

THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The nitty gritty of life cycle management

Exploring the organization of LCM

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[The cover picture is a representation and an exemplification of LCM, including the holistic environmental management of the material and product flows, and the related environmental impacts, of a product chain of companies (in this case within the house building sector). It includes also a visualization of the interpretations and translations taking place as part of adapting LCM into different organizations and into different corporate functions.]

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THE NITTY GRITTY OF LIFE CYCLE MANAGEMENT

Exploring the organization of LCM

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ABSTRACT

Climate change and environmental degradation threaten to cause serious effects on the planet and on society. Scientists thus advocate an urgent shift towards a more sustainable development. Herein, industry is said to play a vital role, as it could positively influence sustainable production and consumption. In this, life cycle management (LCM) is suggested as a possible approach towards corporate management of environmental impacts, as it implies holistic environmental management along the whole product life cycle, from raw material extraction through to product end-of-life.

Studies of the management and organization of LCM in industry practice are scarce, resulting in a need to study this practice in the setting of multinational corporations (MNCs). The aim of this dissertation is thus to explore the ‘nitty gritty’ details of organizing LCM; focusing on the 1) initiatives and activities of LCM, their scope of inclusion, how these develop over time, 2) the role of actors in performing and forming these practices, and 3) the activities of these practitioners.

Studies both in the field (i.e. industry practice) and of literature have been conducted, resulting in five papers (Papers I-V). One group of papers target LCM as it is practiced in one MNC (Paper I-III), by focusing on contemporary practice (Paper I), the LCM development over time (Paper II), and in the context of a product chain collaboration (Paper III). Another group of papers (Papers IV-V) takes a broader perspective on LCM throughout industry and society, focusing explicitly on the practitioners of LCM and their activities (Paper IV), and the different types of LCM that exist (Paper V).

The results show the assiduous efforts of life cycle (LC) practitioners in integrating, adapting and promoting LCM in their organizations, and their importance in bridging discussions in a practice of creative problem-solving, through a process best understood as translation. Adaptation depended much on *possible* activities, rather than on rational choice for implementation. In this, LCM was made relevant by being connected to existing corporate logics and practices, in turn facilitating the uptake of LCM. The results concretize the many practices of LCM and provide a collected and enriched LCM vocabulary, thereby generating a better understanding of developing industry LCM practice.

Keywords: Life cycle management (LCM), life cycle thinking (LCT), sustainability, corporate LCM, product chain LCM, practice, practitioners, organization, management, translation

SAMMANFATTNING

Klimatförändringar och miljöförstöring hotar att orsaka allvarliga effekter på planeten och på samhället. Forskare förespråkar således ett brådskande skifte mot en mer hållbar utveckling. Industrin har här en potentiellt viktig roll, eftersom den positivt kan verka för mer hållbarhet bland annat inom produktion och konsumtion. Vidare föreslås livscykelräkning som ett möjligt sätt för industrin att ta ett holistiskt perspektiv på arbete med miljöfrågor längst med en produkts hela livscykel, från råvaruutvinning till produktens slutfas.

Bristen på studier av organisation och hanterande av livscykelarbete (LCM) i praktiken har lett till ett behov att studera LCM praktik i multinationella företag. Syftet med denna doktorsavhandling är således att undersöka denna praktik, med ett fokus på 1) LCM initiativ och aktiviteter, dess omfattning, och hur dessa utvecklas över tid, 2) livscykelpraktikernas roll i detta arbete, och 3) de aktiviteter som dessa gör.

Denna avhandling inkluderar studier av både fält (industripraktik) och litteratur, vilket resulterat i fem artiklar (manus I-V). Några av dessa manus är inriktade på LCM så som det praktiseras i ett multinationellt företag (manus I-III) genom att fokusera på samtida praktik (manus I), utvecklingen av LCM över tid (manus II) och som del av ett produktkedjesamarbete (manus III). En annan grupp av manus (manus IV-V) fokuserar på aspekter av LCM i industrin som sådan och i samhället, med inriktning på LCM praktiker och deras aktiviteter (manus IV) och på olika typer av LCM som existerar (manus V).

