify the benefits of implementing sustainable and circular economy models. It allows firms to measure and reward performing units. In sustainability, despite availability of tools, such as life-cycle-assessment, firms continue to face challenge in measuring non-economic performance due to lack of formal standards or understanding of sustainability concepts or difficulty in identifying items to measure (Pagell & Wu, 2009). Yet, it is extremely important that firms must make efforts to adopt possible measures as they move with circularity implementations to gain guidance for their future initiatives. This sort of preparedness is critical for firms in developing contingency plans during uncertain times to increase supply chain stability (Li et al., 2017).

The above discussions show that firms pursuing circular economy business models must identify and align at least three scopes – industry, supply chain, and internal – supply chain preparedness. These three scopes commonly interact with each other, and therefore, such alignments in preparedness are bound to make positive and compounded influences towards their supply chain performances.

Table 3 - 10. Factors of supply chain preparedness (SCP) construct identified in supply chain management (SCM) literature

SCP factors	Sub-factors	Meaning in circular economy (CE) context	Articles in mainstream and sustainable SCM literature
Industry level (business environment)			
Governmental factors	Political, legal, environmental, and social conditions	The ability to management conflict of interests in the supply chains while satisfying any national, social, legal and political interests in implementing circular business models.	Aguilar, 1967; Wolf, 2009; Burns & Stalker, 1961; Swamidass & Newell, 1987; Pagell & Krause, 2004
Business factors	Economic viability	The ability to accomplish economic viability of their circular business model in their interactive approaches of handling of borrowing rates, market trends, taxes and duties, overall demand-supply fluctuations to avoid both supply chain performance disruptions and profitability reductions.	Halldórsson et al., 2009; Ahmad et al., 2017
	Stakeholder pressure	The ability to preserving its stakeholders' expectations through endurance, mutuality and conflict avoidance in matching market dynamism and socio-environmental risks.	Seuring & Muller, 2008b; Gillespie 2014
	Competition	The ability to adopt co-operative measures to increasing their market shares in terms of resource capabilities, alliance formulation, and brand reputation, as a collective effort to counter traditional linear models, technological changes, geographic and cultural conflicts.	Farrell & Brandt, 2006; Kumar & Putnam, 2008
Consumer factors	Customer preference, Socio-economic traits	The ability to change perceptions of consumerism, derived from consumers' irrationality and unawareness about economic, environmental, and social aspects.	Kahneman, 1994; Elkington, 1998
Natural forces	Energy conservation	The ability to adopting low carbon energy systems and energy-saving methods.	Lior, 2010
	Environmental hazards	The ability to bring conventionality in tackling environmental hazards.	Chertow, 1998; Zeng et al., 2017; Zhang et al., 2017

End-to end supply chain level (multi-tier)			
Supplier management	Selection mechanism	The ability to selecting appropriate suppliers to reduce institutional distances and support business continuity.	Seuring & Muller, 2008a; Kovacs, 2008; Li et al., 2017; Christopher & Peck, 2004; Wilhelm et al., 2016
	Adaptation approaches	The ability to adapt and apply flexibility with their supply partners.	Li et al., 2017; Cao & Zhang, 2011; Ketchen & Hult, 2007; Wilhelm et al., 2016
	Certification and auditing mechanism	The ability to audit and certify environmental requirements periodically	Seuring & Muller, 2008a; Ahmad et al., 2017
	Information sharing mechanism	The ability to develop methods to share information with their partners	Seuring & Muller, 2008a; Wilhelm et al., 2016
	Training & development, supplier continuity	The ability to train and upscaling partners for supply chain continuity	Seuring & Muller, 2008a
Logistics management	Shipment consolidation, choice of transportation/ packaging	The ability to effectively use sustainable means of transportation, green warehousing, packaging using recycled products, and other possible logistics activities from an environmental viewpoint	Halldorsson & Kovacs, 2010; Min & Kim 2012
	Human and health-related (treatment of partner staff)	The ability to take accountability of partnering firm employees as their own employees	Li et al., 2017
	Distribution & collection mechanism	The ability to plan supply chains for effective distribution of new product, and reusing, reselling, recovering, remanufacturing, and recycling of used products	Tsoulfas & Pappis, 2008
Process management	Material/parts reuse/recovery, energy and material reduction, avoiding	The ability to innovate methods of using scarce resources, develop modularity in improve reusability and remanufacturing, and avoid wastage of material	Sarkis, 2003; Tsoulfas & Pappis, 2008

	hazardous products/processes		
Product management	Product life planning, product innovation & re-design	The ability to apply life cycle assessment (product life planning) and management methods internally and influence supply chains to participate based on degrees of circularity principles adopted.	Hendrickson et al., 2006; Sanchez & Mahoney, 1996; Pehnt, 2006; Svensson, 2007
Focal Firm level (internal)			
Commitment to sustainability	TMT commitment & leadership,	The ability of managerial promptness reflected in planning and execution of circular business initiatives while withstanding pressures from external and/or internal contingencies.	Pagell & Shevchenko, 2013; Porter, 1991; Li et al., 2017; Cao & Zhang, 2011
	Organization culture, transparency, employee policies	The ability of firms' employees to take righteous decisions in tackling implementation hurdles of their sustainable/circular business model initiatives.	Pagell & Wu, 2009; DiMaggio & Powell, 1991; Ahmad et al., 2017; Wilhelm et al., 2016
Risk management	Economic, environmental and social risks	The ability to reduce and/or avoid of supply chain risks by means of alignment and collaboration with its supply chain partners contributes significantly towards supply chain performance of their circularity missions.	Carter & Rogers, 2008; Kleindorfer & Saad, 2005; Ahmad et al., 2017
Integration	Strategic alignment, cross-functional cooperation, traceability, strategic purchasing processes	The ability to handle complexities through strategic alignment of sustainability goals and cross-functional integration within the firm and across supply chains.	Pagell & Wu 2009; Walker & Jones 2012; Chen & Paulraj, 2004; Wilhelm et al., 2016
Performance management	Rewarding, pre-empting and improvement mechanisms.	The ability to quantify the benefits of implementing sustainable and circular economy models and develop contingency plans during unforeseen conditions to increase supply chain stability	Li et al., 2017; Cao & Zhang, 2011; Christopher & Peck, 2004; Ketchen & Hult, 2007; Lee, 2004

Factors of CEBM Performance

In practice, the notion of circular economy business model (CEBM) is still evolving. Given this nascent-stage, even the definitions of CEBM appear elusive, and the measurement of circular economy performance presently lacks an inclusive evaluation model (Elia et al., 2017). Despite these shortcomings, firms adopt CEBM practices to reach an outcome that can create a competitive advantage to their sustainability (or sustainable development) mission. Using this sustainability logic, the success of CEBM practices would hinge upon their performances in three key "sustainability" dimensions – economy, environmental and social (e.g., Tukker, 2015; Ghisellini et al., 2016; Geng et al., 2012; Chertow & Ehrenfield, 2012; Bocken et al., 2016; Linder & Williander, 2017; Geissdoerfer et al., 2018). As such, business model logic (i.e., value creation and value capture) describes the dimension of economic performance of CEBM in both short-term (such as, net income and return on sales) and long-term (such as firm's survival, growth models) (Amit & Zott, 2001; Osterwalder & Pigneur, 2010; Teece, 2010; Geissdoerfer et al., 2018). Apart from economic performance, the sustainability logic describes the dimensions of environmental and social performances of CEBM. For instance, a leasing-based CEBM for refrigerators derives its environmental and social performance by increasing the productive life of refrigerators (Bakker et al., 2014). Table 3-11 presents five major factors upon whose performances reflects the success of CEBM practices.

Table 3 - 11. Factors of CEBM Performance

Factors (Dimensions)	**Description in CEBM context**	**Articles in sustainability literature**
Economic	Short-term gains (e.g., net income , return on sales) and long-term gains (e.g., firm's growth models)	Stahel, 1982; Tukker, 2015; Ghisellini et al., 2016; Geng et al., 2012; EMAF, 2013; Bocken et al., 2016; Linder & Williander, 2017; Geissdoerfer et al., 2018; United Nations, 2015; Porter & Kramer, 2011
Environmental	Reduction of environmental concerns through lesser depletion and/or utilization of natural resources	
Social	Increase in social value (e.g., social benefits, additional job creation and other benefits related to poverty, gender equality, and sustainable cities) by improving environmental value of products/services.	

RESEARCH FRAMEWORK

The literature review on concepts of circular economy and its business models, contingency theory and its relevancies in supply chain management domain, supply chain preparedness and CEBM forms the basis for identification of factors to describe and operationalize the concepts. Accordingly, a guiding contingency framework is derived (See figure 3-9) to represent a fit-based relationship between the constructs of CEBM practices, contextual factors, supply chain preparedness, and the CEBM performance.

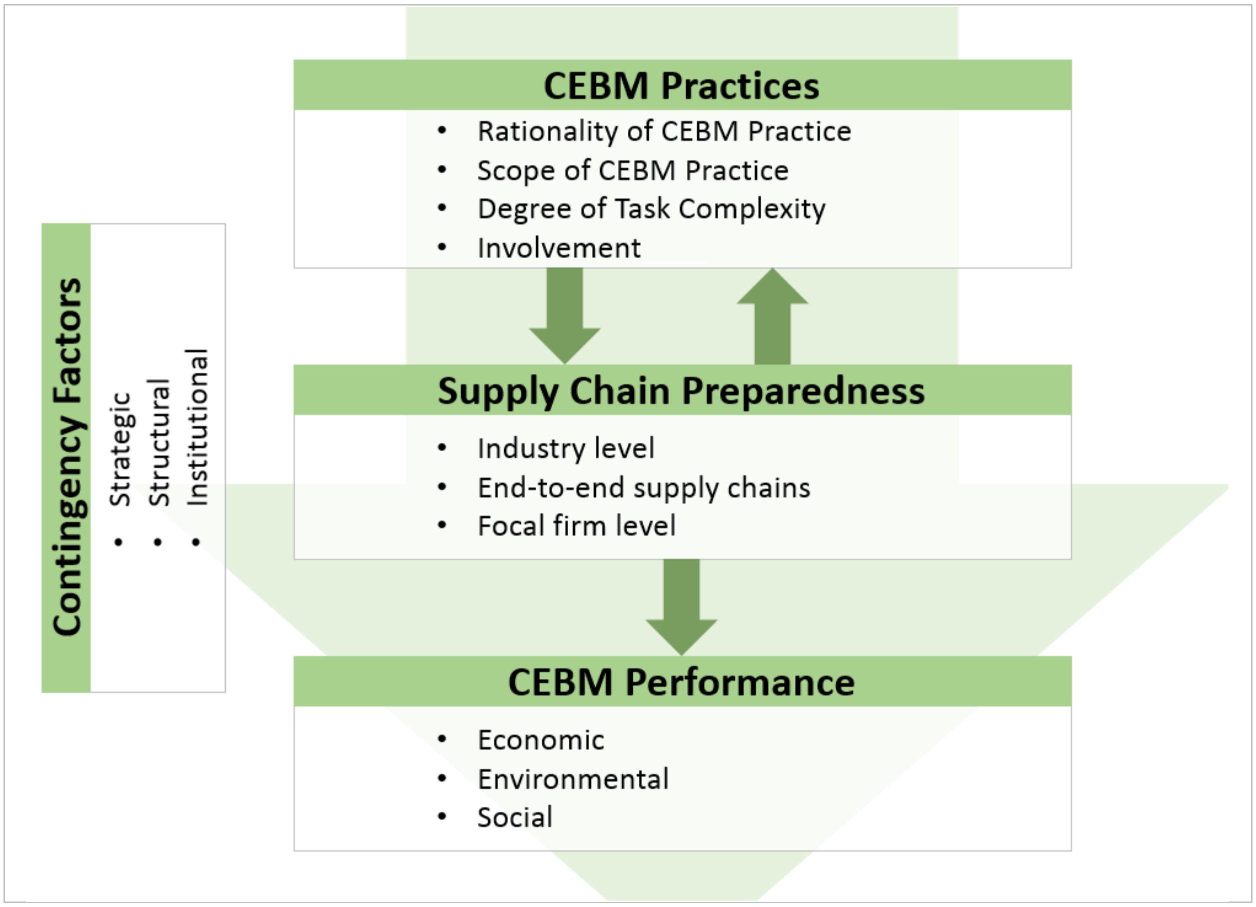

Figure 3 - 9. Guiding Research Framework

CHAPTER SUMMARY

This chapter sets the foundation for the main premise of this study that the focal firm's supply chain preparedness (outcome) to pursue circular economy initiatives (response) is contingent upon several upstream and downstream contextual factors (context). Accordingly, the chapter introduces the research questions first, and moves on to describe the theoretical backgrounds of circular economy and its business models, organizational theories (i.e., contingency theory, institutional theory, and resource-based view), and supply chain preparedness in supply chain context. Thereafter, the discussion moves to establish the relationship between CEBM and supply chain preparedness using the theoretical lens of contingency theory. The key constituents for each of the four constructs extracted from prior literature, and described accordingly. Finally, a guiding contingency framework is developed to depict a fit-based relationship between the constructs of CEBM practices (as response), contextual factors, supply chain preparedness (as outcome), and the CEBM performance. In accordance to the guiding research framework, a multi-case research approach is proposed to answer the research questions. The following chapter describes the proposed research methodology with detailed explanations on multi-case research approach, data collection and validation techniques.

CHAPTER IV

RESEARCH METHODOLOGY

The literature review conducted in Chapter III provides the theoretical background and the guiding research framework to proceed further with this study. Accordingly, this study adopts an exploratory qualitative research approach given the exploratory characteristic of this study. A qualitative study focuses on “naturally occurring, ordinary events in natural setting” so that researchers can visualize a “real life” scenario (Miles et al., 2014). Besides, the field of circular economy is presently showcasing a contemporary phenomenon, and thus requires an investigation using qualitative case studies (Yin, 2015) to create in-depth understandings about unique experiences and settings (Simons, 2014) in supply chain context. As such, an exploratory qualitative approach allows researchers to acquire knowledge about the selected cases through participants’ stories and their insights of the ongoing phenomenon under research scholarship. In addition, this approach also assists researchers to isolate a case or multiple case and explore individually using in-depth data collection techniques from knowledge participants about the study context (Creswell, 1998). More so, through inquisitive interrogation about the concepts and phenomenon related to the research questions, researchers learn richly about the context that enables them to make true reflections about the research in consideration (Stake, 2013; Yin, 2015). Hence, this study approaches a comparative multi-case study design and method to provide robust methodological support for generating new theories, descriptions and taxonomies (Eisenhardt, 1989; Ellram, 1996) to both researchers and practitioners to better understand about CEBM practices in supply chain context. In simpler words, a multiple case study approach will surface both commonality and uniqueness of multiple cases under considerations in this study. Overall, the study attempts to achieve "creative reframing" of the literature in CEBM in supply chain context through in-depth exploration of multiple cases and analyzing several cases both within and between (Eisenhardt, 1989). Broadly, this study predominantly relies on recommendations of Eisenhardt (1989), Eisenhardt & Graebner, 2007, Miles, Huberman & Saldana (2014) and Yin (2015) to meet its objective. Figure 4-1 shows a step-wise depiction of the case selection, data collection and data analysis process.

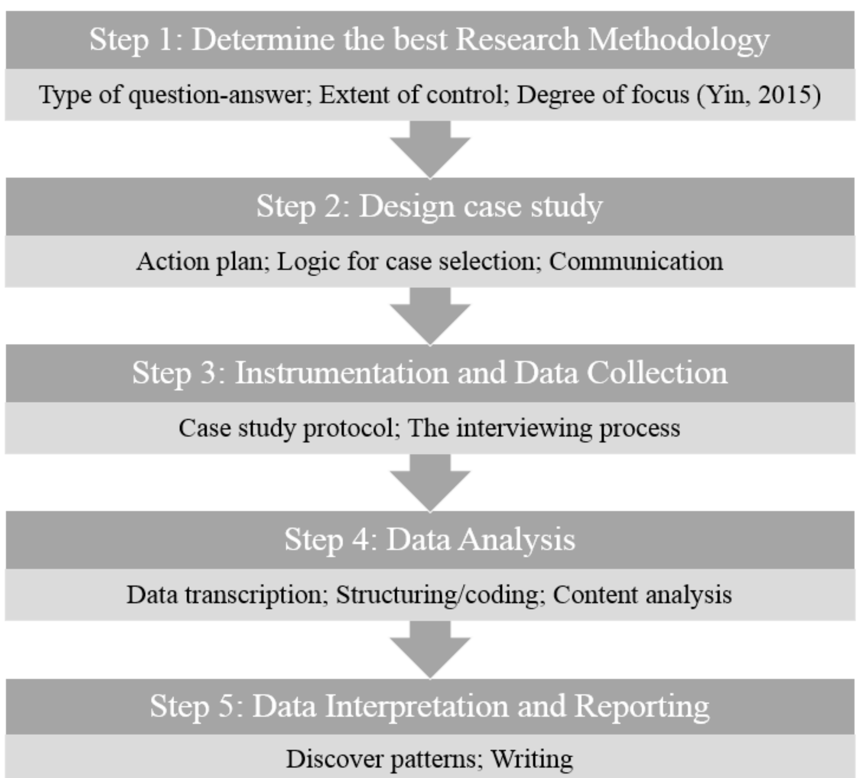

Figure 4 - 1. Research Methodology Framework

CASE SELECTION APPROACH

Broadly speaking, the case selection approach in multiple case based qualitative research and a random sampling approach in quantitative research has the same objective. That is, the selected cases must represent the population and must show worthwhile variance in the theoretical constructs of research interest (Kshetri, 2018; Seawright & Gerring, 2008). However, the difference between the two approaches is about the choice of cases in terms of substantive versus statistical adequacy to represent a target population (Greene & David, 1984).

The unit of analysis for the study is circular economy business models (CEBM) of firms. In Chapter III, the study provides the main literature background by conducting a thorough literature review about the key constructs of the study (i.e., CEBM practices, contingencies of CEBM, supply chain preparedness, and CEBM performance) and about their compositions. The next step was to choose the firms (i.e., multiple cases) to be part of the research. This study uses an established criterion from the literature to choose the firms for this study. Since case study research approach calls for defining a theoretical sampling (Eisenhardt & Graebner, 2007), instead of a statistically representative one, the first step was to define a specific selection criterion. Hence, the main selection criterion was that the representative firm's business model must aligned with circular economy principles (e.g., Bocken et al., 2018; Geissdoerfer et al., 2018). The other criterion was to find these firms from multiple industries with varying degree of maturity and size, in terms of supply chain activities. Multi-industry sampling should reveal different patterns related to specificities and similarities among industries about their supply chain preparedness related attributes in efforts for CE transitions. Since the CE practices are viewed as global sustainability concepts (D'Amato et al., 2017), socially responsible investing

(SRI) indices (Schroeder, 2007) and circular economy programs are proven data sources to identify representative firms with reliability and consistency in satisfying the main selection criteria (i.e., that the representative firm's business model must aligned with circular economy principles). According, the following data sources were consulted:

- The Dow Jones Sustainability Index (DJSI). Launched in 1999, the Dow Jones Sustainability Indices (DJSI) is the first global sustainability benchmarks and is presently managed by S&P Dow Jones Indices and RobecoSAM. Since 2004, RobecoSAM has been publishing "The Sustainability Yearbook" (e.g., The Sustainability Yearbook, 2018). The association's 2017 assessment report claims to have assessed 2,479 companies representing 60 industries from 48 nations using annual questionnaires and by monitoring their performance on critical issues. The association tracks the stock performance of the world's leading companies in terms of economic, environmental and social criteria. The index scores and rankings were calculated in accordance with sustainability information systems that are based on a pre-defined scoring and weighting structure. The indices serve as benchmarks for investors who integrate sustainability considerations into their portfolios, and provide an effective engagement platform for companies who want to adopt sustainable best practices. This study evaluates the list of firms available at https://yearbook.robecosam.com/companies to identify firms matching the theoretical sampling criteria.
- The MSCI Index. The MSCI is a market capitalization index based on 1649 stocks of firms across 23 developed nations and 24 emerging markets based on their sustainability efforts and performance that provides institutional investors with a more robust

environmental, social and governance (ESG) outlook to help them mitigate risk and enhance long term value creation. This study evaluates the list of firms available at https://www.msci.com/constituents to identify firms matching the theoretical sampling criteria.

- Global Reporting Initiative (GRI). Developed by the Global Sustainability Standards Board (GSSB), the GRI is yet another globally recognized comprehensive database that complies sustainability reports of firms in efforts to make them more transparent in terms of economic, environmental, and social impacts caused in their regular business activities. GRI's sustainability reports are regarded as equivalent to independent triple bottom line reporting and corporate social responsibility reporting of firms. This study evaluates the list of firms available at http://database.globalreporting.org to identify firms matching the theoretical sampling criteria.
- EMAF CE100 Programme. The Circular Economy 100 is an initiative by Ellen MacArthur Foundation that documents the circular economy initiatives and resulting capabilities of its global alliance comprising 100 global firms, innovators and regional bodies that works. The broad aim of this project is to collectively help firms and societies learn, network and collaborate with each other in bringing the CE concepts to scale. This study evaluates the list of firms available at https://www.ellenmacarthurfoundation.org/ce100/directory to identify firms matching the theoretical sampling criteria.

In selection of cases, pragmatic, logistical and financial considerations were undertaken (Seawright & Gerring, 2008). In this study, only those firms were selected for which enough information is already available in secondary resources format. Qualitative researchers typically use Eisenhardt & Graebner's (2007) recommendation of about seven cases to be considered as ideal for building theory (e.g., Kshetri, 2018). However, for this study the case selection process continued until a theoretical saturation point was reached, such that no additional information of significance can be obtained (Eisenhardt, 1989; Thompson et al., 1989; Ellram, 1996; Russell & Levy, 2012). In particular, efforts to identify at least twice of the suggested number of cases is imperative for this study. To meet this "number of cases" criteria, this study selects two or more cases per industry to enable enough variations between cases within an industry, and at least five industries to achieve ample diversity among all cases (Seawright & Gerring, 2008). Following these recommendations, the study first create a list of firms categorized by industries by iteratively consulting with the four data sources (i.e., DJSI, MSCI, GRI and CE100 indices/listing). In the next step, the list was passed through further filtration to select only those firms that have documented evidence of operations and activities in the U.S. This filtering provides the basis for regional classification (if any) in terms of industrial regulations, financial and logistical considerations. Lastly, the list of two or more firms representing five or more individual industries was finalized based on documented evidences that the firms' business models were aligned with circular economy principles (i.e., the main selection criteria). Accordingly, one or more key informants per firm were sought given their involvement and general knowledge about each firm's business models (such as, CEO, COO, research head, sustainability officer, purchase officer and supply chain officer) to participate in this study.

DATA COLLECTION AND INSTRUMENTATION

Data Collection Approach

In qualitative research and management studies, interviews are considered as one of the most common and effectively utilized methods (Denzin & Lincoln, 1994; Shah & Corely, 2006). Unlike surveys, interviews yield high response rate, and allows researchers to collect a greater description about a phenomenon under study. Moreover, the descriptive knowledge gained through face-to-face interview helps researchers to capture, understand, and address multi-dimensional issues if properly conducted (Pedhazur & Schmelkin, 1991). Interviews are classified into three different types: structured (formal), semi-structured, and unstructured (informal) (Fontana & Frey, 1994). This study follows the recommendations of Miles et al. (2014) for data collection using semi-structured interviews with key informants of the firms. As such, data were collected primarily by interviewing officers (i.e., sustainability managers, plant managers, purchasing managers and supply chain managers) of the participating firms. A semi-structured interview approach allows this study to gather descriptive information about how the participants' perspective about their respective firms' CEBM practices, their contingencies, their supply chain preparedness and their CEBM performance. This descriptive information was appropriately transcribed and analyzed to provide answers to the research questions of this study (Patton, 2005). This primary data was further complemented with available organizational documents, websites and reports, including annual reports, environmental/CSR policies, and internal newsletters. Such secondary data sources were used for triangulation purpose during the data analysis to mitigate the research limitations (such as biases in the interviews and self-reporting) and to enhance the validity and reliability of the study (Bolis et al., 2014; Yin, 2015).

Upon selection of potential participants from each selected firm, each informant (i.e., interviewee) were contacted via email and/or telephone. Appendix – A, B, and C, and B illustrates the sample copies of IRB (Institutional review Board) approval, informed consent letter, and audio release form respectively, which were used to seek potential interviewees. The main purpose of the step was to seek interviewees' willingness to participate in the study and schedule an interview with interviewees. In addition, this step of communication was also directed to inform the participant about study and interview process, thus help participants to agree upon their time and effort, voluntariness, confidentiality, anonymity, post-interview role and accrued benefits for participation (Miles et al., 2014).

Instrumentation

While the guiding framework and research questions describe the "what to get", and the case selection and data collection plan describes the "whom, why and when" to get information of the study, an interview protocol inexorably serves the purpose of "how to get" required information from the participants. Appendix - D displays the interview protocol instrumented to ask questions to the related participants.

The Structure of Interview. The interviews lasted from 45 to 90 minutes, with an average length of one hour. Prior to the start of the interview, participants were informed about the purpose of the study and be assured about anonymity and confidentiality (See Appendix - B). Interview began only after receiving their consent. The face-to-face interviews were conducted at a place where both participants and the researcher feel comfortable for discussion. During the interview, the participant did not express any discomfort when discussing their experience and knowledge (Eisenhardt, 1989); however, the participants were given a choice to skip a question that he/she may not be comfortable to offer descriptions and narratives. In each interview, the participants' response was recorded through audio recordings (only if the participants consent) and through hand-written notes. The collected data (in audio and/or hand-written notes formats) were then be transcribed to conduct data analysis. While interviewing, the questions were adjusted to each firm's relevance of CEBM practices and their products and services. For instance, the questions asked to the participant of the firm representing manufacturing industry were specific to manufacturing related supply chain activities. The transcribed datasets were be passed on to the participants for check for accuracy concerns in their response. Also, the participants were provided with a replica of the findings of this study as a gesture for their participation. The interview details are provided in table 4-1.

Table 4 - 1. Interview details

Supply Chain Tier (Industry)	Company	Title(s) of interviewees	Interview duration
Tier 3 (Energy)	Company A	▪ Senior Account Manager ▪ Sustainability Manager	59 min.
Tier 3 (Energy)	Company B	▪ President ▪ Customer Service Manager	133 min.
Tier 2 (Electrical manufacturing)	Company C	▪ Plant Head ▪ Purchasing Manager	46 min.
Tier 1 (Mechanical manufacturing)	Company D	▪ Supply Chain Manager ▪ Purchasing Manager	41 min.
Manufacturer (Heavy equipment)	Company E	▪ Plant Head ▪ Supply Chain Coordinator	52 min.
Manufacturer (Recycling/Packaging)	Company F	▪ Chief Sustainability Officer ▪ Purchasing Manager	58 min.
Manufacturer (Recycling/Packaging)	Company G	▪ President & CEO ▪ Supply Chain Manager	67 min.
Retailer (Used appliances)	Company H	▪ CEO ▪ Sales Manager	35 min.
Retailer (Used automotive)	Company I	▪ CEO ▪ Project Manager	40 min.
Retailer (Heavy equipment)	Company J	▪ Service Manager ▪ Sales Manager	54 min.

The Content of interview. Smith (1987) suggest that evaluation is a form of "inquiry" involving the development of meaningful and valid question-answer proposition to make claims with assertion, irrespective of the study following logical analysis, theoretical research, or empirical research method. From a qualitative research perspective, this argument highlights the need to pay attention in developing the interview protocol. As displayed in Appendix - D, an interview protocol is instrumented following the recommendations by Yin (2015). The qualitative nature of this study suggests that interviews must initiate dialogues using a set of general questions on issues, such as participants' demographics and background. The first set of questions are somewhat unrelated to study context, rather posed general questions about participant's professional and organizational activities to gear up for the next stage of evaluation. For instance, these questions ask participants describe how they learned and/or got associated with CEBM practices in their organizations, how long they have been known to the CE principles, how do they relate CEBM with their sustainability practices, similar alike. The purpose of these questions was to make participants comfortable and open for a dialogue filled with insightful content pertinent to the research questions asked. The second set of questions asked are pointed to the study context and asks participants to narrate their perceptions about their CEBM practices, their contingencies, their supply chain preparedness. Before moving from one narrative question to another, the participants were asked specific follow-up questions directed to probe upon different factors (such as specific strategic contingencies in CEBM practices). Efforts were made to encourage participants to "describe actual experiences related to their general perceptions rather than allowing the dialogue to stay at an abstract, experience distant level" (Thompson & Haytko, 1997, p. 19) and to explain their real-life experiences and narratives by means of follow-up questions as needed. In addition, participants were asked about reliable sources of corporate documents and reports relevant to the study. Efforts were separately made to gather those secondary data from referred sources and used for triangulation purpose.

Use of secondary data. Qualitative studies are often criticized for validity and reliability issues such as lack of scientific rigor and poor reasoning for methods adopted, lack of transparency in data analyzing steps, and expressing personal opinions as findings (e.g., Sandelowski, 2000; Rolfe, 2006; Noble & Smith, 2015). In response to these criticisms, qualitative researchers suggest validation techniques that improves reliability and rigor of a study. In one instance, Creswell & Miller (2000) proposed nine validity procedures combining qualitative inquirers' (i.e., lens of researcher, participant or reader) perspective and researchers' paradigm assumptions or worldview (See table 4-1).

Table 4 - 2. Validity Procedures Within Qualitative Lens and Paradigm Assumptions; Adapted from Creswell & Miller (2000)

Paradigm assumptions/Lens	**Postpositivist or Systematic Paradigm**	**Constructivist Paradigm**	**Critical Paradigm**
Lens of the Researcher	Triangulation	Disconfirming evidence	Researcher reflexivity
Lens of Study Participants	Member checking	Prolonged engagement in the field	Collaborations
Lens of People External to the Study (Reviewers, Readers)	The audit trail	Thick, rich description	Peer debriefing

Using Creswell & Miller's (2000) validity procedure, this study adopts "triangulation" procedure for validation purpose since the study in confined within the qualitative lens of the researcher (because as an inquirer only the researcher owns the responsibility about the sense-making of the study) and an assumption of systematic paradigm (because the study is built upon rigorous methods and systematic forms of inquiry). Accordingly, data was triangulated using different secondary sources such as corporate document from practitioner side and literature review from scholarly side. Yet another severe limitation of case research is that findings are hard to generalize due the limitation of number of sample cases. However, the issue of generalizability overshadows the opportunities that a qualitative study provides. For example, the sole purpose of this study is to provide deeper insights about firm's supply chain preparedness for practicing CEBM by exploring several contingencies phenomena. Consequently, if this study raises its concern towards generalizability, it may fail to provide deep insights about the study context. Broadly, the study adheres to Rowley's (2002) guidelines suggested in table 4-2 to improve validity and reliability of qualitative studies.

Table 4 - 3. Case methodology and construct validity; Adapted from Rowley (2002)

Tests	**Case Study Strategies**	**Stage of research**
Construct validity	Use multiple sources of evidence	Data collection
	Establish chain of evidence	Data collection
	Have key participants review draft case study report	Data transcription
Internal validity	Conduct pattern matching	Data analysis
	Conduct systematic explanation building	Data analysis
	Conduct time series analysis (as needed)	Data analysis
External validity	Use replication logic in multiple case studies	Research design
	Use case studies protocol	Data collection
Reliability	Develop case study database	Data collection

DATA ANALYSIS

Prior to initiation of data analysis, the primary data in the form of interviews, hand-written notes, and other observations were transcribed to improve the overall understanding and familiarity with the collected data (Reissman, 1993). Microsoft Word application was used for transcription. Data coding was done by their "meaning" and not by the "sentences" in efforts to systematically interpret the logic used by participants to narrate their experiences and provide response to the questions asked during interviews. The transcribed data was analyzed by employing content analysis techniques and the pattern matching logic following recommendations by Yin (2015). Suitable content analysis software program (i.e., QDA Miner; Lewis & Maas, 2007) was used for data management and data analysis. Using recommendations by Miles and Huberman (1994), within-case analyses were conducted for each company to extract answers for the constructs of this study. Next, cross-case analysis was conducted to identify patterns between cases. Major themes and information were compared across cases to find similarities and differences within and across industries. Interpretations were done from transcriptions using both direct interpretation or “drawing meaning from a single instance” (Creswell, 2007, p. 245) and generalized themes or “making the case understandable and its application to other cases” (Creswell, 2007, p. 246). Next, pattern analysis was conducted to identify common patterns between cases (Creswell, 2007; Stake, 1995). To ensure validity, triangulation was conducted across cases using secondary sources available for each company.

Within Cases Analysis Methodology

Using recommendations by Miles & Huberman (1994), within case analyses were conducted for all companies. It allowed identification of themes and trends within each case study in accordance to the research questions. The results of within-case analysis were used as the source to conduct cross-case analysis for within and across industries and identify common themes between case studies. As such within case analysis helped in explaining how each company objectifies its CEBM practices, its contingency factors, how it prepares itself (SCP) and it measures its performance. It helped extracting information about interactions between the research constructs for each individual case and establish relationships between key constructs. In brief, within case analysis formed the basis for this study to understand how supply chain preparedness affect their CEBM practices and performance based on their contingency factors for each company and their unique industry setting.

Cross-Case Analysis Methodology

The purpose of the cross-case analysis was to identify patterns across the various cases with respect to their specific industries. It was conducted for data reduction and exhibition of meaning information across cases pertaining to research questions (Miles & Huberman, 1994; Yin, 1994). Accordingly, the common themes and patterns were identified, analyzed and reported for each case in a single tabular format. As such it helps in bringing objectivity by organizing and describing the otherwise subjectively rich data for appropriate interpretation (Cruzes & Dyba, 2011). In brief, cross case analysis formed the basis for this study to understand how supply chain preparedness affect their CEBM practices and performance based on their contingency factors vary between cases and industries.

CHAPTER SUMMARY

This chapter presents a description and procedural details of the research methodology adopt for this qualitative study. In the data selection section, the data sources for case selection and the process for case selection are described. In the data collection and instrumentation section, the process of interviewing, the content of interview, the use of secondary sources to overcome methodological limitations are described. The chapter ends with a brief discuss about the approaches and requirements to conduct data analysis for the study.

CHAPTER V

RESULTS

The purpose of this chapter is to present the findings of the selected case companies using qualitative case study approach to answer the exploratory nature of the research question. The research question is to explore how “supply chain preparedness” related to CEBM practices and performance of the CEBMs, and about the factors upon which this relationship is contingent framework (see Chapter III, Figure 3-9). Accordingly, this chapter begins by describing the supply chain relationship between the ten selected companies according to their supply chain tiers. Next, the within case analyses of each company are explained. Finally, the cross case analysis of all the companies are presented.

SUPPLY CHAIN RELATIONSHIPS

In today’s competitive environment, firms operate within a complex form of supply chain relationship and prosper by amplifying their supply chain preparedness. Since the central theme of this study is to understand the importance of “supply chain preparedness” of firms in the relationship between their CEBM practices and their performance, the first task in hand is establish the supply chain relationship of the case companies in this study on a generic supply chain network. As shown in Figure 5-1, the generic supply chain network comprises of upstream, midstream and downstream firms. While a focal manufacturing firm takes the central position as midstream firm, its tier 1-to-n suppliers form the upstream firms and its dealers/distributors and end customers form the downstream firms.

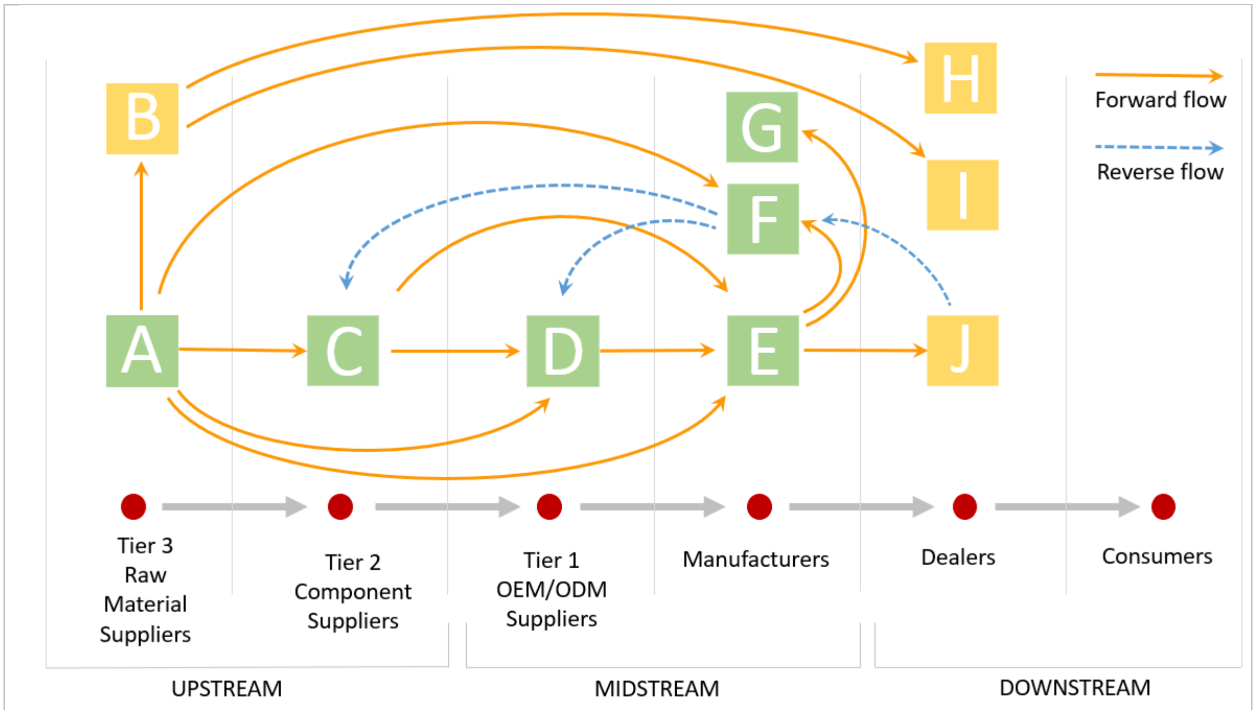

Figure 5 - 1 : Supply Chain Relationship of Case Companies

In this study, it is profoundly seen that companies complement and strengthen their supply chain relationships directly or indirectly at different levels of supply chain tiers through their CEBM practices for superior performance. Starting from the left end of the generic supply chain network, Companies A and B that operate as energy providers are the raw material and resource suppliers. While Company A is an electric generation, transmission and distribution company, Company B is an electric distribution company. These two tier 3 companies act as suppliers to companies at all stages of supply chain network, including Company A being a supplier to Company B as well. In particular, Company A supplies electricity to Companies C, D, E and F that are higher up its supply chain tiers and to Company B which is in the same tier 3.

Similarly, Company C is a component supplier in tier 2 that supplies electric switchgear components to Company D in tier 1 and Company E in focal tier (manufacturing tier). Company D is an OEM supplier in tier 1 that supplies ball bearings to Company E. Company E is a manufacturing company that makes heavy equipment as its core product. Company E supplies and sells its products through Company J which acts as its authorized dealer in specific geography. Also, within manufacturing tier, Company E supplies its heavy equipment product directly (and sometimes indirectly) through Company J, a service company in retail tier) to Company F and G which are manufacturers of recycled packaging and similar other product. Company J also supplies spare parts and servicing for in-use heavy equipment of Company F that are procured from Company E. Interestingly, this study also finds evidences of closed-loop supply chains, where in Company F supplies recyclable packaging material to Companies C and D. Companies H and I are pure service player in dealer tier who specialize in retailing of refurbished appliances and reused automotive parts respectively. Company B also supplies electricity to Company H and I as discussed in detail in the following sections.

WITHIN CASE DESCRIPTIONS

In this section, the within case descriptions of each case company are presented according to respective supply chain tiers. Using the theoretical research earlier explained in Chapter III framework (see Chapter III, Figure 3-9), the within case analyses of each company is presented by providing a brief snapshot of about the company, its CEBM practices using figure 3-6 and table 3-8 as the basis, its supply chain preparedness using figure 3-8 and table 3-10, and its performance using table 3-11 as the basis, its contingencies using figure 3-7 and table 3-9 as the basis.

TIER 3 – RAW INPUT MATERIAL AND RESOURCE SUPPLIERS

The general characteristics of the two companies A and B in tier 3 as raw input material and resource suppliers are shown in table 5-1 below.

Table 5 - 1: Companies A and B in Tier 3 – Raw input Material and Resource Suppliers

	Company A	**Company B**
Research Setting	US	US
Size (No. of Employees)	29,000 (4,500 in SC)	67 in SC
Age of the Company (Years)	114	75
Scope of Operations	National	County
Primary Customers	Residential, Commercial, Industrial, Government	Residential, Commercial, Government
Annual Revenues	$22.74B	$77M

COMPANY A

Company A is a part of a large electric utility conglomerate in the United States. The company generates, transmits and distributes power to residential, commercial, and industrial customers in six states of the US with 11,000 employees. The power generation portfolio of Company A comprises of 50% from nuclear power plants, 25% from natural gas power plants, and 25% from coal-based power plants. Presently, the company has undertaken some solar and wind-based power generation, but they are still in their infancy. In terms of supply chain network, Company A is a supplier of electricity to Companies C, D, E and F that are higher up its supply chain tiers and also to Company B which is in the same tier 3.

CEBM Practices

Company A in collaboration with its parent company has several CEBM initiatives in the areas of power generation, transmission, and distribution. In power generation, Company A strives to reduce the amounts of emissions of harmful gases, recycle solid waste, and test strategies for expanding on energy generation from renewable sources. Since 2005 Company A successfully has decreased carbon dioxide emissions by 31 percent, sulfur dioxide emissions by 96 percent and nitrogen oxides emissions by 75 percent. Company A recycled 87,200 tons of solid waste from landfills for power generation. On the power transmission side, Company A conducts vegetation management program throughout the stretch of 60,000 miles of transmission lines. About 60-100 ft buffer along the transmission lines, has been planted with twice the number of trees that are of different vegetations and do not pose threat to the transmission lines, thus reducing the need for future tree-trimming. The company grows twice the number of trees (forestry) it cuts for clearing transmission line. The purpose of planting different vegetations is to help create better bio-diversity of animals and birds throughout the transmission belt and in making up for the number of birds that get killed through electric shocks. On the distribution side, Company A actively collaborates with its customers for designing and executing several energy efficiency programs that are funded by its customers and the company. These programs resulted in reduction of more than 14,400 gigawatt-hours of energy consumption by the end of 2017.

Company A pursues its CEBM practices at meso level, since it involves coordination with the regional systems. Since the company operates in a highly regulated environment, the CEBM initiatives requires complex interactions and coordination with several entities including customers, local government bodies, environmental bodies, and other related entities. Therefore, complexities for the CEBM initiatives arise at value-chain level. The CEBM practices followed by Company A are oriented more towards reducing material leakages and emissions, and towards curbing demand for electricity.

Supply Chain Preparedness

The CEBM initiatives by Company A involve active interactions of several stakeholders including industrial and residential customers, regulators, environmentalists and local government departments. All residential consumer-focused CEBM initiatives require financial resources, which are partially borne by residential customers alongside of Company A. The regulators play the watchdog's role to ensure that the pools of monies collected from residential customers are spent on power rebate programs and other CEBM initiatives and not on Company A's operating expenses. Designing and monitoring energy efficiency programs in conjugation with different regulatory requirements of the states is a major challenging task for Company A. Company A, therefore, has an entire department dedicated for overseeing the rebate programs and catering to the compliances:

> *". . .we have an entire department that monitors our rebate programs. From our standpoint of being a regulated market player, we have to have that division because we need to report to the public commission annually, and say that "Look we spent $50M on rebates that generate a 100M KWH of energy reduction". We must show a bang for the buck at the end of the day. Afterall, our customers are paying for that $50M. The regulators want to make sure that the $50M is not going into (Company A's) bottom line, rather it is going back to the customers" [Sr. Accounts Manager]*

In many cases, designing and implementing rebate programs require interactions and negotiations with the regulators and the customers. A rebate program that works out in one state might not get approval in another state. The proposed changes by the other state may not be feasible and require hard negotiations by Company A with the regulator. Also, the industrial customers may come up with their own energy saving initiatives that align with the objectives of Company A's rebate programs. In such scenario, Company A partners with those industrial customers on their initiatives and ensures that they get incentivized for the efforts:

> *". . . For example, the Company A had a 3-years payback rebate program in State X. The same program when implemented here, the public commission approved it as a 10-years payback (which means if I took a rebate then I have to be in the program for 10 years, and that means that I will have to pay for 10 years). Now, we are realizing that 10 years is a very long window. Only those customers opt in who have no other option. So, we are working with our state regulator to make the time-window shorter." [Sr. Accounts Manager]*
>
> *". . . For example, when Retailer X comes up with its own energy efficiency program, we partner into their programs in the form of rebate programs. So, we adjust our program in such a way that would specifically allow Retailer X to opt out (they wouldn't have to pay anything – part of the rebate is supported by us). Thus, it saves from creating duplicate programs" [Sustainability Manager]*

Company A also actively engages with the residential customers to get their feedback on the rebate programs and improve them.