I helhet så bidrar denna avhandling med en konkretisering av den variation av LCM praktik som finns, som i sin tur bidrar med en berikat LCM-vokabulär. Det hjälper således till att bättre förstå och utveckla LCM i multinationella företag. Resultaten påvisar LCM som en organiskt framväxande praktik, genom en serie av tolkningar och översättningar, snarare än resultat av en process av 'implementering' och 'diffusion'. Studierna påvisar även LCM som en process där praktiker uppvisar organisatorisk och kreativ problemlösning som ett led i att integrera, anpassa och promota LCM i respektive företag, samt har en viktig roll som översättare i diskussioner till exempel mellan avdelningar. Vidare handlade anpassning av LCM ofta om att göra det som var möjligt, snarare än det som var rationellt bäst utifrån ett miljöperspektiv. Det handlade också om att skapa relevans, genom kopplingar mellan LCM och redan existerande företagslogiker och praktik.

LIST OF INCLUDED PAPERS

Paper I

Nilsson-Lindén, Hanna; Baumann, Henrikke; Rosén, Magnus & Diedrich, Andreas (2018). Organizing life cycle management in practice: Challenges of a multinational manufacturing corporation. *The International Journal of Life Cycle Assessment*, 23(7), 1368-1382. <https://doi.org/10.1007/s11367-014-0818-y>

Paper II

Nilsson-Lindén, Hanna; Diedrich, Andreas & Baumann, Henrikke (n.d.). Life cycle management as a process of translation: The case of a manufacturing company.

Manuscript submitted to *Organization & Environment*.

Paper III

Nilsson-Lindén, Hanna; Rosén, Magnus & Baumann, Henrikke (n.d.). The formation of collaborative life cycle management practice: The case of the Sustainable Transport Initiative.

Manuscript under review in *Business Strategy and the Environment*.

Paper IV

Nilsson-Lindén, Hanna; Baumann, Henrikke & Rex, Emma (2018). LCM development: Focusing on the LC promoters and their organizational problem-solving. *The International Journal of Life Cycle Assessment*. <https://doi.org/10.1007/s11367-018-1523-z>

Paper V

Baumann, Henrikke & Nilsson-Lindén, Hanna (n.d.). The many paths of LCM: A practice review.

Manuscript intended for *Sustainable Production and Consumption*.



CONTRIBUTIONS BY THE AUTHOR

Paper I – The lead author has conducted the literature review and the empirical field study and has authored most of the manuscript. The manuscript has been iterated and discussed with all co-authors.

Paper II & Paper III – The lead author has initiated, planned and conducted the empirical field study, which has been discussed and iterated with all co-authors. The lead author has authored most of the manuscript, although all co-authors have contributed to the analysis, and the processing of the manuscript.

Paper IV – All authors have contributed to the empirical material from their previously conducted studies. The lead author has planned and managed the writing process, of which all co-authors have contributed to the results, conclusions and processing of the manuscript.

Paper V – Both authors have contributed in the execution of the study and in authoring the manuscript.

OTHER PUBLICATIONS BY THE AUTHOR

Nilsson-Lindén, Hanna (2014). A knowledge management perspective on environmental life cycle management: A manufacturing company example. Licentiate thesis, Chalmers University of Technology.

Nilsson-Lindén, Hanna; Baumann, Henrikke; Rosén, Magnus & Diedrich, Andreas (2014) Linking environmental LCM and knowledge management: The case of a multinational corporation. *Proceedings of the 4th International [avniR] Conference*, Lille, France, November 5-6, 2014.

Nilsson-Lindén, Hanna; Baumann, Henrikke & Diedrich, Andreas (2013). The role of knowledge and capabilities in a sustainable product chain context - A literature review. *Proceedings of the 8th EISAM colloquium on Organizational Change & Development*, Ghent, Belgium, September 12-13, 2013.