CEBM Performance

On the economic side, though the CEBM initiatives do not directly contribute to Company A's profit margins, they help the company to stay in business by customer retention and regulatory compliances. On the environmental side, the CEBM practices of Company A help in regeneration of forestry and wild-life habitats, reduction in emission of harmful gases and materials into the environment, and reduction in demand for electricity. With regards to the generation of energy from renewable energy sources, Company A offers an alternative perspective for the greenness of the initiative. Company A believes that none of the energy production techniques are 'green' per se. In the case of sustainable energy, it believes that even though power is generated from renewable sources, the huge number of batteries that required to store the power are made using natural resources and are harmful to the environment when disposed. Also, it argues that the process of shipping the raw materials for the batteries, and the batteries themselves from low-cost production regions consume huge quantities oil for transportation. All these factors need to be accounted for considering the greenness of sustainable energy generation. Thus, Company A alternatively focuses on regenerating the energy resources that are consumed and encourage the customers to use the electricity in a prudent way:

> *"In speaking about our reluctance towards sustainable sources of generating energy (wind/solar sources), we hold a different view because we believe that there is nothing such as "green" energy, per se, when you count the material used to make batteries for storage, methods to dispose batteries and means of shipping from China (burning oil). Every energy source has a negative environmental consequence. In a way, "green"*

energy is only that particular energy that is not getting used. Instead, our philosophy is to focus on recreate those green energy sources that we consume while doing business."

[Sr. Accounts Manager]

However, Company A also believes that innovation might make storage of solar generated electricity to become economically viable, and that might lead it to turn off the gas/coal plants. On the social side, Company A indirectly contributes to the local economy and quality of life by engaging with their customers to enhance their energy efficiencies.

Contingency Factors

The success of Company A's CEBM practices are mainly affected by the institutional contingency factors pertaining to industry relevance and regulations. Energy costs of the customers is an important factor to be managed by Company A to survive in this industry because high prices will result in customer complaints to regulatory board which determines Company A's territorial contracts. Thus, company A recognizes cost as a competitive priority. As a supplier of input resources (i.e., electricity), the company is willing to partner with its industrial and commercial customers to support their standalone energy efficiency programs, even at the cost of its own loss in revenue. For example, recently when a major retailer's launched an energy saving light-bulb product on discounted prices, Company A offered to fund the discounted amount from its on pool. As such, it assumes that by not doing so, it may end up losing all types of customers. In particular, losing out on industrial customers will have significant negative impact not only for Company A, but also for the local economy in terms of losing out on the positive effects of job creation by the industrial companies that are Company A's customers:

“Because of lower cost structure of electricity in this state, they came here, but may go to other states if we do not support their energy efficiency missions. We recognize that we might have to sacrifice a few dollars here. But we also understand that this will help our community in the long run through jobs (i.e., to expand through profits earned). So, it is the right thing for us to do right now from a customer servicing perspective.” [Sr. Accounts Manager]

In the case of generating sustainable energy, there is a growing demand from today’s customers and regulators in general. However, for Company A, there are several strategic contingency factors of economic importance that need to be considered for transitioning from traditional power generation to sustainable power generation. In Company A’s opinion, complete transition to solar and wind-based power generation is not a viable option at this point of time, because it would result in incurring huge costs on the facilities and storage systems, duplicity of the assets, efficiency problems, and consequently higher electricity prices for the customer:

“Our customers want inexpensive electricity while expecting us to be environmentally responsible. Our customers want us to bring solar energy, but that costs five times of current cost which they don’t want to pay, and therefore, doesn’t serve the purpose.” [Sr. Accounts Manager]

“. . . from a survival standpoint, total shift to solar or wind energy generation is not viable option and would end up becoming into duplicacy (duplicity) of assets and resources. Even though, we are treading towards it but slowly. Solar/wind also has its own efficiency problems. However, when storage technology for solar generated electricity become economically viable, we can expect to turn off the gas/coal plants. So, we have to wait for that tipping point to arrive.” [Sustainability Manager]

There is another aspect of regulatory factors that affect the success of the CEBM practices of Company A. Company A serves in six states and each state has a different regulatory environment that affects the approval of energy efficiency programs running in that state. Subsequently, Company A has to design varied versions of the energy efficiency programs that comply with the local regulatory requirements and approved by the regulators:

"We serve in six states and each state has a different regulatory requirement. There are different programs that each of our six utility operations has to take approval from their respective regulators. For some of our utilities, their public commission might say that it is not worth the money, and therefore, not approve. What's good in one state may not be the best for another state." [Sr. Accounts Manager]

COMPANY B

Company B is a member owned, not-for-profit, electric cooperative dedicated to distribution of energy to four economically poor and/or rural counties in a south eastern state of the US. Company B is a part of a central cooperative conglomerate that supports in various operational activities. Company B does not have power generation facilities, rather it procures power from other power generating companies including Company A through its central cooperative purchasing consortium. Bulk of the power purchased by Company B is coal-based owing to its cheaper price. Apart from coal-based power, Company B procures some amount of coal and some amounts of hydel and nuclear power. Company B also has a solar electricity farm that customers can subscribe to. However, the farm is limited to a smaller capacity due to the higher costs and efficiency fluctuations associated with solar power generation. 90% of Company B's customers are residential and the remaining are a mix of industrial and commercial. In terms of supply chain network, Company B is a customer to Company A as purchases electricity from Company A during peak hours, and Company B is a supplier of electricity to Company H and I.

CEBM Practices

Company B supports their residential customers in making their homes energy efficient through a state-wide program supported by the central cooperative. This program provides customers with an option to conduct an energy survey through specific contractors. The contractors provide recommendations to improve energy efficiency of the house. Company B supports the customers to implement these recommendations by lending them financial support up to $10,000, that can be paid back in monthly installments. This financial support offered by Company B helps in handholding the customers, who typically have a lower affordability, to implement the recommendations for energy efficiency and achieve the objectives of the program. Company B also provides energy efficiency tips to the customers through its website. For the industrial customers, Company B helps in planning their business operations to curb the peak-demand, which subsequently reduces the costs and the environmental impact associated with the peak demand of electricity.

Also, about two years ago, Company B has invested $0.5 million on a solar farm capable of generating 0.25 megawatts of electricity as a part of bigger solar program supported by the central cooperative consortium. The solar farm caters to the customers who are interested in solar energy but cannot afford to install their own infrastructure due to non-viability of costs and/or non-suitability of their premises for setting up solar panels. Interested customers can subscribe to the solar energy farm and their energy usage is matched and deducted from subscription cost.

The electricity generated from this farm, therefore, costs similar to the regular energy. Another CEBM initiative undertaken by Company B pertains to reuse of the old electric poles as fence-posts instead of disposing them to recyclers. In summary, CEBM initiatives by Company B relate indirectly to preserving natural resources by supporting reduction in electricity consumption that leads to reduction in power generation. The company's CEBM practices also relate to enhancing use of renewable energy and enhancing the life-time value of the electric poles. The CEBM initiatives help in slowing the resource loop and improving efficiency to curb new demand.

Company B pursues CEBM initiatives at micro level involving its customers and complexities of these initiatives arise mainly at business model level, since they involve possibility of several scenarios and adaptations made to the business model to deal with such situations. One example of such complexity is a scenario where a customer defaults in paying back the loan given by Company B for implementing the energy efficiency recommendations.

Supply Chain Preparedness

While the CEBM initiative of energy efficiency program benefits from the support of the central cooperatives on the process and political aspects, the program suffers from the risk aspect of recovering the money lent for implementing the energy efficiency recommendations. There are several stages associated with this program right from the expression of interest by the customer until the loan amount is recovered. Having qualified and competent personnel to communicating these process details to the customers is often a challenge for this CEBM initiative.

As for the CEBM initiative of solar farm, Company B benefited to a great extent from the support of the central cooperative. Building the facility required coordination with several local governing bodies in terms of meeting several regulatory compliances. Company B hired personnel specifically for this coordination. On the subscription side however, the solar farm has subscriptions only for half its capacity. The lower subscription rates are partly due to Company B's lack of aggressive marketing efforts about the program. The not-for-profit nature of Company B presents some strategic dilemmas on CEBM initiatives and impedes it in planning and doing things outside their normal routine:

> *"In these kinds of projects where we need to step outside our normal routine, we struggle to decide what is good or bad. Solar, for example, part of the problem is to justify the cost of the project. We didn't put them in to make profit. If profit was the motive, we should bring in a robust sales team." [President]*

CEBM Performance

On the financial side, since Company B is a non-profit organization and does not generate electricity, the impact of the CEBM initiatives cannot be assessed based on reduction in operation costs or increased profits. Rather, the economic impact of the CEBM initiatives can be assessed by the reduction in the customers' electricity costs through the energy efficiency program and in that context, there is a definite positive impact. The slack revenue that the company possesses is diverted back into programs that serve the customer interests. On the environmental side, Company B focuses more on reducing the consumption of electricity and thereby, reduce the energy generated and the associated natural resource consumption. The solar energy initiative has a positive impact on the environment by reducing the use of electricity generated from other methods that have relatively more negative impact on the environment. On the social side, the CEBM initiatives have a positive impact on the community since they are the means for and outcomes of customer engagement with Company B. This engagement can potentially contribute to persistence of the existing CEBM initiatives and initiation of several others.

Contingency Factors

The main contingency factors that influence the CEBM initiatives of Company B are the customer's push for cheap and/or sustainable energy, support from the central cooperative, and its own organizational structure. Since Company B is a not-for-profit member owned company any slack revenue is spent for initiatives that serve the interests of customers. Company B's customers belong to rural and not-so-wealthy backgrounds and emphasize on affordability and availability of electricity. The energy efficiency program caters to and helps them achieve these objectives. The money spent on implementing the energy efficiency programs is typically recovered in 2 to 3 years:

> *"We are a member-owned company. So, once we make a certain amount of money and have enough money to run our business, anything over and above is sent back to our members (customers) every year" [President]*
>
> *"We operate in a more sort of rural area (not-so-wealthy area). And, if our folks (members) have really high power bills, lot of time they can't afford it and that puts them is a bad situation. So, we can help them make their electricity more affordable." [Customer Service Manager]*

Some of the Company B's customers emphasized on having solar energy and this interest set impetus for the solar energy program. The central cooperative provides the required infrastructure, technology and knowledge support for planning and executing the CEBM initiatives. This support plays a crucial role in the success of the CEBM initiatives of not only Company B, but of other participating cooperatives as well. The pooled effort provides bargaining power in acquiring the necessary knowledge and material resources and eliminates duplicity of efforts. Company B also benefits from being part of other central associations for dealing with the political aspects of the CEBM initiatives and learning about other CEBM initiatives that are successful in other states:

> *"For instance, to build the solar farm, XXX (the central cooperative) hired a contractor to build a combined 5 MW solar capacity at different locations for all of our 20- co-ops. It saved each of us to start over and build our individual solar farms. The upstream companies therefore help us not to re-invent the wheel 20 times and making the expertise available with us without any duplicity of resources." [President]*

The organizational structure of Company B in some ways has a constraining effect on some of the CEBM initiatives, especially when in the case of strategizing and expanding. Due to its not-for-profit characteristic, the company cannot create and spend on active marketing strategies for the CEBM initiatives. Therefore, the CEBM initiatives remain under-marketed, in turn leading sub-optimal performance outcomes. Since Company B is a community service focused company, it cannot rapidly expand itself and increase its revenues by selling more electricity, gain the benefits of a large sized company for initiating a bundle of sustainability initiatives successfully. Rather, it has to lead the initiatives within its realm and catering to its members' interests:

"As an industry, one of the struggles that we have as electric co-ops is to define what it means to move along. Some might argue that increasing (selling) more electricity is moving along (and make more profit). Because we are not-profit oriented, instead, we are service-oriented, so, all of our co-ops are looking at how can we better serve our members within our limited scope, e.g., if XXX (Company B's large sized for-profit counterpart) is so successful with their sustainable business practices or any other business practices (it) is because of their massive size." [President]

TIER 2 – RAW INPUT MATERIAL AND RESOURCE SUPPLIERS

The general characteristics of Company C in tier 2 as component suppliers is shown in table 5-2 below.

Table 5 - 2: Company C in Tier 2 – Component Suppliers

	Company C
Research Setting	US Plant
Size (No. of Employees)	96,000 (800 in SC)
Age of the Company (years)	107
Scope of Operations	Global (175 countries)
Primary Customers	Commercial, Industrial, Government
Annual Revenues	$20.4B

COMPANY C

Company C is a plant located in the Eastern US, that deals with commercial distribution products and assemblies based electrical requirements. In terms of supply chain network, Company C is a customer of Companies A and F, and a supplier to Companies D and E. It manufactures low voltage panelboards and switchboards for commercial and industrial applications. The customers for the products typically include large business facilities around its location. Company C is a part of a large US business conglomerate with 97,000 employees and business operations spanning more than 175 countries.

CEBM Practices

Company C embarked on several CEBM initiatives in its business operations and is the first site in the entire company that has a zero-waste landfill. Company C recycles all the materials that are used in the operations including paper, plastic, wood and some amount of left-over metals. The company strives to use most of the left-over metals in other components. For the small amount of waste that is left, the company partners with recyclers and incinerators for recycling the waste or incineration to convert the waste into energy. Company C focuses on circularity practices including water and electricity usage, at all levels of its operations. Productivity of all the operational units are indexed to their material and natural resource consumption. Company C partners with the energy supplier (Company A) to make their operations energy efficient. Overall, the CEBM practices of Company C aspires to be a good environmental steward by reducing emission levels into the environment, enhancing renewable and recyclable resource utilization and setting benchmark for CEBM practices in the industry. These CEBM practices contribute to slowing resource loops, narrowing resource flows, closing the resource loops, and reducing material leakages and emissions into the environment.

Complexities for these CEBM practices arise at design, production system, and value chain levels. At design level, the most complex part is the decision-making about upfront investment for using eco-friendly materials in their operations, which typically cost more than their mainstream counterparts. At production system level and value-chain level, complexity arises in convincing the suppliers to reuse the packaging material and coordinate the plant operations to include effective management of reusable packaging material flows. Therefore, these CEBM practices are pursued not only at the firm level, but also at value chain level and regional level through partnerships with the suppliers, energy providers, and recyclers.

Supply Chain Preparedness

While Company C actively pursues CEBM practices at firm level and is quite successful in achieving intended environmental goals, it requires active participation of its suppliers and other partners to succeed. It also requires commitment of its employees to redesign and standardize organizational processes to suit the CEBM goals. The supply chain processes aligning with Company C's CEBM goals vary. Even though Company C offers to share the process knowledge and support the suppliers with the process execution, some suppliers resist to get involved with Company C's CEBM goals. For example, sending reusable packages back to the suppliers has been a major challenge for Company C because it is not a mainstream supply chain practice in their industry:

> *"The main challenge came from our supply chain (logistics) perspective of how to return these reusable containers from where they originated. Getting the product from the suppliers to here is not the problem. Rather, getting the containers back to the suppliers for their reuse/repackaging was the largest challenge because that's outside the normal supplier-customer relationship that traditionally works." [Plant Manager]*

In other words, tier 3 suppliers are not used this practice because Company C's competitors do not apply similar approaches. In such instances of supplier resistance to CEBM practices, Company C forces and mandates its suppliers for their cooperation and coordination:

> *". . . we learn more from (the CEBM practices), but, have to force the issue with the suppliers. We have to make it important to the suppliers in our customer-supplier relationship. We pretty much say that this is how we have done it and has been successful and this is how you need to do it to secure the business. We convert that into a process and put that in the supplier-customer PO#/agreement." [Plant Manager]*

In the case of reducing energy consumption, Company C partners with its energy provider to analyze its electricity and water consumption patterns and identify opportunities to reduce the consumption. The energy provider understands the common environmental goals and is willingly supporting these initiatives, even though it means a loss in revenue from Company C:

> *"(Our energy provider) doesn't like the fact that we will be buying less power, but, they also understand that everyone is working towards sustainability goals and recognize that the society is moving in this direction. So, the two industries are working for a same goal" [Plant Manager]*

On the other hand, CEBM practices require Company C to internally redesign its existing processes, which could be challenging sometimes. For example, the organization had to learn and innovate to design the process of retrieving and shipping the reusable containers back to suppliers:

“. . . we are experienced in sending products to our customers, but, we are not as experienced in understanding how we rotate this packaging back-n-forth. Because when it is difficult for the suppliers, it is also difficult for us too. At some point, you walk around and say, why do we have all these returnable packaging that's not made its way back to the suppliers. In that scenario, we tried to set up visual systems that observes the area getting filled and get a truck to send it back to the supplier.” [Plant Manager]

CEBM Performance

Most of the CEBM practices of Company C require investments made in short term and yield economic benefits in the long run. For example, the company had to invest in huge number of reusable containers to avoid shortages of containers affecting the product shipments. This involves incurring expenditure in the short term, but is expected to save the packaging material costs in the long run, across the value chain:

“. . . (in) short term when you are buying the material, it does not (help to gain economically). e.g., freight cost. But (in) long term, it leads not to purchase pallets, boxes etc. it pays back.” [Plant Manager]

On the social side, Company C has internalized the environmental consciousness across all levels of employees and operations and consequently, positive externalities resulting from this internalization extend to other stakeholders and the communities around Company C as well. Company C actively engages in local community services that contribute to sustainability of the environment.

Contingency Factors

The main contingency factor that affected the success of the CEBM practices at Company C is the strategic emphasis on sustainable business operations laid by the top management of the company's conglomerate. The emphasis trickled down across all levels of organization, until the very bottom level. This led to the employees at all levels rethinking on how to make existing business practices more environment friendly and subsequently to several process and product innovations:

"Well, the corporation has become more environmentally conscious and one of our key aspirational goal is to be a good environmental steward and we want to be a good partner in the community that we serve. This has come from the highest level. As a corporation, this has become a huge point and is driven all way down to the individual engineer. It's a top-down decision" [Plant Manager]

Another contingency factor that affected the success of Company C's CEBM practices is the degree of buyer's power over their suppliers. Using its buyer's power, Company C mandates its suppliers to participate and align their operations so as to help achieve its zero-waste landfill policy across the value chain. At plant level, this contingency factor is demonstrated by the example of how the company organizes itself and its suppliers ship products and material in reusable containers.

"We work all the way with our supplier that we are minimizing the amount of scrap that we have in-house. Some suppliers are located in our industrial parks and others are located in other states. It's easier to deal with suppliers that have large amount of business with. Smaller suppliers are lot more difficult to deal with. Basically, our scope and leverage with our suppliers is what it really allows us to dictate that we are going to utilize each program." [Plant Manager]

TIER 1 – OEM/ODM SUPPLIERS

The general characteristics of Company D in tier 1 as original equipment manufacturing (OEM) and original device manufacturing (ODM) suppliers is shown in table 5-3 below.

Table 5 - 3: Company D in Tier 1 – OEM/ODM Suppliers

	Company D
Research Setting	US Plant
Size (No. of Employees)	46,000 (200 in SC)
Age of the Company (years)	77
Scope of Operations	Global
Primary Customers	Commercial, Industrial, Government
Annual Revenues	$8.11B

COMPANY D

Company D is a plant located in the Eastern US, that manufactures customized bearings to meet the unique application requirements of industries such as aerospace and defense, commercial aerospace, industrial machinery, medical systems, mining, oil and gas, radar, and renewable energy. In 2014, Company D has been acquired by a large industrial and automotive conglomerate with operations spanning 130 countries and headquarters in Sweden. In terms of supply chain network, Company D is a customer of Companies A, C and F, and a supplier of Company E.

CEBM Practices

Company D's CEBM practices are mainly oriented towards achieving operational efficiencies, meeting customer requirements, and complying with the environmental regulations and standards. Emphasis on CEBM practices, however, have seen a positive shift since the acquisition by the current parent company, which is aggressive in implementing sustainability policies. Some of the CEBM practices currently implemented by Company D include selling the scrap material to the recyclers and repurchasing the recycled metals from them, implementing energy efficient solutions such as upgrading heating, ventilation, and air-conditioning systems, and lighting automation, and conducting regular life testing on bearing equipment to increase their operational life. Another prominent CEBM practice is the new "clean line solvent system" (CLSS) that are recently implemented. This system comprises of two new high-speed automated cleaning machines that cycle the bearings through the solvent to eliminate hazardous powder and other forms of debris and make them as clean as possible from an environmental and health safety perspective. The powder is very harmful for the integrity of the bearing products and for its future users from environmental and health standpoint. The company intends to install six more in future. The CEBM practices of Company D contribute to slowing and closing resource loops.

Complexities for the CEBM practices of Company D mainly arise at design level, due to the unique set-up (factory layout rigidness) of the plant. Installation of the two CLSS has taken two years of background work for getting the right specifications and installation space. Training and operating procedures for the systems, however, are not very complex.

Supply Chain Preparedness

The approach to CEBM by Company D is oriented more towards a pull-strategy rather than a push-strategy. In this case, the parent company and the customers require Company D to pursue CEBM initiatives. Therefore, the challenges to pursue CEBM are more internal rather than external. With the acquisition by its parent company, Company D has undergone several transformations in its business practices that are required for a good integration with the parent company. These transformations in the business practices carried the burden of change management at every level of the organization. In order to be successful in its CEBM initiatives, Company D needs to deal with this burden of change management:

> *"Our maintenance management team were initially clueless about this whole thing. It took them some time to understand the whole CLSS thing to get going. An unrelated example is that of ERP implementation that has been forced upon us through XXX (parent company) for integration reasons. The change management part is overwhelming for us at this point from a supply chain perspective. We anticipate XXX (parent company) to have us implement more sustainable business practices/initiatives." [Supply Chain Manager]*

However, with each implementation of new business practices, the employees get to learn new concepts and skills and the process of undergoing the changes keeps them prepared for the subsequent transformations. The contingencies thus, are enhancing the preparedness of Company D to pursue CEBM practices: *"The lesson learnt (either through production floor experience or through workshops) makes us readier for the next implementation" [Supply Chain Manager]*

Perhaps, the company is anticipating that its parent company will require the plant to apply more innovative process management approaches in supply chain activities in order to avoid emission and leakage of hazardous material from the start of the production process. From a supply chain preparedness perspective, these CEBM practices will not only help Company D meet its customers' requirements, but also to fulfil its parent company's commitment to sustainability.

CEBM Performance

On the economic side, the CEBM practices of Company D in general do not directly contribute to the profitability of the company. Instead, it perceives that the practices contribute towards satisfying its customers' demands to stay in business. Therefore, it argues that its CEBM practices are simply the costs of doing business:

> *"CLSS was a requirement that was initiated from the customer side (Lot of our customers now stress upon the quality cleaning of bearings before delivering). So, the ones that we had been applying were really not meeting our customer expectations. It helps us from both quality and throughput perspective now. Apart from that it supports our business from sustainability standpoint" [Supply Chain Manager]*

However, Company D also advises that the practices are expected to have positive impact on the environment in terms of reducing the hazardous material released into the environment and conserving energy. For example, these CEBM practices have provided the company with a scope to replace its older machineries with newer ones that meets global environmental compliances and enhances work-place safety. Thus, the social impacts of its practices are attributed as employee satisfaction of work-pace safety and learning new skills pertaining to energy efficient operations: *In satisfying our customer requirements, our staff learn new skills about how to become environmentally efficient." [Supply Chain Manager]*

Contingency Factors

The primary contingencies that triggered and affected the success of the CEBM practices of Company D are the recent acquisition of the company by its current parent company and the pressure from the customers to pursue some of the CEBM practices. Since its acquisition, Company D is undergoing several changes with respect to policy and business process improvements to align with the environmental goals of the parent company. The parent company has a 'Leadership in Energy and Environmental Design' (LEED) certification and expects Company D to procure this certification in near future. Towards this end, Company D hired an 'environment, health and safety' (EHS) officer to oversee its sustainability goals:

> *". . . our parent company has made us hire a EHS manager to take charge of our sustainability goals. Like CLSS practices, we expect more upgrades to our older inefficient machines, and honestly, we have started seeing that after (the acquisition) thing." [Supply Chain Manager]*

Demands from Company D's customers for environment conscious operations and certifications have set impetus to several CEBM practices within Company D. The customers demanded "Restriction of Hazardous Substances Directive" (ROHS) certification that has triggered changes in several business practices to comply with the sustainability goals required for the certification. Installation of CLSS is a direct effect of pressure imposed by the customers. Subsequently, Company D has changed its procurement policies that now requires its suppliers to be ROHS certified. In this way, Company D's customers have triggered a chain of strategic contingencies that are manufacturing process and technologies related and conformance and quality related. These contingencies have trickled down to the bottom layers of the supply chain:

“. . . our customers require that a bearing be clean and certified to a certain specification. Other reasons are purely government regulations. For example, ROHS regulations played a major role in amending our business practices towards sustainability. On one hand, we consistently had this as a requirement from our customer, but also internally, we were also looking at our aging equipment for how we improve upon it.” [Purchase Manager]

MANUFACTURER TIER – FOCAL FIRMS

The general characteristics of company E, F, and G in manufacturers tier as focal firms are shown in table 5-4 below.

Table 5 - 4: Companies E, F and G – Manufacturer Tier – Focal Firms

	Company E	**Company F**	**Company G**
Research Setting	US Plant	US Headquarter	US Headquarter
Size (No. of Employees)	96,000 (250 in SC)	20,000 (1,000 in SC)	183
Age of the company (years)	93	119	25
Scope of Operations	Global	Global	Global
Primary Customers	Other Plants	Commercial and Industrial firms	Commercial firms
Annual Revenues	$45.5B	$5.04B	$58M

COMPANY E

Company E is a conglomerate that manufactures heavy equipment for construction, mining, pipeline and agriculture industries, and has global presence in over 180 counties with over 300 products. Company E’s plants in this study manufactures hydraulic cylinders and precision pins. Company E’s plants supply the products internally to its other US based plants. Company E employs 250 employees and procures raw materials from different countries including US, Romania, Italy, Turkey and China. In terms of supply chain network, Company E is a customer to Companies A, C and D, and supplier to F, G, and J.

CEBM Practices

Company E's follows several CEBM practices that include tracking and reducing the natural resource consumption and waste material leakages into the environment, innovating to extend the functional life of its products, reusing the packaging material, and mandating suppliers to acquire 'Trusted Supplier Certification Program'. As a policy propagated from the parent conglomerate, Company E has adopted a robust waste management system that tracks greenhouse gas emissions, water consumption, waste water treatment and reuse, and separation of by-products from the production waste. Company E has voluntarily acquired US Leadership in Energy and Environmental Design (US LEED) certification to be able to measure and monitor its performance on sustainability missions. With respect to reusing the packaging material, Company E has designed its downstream supply chain processes in such a way that the packaging containers of hydraulic cylinders flow back from its internal customers to Company E for reuse. However, Company E is unable to replicate the same processes with its upstream supply chain organizations mainly due to complexities associated with their disparate geographic locations. Company E ensures that its suppliers follow sustainability practices by mandating them to acquire the 'Trusted Supplier Certification.' This certification program requires the supplier to go through a series of validation processes of the supplier's manufacturing, labor, and waste management practices. As such, these practices contribute directly and indirectly to slowing resource loops and reducing material and emission leakages into the environment.

All these CEBM practices are practiced and have impact at micro and meso levels since it involves their plant-level processes and multi-tiered suppliers. Complexities for these CEBM practices arise mainly at the design level. The implementation of these practices require major revamping in its existing plant layouts and its product designs. However, these practices are important for extending its products' overall functional life from sustainability standpoint.

Supply Chain Preparedness

Company E ensures that their product catalogs contain detailed information on the energy consumption, material efficiency, emissions, and other sustainability metrics of the end products. all the information of the end products that the end customers of their products. In that way, its product users (e.g., construction, pipeline and mining companies) are aware of all the product information and plan for their effective use:

> *"Our product catalogs are very detailed in terms of energy consumption, material efficiency, emissions, and other sustainability concepts. The purpose is to make the customers aware of how our machineries are made and how they would perform when they use it. Being an industry leader, we make these considerations to increase transparency in operations and gain our customers' trust while doing business." [Plant Head]*

Internally, Company E invests heavily on redesigning their processes and plant facilities to support changes in product design that conforms with its sustainability practices. There is huge focus on staff training as well, about what sustainability means to Company E and how to incorporate the concept in day-to-day business operations:

"We would like to build strong metrics for our practices. For our sustainable practices, awareness is the first item; we need to be aware of what sustainability means – trash handling, leaving lights on, dealing with scrap, etc., For example, in our paint system, if our engineers don't understand the importance of scheduling, we end up waste a lot of paint." [Plant Head]

CEBM Performance

Company E argues that the CEBM practices do not seem to have a major direct impact on its profitability. Instead, it perceives that these CEBM practices have a significantly positive impact on its brand image that helps the company to sell its products:

"Impact-wise, we are a major equipment provider for the mining, pipeline, and construction equipment industry, but we are also heavily focused on sustainability. So, the industries that we serve associate themselves with our brand image. It helps their brand as well. Our customers consider our products because the sustainability concepts (inbuilt in our equipment in term of fuel/energy efficiency and environmental expectations in terms of emissions) helps their businesses as well." [Plant Head]

Environmentally, the CEBM practices aid in reducing the carbon print and other waste material leakages into atmosphere and enhancing the health of its employees. The LEED certification enabled Company E to reduce its energy consumption by 30%, which is an important milestone in achieving the desired environmental impact from the CEBM practices:

"Our machines consume lot of energy. So, one of considerations that we made was to acquire LEED certification that enabled us to apply practices that would make us consume 30% lesser amount of energy than the average manufacturing facility levels,

this making our energy efficiency practices more robust. To do this, it required us to implement complex planning and modifications in terms of energy consumption and (noise pollution too). We spent about $150M on our machine shops to build containment/walls for sound proofing – a major reason for health hazard otherwise." [Plant Head]

On the social side, these practices help in improving work place safety and working conditions of its employee. In addition, the staff trainings on sustainability creates awareness among its employees, which in turn makes its employees conscious about factors of environmental importance in their day-to-day work activities. Also, its sponsorships for sustainability programs and engagement with community programs help the local community to stay engaged and motivated in pursuing larger sustainability goals, such as forestation, clean-up camps, social education, and so on.

Contingency Factors

The success of the CEBM practices of Company E are product and sustainable policy related contingency factors. Company E is well-aware that while its products contribute to the productivity of its product users (e.g., construction, pipeline and mining companies), these products have harmful effects on the environment in terms of fuel consumption and waste gas emissions. Therefore, Company E and its peer companies continuously innovate on their product designs to increase fuel efficiency and reduce waste gas emissions. Any changes to product designs translate to changes in component designs and manufacturing processes:

"As an industry, we are fully aware that our tooling products generate lot of fuel (GHG) emission, and are used in other forms of environmental depletions while conducting

activities such as mining, construction, digging of pipeline projects, etc. So, we want to serve these industries by being as much sustainable as possible….from a purely industrial design standpoint (such as designing a new engine), it is very complicated because it depends on establishing the levels of emission and other factors of parts/components that make the whole engine. For example, the efficiency of a tractor is highly correlated to the quality and design of the hydraulic cylinders and not just the fuel consumption." [Plant Head]

COMPANY F

Company F is a manufacturer of diverse packaging product and services with 20,000 employees and operations spanning across 85 countries in the world. The company's packaging-based manufacturing operations is split into two lines of packaging businesses namely consumer (primarily, food packaging) and industrial packaging. Company F has other lines of related business operations including a digital media group that deals with art-work and packaging graphics, a paper brokering group that deals with purchasing and inventorying of corrugated paper and supply for the paper mills, a recycling group that takes care of the recycling the waste packaging products. The company offers packaging products and solutions for a wide range of products including food products, industrial products, automotive parts, pharmaceutical products gardening products, and inks and films for product labels. In terms of supply chain network, Company F is a customer to Companies A, E and J, and supplier to Companies C and D.

CEBM Practices

The business model of Company F hinges heavily on making use of material recycled from used paper and plastic. The recycling group of Company F recycles about 3 million tons of used paper, plastic and other materials annually. The recycled material is fed back into the internal packaging and other supply chains. Although Company F uses recycled material in much of its packaging products, it is compelled to use virgin plastic for packaging the food products to avoid food contamination and other health risks. In order to reduce the consumption of virgin plastic, the company uses "layering" technique wherever possible, wherein, the immediate layer in contact with the food products is made of virgin plastic material and the subsequent layers are made from recycled material. Company F uses 19% recycled material in food packaging, which is much greater than its counterparts in food packaging industry. Company F actively engages with its suppliers, customers, and competitors to find innovative ways of utilizing the recycled material and explore new ways of collecting the used packaging material. Apart from these CEBM practices, the recycling group of Company F offers education and training programs on recycling to interested customers, schools, and other community members. Every year, the recycling group recognizes its own facilities and other organizations for achieving significant milestones in landfill diversion and waste reduction with a sustainability award. Thus, Company F relies on its CEBM practices of recycling and innovative use of recycled material for its competitive position in the packaging industry. For example, the company promotes that its fresh food packaging boxes be reused by the consumers for other purposes. In short, the CEBM practices are geared towards achieving sustainability by involving suppliers and consumers to adopt means for slowing resource loop and reducing material leakage into the environment.

In its quest to achieve higher degree of sustainability, Company F's CEBM practices are particularly complex at design level. Such complexity arises as design level because its packaging solutions cater to a wide variety of product requirements, handling conditions, and post-usage recyclability aspects. These practices have impact at micro and meso levels as it involves continuous co-ordination with designers, suppliers (waste traders) and multi-industry customers in meeting high quality packaging orders.

Supply Chain Preparedness

Usability of the recycled material is a major factor that affects the costs associated with packaging. Typically, one can derive only 70% value from recycled material. The quality of the recycled material in turn depends on the quality of the input waste material. Company F promotes quality input waste material by incentivizing its suppliers by offering payments for the material. In alternate scenarios, the suppliers pay Company F for disposing the waste material:

> *"Our collection of input material is highly dependent on market price. So, we consider paying more to our supplier of recyclable materials, if the bail material is of good quality. If only 50% is usable, then, they pay us. So, we are constantly balancing the usefulness, the cost to process, the disposal cost." [Chief Sustainability Officer]*

The lack of control on household waste collection is an important barrier for avoiding the used material contamination. Separate bin systems for the used material turns out to be inefficient for the city departments (in the South East Coast region of the US, where Company F is headquartered at) due to consumers' indifference in managing multiple trash bins and additional logistic effort in collection of separate streams of waste. Therefore, local departments and waste collectors in this geographic territory find it cost efficient to collect the waste in a single stream and separate them at the collection hubs. This system drastically affects the quality of the recovered waste material:

"Research shows people don't like separation of trash, and in addition, different bin system doesn't meet the customer requirement (when the recycling bin gets filled up, people start putting recyclables into trash cans. So, logistics (and economy of scale) doesn't support garbage collectors to have two separate bins. Hence, industry felt that that it works well from economic standpoint to have a single stream than separate streams, even if they hate to have it single stream from contamination standpoint. So, technologically, it's easier to separate at recycling point. The city needs to be innovative in training consumers." [Chief Sustainability Officer]

On the customer side, some of larger customers often come out with new recycling initiatives, which compel Company F to proactively adjust their inputs, processes and technologies to suit the customer initiatives. The diverse portfolio of Company F helps greatly in making such adjustments. Company F also collaborates with its competitors as well to improve on recycling methods:

"For example, we are working on a project called clear produce packaging (that used to pack lettuce tomatoes, spinach), we want that packaging back in the recycling stream. In bottling industry, it works pretty well. In CA state, at least 20% of the recycled bottles come back to us. We are working with competitors to improve the recycling of those produce packaging. That is a major effort that we are putting to make a true-closed loop system." [Chief Sustainability Officer]

At industry level, increase in the cost of the good quality (less impure) raw material is a negative driver for using recycled material. This in turn increases the overall operating costs due to greater efforts of recycling impurity and/or cost of adding virgin raw material. Company F, therefore, faces a significant challenge to make its customers accept for the higher cost of production of the packaging products. From a supply chain standpoint, Company F uses such contingencies as an opportunity to innovate newer packaging products with lesser amount of input materials and to renegotiate for long term contracts and pricing models that creates win-win situation for both sides:

> *". . . it is about how to reduce the cost of raw material across the industry. Typically, virgin raw material costs more than recycled material. So, with market imbalance (recycling trend going down), we consider how we can recycle more by looking at the economics of decreasing our raw material cost and by increasing our operational cost." [Chief Sustainability Officer]*

> *" . . . we try to tell our customers beforehand about increase in cost of manufacturing packaging in reduced materials. Since we have long-term partnerships, they understand us and are always willing to negotiate on pricing or other terms to make a win-win situation that helps their as well as our business operations." [Purchase Manager]*

Overall, Company F contends that the concept of circularity is not well integrated across suppliers, customers and society. Therefore, Company F strives to address this gap by collaborating with trade allies, industry, government, and communities for developing and sharing best practices and thought leadership:

> *" . . . we recognize the importance of sustainability/circularity, but, on its own the idea is not well integrated. So, being a leader, we intend to do integrate it better by working with our trade allies, industry, government, and communities, such as sharing our best*

practices, thought leadership, etc. Governments typically mess it up so much." [Chief Sustainability Officer]

CEBM Performance

Company F's CEBM practices are of strategic importance to its business model and therefore, significantly contribute to its profitability. On the environment side, the CEBM practices help in finding innovative ways of using the recycled material, reduction in infusion of new plastics into the environment, and reducing the landfill. On the social side, the recycling awareness programs help in greater awareness and engagement of community members in recycling activities. More precisely, Company F's practices contributes significantly towards improving sustainability standards, such as increasing awareness about how to reuse of plastic products after first consumption, less use of environmentally harmful material and so on.

Contingency Factors

One of the main contingency factors that Company F's CEBM practices have no control (i.e., institutional contingency) is that of China's regulatory ban on importing bails of impure plastic material from the US in 2016. While this ban posed a dilemma of how to dispose the recyclable plastic bails within US through landfill or incineration, it also presented an opportunity for other US-based recyclers to invest for building recycled plastic production capacities. As such, prior to the ban the recycled material from US recyclers had to charge for higher price due to higher production costs resulting from inconsistent supply of waste material because 99.5% and above clean plastics exported to China. But after the ban, the prices of recycled material came down due to sufficient supply of post-usage plastic as input raw material. Company F benefits (or suffers) from the lower (or higher) costs of the post-usage plastic input material. This contingency factor also applies in the case of availability of waste paper for manufacturing corrugated paper packaging products. Second, the global market fluctuations for supplies of raw material also act as an institutional contingency at times:

> *"In terms of supplies challenge, a few years ago when China and Indonesia were developing large corrugated paper mills, we had a supply issue of global range because everything was going out to China and Indonesia. Large paper mills when started can't be easily stopped (continuous flow production). It costs about $300,000 to stop the production. So, these countries were taking away all market supplies. And, for us, the prices went up. So, it was quite a bit of challenge to maintain our supply levels. Otherwise, when the market is depressed (like now after China ban), it is not at all a challenge." [Chief Sustainability Officer]*

Another contingency factor that affects the success of the CEBM practices of Company F is its lack of reachability to consumers on used product collection from the consumers. The recycling processes benefit to a great extent, if the consumers are trained for proper usage and disposal of products. However, waste collection is typically performed by the local city departments. City departments, however, look at their own cost efficiencies in collecting the trash that does not necessarily have a positive impact on recycling process:

> *"In terms of used-material collection from our suppliers, our abilities are limited since we don't communicate with the consumers. The city/municipals do that. Some cities do that very well while others are still learning." [Chief Sustainability Officer]*

COMPANY G

Company G engages in trading and processing of post-industrial, post-commercial, and post-consumer scrap including plastic, paint, paper, and metal scrap. This company employs 183 personnel with an annual revenue of approximately $114 million. The current operations span worldwide, with its offices located in United States of America, United Kingdom, China, Columbia, Mexico, India, Russian Federation, Guatemala, Ecuador, and Brazil. The present research study focused on Company G's operations of post-consumer plastic and resin scrap, since this part of Company G's operations related more closely with the innovative CEBM practice in the U.S. market. Collection and processing of plastic scrap constituted significant portion of Company G's operations and revenues. In terms of supply chain network, Company G is a customer to Company E.

CEBM Practices

Company G buys scrap from some of the popular grocery chains in the U.S., processes it using semi-automated cleaning mechanism, and packs the processed material in bails of 2000 pounds. These bails were exported to China until 2016. However, in 2016 as mentioned earlier, China imposed a ban on import of plastic material below 99.5% purity. This regulatory move by China posed a survival challenge for Company G and prompted it to extend its operations to recycle the waste plastic into plastic pellets. These plastic pellets are supplied to plastic bag or durable plastic product manufacturers in the U.S. (domestic) market.

The CEBM practice of recycling and reusing plastic waste by Company G helps in reducing the plastic material leakage into the U.S. environment by (a) reusing the stockpile plastic that would have otherwise ended up as landfill and (b) indirectly regulate the total volume of the plastic material in the environment by reducing the generation and import of new plastic material. Company G pursues CEBM at micro and meso level since the business model is primarily oriented on this CEBM practice. It requires involvement and commitment of employees across all levels of the organization and the entities along its value chain. Regarding the complexity associated with the CEBM practice, the process of recycling and reusing the plastic in itself is not complex at production level. However, complexity exists at value chain level since it requires synchronization of several factors such as subsidies for partnering firms at meso level for being successful. Some of the other factors include greater awareness of the community on usage of plastic and government enforcing regulations that reduce the usage of new form of plastic.

Supply Chain Preparedness

While Company G is able to respond to the contingency factors positively to its advantage, challenges still remain in terms of improving its operations to have better economic, environmental, and social impact. One such challenge is limited demand for recycled plastics. Recycled plastic products tend to have varying consistency and quality, as discussed earlier, when compared to products manufactured from virgin plastic. Therefore, the customers such as grocery and retail chains seek the easier path of procuring new plastic, rather than recycled plastic. Also, the petrochemical companies that supply new plastic have more control on government regulations through lobbying. As such, the current regulations do not restrain customers to buy plastic products made from virgin plastic resin or recycled plastic. Therefore, Company G anticipates that regulation should support this CEBM practice either by penalizing or by advocating customers to refrain from buying new plastic products.

“Whether we create demand by legislation or advocacy, recycling will not increase without it. Business takes the path of least resistance, which is to use virgin resin.” [CEO]

On the product side, generating plastic pellets of consistent quality is a challenge. The quality of the plastic keeps deteriorating as it is reheated again and again. Further, the plastic scrap that is procured is usually contaminated to varying degrees. Sorting the plastic scrap that can be recycled and reused constitutes an important activity that directly affects the quality of the end product. Procuring cleaner and pre-assorted plastic scrap requires active involvement and coordination of the suppliers. However, since the domestic recycling is a relatively new phenomena to all the involved entities in the U.S., some amount of training and advocacy is required to design and standardize waste disposal practices.

“(We try to) educate and push our suppliers to provide us cleaner and pre-assorted scrap. We pay more for better grade/quality scrap.” [CEO]

Company G revealed that it is working with its plastic waste suppliers in advocating for wiser use of plastic products as that would make the recycling process much efficient. Also, Company G has successfully created circular supply chains with some of its customers for plastic bags by making them supply post-usage recycled plastics as input. It anticipates that this circular supply chain phenomenon would gain momentum through adequate training of its customers to support them in supplying used and less impure plastic too.

“Since the domestic recycling phenomena is so new that our suppliers need training. One important thing that keeps us motivated to make such adjustment is because our suppliers are our buyers too.” [Supply Chain Manager]

CEBM Performance

Creating value out of post-industrial, post-commercial, and post-consumer scrap is at the core of Company G's business model. The company realized much greater value in extending its business operations to recycle the plastic waste to plastic pellets and supply them to plastic manufacturers in the U.S. The plastic recycling division currently contributes to 25% of the company's annual revenues. The CEBM practices of Company G are bound to have a great impact on environment by limiting the volume of 'new' plastic entering into Earth's environment. On the social side, Company G is promoting its recycling solutions to other plastic scrap generators, thus, generating new jobs.

"There is more value to be realized and shared. We will help them see that recycling can pay. It has to make economic sense; only then will the recycling story be successful." [CEO]

Contingency Factors

The main contingency factor that affected the success of Company G's business activities is the regulatory move by China imposing ban on import of plastic material below 99.5% purity. This move directly changed Company G on the downstream side of its supply chain, since Chinese companies were the main customers for the bails of plastic waste.

> *"I think, it was more of a survival/existence reason for us. If China had not imposed such plastic ban, we probably would have continued being scrap dealer and never thought of becoming plastic/resin recycler. So, (Chinese) government policy was probably the sole reason for getting much more involved with pursuing circular business practices." [CEO]*

The Chinese ban on plastic imports significantly disrupted Company G's supply chain activities, by forcing it to extend its business operations to recycling plastic waste into plastic pellets. With this extension, Company G contributed to circularity by closing the loop of the plastic waste, which was otherwise, disparate, fragmented and ineffective.

DEALER TIER – RETAIL SERVICE FIRMS

The general characteristics of company H, I, and J in dealer tier as retail and distribution service firms are shown in table 5-5 below.

Table 5 - 5: Companies H, I and J – Dealer Tier – Retail Servicing Firms

	Company H	**Company I**	**Company J**
Research Setting	US Headquarter	US Headquarter	US Headquarter
Size (No. of Employees)	10 in SC	20 in SC	250 in SC
Age of the Company (years)	40	59	36
Scope of Operations	US (Regional level)	US (Regional level)	State
Primary Customers	Consumers	Consumers, Service Shops	Contractors
Annual Revenues	N/A	N/A	$346M

COMPANY H

Company H sells, installs and repairs new and used appliances including washers, dryers, refrigerators, cooking appliances, and dishwashers. The used appliance sales constitute about 10-20% of the company's total sales. The company provides full range of appliance services across five counties in the US state of South Carolina. For the present study, the Company H's business models of selling used appliances is considered. In terms of supply chain network, Company H is a customer to Company B.

CEBM Practices

Company H's business model of selling used appliances gives opportunity for customers with lower income levels to purchase the used appliances at lower prices. It also caters to the needs of transiting people, who constitute a significant percentage of local population. In the case of customers looking to buy a new appliance, Company H offers a buyback price for their old appliance. In this way, Company H contributes to slowing the resource loop of consumer durable products by offering value proposition to both the customer segments seeking new and used appliances. Environmentally, this CEBM increases the usage-life of the products by reselling the used goods to the relevant customer segment and servicing the machines back to working condition. Subsequently, these services slow down the process of appliance disposal to the landfill.