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My process of becoming a Ph.D. has included its ups and downs, hills and valleys. I have many times thought of it as a roller coaster, where I have been riding the train on the elevated railroad track that is the research process, experiencing the tight turns, steep slopes, and inversions of field work and desktop research. The speed of research might not be compared to that of the roller coaster, however, during these last couple of years I have still felt like time sometimes flies by. And little did I know, that I would eventually encounter the actual practices of the transport industry in my research.

There have been many who have provided me with their valuable knowledge and support during this ride. Especially, I would like to thank Henrikke Baumann, for her valuable ideas and guidance throughout the years, and for her continued faith in me. I also extend a big thank you to Magnus Rosén and Andreas Diedrich for also their great guidance and support during these years. Without the help of my supervisors, the positive experiences during this journey would definitely had been fewer. Also, thank you Anne-Marie Tillman for your help along the way, it has been much appreciated.

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Gothenburg, October 2018

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Let's fight for sustainability together

- Concluding sentence from an interviewee
(Paper III), in e-mail conversation

1. INTRODUCTION

There is no plan B, as there is no planet B

“There is no plan B, as there is no planet B”. This quote (UN News, 2014), by Ban Ki-Moon, former Secretary-General of the United Nations (UN), is worth repeating, as it clearly formulates the challenges of climate change and environmental degradation. With the current increase in global warming effect, there is a high risk of irreversible environmental degradation (Wijkman and Rockström, 2012; Ripple et al., 2017). Therefore, more than 15.000 scientists declare, in their ‘warning to humanity’, that there will soon be “too late to shift course away from our failing trajectory” (Ripple et al., 2017, p. 3), and that “we are jeopardizing our future” (p. 1). Environmental scientists thus argue for an urgent need of transition, so as to “[bend] the curve of negative global environmental change” (Rockström, 2015, p. 7), partly by actions within the contemporary development paradigm, and also with what Rockström (2015) refer to as a ‘profound mind shift’ where development occur instead *within* the boundaries of a ‘resilient Earth’. To take bold steps of transition are thus proposed, especially within the area of production and consumption, if we are to carry the weight of 9 billion people by 2050 (Wijkman and Rockström, 2012). Also, within the management research community the challenge of sustainable development has been given much relevance, where it has been referred to as ‘one of the greatest challenges in the 21st century’ (Howard-Grenville, Buckle, Hoskins and George, 2014).

The urgency for action has been heeded by many world leaders and organizations, leading to, among other actions, the adoption of the 2030 Agenda for Sustainable Development, and its 17 Sustainable Development Goals (SDGs) (Muff, Kapalka and Dyllick, 2017), in 2015. In order to meet these ‘grand challenges’ of the SDGs (see George, Howard-Grenville, Joshi and Tihanyi, 2016), the contribution of industry is considered vital (SMART, 2016). Companies are suggested to have an important role in the transition towards sustainable development, due to its possibility to positively influence their global product chains and advancing sustainable production (Welford, 2003; Golden, Subramanian and Zimmerman, 2011; Howard-Grenville et al., 2014; Blok et al., 2015). Environmental scientists argue that

business as usual is no longer considered possible (Wijkman and Rockström, 2012; Ripple et al., 2017). Moreover, it is argued that single actors (e.g. companies and governments) cannot solely solve the grand challenges of sustainability (Muff et al., 2017). Instead, collaboration is considered a key ingredient in dealing with the challenges of sustainability (Lozano, 2007). A systems perspective is further suggested, where the focus is on the whole, rather than on the individual parts (Wijkman and Rockström, 2012). In relation to this, the life cycle perspective has been proposed as a critical ingredient of a sustainable society, and a way to achieve and enhance corporate sustainability efforts (Rebitzer, 2015; SMART, 2016). It has also been suggested as a key way of facilitating the transition from the traditional linear economy, towards “unlocking the circular economy”, as it is stated in EU parliament discussions (Colens, 2017). In any case, as the challenges of sustainability and climate change are presumed to reshape company supply chains (Howard-Grenville et al., 2014), the concept of environmental life cycle management (LCM) is suggested as a possible approach towards companies managing their environmental impacts (e.g. Remmen et al., 2007; Sonnemann and Margni, 2015).