Company H pursues this CEBM practice at micro level, since it has no control over the supply of used appliances. Also, success of this CEBM is heavily dependent on technicians' ability to repair the products and availability of the required parts. Complexity for this CEBM therefore, exists at service design level.

Supply Chain Preparedness

Company H's business model of selling used appliances depends on several factors across the supply chain. The first factor is supply of the used appliances. The company procures the used appliances from the customers who buy new ones. Sometimes, when there is demand for used machines, the stock may be limited. The second factor is the procurement of spare parts. Company H procures spare parts from the manufacturers or specialized part-houses. Spare parts are usually priced higher, which affects the survival of this business model. Also, continual introduction of new models in the market and discontinuance of older models further complicates the supply chain of used appliances. The difficulty in procuring the spare parts is tempered down to some extent by retrieving all the working parts from the appliances that are no longer viable to be fixed. The third factor that affects the functioning of this business model is the skillset of the technicians. In the background of continuously changing technologies, the technicians working at Company H need to keep updating skillsets to cater to the repairing services of the new models. However, they need to be versatile with repairing the older models as well to cater to the repairing services of the used appliance segment. To achieve this, Company H invests on the technicians by sending them to technical centers and training them. Such trainings help its technician to earn a better pay and have high job prospects, this improving their quality of life.

> *"We invest on them (the technicians) by sending them to school and training them at our own cost. We need to keep the technicians updated because technology continues to change. They have to keep up with repairing older stuff as well as new ones."[CEO]*

CEBM Performance

On the business side, selling used appliances and servicing the appliances are the significant value propositions offered by Company H, which makes them an attractive option to the local people for buying appliances. This part of business adds up to their customer base and build relation with them, so that they keep coming back. They constitute a significant part of Company H's revenue.

> *"The used model adds more revenue. Selling used appliances obviously allows us to get a group of customers that can't afford new. Being able to service something that you*

bought from me, as supposed to have to call the 1-800 number and wait/plead. Economically, it adds our customer base because that helps us to make more business with them. We form a relationship with them." [CEO]

In some cases, however, where it is no longer viable to fix the used machine, Company H tends to lose out on money and customer loyalty. In such cases, technicians put in effort in terms of inspection and exploring the possibilities, but the outcome of the effort is on the negative side. In such cases, the customer has lost the money with which he/she bought the appliance and is unhappy. Company H strives to retain the customer by deducting the money spent in the subsequent purchase of a similar appliance from Company H. On the social side, Company H helps people save some money on the appliances and create jobs for local technicians. As such the economic and social benefits that the customers gain are intertwined with each other, thus improving the quality of life of their customers.

On the environmental side, Company H strives to reuse the appliances and parts as much as possible and slow down the process of the appliance and its parts ending up in the landfill. However, there's a downside to reusing the old appliances in terms of greater energy consumption by the older appliances.

"We try to put as little as possible in the recycles. We don't throw anything out on the road. We haul back anything that is left and hope that they do what they are supposed to do. We are environmentally conscious in our business practices." [CEO]

Contingency Factors

The main contingency factors that affect the success of Company H's used appliance business model are the availability and prices of the spare parts. Sometimes, the parts that need to be replaced to bring the appliance back into working condition turn out to be very expensive, nullifying the value proposition of saving money. The customers can get a new machine for the price of repairing the older machine. In some other cases, the product is so old that the replacement parts are no longer available in the market:

> *"As for the parts, they are procured from two places - the manufacturers or specialized parts places who sell parts only. The prices of the parts continually go up because they (the appliance manufacturers) know that customers want to repair instead of replacing with new appliance. We always see customers complaining that these parts are ridiculously priced." [CEO]*

Another contingency that affects the success of the used appliance business model is the volatility in the demand and supply of the used machines. The demand for the used appliances is greatly dependent on how the economy is doing. It tends to be good, when the economy is not doing well. However, on the supply side, Company H procures used appliances from the customers who buy new ones. Typically, when the economy is not doing well, there may not be sufficient sale of new appliances and that subsequently affects supply of used appliances, creating a paradoxical effect:

> *" . . . it (the demand) is also dependent on the economy that has to support more used business and repair model during times when the economy is not doing good. People will be more interested to buy used vs. new one. But, the bottom line is that we have to sell out more new appliances to get more used ones in." [CEO]*

COMPANY I

Company I is a third-generation family owned business that deals with resale of undamaged auto parts extracted from wrecked cars. The damaged cars are procured from the auto insurance companies at local auto-auctions. The damaged cars are then dismantled to retain the reusable parts, which are then sold to retail outlets or individual customers. The company is headquartered in a small town in the Eastern US with a 50-acres facility for dismantling and employs 25 people. In terms of supply chain network, Company I is a customer to Company B.

CEBM Practices.

Company I's business model is based on the CEBM practice of capturing the residual value that is remaining in the wrecked vehicles that would otherwise have ended up in junkyard. These retrieved parts are sold to the customers that need these parts to make their car functional. Also, the recoverable materials from the wrecked cars is retrieved, processed and sold to the recyclers. Environmentally, the business model helps in deriving maximum residual value of wrecked cars in terms of reusable parts and recyclable material. The overall life-time value of the reusable car parts is enhanced with this CEBM practice. Additionally, this CEBM practice serves as a low-cost alternative to procure the required automotive parts. The reusable parts also help in extending the life of other cars that are in use. The business model thus, contributes to slowing and closing the resource loops of automobiles. In addition, Company I has implemented strict measure of environmental importance by installing storm-water run-off, catch-basins and oil-water separators in its plant facility.

Company I practices this CEBM practice of deriving residual value from wrecked cars at micro level, since the company's involvement with the practice more at a firm level and not much at the supply chain or community level. The complexity of the CEBM practice is mainly at the service design level, especially with tacit knowledge involved in estimating the value of the wrecked cars based on the extent of the cars' damage and the expected demand for its reusable parts.

Supply Chain Preparedness

The success of Company I's CEBM practices is mainly affected by the lack of cooperation and guidance on the car models from the automobile manufacturers. At present, automobile manufacturers offer two-hour workshops to the external technicians at the trade shows, as opposed to a week-long training to their franchised technicians. Apart from these training sessions, there are no other sources catering to the training needs of these external technicians.

"One of the biggest things that we need to do as an industry, it takes us back to the technology question. I think, industrial training would be a big help. Also, transparency in terms of information sharing by automotive manufacturers." [CEO]

From a car manufacturers perspective, Company I practices is seen by traditional car manufacturers as their substitute and not as a competitor.

"For example, [a car manufacturer] no longer provides any price information about their cars to the auto recycling industry. The auto manufacturing industry probably does not care about our industry at all. Therefore, they do not consider us as a competitor. We are not a factor in their business model. Basically, once their warranties are over, they wash away their hands, even though, they are aware that the car still has good remaining value." [Project Manager]

To make up for this shortcoming in the automobile knowledge, Company I tries to recruit people who got the franchisee training from the automobile manufacturers. Other technicians rely on experiential learning to decide on the parts to recover.

> *". . . there is nothing to the best of my knowledge within our industry that one such extensive training program is currently available. So, from time to time, we pick someone up who has received such training about automotive salvage. We also hire people with higher aptitude because we are not brand or model specific – aptitude guides technicians to kill one part in order to save another part that may have more value." [CEO]*

CEBM Performance

The CEBM practice of Company I is its source of revenue. Even though, there are down-times in the market induced by various institutional factors such as the cash-for-clunker program, Company I survived through the years and is presently doing well. The CEBM practices have environmental benefits in terms of reusing auto parts that would have been otherwise disposed with no value. The dismantling operations are performed complying to the best environmental, health and safety standards without causing oil spills and polluting the environment.

> *"Since 1959, we have never ever had any oil spill case. We test our storm-water run-off enough, so that it is as clear as the grocery stores. We have installed catch-basins, oil-water separators. We have installed the equipment on site." [CEO]*

On the social side, the Company I's CEBM practices help in offering a reliable low-cost alternative to buying new automotive parts. The company's business model also offers value to salvage vehicle owners by offering some value to those vehicles and clearing them up from their premises.

Contingency Factors

The success of Company I's CEBM practices are mainly affected by industry and market related contingency factors. The industry related contingency factors are pertaining to new models of cars with new technologies such as hybrid cars and the lack of information on the internal parts of the car models. Several of the automotive recyclers such as Company I have set up the dismantling equipment that suits the traditional models (e.g., gasoline cars) and the technicians' knowledge is limited to those car models. When cars with completely new technological make-up are introduced in the market, Company I and other car recyclers are constrained with the lack of equipment and knowledge to deal with recycling of the wrecked cars of this new segment. Company I faced this type of situation and missed on the opportunity of handling hybrid cars due to the equipment and knowledge constraints. As such, this has led Company I to bear a significant loss of profits by not addressing a profile of customers who drive hybrid or battery-operated cars.

> *"With the advent of hybrid-vehicle, we were not ready to handle/dismantle hybrid safely. We did not know how to maximize value of the hybrid vehicle. We tend to buy very few hybrid vehicles because we never developed the market (i.e., bought equipment to dismantle hybrids)." [CEO]*

In addition to lack of knowledgeable technicians, another institutional contingency factor that affects the success of CEBM practices of Company I is about unavailability of reliable information of auto parts of recent car models. For the CEBM practice to be effective, the car parts need to be inventorized with complete information on where they can fit. In the past, the automobile manufacturers released the automobile's internal information immediately after it is introduced in the market. Presently, there is a time lag of 14 months between the introduction and release of internal information. The CEBM practice does not turn out to be effective due to this delay in the information flow from the car manufacturers to its inventory system. Therefore, it suffers in efficient extraction of automotive parts from recent models of wrecked cars.

> *"At industry level, we currently face unavailability of good information. We call that as interchange of information. That means "What and where does this auto part fit?". Earlier, our software supplier used to keep us updated to the current year of automobile logs. But, right now, there is about 14 months lag time between new vehicle and their data availability in our inventory system. The information flow from the industry doesn't fully support our business." [CEO]*

On the market side, a major contingency that happened recently is the introduction of the U.S. federal scrappage program "Car Allowance Rebate System", also known as "cash for clunkers". This program aimed at making people in the US to dispose their old cars and purchase new – more fuel-efficient vehicles – by providing economic incentives. Due to this program, nearly half of Company I's customers did not require the reusable automotive parts since they bought new cars, which would not have any functional issues for several years. As such, this externality has impacted its business for several years.

> *"The "cash for clunker" program didn't really play out well for our industry. During that period, several hundreds of thousands of cars were taken of the roads. Those were my retail customers, who were put on newer cars with warranties. So, the retail*

customers (who would come to me for damaged replacements) were gone for that period of years. And, it took several years for the cars that those customers purchased to age/wear, before they would need me again.” [CEO]

COMPANY J

Company J is a dealer company for new and used heavy machinery for construction, mining, logging and agriculture. Company J sells equipment of several companies and is the exclusive franchised dealer of Company E’s parent conglomerate. The company also provides ancillary services such as financial services, repairing, rental services and parts sale. The company operates within the US state through its 12 branches and has 250 employees. In terms of supply chain network, Company J is a customer to Company E and supplier to Company F.

CEBM Practices

The CEBM practices of Company J include providing leasing option for the heavy machinery, reusing the parts of the used machinery, and enhancing the functioning of the machinery by providing engineering services and getting feedback from the customers product performance and enhancing the performance using supplementary technologies available in the market. The first CEBM practice of Company J pertains to offering leasing option to the heavy machinery. This option helps in serving the short-term requirements of the customers and contributes to effective utilization of the machines and making use of idle machines. The second CEBM practice concerns to reusing the used parts. The attachments and parts of the heavy machines tend to be very expensive and consume large amounts of resources in manufacturing including raw-materials, logistic resources and engineering skills. Procuring the good quality parts from used and non-conformed new equipment (e.g., The company’s new products rejected for non-compliance of one or more quality aspects; however, they may contain quality parts.) helps in reducing costs to the customers for up to 70% and associated resource losses. The third CEBM practice concerns to receiving feedback from the customers on the performance of products and enhancing their performance using supplementary technologies available in the market. With the encouragement of Company E, Company J conducts consumer surveys about performance of their new designs, especially in the aspects of efficiency and emissions, and sends the feedback to Company E. Also, based on the findings of the surveys, Company J recommends the customers on adding accessories that can potentially enhance the performance of the machines in terms of their operational safety and environmental efficiency. Company J invests on employing technical team with specialized skills to cater to these ancillary engineering services for the sold equipment.

In summary, Company J's CEBM practices help in slowing resource loops, provide alternatives to restrain unneeded new demand, and reducing material leakages and emissions into environment. The CEBM practices, in general, are standardized and simple to follow. Company E provides the necessary training and knowledge resources to Company J's technical team to plan and implement the recommendations for enhancing operational safety and environmental efficiency of Company E's products. Company J's CEBM practices span at micro and meso levels, involving its internal personnel, Company E and the customers.

Supply Chain Preparedness

The supply chain preparedness for Company J's CEBM practices is on the higher side, both internally and externally. The supply chain partners actively collaborate with Company J which is a link between their products and the end customers by offering training, knowledge resources, and support for procuring used parts. Company J's customers actively provide feedback on the product performance, which subsequently is passed on to the respective product manufacturers. The customers also coordinate actively with Company J to implement the recommendations on enhancing the product performance. Internally, Company J copes up well with the changing market needs by providing the necessary support to its employees. Company J also ensures transparency in the product information with respect to their fuel consumption and emissions, so that customers make informed decisions on the procurement and use of the heavy machinery products.

CEBM Performance

Company J's supplier preparedness for CEBM practices has significant economic impact on the company's revenues and costs of its customers. The ancillary services provided by Company J, especially the rental services, repairing, and parts resale contribute up to 60% of Company J's revenue and up to 70% cost reductions to the customers. As such, this revenue mix helps their business model thrive.

> *"From an economic standpoint, these business practices collectively make up to about 60% of our total revenues. Parts and service are our two largest revenue sources (about 50-50 split)." [Sales Manager]*
>
> *"Replacement of these parts are very expensive. So, our practice is to find those parts in our inventory system or in other equipment that stayed undamaged, and we supply/service those parts to our customers. That helps dropping the customer cost by up to 70%." [Service Manager]*

On the environmental side, the CEBM practices contribute significantly in extending the life of the heavy machinery products and reduce the landfill. They also help in reduction of harmful emissions into the environment. On the social side, the CEBM practices result in customer engagement to enhance the efficiency of the products they are using and extend the equipment's useful life. As such, this practice allows its customers to gain new knowledge about how to operate the machineries in a sustainable manner for both environmental and societal standpoint increasing their satisfaction.

Contingency Factors

The success of CEBM practices of Company J are influenced by the market need (structural), availability of product parts (product related), and the support of its supply chain partner (structural) that is Company E. The customer demand for leasing options and reuse of the machine parts are the basis for Company J's CEBM practices. These CEBM practices provide value proposition both for Company J and its customers.

> *"It is primarily consumer-driven. We need to have this mix because it satisfies our customers. For example, we have a customer who has a contract for a very specific job (say, for 60 days only). So, it doesn't make sense to invest in new equipment for short-term contract. In addition, there are contractors who consider leasing to supplement their existing inventory to meet their timelines. The demand for leasing equipment has been increasing year per year. The reason for that is because our customers find operationally more viable because Company E becomes responsible for issues such as repair/servicing and mobilizing from one site to another." [Sales Manager]*

Apart from customer demand, the success of CEBM practice of selling used machinery parts is affected by availability of used machinery parts as well. In this case, Company J effectively uses its strategic relation with Company E and others to pool up the used parts. The company also tries to fix the faulty parts that get accumulated from product recalls and add them to their inventory of used parts.

> *". . . assume that there is a design failure about a part in a XXX machine model that has been reported and validated. So, it ends up becoming a service letter for all our customers in (the state) who are currently using that faulty equipment. It implies that operators of these equipment need to get this fixed. This further implies that we create a stockpile of unusable parts that Company J sees value in purchasing from XXX, fixing them in-house (instead of letting it go to recycling centers) and selling it with service warranties to the customers who are willing to buy it for a discounted price based on different levels of warranties/certification/standing behind." [Service Manager]*

The CEBM practice of acquiring customer feedback on product performance and acting upon the feedback to enhance the performance is mainly influenced by the strategic support offered by Company J's supply chain partner that is, Company E.

> *"It's not complex because Company E has provided sufficient training guidance and software that makes it easier for our technical team to adapt to new situations very quickly. These mechanics of these practices are well laid out in terms of specifications that we get from Company E. Our technical advisers helps solving convoluted issues, if any. And, above that we can access Company E support team to assist us." [Service Manager]*

CROSS CASE DESCRIPTIONS

In this section, the cross-case descriptions of the case companies are presented according to respective supply chain tiers. Each case described above has a set of CEBM practices, supply chain preparedness attributes and the economic, environmental and social performance measures for the CEBM practices and contingencies. In the section below, a short briefing of the comparison findings (followed by table summary) of all 10 case companies about their CEBM practices, their contingencies, their preparedness as suppliers, and their performance low are presented in sequential order.

CEBM PRACTICES AND THEIR CHARACTERISTICS

Evidence from the cross-case analyses suggest that the companies belonged to different industries and varied in size within supply chain tiers. Accordingly, a detailed cross case analysis of the CEBM practices of all ten companies was conducted. For the purpose of analysis, cross case summaries were generated as table 5-6 from the descriptive cross case analysis presented in table 5-7 to make broad generalizations. As summarized in table 5-6, case companies were grouped into two types of CEBM practices (a) CEBMs as "core business" and (b) CEBMs as "part of sub-systems. This classification is based on the extant literature on business model (Priem et al., 2018). This CEBM classification enabled further clarity for comparing and contrasting the rationalities, scope, complexities and impacts of the CEBM practices of the case companies.

Table 5 - 6: CEBM Practices and their characteristics

	CEBM as "core business"	**CEBM as "part of business sub-systems"**
Company ID (Supply chain tier)	▪ Company F (Manufacturer) ▪ Company G (Manufacturer) ▪ Company H (Retailers/Service) ▪ Company I (Retailers/Service)	▪ Company A (Tier 3 supplier) ▪ Company B (Tier 3 supplier) ▪ Company C (Tier 2 supplier) ▪ Company D (Tier 1 supplier) ▪ Company E (Manufacturer) ▪ Company J (Retailer/Service)
Rationality	▪ Enhance recyclable resource utilization ▪ Enhance products' lifetime value	▪ Preserve/enhance nat. resource ▪ Reduce GHG levels
Scope	▪ Slowing and closing resource loops ▪ Reduce material leakages into the environment ▪ Encourage suff./curb demand	▪ Slowing and narrowing resource flows ▪ Reducing material leakages and emissions into the environment
Complexity	▪ At process/product design level and value chain level	▪ At process/product design and value chain levels
Level	▪ At Micro and Meso-levels	▪ At Micro and Meso-levels; rarely macro level

Table 5 - 7: Cross Case Analysis – CEBM Practices and their characteristics

Case	**Supply Chain Tier (Industry)**	**Size**	**CEBM Practice**	**CEBM Practice Characteristics**			
				Rationality	**Scope**	**Complexity**	**Impact**
Company A	Tier 3 (Energy)	Large	Power generation programs to reduce harmful gas emissions, recycle solid waste, and expand renewable energy bases; Transmission-side bio-diversity programs; Distribution-side energy-efficiency programs	Preserve natural resource by efficient use of input material; Reduce greenhouse gas emission levels; Enhance renewable resources through forest management	Slowing and narrowing resource flows (i.e., curbing demand for electricity); Reducing resource leakages and harmful emissions (i.e., burning coal) into the environment	At value-chain level since their initiatives require interactions and co-ordination with multiple stakeholders	At meso-level as it involves co-ordination with regional systems
Company B	Tier 3 (Energy)	Medium	Home energy efficiency program (Help-my-house Program; Solar farm initiative (Green Power Program); Light-	Reduce greenhouse gas emission levels by curbing energy wastage; Enhance renewable	Slowing and narrowing resource flows; Encourage sufficiency by curb demand for traditional electricity;	At business-model level since being a co-operative company, their programs require several business-level	At micro-level as it involves their customers (distribution side) primarily

Table 5 - 7: Cross Case Analysis – CEBM Practices and their characteristics

Case	**Supply Chain Tier (Industry)**	**Size**	**CEBM Practice**	**CEBM Practice Characteristics**			
				Rationality	**Scope**	**Complexity**	**Impact**
			pole re-purposing	energy cycles; Enhance light-pole's lifetime value	Reducing material leakage and harmful emissions	adaptations with customer expectations who are their owners too.	
Company C	Tier 2 (Electrical Manufacturing)	Large	Zero-waste landfill practices	Preserve natural resources (energy bases); Reduce emission levels; Reduce material losses; Enhance packaging product life-cycle	Slowing, narrowing and closing resource loops; Reducing material leakages/ emissions into the environment; Encouraging sufficiency of packaging material	At design, production system and value chain levels due upfront investments, supplier co-ordination and plant operations	At micro and meso- levels as it involves both internal functions and suppliers
Company D	Tier 1 (Mechanical Manufacturing)	Large	Operational efficiency programs (e.g., scrap handling, recyclable packaging, energy efficient	Preserve natural resources (energy bases); Reduce emission	Reducing material leakages and emissions into the environment	At design level due to factory layout rigidness. Training and operating procedures are	At micro and meso-levels as it involves plant functionaries to work internally, with

Table 5 - 7: Cross Case Analysis – CEBM Practices and their characteristics

Case	**Supply Chain Tier (Industry)**	**Size**	**CEBM Practice**	**CEBM Practice Characteristics**			
				Rationality	**Scope**	**Complexity**	**Impact**
			facilities); Clean Line Solvent System (CLSS)	levels; Reduce material losses		not very complex	sustainability design experts, and up/down-stream supply chains
Company E	Manufacturer (Heavy Equipment)	Large	Waste management system; US LEED certification; Recyclable packaging	Reduce greenhouse gas emission levels; Enhance packaging product life-cycle	Reducing material leakages/ emissions into the environment; Encouraging sufficiency of packaging material	At design level to match product design changes with functional life extension and other sustainability missions	At micro and meso levels as it involves their plant-level processes and suppliers
Company F	Manufacturer (Recycling/ Packaging)	Large	Consumer and industrial packaging products using corrugated paper, scrap aluminum, and post-usage plastic materials	Enhance recyclable resource utilization by recycling post-usage paper, aluminum and plastic that helps reducing	Slowing resource loops; Reduce material leakages into the environment	At design level as its packaging solutions caters to a variety of products with unique packaging requirements and their post-	At micro and meso levels as it involves continuous co-ordination with designers, suppliers (waste traders) and multi-industry

Table 5 - 7: Cross Case Analysis – CEBM Practices and their characteristics

Case	Supply Chain Tier (Industry)	Size	CEBM Practice	CEBM Practice Characteristics			
				Rationality	Scope	Complexity	Impact
				environmental pollution		usage recycling aspects	customers in meeting high quality packaging orders
Company G	Manufacturer (Recycling/ Packaging)	Medium	Recycle post-usage commercial plastic wastes sources from stores into colored plastic pellets, partnering with plastic bag makers, and selling it back to stores	Enhance recyclable resource utilization by recycling post-usage plastic materials that helps reducing environmental pollution (i.e., incineration or landfill)	Closing resource loops by recycling of post-usage plastic material into plastic pellets, and further into plastic bags	At value chain level due to need for collaboration with consumers, stores, plastic makers, and city authorities, but not at operation level	At micro and meso-levels as it involves working with several stakeholders to create greater awareness about plastic usage that helps decreasing impurities in post-usage plastics (input)
Company H	Retailer (Used Appliances)	Small	Recover, refurbish and sell home appliances	Enhance appliances' lifetime value by serving	Slowing resource loops of home appliances	At initial design level due to technician skills and parts availability	At micro-level as it engages technicians and individual customers

Table 5 - 7: Cross Case Analysis – CEBM Practices and their characteristics

Case	Supply Chain Tier (Industry)	Size	CEBM Practice	CEBM Practice Characteristics			
				Rationality	Scope	Complexity	Impact
				transiting/low-income people			
Company I	Retailer (Used Automotive)	Small	Recover damaged auto parts from wrecked vehicles and sell to retail customers or through their repair shops	Capturing maximum residual value of auto-parts' by extracting and selling to retail /service shops as low cost yet faster alternate	Slowing and closing resource loops of automotive	At design level with demand forecast and price estimation of purchasing wrecked automobiles	At micro-level as it engages technicians/ engineers, retail customers and car repair shops
Company J	Retailer (Heavy Equipment)	Medium	Leasing and refurbishing of heavy equipment and its spare parts abandoned by Company E	Serving short-term user requirements by exploiting redundant and used equipment (i.e., capturing residual value)	Slowing resource loops and encouraging sufficiency by curbing new demand of heavy equipment	At business-model level in making supply-demand forecast due to stiff competition while meeting customer expectations	At meso level as it involves its internal personnel, Company E and customers

SUPPLY CHAIN PREPAREDNESS

The cross-case analysis of the ten companies within multiple supply chain tiers revealed that companies vary across their supply chain tiers in their supply chain preparedness at firm-, supply chain- and industry levels. Table 5-8 shows a summary of the cross case analysis for supply chain preparedness at different levels that is derived from the descriptive cross case analysis of supply chain preparedness presented in table 5-9. Some of the preparedness factors that emerged in this study include integration and commitment to sustainability at firm-level, supplier and process management at supply chain-level, and business and government-related at industry-level. The influence of these dominant supply chain factors on CEBM practices discussed in the discussion section in Chapter VI.

Table 5 - 8: Cross Case Analysis – Supply Chain Preparedness

Case (Supply chain tier)	**Supply Chain Preparedness (Output)**		
	Firm-level	**Supply chain-level**	**Industry-level**
Company A (Tier 3)	▪ Integration ▪ Performance management	--	▪ Business-related ▪ Government-related
Company B (Tier 3)	▪ Integration	--	▪ Government-related
Company C (Tier 2)	▪ Commitment to sustainability	▪ Supplier management ▪ Process management	--
Company D (Tier 1)	▪ Commitment to sustainability ▪ Integration ▪ Performance management	▪ Process management	--
Company E (Manufacturer)	▪ Commitment to sustainability ▪ Business-related	▪ Supplier management ▪ Process management	--

		▪ Product management	
Company F (Manufacturer)	▪ Integration	▪ Process management ▪ Supplier management	▪ Business-related ▪ Government-related
Company G (Manufacturer)	▪ Integration	▪ Process management ▪ Supplier management	▪ Government-related ▪ Consumer-related
Company H (Retailer)	▪ Integration	--	--
Company I (Retailer)	▪ Integration	--	▪ Business-related
Company J (Retailer)	▪ Integration	▪ Supplier management ▪ Product management	--

Table 5 - 9: Cross Case Analysis – CEBM Practices, Contingencies Supply Chain Preparedness, CEBM Performance

Case	CEBM Practices	Contingency Type	Supply Chain Preparedness (Output)			Performance (Outcome)
			Industry-level	**Supply chain-level**	**Firm-level**	
Company A	Power generation programs to reduce harmful gas emissions, recycle solid waste, and expand renewable energy bases; Transmission-side bio-diversity programs; Distribution-side energy-efficiency programs	Strategic; Institutional	▪ Pro-active engagement with stakeholders ▪ Aligning regulators sustainability missions and customer expectations with energy efficiency initiatives	--	▪ Creation of financial resources for sustainable energy generation and energy efficiency programs ▪ Designing and monitoring energy efficiency programs	Customer retention and regulatory compliance; Regeneration of forestry and habitat, reduction in emission levels by curbing energy demand; Indirect contribution to growth of local economy and quality of life
Company B	Home energy efficiency program (Help-my-house Program; Solar farm initiative (Green Power Program); Light-	Strategic; Institutional	▪ Leveraging on co-operative association to deal with regulatory and market situations	--	▪ Gaining competence to effectively communicate customers about energy efficiency and solar programs	Reducing customers' overall energy costs; Reducing natural resource consumption by curbing energy wastage and

Table 5 - 9: Cross Case Analysis – CEBM Practices, Contingencies Supply Chain Preparedness, CEBM Performance

Case	CEBM Practices	Contingency Type	Supply Chain Preparedness (Output)			Performance (Outcome)
			Industry-level	Supply chain-level	Firm-level	
	pole re-purposing				▪ Changing work-culture of a not-for-profit organization	adding renewable electrons; Positive imprint on local community to help them pursue their CEBM initiatives
Company C	Zero-waste landfill practices	Strategic; Structural	▪ --	▪ Directing suppliers and partners to align their processes with itself (e.g., reusable packaging). ▪ Engaging energy provider to analyze its electricity and water consumption	▪ Higher commitment to/of employees in re-designing and standardizing sustainable business processes	Long-term economic benefits; Environmental preservation goals; Internalization of environmental consciousness across its employees and related stakeholders

Table 5 - 9: Cross Case Analysis – CEBM Practices, Contingencies Supply Chain Preparedness, CEBM Performance

Case	CEBM Practices	Contingency Type	Supply Chain Preparedness (Output)			Performance (Outcome)
			Industry-level	**Supply chain-level**	**Firm-level**	
				patterns, and identify opportunities to reduce consumption		
Company D	Operational efficiency programs (e.g., scrap handling, recyclable packaging, energy efficient facilities); Clean Line Solvent System (CLSS)	Strategic; Structural	▪ --	▪ Applying innovative process management techniques in supply chain activities to avoid material leakage and hazardous emission from the start of the production process	▪ Strategic alignment and integration of existing business processes with corporate sustainability goals. ▪ Apply change and performance management techniques	Customer satisfaction (as cost of doing business); Reducing the hazardous material released into the environment and conserving energy; Employees learning of new skills pertaining to energy efficiency and emission reduction processes

Table 5 - 9: Cross Case Analysis – CEBM Practices, Contingencies Supply Chain Preparedness, CEBM Performance

Case	**CEBM Practices**	**Contingency Type**	**Supply Chain Preparedness (Output)**			**Performance (Outcome)**
			Industry-level	**Supply chain-level**	**Firm-level**	
Company E	Waste management system; US LEED certification; Recyclable packaging	Strategic; Structural	--	▪ Training upstream/downstream suppliers about product features in terms of sustainability metrics.	▪ Improving customer awareness by detailing product descriptions about energy consumption, material efficiency, emissions, and other sustainability metrics Investing in redesigning plant processes and facilities and staff training to support product design adjustments and sustainability practices	Reducing footprint and other waste material leakages into atmosphere and enhancing the health of its employees; Creating awareness through staff training and community programs on sustainability
Company F	Consumer and industrial packaging products using corrugated paper, scrap aluminum, and post-usage plastic materials	Strategic; Structural; Institutional	▪ Collaboration with large customers, competitors, trade allies, communities on new recycling and packaging	Encouraging and incentivizing suppliers for supplying high quality raw material	▪ Improvements in production process (such as “Layering” technique to avoid food contamination)	Profit margins; Finding innovative ways of using recycled material, reducing infusion of virgin plastic in production and

Table 5 - 9: Cross Case Analysis – CEBM Practices, Contingencies Supply Chain Preparedness, CEBM Performance

Case	**CEBM Practices**	**Contingency Type**	**Supply Chain Preparedness (Output)**			**Performance (Outcome)**
			Industry-level	**Supply chain-level**	**Firm-level**	
			initiatives and sharing best practices Mutual contingency contracts with customers to avoid input market price fluctuations			reducing landfill; Recycling awareness programs for
Company G	Recycle post-usage commercial plastic wastes sources from stores into colored plastic pellets, partnering with plastic bag makers, and selling it back to stores	Strategic; Structural; Institutional	▪ Lobbying for regulatory measures on introducing “new” plastic into markets ▪ Influence buyers to buy products made from recycled plastic	Standardize plastic waste disposal practices through active involvement with suppliers for procuring cleaner and pre-assorting of plastic scraps	▪ Improvements in production process (such as better plastic scrap sorting techniques) to support use no or lesser virgin plastic mix	Revenues; Limiting entry of “new” plastic into the environmental system; Advocating recycling solutions with plastic waste suppliers and promoting awareness among communities for

Table 5 - 9: Cross Case Analysis – CEBM Practices, Contingencies Supply Chain Preparedness, CEBM Performance

Case	CEBM Practices	Contingency Type	Supply Chain Preparedness (Output)			Performance (Outcome)
			Industry-level	Supply chain-level	Firm-level	
						better usage of plastic (i.e., not throwing unclean plastics into recycling container) to help improve the quality of input material
Company H	Recover, refurbish and sell home appliances	Institutional	--	Increase supply of used appliances	▪ Improving technical skill of engineers ▪ Recovering spare parts from discontinued models	Larger customer base; Re-use of used appliance and delaying recycling; Saving people's money
Company I	Recover auto parts from used/damaged and sell to retail/repair shops	Institutional	Anticipating auto industry co-operation for extensive technical trainings and workshops	--	▪ Recruiting skilled engineers ▪ Scoping experiential learning for engineering	Profitability; Re-use of auto parts and avoiding disposal/compliance with environmental, health and safety standards; Offering reliable

Table 5 - 9: Cross Case Analysis – CEBM Practices, Contingencies Supply Chain Preparedness, CEBM Performance

Case	CEBM Practices	Contingency Type	Supply Chain Preparedness (Output)			Performance (Outcome)
			Industry-level	Supply chain-level	Firm-level	
						low-cost (and faster) auto parts
Company J	Leasing and refurbishing of heavy equipment and its spare parts abandoned by Company E	Strategic; Structural	--	▪ Collaboration with Company I for product training, knowledge resources, and support for procuring used parts ▪ Interacting with customers to capture product performance feedback and implementing Company E's product upgrades	▪ Providing necessary managerial and technical support to managers and employees about market dynamics. ▪ Ensuring transparency in the product information, such as fuel consumption and emissions, for customers to make informed purchase decisions of Company E's product	Economic contribution to company's revenues; Help extend life-span of heavy machinery products; Positive customer engagement

CEBM PERFORMANCE

The cross case findings of this study univocally suggest that companies consider CEBM practices for different rationalities and scopes, contain complexity at multiple stages and are impactful at different levels. Also, companies consider CEBM as their "core business" and/or as "part of their business sub-systems". Within and cross-case analysis reveals that companies work hard to gain supply chain preparedness by addressing their contingencies, and their higher supply chain preparedness makes their CEBMs perform better in three key "sustainability" dimensions – economy, environmental and social. From economic standpoint, CEBM practices of these companies improve their economic performance through circular approaches, such as reduction in costs of input material, lesser wastage, material circularities, resources efficiency, and brand recognition. From environmental standpoint, CEBM practices help companies to bring environmental stability through preservation of raw material, reduction in material leakage and harmful gases into environment, and enhancement of recyclable resources and renewable energy sources. From societal standpoint, these practices help companies gain confidence of their customers, employees, communities and government. Hence, CEBM practices of companies provides a symbiotic relationship between the three aspects of "sustainability" performance — economic, environmental, and social. Interestingly, within and cross-case analyses suggest that companies apply a mix of economic, environmental and social performance metrics to portray the success of their CEBM practices.

Based on the descriptive cross case table presented in table 5-9, the summarized findings of the cross-case analyses of the case companies for CEBM performance is presented in table 5-10.

Table 5 - 10: Cross Case Analysis – Performance

Case (Supply chain tier)	**Performance (Outcome)**		
	Economic	**Environmental**	**Social**
Company A (Tier 3)	▪ Long-term gains	▪ Reduction in emission levels ▪ Adding new sources of energy	▪ Indirect contribution to growth of local economy and quality of life
Company B (Tier 3)	▪ Long-term gains	▪ Reduction in emission levels ▪ Adding new sources of energy	▪ Positive imprint on local community
Company C (Tier 2)	▪ Long-term gains	▪ Reduction in emission levels	▪ Increase in social value
Company D (Tier 1)	▪ Long-term gains	▪ Reduction in emission levels	▪ Positive imprint on employees
Company E (Manufacturer)	▪ Long-term gains	▪ Reduction in emission levels	▪ Increase in social value
Company F (Manufacturer)	▪ Short and long-term gains	▪ Resource reutilization	▪ Increase in social value
Company G (Manufacturer)	▪ Short and long-term gains	▪ Resource reutilization	▪ Increase in social value
Company H (Retailer)	▪ Long-term gains	▪ Extend product life-span	▪ Saving people's money
Company I (Retailer)	▪ Short and long-term gains	▪ Extend product life-span	▪ Saving people's money
Company J (Retailer)	▪ Short and long-term gains	▪ Extend product life-span	▪ Positive customer engagement

CONTINGENCIES

The cross-case analysis of the ten companies within multiple supply chain tiers revealed that the themes identified from contingency research in SCM literature were observable within the companies. Table 5-11 shows a summary of the cross case analysis for contingency factors that is derived from the descriptive cross case analysis of contingencies presented in table 5-12. The dominant contingencies that emerged organizational size, organizational structure and product type as strategic contingencies, demand for sustainable products as structural contingency, and industry type (regulations and buyer's power over supplier) as institutional contingencies. These factors as key moderators in the relationship between the CEBM practices and supply chain preparedness are discussed in the discussion section in Chapter VI.

Table 5 - 11: Cross Case Analysis – Contingencies

Case (Supply chain tier)	Contingency Type		
	Strategic	**Structural**	**Institutional**
Company A (Tier 3)	▪ Manufacturing process & technology related ▪ Size (Large)	--	▪ Industry relevance ▪ Regulations ▪
Company B (Tier 3)	▪ Organization design ▪ Size (Medium)	--	▪ Socio-cultural context
Company C (Tier 2)	▪ Sustainability policies ▪ Size (Large)	▪ Internal task environment (Task interdependence)	--
Company D (Tier 2)	▪ Sustainability policies ▪ Size (Large)	▪ External business environment (Customer-product fit)	--
Company E (Manufacturer)	▪ Sustainability policies ▪ Size (Large)	▪ External business environment (Customer-product fit)	--
Company F (Manufacturer)	▪ Product related ▪ Size (Large)	▪ External business environment (Market-level fit)	▪ Regulations
Company G (Manufacturer)	▪ Product related ▪ Size (Medium)	▪ External business environment (Market-level fit)	▪ Regulations ▪ Liability of newness
Company H (Retailer)	▪ Size (Small)	--	▪ Industry relevance ▪ Socio-cultural context
Company I (Retailer)	▪ Size (Small)	--	▪ Industry relevance ▪ Competition (as substitute) ▪ Socio-cultural context ▪ Regulations
Company J (Retailer)	▪ Product related ▪ Size (Medium)	▪ External business environment (Customer-product fit and Market-level fit)	--

Table 5 - 12: Cross Case Analysis – CEBM Practices and their Contingencies

Case	CEBM Practices	Contingency	Contingency Type		
			Strategic	Structural	Institutional
Company A	Power generation programs to reduce harmful gas emissions, recycle solid waste, and expand renewable energy bases; Transmission-side bio-diversity programs; Distribution-side energy-efficiency programs	▪ Industry relevance in terms of supporting energy saving measures (i.e., energy costs) and renewable energy for its customers ▪ Economic constraints (i.e., duplicacy of energy generation assets/resources, cost of energy storage, etc.) in transitioning from traditional to renewable energy sources ▪ Regulatory factors (acquiring approval and meeting regulatory requirements from 6 different state public commissions to launching energy efficiency program across all 6 operating states	X	--	X
Company B	Home energy efficiency program (Help-my-house Program; Solar farm initiative (Green Power Program);	▪ Co-op organizational structure that makes them cater to their customers' expectation for affordable and reliable energy, instead of investing on sustainable projects ▪ Co-op size in terms of bargaining power, sub-optimal performance in selling and growing solar farm, supervision of energy-efficiency program	X	--	X

Table 5 - 12: Cross Case Analysis – CEBM Practices and their Contingencies

Case	CEBM Practices	Contingency	Contingency Type		
			Strategic	Structural	Institutional
	Light-pole re-purposing				
Company C	Zero-waste landfill practices	▪ Strategic emphasis on sustainable business operations by top management due to its diverse industrial business portfolio ▪ Designing to devoid suppliers' reluctance to participate/align their operations with itself	X	X	--
Company D	Operational efficiency programs (e.g., scrap handling, recyclable packaging, energy efficient facilities); Clean Line Solvent System (CLSS)	▪ Recent acquisition by its parent conglomerate who is a global sustainability leader in energy and environmental design issues. ▪ Customer pressure for environmental and health safety assurance (ROHS certification) for buying its product	X	X	--
Company E	Waste management system; US LEED certification; Recyclable packaging	▪ Product related and sustainable policy related due to the harmful effects on the environment in terms of fuel consumption and waste gas emissions. ▪ Product upgrade designs complexities in terms of component designs and manufacturing processes.	X	X	--

Table 5 - 12: Cross Case Analysis – CEBM Practices and their Contingencies

Case	CEBM Practices	Contingency	Contingency Type		
			Strategic	Structural	Institutional
		▪ Constraints in enforcing LEED compliance with global suppliers			
Company F	Consumer and industrial packaging products using corrugated paper, scrap aluminum, and post-usage plastic materials	▪ Regulatory ban by China on importing bails of impure plastics (This acted in favor of the company in procuring recycled plastic bail supplies at a lower cost in domestic market). ▪ International recycling market (China and Indonesia) created short supply of corrugated and used papers ▪ Limited reachability (direct contact) with consumers to conduct advocacy/training on post-usage waste disposal during collecting trash.	X	X	X
Company G	Recycle post-usage commercial plastic wastes sources from stores into colored plastic pellets, partnering with plastic bag makers, and selling it back to stores	▪ Regulatory move by China imposing ban on importing plastic material (with purity less than 99.5%) ▪ Liability of "newness" – recycling of plastic is a new phenomenon in domestic market ▪ Import of plastic products from China (market-level fit related) by the buyers ▪ Lack of regulation on buying "new" plastic products from petrochemical companies ▪ Deterioration in quality attributes of recycled plastic upon subsequent reheating (over 200 degree Celsius), thus addition of virgin plastic	X	X	X

Table 5 - 12: Cross Case Analysis – CEBM Practices and their Contingencies

Case	**CEBM Practices**	**Contingency**	**Contingency Type**		
			Strategic	**Structural**	**Institutional**
		becomes unavoidable to maintain quality attributes of plastic pellets			
Company H	Recover, refurbish and sell home appliances	▪ Non-availability and price of spare parts ▪ Volatility in demand/supply (buying power)	--	--	X
Company I	Recover auto parts from used/damaged and sell to retail/repair shops	▪ Introduction of newer models/technologies leading to lack of technical knowhow about dismantling (e.g., hybrid cars). ▪ Time lag in availability of specifications about auto parts from auto manufacturers ▪ US federal scrappage program (Cash for clunkers)	--	--	X
Company J	Leasing and refurbishing of heavy equipment and its spare parts abandoned by Company E	▪ Market demand for leasing option ▪ Availability of product parts ▪ Alignment with Company E's strategic sales/support mission (e.g., product recall support)	X	X	--

CHAPTER VI

DISCUSSIONS AND IMPLICATION

Chapter VI explores the theoretical perspectives and case study findings to develop propositions between the constructs of the guiding theoretical framework (earlier shown in Chapter III as Figure 3-9). Explanations for each proposition along with the empirical results, developed from the analysis of cases that support the explanations. A revised theoretical framework is proposed (see figure 6-1). The chapter concludes with limitations of the study and implications for future research.

CEBM PRACTICES, SUPPLY CHAIN PREPAREDNESS AND CEBM PERFORMANCE, AND CONTINGENCES

Drawing on the empirical evidence from ten companies presented in chapter V and theoretical themes from the CEBM, Contingency Theory, and Supply Chain Preparedness literature, this section proposes a conceptualization of the relationships between CEBM practices, firms' supply chain preparedness (SCP) and CEBM performance, and their contingencies, which relates to the third (last) research question is stated as follows:

RQ 3: How is "supply chain preparedness" related to the CEBM practices and the CEBM performance, and what are the factors upon which the relationships are contingent?