Traditionally, the approach taken by companies has been to manage environmental impacts mostly by targeting the environmental aspects more directly linked to the company (Rebitzer, 2015), sometimes referred to as corporate environmental management (CEM) (see Meima, 2002). This can be achieved through various approaches. However, the actions of companies often influence environmental impact elsewhere in the product life cycle (see Ehrenfeld, 1997), and by the use of tools such as life cycle assessments (LCA) it has been shown that ‘hotspots’ for environmental impact can be located upstream or downstream in companies’ product chains¹ (Baumann and Tillman, 2004). Delimiting the scope of environmental consideration to only a part of the product chain, such as an individual company, is thus suggested to lead to a problematic limitation. Instead, companies that do search for actual change towards sustainability would need to move away from a firm-centric view of corporate sustainability (Figge and Hahn, 2018). Collaboration between firms is thus suggested as important in the transition towards a more sustainable society (Niesten, Jolink,

¹ The term ‘product chain’ is here used to indicate the chain of actors that are involved in the material flows related to a product (see Boons, 2000) from raw material extraction through to product end-of-life, as the term ‘supply chain’ instead often imply only the upstream actors (Balkau, Gemechu and Sonnemann, 2015).

de Sousa Jabbour, Chappin and Lozano, 2017). The use of the life cycle perspective is thus proposed to serve as an analytical framework which broadens the scope of ecological thinking (Ehrenfeld, 1997), and as a guiding logic for action (Heiskanen, 2002).

Society thus faces huge environmental sustainability challenges, which need to be solved by coordinated efforts by multiple actors (George et al., 2016). For this, LCM has been suggested as a holistic approach to help shifting towards sustainable development. With such claims, it becomes relevant to explore what LCM implies in practice.

1.1 LIFE CYCLE MANAGEMENT

When discussing the life cycle approach, life cycle thinking (LCT) and LCM are common terms within the broader field of industrial ecology. LCT can be described as an idea of a life cycle perspective, which is about “going beyond the traditional focus on production sites and manufacturing processes so to include environmental, social and economic impact of a product over its entire life cycle” (Remmen, Jensen and Frydendal, 2007, p. 12). LCM is instead described as “the managerial practices and organization arrangements that apply LCT” (Baumann and Tillman, 2004, p. 62, see also e.g. Bey, 2018, for a similar description). Whilst LCM hold many definitions, in all, the concept implies a holistic perspective on environmental management in the whole product life cycle (i.e. from raw material extraction through to product end-of-life), and an aspiration for minimization of the total environmental impact of a product, independent of the place of occurrence in the product chain (e.g. Hunkeler et al., 2003; Baumann and Tillman, 2004; Poikkimäki, 2006; Sonnemann et al., 2015), and to reduce sub-optimizations (e.g. Baumann and Tillman, 2004; Bey, 2018). An often-used tool in LCM is LCA, which is a method for, in quantitative terms, describing natural resource use and pollutant emissions (i.e. environmental impact) across the whole product life cycle (Baumann and Tillman, 2004).

LCM gained relevance, for example, in the light of the critique towards CEM and the use of environmental management systems (EMSs) as these were considered too internally focused towards corporations, especially in relation to the risk of creating ‘weightless’ corporations. The background for this is that some, or all, of the environmental impacts related to the