PROPOSED RESEARCH FRAMEWORK

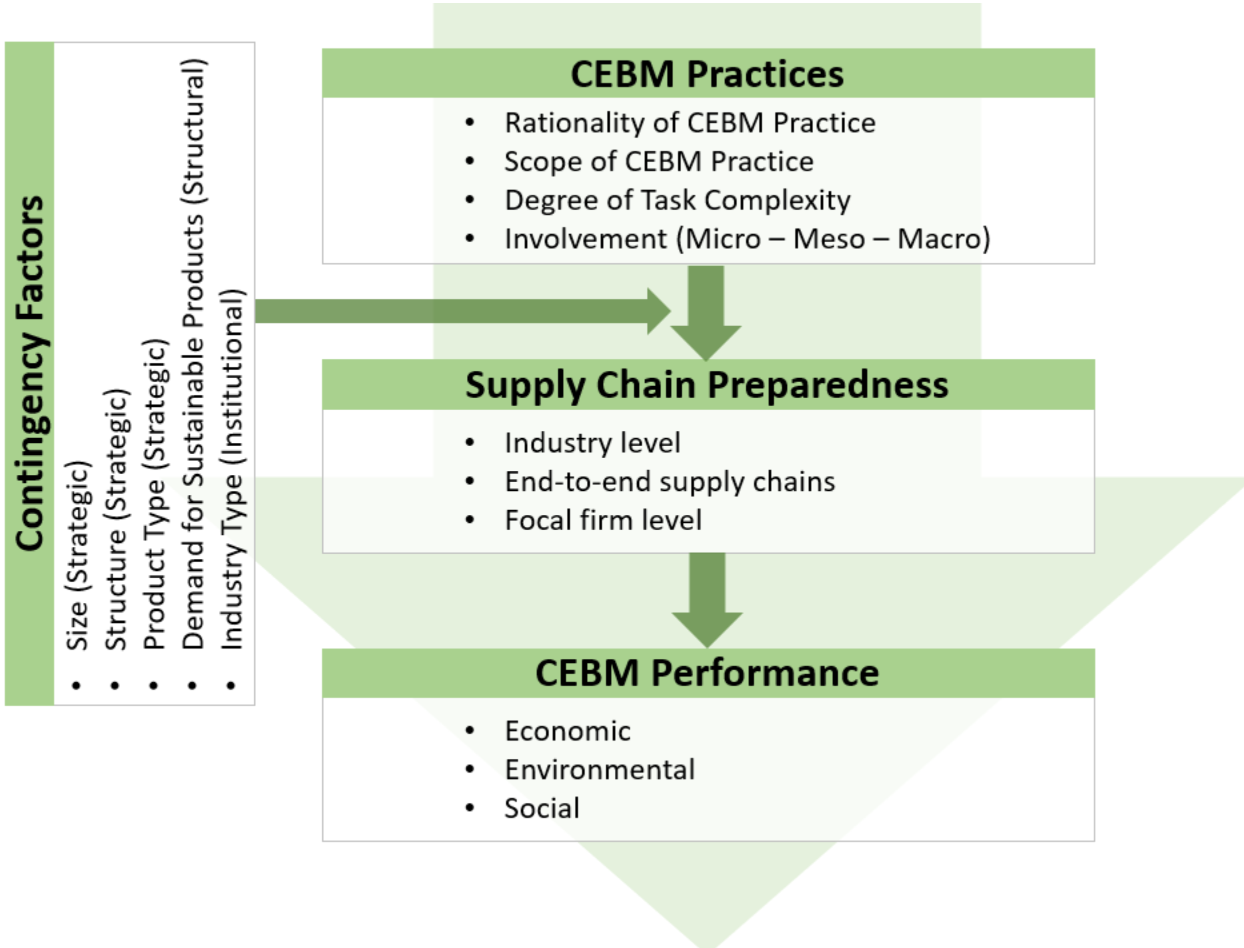

Figure 6 - 1. Proposed Research Framework

In the remainder of the sections, the relationships between each constructs are discussed. Accordingly, a set of propositions are drawn. A revised theoretical framework is proposed (Figure 6-1). In this study, any moderating contingency factors in the relationship between supply chain preparedness and the performance of the CEBM practices were unfound. Finally, the implications and constraints of the study are discussed.

CEBM PRACTICES AND THEIR SUPPLY CHAN PREPAREDNESS

Evidence from the supply chain network analysis (See figure 5-1) and cross-case analyses suggest that CEBMs practiced by the companies varied in terms of rationality, scope, level of complexity and level of impact. A close review of the findings provide evidence that the CEBM practices can be categorized as CEBM practices as “core business” and as “part of business sub-system”. Out of the 10 case companies, four companies pursue CEBM as “core business”. These case firms are represented as Companies F and G from manufacturer tier and companies H and I from retailer tier. The CEBM practice of the remaining six firms is a part of their business sub-system. These case firms are represented as Companies A and B as Tier 3 suppliers, Companies C as Tier 2 supplier, D as Tier 1, E as Manufacturer and J as retailer.

This finding is consistent with the literature that firms may pursue their business models as “core business” or “part of their business systems” (Priem et al., 2018). Firms pursuing CEBMs as “core business” are oriented toward the rationality for increasing recyclable resource utilization and capturing maximum residual value by enhancing their product’s life-time value. The scope of their CEBMs is geared to slowing and closing resource loops of their respective products. The complexities are primarily hinged at design and value-chain stages due to the need for collaboration with different stakeholders to help them anticipate customers' expectations and forecast over supply/demand, but not at their singular business model and production system levels. According to resource-based view, the CEBM practices of these firms are unique; and these unique practices coupled with their high levels of supply chain preparedness may lead them to have sustainable competitive advantage (Wernerfelt, 1984; Barney, 1991; Grant, 1991). In particular, this competitive advantage occurs when the resources and capabilities as their supply chain preparedness may become intangible (Conner, 1991; Taylor-Coates & McDermott, 2002). As such, their CEBMs have an impact at micro, meso-levels and at macro-levels due internal and supply-chain involvements. In this study, it was noted that firms pursuing CEBMs as "core business" focus on achieving supply chain preparedness by paying larger attention to integration efforts at firm-level, supplier and process management at supplier-level, and regulatory compliances at industry-level. For example, the nature of Company F's and G's CEBM practices with recycled packaging requires meeting several integration requirements, supplier management, and regulatory requirements such as landfill avoidance at industry level:

> "*Managing the swings is our main consideration. At industry level, it is about how to reduce the cost of raw material across the industry. At supply chain, our collection of input material is highly dependent on market price. At internal levels, we invest time to look on innovative ways to improve our input collection methods*" (Sustainability Officer, Company F).

Hence it is proposed as follows:

Proposition 1: *Firms that implements CEBM practices as "core business" emphasize supply chain preparedness at three levels: firm-level, supplier-level and industry-level.*

Contrarily, firms pursuing CEBMs as "part of business sub-systems" are concerned with the rationality of preserving natural resources through efficient (lesser) use of raw material, water and energy, reducing hazardous waste and harmful gas emission into the environment, and reducing material losses by adjusting production processes (such as zero-landfill program). The scope of their CEBM are targeted towards slowing and narrowing (but not closing) resource flows and reducing both resource leakage and harmful emissions (e.g., burning coal, land-filling). To a great extent, these companies are attempting to acquire legitimacy to conform to the demands of its institutional stakeholders, such as their parent company and regulatory bodies, even though they are constrained by location, resources, and/or expertise (Bhakoo & Choi, 2013). Institutional theory explains that these firms may be implementing these CEBM practices in response to institutional pressure in the quest for organizational legitimacy (Meyer & Rowan, 1977). The complexities arise at design, production, business-model and value-chain levels due their organizational size and structure that requires higher degree of interaction with their stakeholders ranging from customers to regulators. As such, their CEBMs have an impact at micro and meso-levels due internal and value-chain involvements, and sometimes at macro level in creating collaborative efforts between industries (e.g., Company C and D are located at an industrial park and uses the same recycling/scrap company under the industrial park's guidelines). Evidence shows that firms pursuing CEBMs as "part of business sub-systems" focus on achieving supply chain preparedness by paying greater attention to their commitment to sustainability efforts at firm-level and supplier and process management technique at supply chain-level. For example, the nature of Company C's, D's and E's CEBMs is to deal with variety of environmental sustainability issues by following their corporate commitment to sustainability at firm level, and process and supplier management techniques that require meeting several regulatory requirements such as landfill avoidance at supplier level:

> "*This is the first site in our company that has a zero-waste landfill. At lower level we recycle paper and plastics. At larger level we recycle wood and metals. Typically, we reuse the left-over metals on other components. We use a variety of metals in our components. The small amount of waste that is left, we partner with recyclers and incinerator to convert it into energy*" (Plant Head, Company C).

Hence it is proposed as follows:

> ***Proposition 2:*** *Firms that implement CEBM practices as "part of business subsystems" emphasizes on supply chain preparedness at firm- and supplier-levels and not at industry-level.*

SUPPLY CHAIN PREPAREDNESS AND CEBM PERFORMANCE

The supply chain network, within and cross case analysis of case companies show that supply chain preparedness is critical for superior performance of their CEBM. However, it varied among companies on the economic, environmental and social dimensions of CEBM performance. In this study, it was found that in the case of companies (namely, F, G, H and I) with CEBM practices as "core business", they consider supply chain preparedness at all three levels (i.e., firm-, supplier- and industry-level). One reason that may explains their situation is that their survival depends on how prepared they are on all three dimensions – strategic, structural and institutional, which in turn has positive influence on their CEBM performance. Such preparedness have positive influence on the performance of CEBM practices. On the economic dimension, these firms are keen on both short and long term gains because the CEBM practices in itself is such that it allows them to meet operating expenses while focusing on the longevity aspects of the business model. On environmental dimension, these companies focus on resource reutilization and product's lifespan extension. On social side, they focus on increase the overall social value:

> "*From economic standpoint, profits matter most for our survival. From environmental standpoint, we have established measures for resource reutilization that are set based on the reactions of our customers and competitors to make sure that we stay relevant in our customers eyes. From societal standpoint, our activity helps our society by saving upon damages to their products from water, physical, heat etc. It helps saving natural resources (energy, water, etc.) that would otherwise be used in making those products again*" (Sustainability Officer, Company F).

Hence, it is proposed as follows:

> ***Proposition 3:*** *Supply chain preparedness of the firm that implements CEBM practices as "core business" has a positive effect on (a) its CEBM's economic performance as both short-and long-term gains, (b) environmental performance as increase in resource reutilization and product's lifespan extension, and (c) social performance as increase in overall social value.*

In the case of companies with CEBM practices as “part of business systems”, it was found that these companies (namely, A, B, C, D, E and J) consider supply chain preparedness at two levels (i.e., firm- and supplier-levels). One reason that explains their situation is that the core of their businesses are not directly involved with sustainability goals. Their commitment to sustainability is either by choice or due to customer requirements. Such preparedness also have positive influence on the performance of CEBM practices. On the economic dimension, these firms are keen on long term gains such as brand image, customer retention. While these firms do not consider that these CEBM practices would earn them profits in the short term, they univocally agree it as cost of doing business, which speaks about longevity aspects of their businesses. On environmental dimension, these companies measure success by reducing emissions and avoiding harmful gases to enter into the environment. On social side, they measure success by increasing the overall social value of their customers, community, employees and stakeholder by creating positive imprint about their social sustainability efforts:

> "*Economic-wise, it’s difficult to measure economic success in the short run. If we are investing on any of the sustainability practices, we tend to look at the long term return on that investment. Environment-wise, our EHS group manages the sustainability performance because the environmental safety metrics are reported monthly and audited quarterly for all plant facilities that sums up in our sustainability reports releases. Society-wise, our socio-economic actions (community outreaches, waste management, Earth Day sponsorship) and their impacts on society/communities are tracked*" (Plant Head, Company E).

Hence, it is proposed as follows:

Proposition 4: *Supply chain preparedness of the firm that implements CEBM practices as "part of business sub-systems" has a positive effect on (a) its CEBM's economic performance as long-term gains, (b) environmental performance as reduction in emission levels, and (c) social performance as increase in overall social value.*

THE MODERATING EFFECT OF CONTINGENCIES ON THE RELATIONSHIP BETWEEN CEBM PRACTICES AND SUPPLY CHAIN PREPAREDNESS

The supply chain network and cross-case analyses of the ten companies revealed that the themes identified from contingency research in SCM literature were observable within the companies. In particular, the contingencies varied from company to company based on their CEBM practices and qualifies into all three categories – strategic, structural and institutional. More precisely, the dominant contingencies include organizational size and structure of firm as strategic contingencies, customer-product and market-level fit (i.e., demand) as structural contingencies, and product type and industry type as institution factors.

Organizational Size. It was observed that the relationship between CEBM practices and their supply chain preparedness is moderated by the size of the firm - a strategic contingency factor. For example, smaller firms (namely, companies H and I) lack resources in fending away their CEBM practice related challenges, thus, limiting the scope of their CEBM practices to serve their customers through their internal firm-level preparedness only:

"*The logic for deciding on the purchase price of a wrecked vehicle at the auction is an "art". There are many efforts (by companies bigger than us) that have tried to make it scientific, but it has severely failed. Either I don't understand science, or science is not good enough to explain the remaining value of a wrecked vehicle. It is sort of our core-*

competence that we have learned from our experiences, but, it's hard to explain on paper. This business is such that you either get better and better, or you disappear" (CEO, Company I).

On the other hand, the CEBM practices of medium firms (namely, companies B has sub-optimal preparedness in selling solar farm subscriptions). On the other hand, the CEBM practices of large firms (namely, companies A, C, D, E and F) face other challenges but have adequate resources to improve their supply chain preparedness at firm- and supply-chain level: "*Our regional competitor is so successful with their sustainable business practices is because of their massive size*" (CEO, Company B).

Hence, it is proposed as follows:

Proposition 5: *Size of a firm moderates the relationship between CEBM practices and supply chain preparedness at firm- and supply chain-levels. As size of the firm increases, the relationship between its CEBM practices and supply chain preparedness becomes stronger at firm- and supply chain-levels.*

Proposition 6: *Size of a firm moderates the relationship between CEBM practices and supply chain preparedness at supply chain- and institutional-levels. As size of the firm decreases, the relationship between its CEBM practices and supply chain preparedness becomes weaker at supply chain- and institutional-levels.*

Structure of firm. It was observed that the relationship between CEBM practices and their supply chain preparedness is moderated by the type of the firm – a strategic contingency factor. For example, Company B faces significant challenges in promoting solar-farm based

CEBM practice because the way in which the company is structured. Company B is structured as a not-for-profit organization to supply electricity cost-efficiently to three rural counties of a South Eastern state in the U.S. Its members are its owners too. Its structure enables its members to restrain its ability to resourcefully invest into non-traditional and economically risky projects, such as solar-electricity. When Company B installed the solar farm, it anticipated that its members would subscribe for solar electricity and did not consider to promote the solar electricity subscription. The members non-risk taking behavior made Company B suffers from sub-optimal preparedness in selling solar farm subscriptions:

> "*One of the unique thing about co-ops is that we are not-for-profit. So, in lot of ways it puts our challenges upon us in growing and doing different things. Some of our members show their reluctance in making risky investments and ask us to keep their lights stay on at reasonable price and not do anything else. These are inhibitions that have been cultured over years and there is a great momentum that we have to overcome to make these practices work in our common favor. So, we want to take our time to get these practices because if we try to turn too quickly, it might over-turn*" (CEO, Company B).

On the other hand, for-profit organizations, such as Companies A, C, D, and E, pursue CEBM practices more aggressively in preparing for higher returns. Hence, it is proposed as follows:

> ***Proposition 7:*** *Structure of a firm moderates the relationship between CEBM practices and supply chain preparedness. "Not-for-profit" structure of the firm weakens the relationship between its CEBM practices and supply chain preparedness.*

Proposition 8: *Structure of a firm moderates the relationship between CEBM practices and supply chain preparedness. "For-profit" structure of the firm strengthens the relationship between its CEBM practices and supply chain preparedness.*

Product type. It was observed that the products of the case companies can be classified as sustainable products and standard products. In this study, Companies F and G are the only ones that qualify as manufacturers of sustainable products. Company F and G deal with commercial/industrial packaging and plastic pellets based packaging products respectively that are made from recycled materials. These product offerings are meant to meet sustainability expectations of our markets and society. Thus, the CEBM practices of these two companies must demonstrate sustainability-oriented characteristics in their product offering through reverse flow techniques such as recovering and recycling. Since their CEBM practices are so well related to recycling processes that their product type has a positive influence on its supply chain preparedness. Hence, it is proposed as follows:

Proposition 9: *Product type of a firm moderates the relationship between CEBM practices and supply chain preparedness. Sustainable products of the firm strengthens the relationship between its CEBM practices and supply chain preparedness.*

The other eight companies in this study deal with products that are not mandated for sustainability goals, rather, these products can be classified as standard products. For example, Companies H and I through their CEBM practices offer used home appliance and automotive parts respectively. While these products undergo frequent technological upgradations in terms of safety and reliability, but they do not change significantly in their build in terms of serving the basic needs of our societies (e.g., washing clothes, commuting means, etc.) and sustainability is not their main goals. Since their inception, they have undergone moderate adaptation in their key raw materials, production processes, and basic appearance only. Customer demand for these products follow obviousness (i.e., value for money). Such reasons compel firms to look for scope to increase efficiency and decrease costs by standardizing production processes, since they operate in highly competitive markets. These factors do not apply to firms pursuing CEBM. However, each of these companies have adopted varying degrees of sustainability-oriented design for their standard products. For example, Company D installed CLSS processes to remove hazardous residuals from their bearings product. Similarly, Since Company E's products are meant for environmental depletion, such as mining and construction, they have taken a lead role to make their products designed for sustainability as far as possible:

> "*As an industry, we are fully aware that our tooling products generate lot of fuel (GHG) emission, and are used in other forms of environmental depletions while conducting activities such as mining, construction, digging of pipeline projects, etc. So, we want to serve these industries by being as much sustainable as possible*" (Plant Head, Company E).

Hence, it is proposed as follows:

Proposition 10: *Product type of a firm moderates the relationship between CEBM practices and supply chain preparedness. Standard product that has high degree of design for sustainability strengthens the relationship between the CEBM practices and supply chain preparedness of the firm.*

Proposition 11: *Product type of a firm moderates the relationship between CEBM practices and supply chain preparedness. Standard product that has lower degree of design for sustainability weakens the relationship between the CEBM practices and supply chain preparedness of the firm.*

Demand for sustainable products. Demand for sustainable products is a structural contingency factor that qualifies for two possible reasons – market-level fit of the product or customer-product fit of the product that a company offers. In the case of Company G that manufactures and sells plastic pellets (the CEBM practice), its success is contingent upon the demand conditions. From market-level fit perspective, Company G is yet to form a strong domestic customer base for its plastic pellet based products (although, it is growing). From a customer-product fit perspective, Company G faces struggles to convince customers to buy recycled plastic product over virgin plastic product because customers are not well advocated about the adversary effects of allowing new plastic to enter ecosystem:

"*The limited demand for recycled plastics is our biggest challenge. Whether we create demand by legislation or advocacy, its demand will not increase. Businesses takes the path of least resistance, which is to buy virgin resin based plastic products*" (CEO, Company G).

Thus, for a firm pursuing CEBM, higher customer-product fit and market-level fit (i.e., demand) has a positive influence on its supply chain preparedness. Hence, it is proposed as follows:

Proposition 12: *Demand for sustainable products moderates the relationship between CEBM practices and supply chain preparedness of the firm. As the degree of demand* *for a sustainable product increases the relationship between the CEBM practices and supply chain preparedness of the firm becomes stronger.*

Industry. It was observed that the CEBM practices of firms face different types of contingencies based on their industry participation in terms of the degree of regulation. For example, Companies A and B participate in a highly regulated industry as electricity suppliers. Their CEBM practices are directed towards preserving natural resources and reducing greenhouse gas emission levels and enhancing sources for renewable energy sources such as bio-diversity programs, energy efficiency programs, and solar farm projects. This industry is regulated at both federal and state levels for pricing, reliability and safety. Electric power generation industry ranks second (after transportation industry) for a total GHG emissions of as high as 27%. These gases are released during the combustion of fossil fuels, such as coal, oil, and natural gas, to produce electricity. In addition, electric transmission requires cutting of trees for acres of land-stretch and electric distribution needs balancing in consumption through efficient usage. Therefore, these company come under tremendous regulatory pressure to preserve natural resource and reduce emission levels of GHG and their negative environmental impact. Under regulatory pressure and various tax-incentive, these companies tend to strategically design and implement CEBM practices such as clean and green energy initiatives and energy efficiency programs. However, these practices must go through lens of regulatory commissions before being implemented. Structurally, these companies do not face challenges in implementing their CEBM practices. From a global and national regulatory standpoint, it may vary based on other socio- and geo-political factors. Hence, it is proposed as follows:

Proposition 13*: Degree of regulation of the industry that a firm participates moderates the relationship between CEBM practices and supply chain preparedness. The higher the degree of regulation of the industry that a firm participates stronger is the relationship between its CEBM practices and supply chain preparedness.*

From a supply chain network standpoint, yet another industry type contingency factor is about the degree of buyer's power over supplier (Porter, 1979). For example, in a supply chain network, A, C, D, E and F are suppliers to each of the company that is higher up its tier. Each of these companies individually exercise their varying degree of buyer's power over their supplier, when they act as buyers. As such, the strength of each firm's buyer's power allows it to mandate its supplier to participate and align its own operations so as to help achieve its sustainability practices such as zero-waste landfill policy across the value chain. "Basically, our scope and leverage with our suppliers is what it really allows us to dictate that we are going to utilize each programs" (Plant Head, Company C). This contingency factor is demonstrated by the example of how these five company organizes themselves and their suppliers to actively participate in their sustainability missions. Hence, it is proposed as follows:

Proposition 14*: Degree of buyer's power over its supplier firm moderates the relationship between CEBM practices and supply chain preparedness of the supplier firm. The higher the degree of buyer's power over its supplier firm stronger is the relationship between the CEBM practices and supply chain preparedness of the supplier firm.*

REFLECTIONS ON SUPPLY CHAIN NETWORK

The main theme of the study is to understand supply chain preparedness of suppliers. Therefore, an additional investigation of the supply chain relationships of between the Companies A, B, C, D, E and F, as shown in Figure 6-2, revealed an interesting pattern.

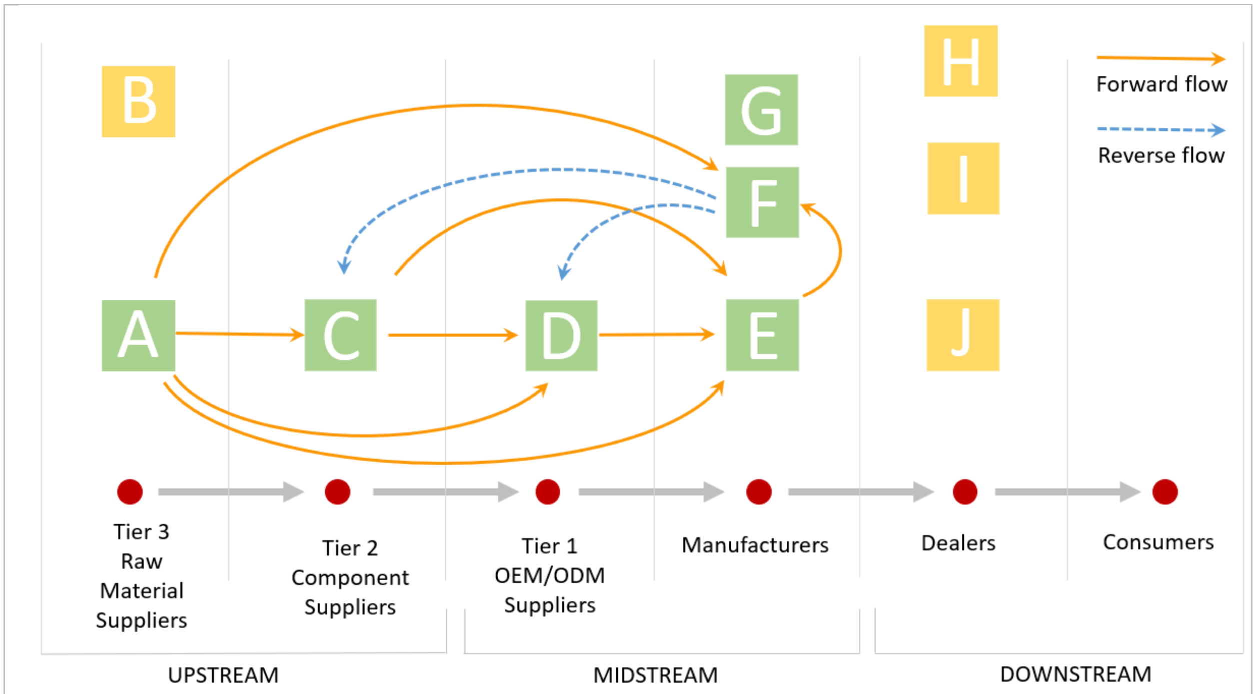

Figure 6 - 2: Supply chain network

In our data sample, the companies in each tier of the supply chain network represents different industry (i.e., Company A in tier 3 represents energy; Company C in tier 2 represents electrical manufacturing; Company D in tier 1 represents bearings manufacturing; Company E represents heavy equipment manufacturing and Company F represents recycling and packaging manufacturing). Each company acts as suppliers to companies at different tiers of supply chain. As noted in Chapter V, Company A supplies energy to Companies C, D, E and F, Company C supplies electrical components to Companies D and E, Company D supplies bearings to

Company E, Company E supplies heavy equipment to Company F, and lastly, Company F supplies industrial packaging to Companies C and D. It is obvious that this multi-tier supply chain network is complex for several reasons such as geographic dispersion, product type, industry regulation, information sharing and so on. However, in line with prior studies (e.g., Choi & Linton, 2011), one thing that surfaced in this study is that the firm that holds the higher position in the supply chain network plays an instrumental role for achieving sustainability compliance along the supply chain:

> "*Our CEO/Top management recognizes that our customer demands us to transform our business model to become sustainability oriented. We recognize that if our customers are not successful, then we are going to lose them*" (Company A, Sr. Account Manager) and "*Our previous method of cleaning was so old and inefficient that it was not meeting customer requirement. Our customers require that a bearing be clean and certified to a certain specification. We understand that the new CLSS are more efficient and potentially more sustainability driven*" (Company D, Supply Chain Manager).

According to institutional theory (Meyer & Rowan, 1977) each supplier therefore has no choice but to implementing adequate CEBM practices in response to institutional pressure and thus attain organizational legitimacy within their supply chain network. Thus, to a great extent, the seriousness in implementing CEBM practices in fulfilling suppliers' requirement depends on their proximity to their buyers within the multi-tier supply chain network (Choi & Linder, 2011; Wilhelm et al., 2016). Additionally, stakeholder theory may be an appropriate theoretical lens to understand the supplier firm's shareholders pressure to implement CEBM practices.

In another instance, it was noted that the lead firms role to incentivize their supplier separately helps them to achieving sustainability compliance along the supply chain: "*Our collection of input material is highly dependent on market price. So, we consider paying more to our supplier if the input material is of good quality*" (Sustainability Officer, Company F). Agency theory may be an appropriate theoretical lens to understand the supplier's agency behavior to their principal buyers to align their CEBMs sustainability with supplying function. (Eisenhardt, 1989; Jensen & Meckling, 1976). In the earlier discussions, several contingency factors (e.g., size, buyer's power over supplier, degree of design for sustainable product) were found to be the dominant influencing factors for relationship between the CEBM practices and supply chain preparedness of the supplier firm. In a supply chain network, such contingencies when coupled with each principal-agent dyad's role present an interesting phenomenon.

Yet another phenomenon that this study found is about the level of transparency that the supply chain network should maintain (Wilhelm et al., 2016). For example, Company E is a US LEED certified firm. It means that Company C would anticipate Company A to make recommendations for controlling energy consumption and using sustainable energy more. In order to earn Company E confidence, the companies must maintain a transparent supply chain that would help Company E as the buyer to monitor the electron mix of Company A's energy supplies. It appears simple in this study since the case companies are located in one region within the U.S. However, given the geographic dispersion of present-day supply-chains, this is both complex and ambitious situation:

> "*With our global suppliers, this sort of a process is difficult (cost and coordination reasons) because almost 70% of our input material comes from overseas (China), our*

raw tubes come from Europe (Italy, Romania, Turkey) – this is the region where heavy engineering companies are located" (Plant Head, Company E).

One way to resolve this ambiguity would be to implement multi-tier collaborative technologies to help in monitoring and nurturing a transparent relationship further upstream in the supply chain network.

IMPLICATIONS

Implications for research

This multi-industry multi-supply chain tier study establishes that firms practicing CEBM in supply chains undergoes through a multifaceted and complex process. To gain adequate supply chain preparedness as output and higher performance as outcome, firms must comprehend upon several upstream and downstream contextual factors of such CEBMs. Such contextual factors include organizational size and structure, industry, product characteristics, customer expectations, supplier resistance, regulators, investments. By and large, firms anticipate and develop a set of supply chain preparedness at internal, supply chain and industry levels to counter such contextualities. Such preparedness leads firms' CEBMs to achieve better performance in three sustainability dimensions – economic, environmental and social, but in varying order. While this study establishes a contingency approach to achieve supply chain preparedness for pursuing CEBMs more effectively, the findings of this study paints a canvas for future scholars of sustainable supply chains to examine this phenomenon with greater depth for unique industries and performance priorities, and other constraining conditions.

Implications for practice

The contingency model approach may appeal to managers to describe their respective firms' contingency relationship between CEBM practices, their context, supply chain preparedness, and CEBM performance. The qualitative validation steps using multi-industry cases and the findings of this study provides a schema to managers about how to relate their CEBM scenarios from several perspectives (such as industry, product, skills, and so on). Furthermore, the empirical analysis can help managers recognize types of CEBM practices that may suit their supply chains and also recognize the benefits that may accrue thereon. The proposed framework and propositions may encourage managers to think out-of-box to innovate and implement new CEBM practices for their firms that can resist external and internal pressures and capture broader benefits for their individual firms and supply chains. Managers may find the study's findings useful to assess and clarify parts of CEBM practices that are related and/or not related with their present sustainability initiatives and supply chain management practices. Lastly, managers may find the study useful to evaluate whether preparing supply chains for practicing CEBM is related to their higher-order strategic goals, such as sustainability firm performance, social recognition, and corporate branding.

CONCLUSIONS

Limitations of the study

Like all empirical studies, this study also has its own limitations that must be carefully considered in interpreting the findings. First, the study findings are based on contemplations of ten case studies that have embraced CEBM practices in supply chain context. Considering that, a major concern is about how generalizability aspects of these findings for similar organizations in their respective industries in the US and other developed nations. Second, this study has paid attention on small, medium and large firms as sample firms from different industries that have already established CEBM practices. Consequently, the case studies do not represent those firms that are unestablished or under-established in CEBM practices due their non-implementing or in-planning stages of implementing CEBM practices. Third, in terms of size proportionality, the ten case studies can be classified as two small, two medium and four large firms. Sustainability studies have shown that firms behave differently based on their size that indeed acts as a proxy for their availability of resources to commit to sustainable business practices (e.g., Walker & Jones, 2012). Contradictorily, smaller firms make up for a much larger proportion (about 99%) of firms in the US, UK and worldwide (Walker & Preuss, 2008). The proportional mismatch inherent in this study might affect upon its generalizability not only from organizational size, but also from industry perspective. Four, the study develops a contingency approach for supply chain preparedness of CEBM practices, but it is beyond the scope of the current study to understand the root cause of such contingencies. Five, since the study adopted a qualitative approach of using multiple case studies to analyze the research questions, the findings study is based on data provided by two participants per case study, transcription of data by two researchers and interpretation of data by two researchers. Thus, presence of researcher bias cannot be fully ruled out. Lastly, this study did not find any moderating contingency factors in the relationship between supply chain preparedness and CEBM performance . This may be due to the way the questionnaires were asked to the informants; however, it may not be completely ruled out.

Agenda for future research

The study has enough potential to be extended through a large-scale within-industry and cross-industry survey to identify different contingency factors and explore relationships between those factors and supply chain preparedness of CEBM practices of firms. Future research could also focus on how this contingency-preparedness relationship are approached in multi-tiered buyer-supplier levels. This could potentially help in addressing the contingencies of CEBM practices more pro-actively (i.e., life-cycle management of contingency-preparedness relationship in supply chain networks). Yet another scope for future research exists in studying the interaction effect between the contingency factors that this study unearth as potential moderators in the relationship between CEBM practices and supply chain preparedness of firms. Also, future studies may use alternate theoretical lenses, such a stakeholder theory perspective (Freeman, 1984), resource dependence theory perspective (Pfeffer & Salancik, 1978) and agency theory (Jensen & Meckling, 1976) to understand themes beyond contingency-preparedness scope in CEBM practices. Further, this contingency-preparedness scope could also be adopted to explore reasons that firms consider for avoiding sustainability paths. In addition, extensive research is required for understanding the contingencies that smaller firms face in pursuing CEBMs. Lastly, this study attempts to propose a theoretical framework and a set of propositions to theorize why and how firms develop their supply chain preparedness for their CEBM initiatives. More research is needed to validate the advised framework and propositional statements in varying supply chain contexts, in different sectors and, at different time points. Overall, CEBM practices in supply chain context is increasingly becoming an important aspect for firms, policy-makers, individual buyers, and scholars alike.

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APPENDIX: A - D

APPENDIX - A

IRB APPROVAL LETTER

The University of Texas
Rio Grande Valley

Office of Research Compliance
Institutional Review Board for Human Subject Research

Date: July 20, 2018

PI: Santosh Nandi

Dep: Management

Title: A Contingency Approach for Supply Chain Preparedness to Pursue Circular Economy Business Models.

Re: IRB Exempt Determination for Protocol Number 2018-137-06

Dear Santosh Nandi

A University of Texas Rio Grande Valley IRB reviewer has approved the proposal referenced above. The approval is effective as of July 20, 2018 within the exempt category of:

Category 2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (a) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (b) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Research that is determined to be Exempt from IRB review is not exempt from ensuring protection of human subjects. The Principal Investigator (PI) is responsible for the following through the conduct of the research study:

1. Assuring that all investigators and co-principal investigators are trained in the ethical principles, relevant federal regulations, and institutional policies governing human subjects research.
2. Disclosing to the subjects that the activities involve research and that participation is voluntary during the informed consent process.
3. Providing subjects with pertinent information (e.g. risks and benefits, contact information for investigators, and IRB/ORC) and ensuring that human subjects will voluntarily consent to participate in the research when appropriate (e.g. surveys, interviews).
4. Assuring the subjects will be selected equitably, so that the risks and benefits of the research are justly distributed.
5. Assuring that the privacy of subjects and confidentiality of the research data will be maintained appropriately to ensure minimal risk to subjects.

Exempt research is subject to the ethical principles articulated in The Belmont Report, found at the Office of Human Research Protections (OHRP) Website:
www.hhs.gov/ohrp/humansubjects/guidance/belmont.html

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Institutional Review Board for Human Subject Research

Unanticipated Problems: Any unanticipated problems or complaints must be reported to the IRB/ORC promptly. Further information concerning unanticipated problems can be found in the IRB procedures manual.

Continuing Review: Exempt research is not subject to annual review by the IRB.

Modifications: Any change to your protocol requires a Modification Request for review and approval prior to implementation. The IRB may review the exempt status at that time and request an application for approval as non-exempt research.

Closure: Please notify the IRB when your study is complete through submission of a final report. Upon notification, we will close our files pertaining to your study.

If you have any questions please contact the Office of Research Compliance by phone at (956) 665-2093 or via email at irb@utrgv.edu.

Sincerely,

Laura D. Seligman

Laura Seligman, Ph.D.
Institutional Review Board Chair

APPENDIX - B

INFORMED CONSENT FORM

The University of Texas Rio Grande Valley

Informed Consent Form

A Contingency Approach for Supply Chain Preparedness to pursue Circular Economy Business Models

Investigators: Santosh Nandi (Primary investigator); Hale Kaynak, Ph.D. (Faculty advisor)

Background: We are conducting a research study to empirically investigate how firms seek supply chain preparedness in practicing circular economy business model (CEBM), and how such preparedness impacts their CEBM performance. This research study, my dissertation, is part of my doctoral degree requirement at The University of Texas Rio Grande Valley (UTRGV). My dissertation will contribute to the field of sustainable supply chain management (SSCM) by exploring the role of supply chain preparedness of firms in their efforts in implementing circular economy business models (CEBM), a SSCM practice. The research study uses a contingency approach to identify the constituent factors from available literature, in terms of CEBM practices, their contingencies, and their preparedness and performance outcomes. Next, a guiding contingency research framework is developed to conduct a qualitative case study-based investigation the mediating role of "supply chain preparedness" in the relationship of CEBM practices and their performance, and the factors upon which the overall relationship is contingent upon.

Procedure: As stated above, this research study will involve an interview of approximately 45 – 60 minutes in length to take place in a mutually agreed upon location. Interview format is a semi structured interview. Questions in the interview are open ended to capture insights of the phenomena. If you are willing to participate, you will be asked questions about the prevailing circular economy driven business model (CEBM) practices and its associated supply chain preparedness of your organization. You may decline to answer any of the interview questions that make them uncomfortable or simply do not want to answer. Further, you may decide to withdraw from this research study at any time without any negative consequences by advising the researcher. With your permission, the interview will be tape-recorded to facilitate collection of information, and later transcribed for analysis. I will provide an audio recording permission letter that you will be asked to sign or you can verbally give permission. Without permission, I will not use tape recorder however I will take notes during the interview. Shortly after the interview has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish. All information you provide is considered completely confidential. Your name will not appear in any thesis or report resulting from this research study, however, with your permission anonymous quotations may be used. Data collected during this research study will be retained for a year in locked office. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this research study.

Risks or Possible Discomforts Associated with the Research Study: There are no known anticipated risks associated with your participation in this research study. Questions of the survey are only research purposes and context of the question has no risk to participant.

Benefits of Participation: There is no direct benefit to participants. After completion of my research, results of the study will be shared with every participant as a reward. I hope that the results of my research study will be of benefit to those organizations directly involved in the study, other voluntary recreation organizations not directly involved in the study, as well as to the broader research community.

The University of Texas Rio Grande Valley
IRB APPROVED
IRB# 2018-137-06
Expires:--/--/--

IRB APPROVED UTRGV

Page 1 of 2

The University of Texas Rio Grande Valley

Informed Consent Form

Voluntary Participation: Your participation in this research study is voluntary; you may discontinue your participation at any time without penalty. If for any reason you decide that you would like to discontinue your participation, simply tell the researcher that you wish to stop.

Anonymity and/or Confidentiality: Aforementioned, your participation and data generated from this research study will be kept confidential. Data and all information from participants will be stored in a locked office. Data will be kept for three years for research purposes.

Who to Contact for Research Related Questions: For questions about the research itself, or to report any adverse effects during or following participation, contact the researcher, Santosh Nandi at phone number (956) 457-4905, and/or email: santosh.nandi@utrgv.edu. My faculty advisors contact phone number is (956) 665-3351 and email: hale.kaynak@utrgv.edu.

Who to Contact Regarding Your Rights as a Participant: This research study has been reviewed and approved by the Institutional Review Board for Human Subjects Protection (IRB). If you have any questions about your rights as a participant, or if you feel that your rights as a participant were not adequately met by the researcher, please contact the IRB at (956) 665-2889 or irb@utrgv.edu.

Signatures: By signing below, you indicate that you are voluntarily agreeing to participate in this research study and that the procedures involved have been described to your satisfaction. The researcher will provide you with a copy of this form for your own reference.

______________________________________ ____/____/______

Participant's Signature Date

The University of Texas Rio Grande Valley
IRB APPROVED
IRB# 2016-137-06
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APPENDIX - C

AUDIO RELEASE FORM

The University of Texas Rio Grande Valley

Audio Release Form

A Contingency Approach for Supply Chain Preparedness to pursue Circular Economy Business Models

Researcher: Santosh Nandi
Phone: (956) 457-4905
Email Address: santosh.nandi@utrgv.edu
Faculty Advisor: Hale Kaynak, Ph.D.

I hereby give permission to Santosh Nandi to audio record my responses during the interview for this study, A Contingency Approach for Supply Chain Preparedness to pursue Circular Economy Business Models. I further understand that researchers will use a pseudonym to identify me and that neither my name nor any other identifying information will be associated with the audio recording or transcription of my recorded responses. The recorded material will only be used for research purposes. As with all research consent, I may at any time withdraw permission for audio recorded material of me to be used in this research project.

I acknowledge that there is no compensation for allowing myself to be audio recorded.

I am permitting the review and transcription of my recorded interview by the investigators. The recorded material will be securely stored in a safe (locked) drawer for approximately for three years. After that time, all recorded data will be destroyed. No one other than the investigators will have access to the data.

Participant Signature:____________________________________

Date:__________________

Please keep a copy of this sheet for your reference.

The University of Texas Rio Grande Valley
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APPENDIX - D

CASE STUDY PROTOCOL

Date	
Company ID	
Pseudonyms (Optional)	
Title of Participants	

Introduction

- ✓ Introduce and describe the purpose of the study to the participants
- ✓ Provide copies of letter of IRB approval and informed consent (See Appendix - C) to the participants
- ✓ Describe the structure of the interview to the participants (i.e., audio/video recording, taking notes, and use of pseudonyms)
- ✓ Ask if the participants have any questions
- ✓ Test audio/video recording equipment (when the participants permit)
- ✓ Make the participants feel comfortable

General Questions about the organization and its Circular Economy Business Models

1. Vision and mission; Inception and history; Main activities; Key markets; Business model; Revenue model
2. Supply chain related: Key supply chain activities and structure
3. Circular economy (CE) related:
    - Sustainability and Sustainable development initiatives;
    - Involvement of top-management, employees, and upstream/downstream supply chain partners;
    - Benefits and challenges of implementing circular economy (CE) principles;
    - Long-term sustainable development goals

Questions about Circular Economy Business Model (CEBM) Practices

1. What is the CEBM that your organization practices?

2. What were the major reasons and events that led your organization to start the CEBM practice? What is the present state of the CEBM practice, in general?

3. What is the main idea of the CEBM practice? Is it single or multi-objective? If multi-objective, is there an order of priority? For example, the CEBM is expected to:
   - Preserve natural resources
   - Reduce emission levels
   - Reduce material losses
   - Enhance renewable and recyclable resource utilization
   - Enhance product's lifetime value

4. How is the CEBM operationalized? What are the key activities and processes that the CEBM scopes. For example, the CEBM creates value by:
   - Slowing resource loops (e.g., car leasing models, re-furbished electronics, luxury green products, no-fee upgradable products)
   - Closing resource loops (value-chain enhanced products, eco-industrial parks)
   - Narrowing resource flows (e.g., cloud-computing services)
   - Encouraging sufficiency to curb new demand (i.e., related to material/resource extraction)
   - Reducing material/resource leakages and emissions (i.e., related to material/resource processing)

5. Do you agree that activities/processes of this CEBM are very complex? If so, please describe the level of complexity at following levels:
   - Design level
   - Business model level
   - Production system level
   - Value chain level

6. At what level does the CEBM makes its impact?
   - Micro/Meso/Macro
   - And, how?

Questions about Contingencies related to Circular Economy Business Model Practices

1. Do the CEBM practice face any kind of challenges (i.e., contingencies)? How does your organization encounter such challenges? How often do the firm have control over those contingencies? Please cite few example of such challenges.

2. From a strategic decision, do these challenges of practicing CEBM classify into some of the following ones? If so, please describe the relevant ones.
   - Product related
   - Facilities and logistics related
   - Manufacturing process, equipment & technologies related
   - Conformance & performance quality
   - Organization design and supplier configurations
   - Human resources policies

- Sustainability policies

3. From a structural perspective (i.e. how the CEBM practice is structurally integrated internally and with its supply chain), do these challenges of practicing CEBM classify into some of the following ones? If so, please describe the relevant ones.
   - External business environment related
      i. Market level fit related
      ii. Customer-product fit related
   - Internal task environment related
      i. Task uncertainty
      ii. Task interdependence for product-process system
      iii. Task similarity in product-process system
      iv. Technological expertise

4. From an institutional (i.e., growing or originating from outside of the firm that the managers have no control) perspective, do these challenges of practicing CEBM classify into some of the following ones? If so, please describe the relevant ones.
   - Socio-cultural context
   - Industry relevance
   - International relevance
   - Liability of newness
   - Competition
   - Regulations

5. Does the strategic, structural and institutional contingencies follow any precedence? Also, are they related (i.e., one leads to the other)?

Questions about Supply Chain Preparedness

1. What is your organization's *preparedness, unpreparedness or contra-preparedness* to pursue, plan and/or implement the CEBM practice, in terms of:
   - Industry level aspects
      i. Political, legal, environmental, and social conditions
      ii. Business (i.e., economic viability, stakeholder pressure, competition)
      iii. Customer preference and other socio-economic traits
      iv. Natural forces (i.e., handling energy conservation, environmental hazards)
   - End-to-end supply chain level aspects
      i. Supplier management (i.e., selection, adaptation, certification, information sharing, training & development)
      ii. Logistics management (i.e., shipment consolidation, choice of transportation/ packaging, Human and health-related, distribution & collection mechanism)
      iii. Process management (i.e., material/parts reuse/recovery, energy and material reduction, avoiding hazardous products/processes)

    iv. Product management (i.e., product life planning, product innovation & re-design)
- Focal firm level aspects
    i. Commitment to sustainability (TMT commitment, culture, HR policies)
    ii. Risk management (managing economic, environmental and social risks)
    iii. Integration (i.e., strategic alignment, cross-functional cooperation, traceability, strategic purchasing processes)
    iv. Performance management (i.e., rewarding, pre-empting and improvement mechanisms)

2. How do the contingencies (individually or in set) help establish your organization's supply chain preparedness for the CEBM practice?

3. Does higher (lower) supply chain preparedness lead your organization to make adjustments in the CEBM practices? If so, please elaborate.

Questions about Circular Economy Business Model (CEBM) Performance

1. How does your organization measure the performance of the CEBM practice?

2. What are the positive outcomes that your organizations achieves through the CEBM practice, in terms of following metrics:
    - Economic (i.e., short and long term gains)
    - Environmental (i.e., reduction of environmental concerns through lesser depletion and/or utilization of natural resource)
    - Social (i.e., increase in social values , such as social benefits, additional job creation and other benefits related to poverty, gender equality, and sustainable cities)
    - Protection of future generations (i.e., stable and long-term circular production systems)
    - Management (i.e., improvements in management innovativeness, pro-active and multiple stakeholder-ship, information and technological system, new capability development, and employment stability)
3. Does your organization's CEBM performance increases when it is more prepared for practicing CEBM? In other words, do interactions between the CEBM practice and supply chain preparedness affect the CEBM performance outcome? Please explain how.

Concluding Questions

4. Is there anything else you would like to add or share about this topic that you feel is important for other executives interested in circular economy and supply chain management to know?
5. Any other inputs that added value to our conversation?

Concluding Statement

- ✓ Thank them for their participation
- ✓ Ask if they would like to receive a copy of the results
- ✓ Record any observations, feelings, thoughts and/or reactions about the interview

BIOGRAPHICAL SKETCH

Santosh Nandi is an Assistant Professor of Management at University of South Carolina - Sumter. He has earned his Ph.D. in Business Administration from The University of Texas Rio Grande Valley (UTRGV). He has earned his MBA from Xavier University (formerly, XIMB in India) and his B.S. in Architecture from Indian Institute of Technology Roorkee (IIT-Roorkee, India). His industry experience includes technology entrepreneurship in telecommunication, global positioning system (GPS), and location content domain. His teaching and research interests include circular economy and its business models, supply chain management, strategic entrepreneurship, and open innovation.

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