activities of the company might not show in the EMS, as these activities can instead be outsourced to suppliers upstream the product chain (Welford, 2003). The idea of LCM is thus to take a holistic perspective on environmental impact, and to avoid such burden-shifting in the product chain (see Welford, 2003; Sonnemann, Gemechu, Remmen, Frydendal and Jensen, 2015). Although, CEM and LCM have many similarities, the critical difference lies in the extended environmental consideration and management from one company and its traditional boundaries towards the whole product life cycle (Poikkimäki, 2006). The life cycle approach is proposed as a way to make clear the link between companies and their use of natural resources and emissions of pollutants in different parts of the product chain (Ehrenfeld, 1997; Boons, 2000) as LCM relates to the physical life cycle (Bey, 2018). LCM could thus help companies to see the effects of their choices (e.g. Sonnemann et al., 2015), but also generate uncertainty on how to balance aspects of economy and sustainability (Boons, 2000). Further, studies have shown that by reshaping product chains, as part of LCM, often imply a better knowledge of, and increased interaction with, the actors part of the product chain. Such rebuild of the product chain can also imply an increase in number of actors, as part of making it more sustainable (e.g. certification bodies) (Kogg, 2003; Afrane et al., 2013).

In the literature on LCM it is described as (among other definitions): a management concept (Bey, 2018); a guiding principle or logic (Heiskanen, 2002); a product management system (Remmen et al., 2007); and an umbrella for a wide range of tools (see e.g. Poikkimäki, 2006; Sonnemann and Margni, 2015). One tool proposed as key in the LCM toolbox is LCA (e.g. Sonnemann and Margni, 2015; Bey, 2018). With LCA it is possible to, for example, determine the environmental state or condition of a product system, compare alternative systems, and provide data for targets and indicators (Bey, 2018). Apart from LCA, the LCM toolbox entails a wide range of tools which feature prominently in LCM literature (see e.g. Westkämper, Alting and Arndt, 2001; Remmen et al., 2007; Power, 2009; Balkau and Sonnemann, 2010), such as design for environment, key performance indicators, design for recycling, and many more tools that can include life cycle consideration. Working with a life cycle perspective of products can also include aspects of changing material product flows, for example, by reusing products or parts of products, repairing of products, recycling of

material, reduction of energy or material consumption, replacing harmful substances and/or rethinking product design and function (e.g. Remmen et al., 2007).

The life cycle field

The idea of LCM was discussed already in the 1990s. Brattebø suggested the term ‘environmental life-cycle engineering’ in 1995, presenting it as “a new overall concept for the understanding of preventative environmental engineering” (Brattebø, 1995, p. 1), with the aim to “integrate preventative, environmental and life-cycle thinking as key elements of engineering disciplines”. The importance of streamlining LCA and disseminating LCT was the topic of the 1996 conference report from the US Environmental Protection Agency (EPA) (Curran and Young, 1996). In the same report, the term LCM is suggested, describing it as a “general and pragmatic approach” (advocated by the organization Environment Canada) (Curran and Young, 1996, p. 58). In 1997, Fava described how the LCA methodology gained currency in environmental management, and further discussed the relevance of LCA for future use. The life cycle approach, he argued, “whether conceptual or quantitative, is thus a way of addressing environmental problems from a systems or holistic perspective” (Fava, 1997, p. 8). The life cycle idea further gained prominence in the early 2000 (Wolf and Chomkhamsri), resulting in the launch of the first LCM conference in 2001 among other things. The conference series has since then continued on a biannual basis, with the latest taking place in 2017².

The emergence of LCA and LCM are closely linked. As such, it is not surprising that the LCA methodology and its applications have held prominent positions in discussions on LCM, for example, featuring frequently at LCM conferences (see e.g. Finkbeiner, 2011; Sonnemann and Margni, 2015; Benetto, Gericke and Guiton, 2017). Parallel to these discussions, there has been a growing interest in the implementation and mainstreaming of LCM in industry and business practice, identifiable specifically in the collected LCM texts of the LCM conference of 2015, also titled ‘LCM’ (see Sonnemann and Margni, 2015). In this literature, integration of LCM in business is advocated, suggesting for example the importance of top management support, development of strategic goals, explicit

² This brief description of the history of LCM is intended as an introduction to the research on the life cycle approach, rather than a complete compilation of the history of LCM.

communication in the organization, active involvement and collaboration of employees from all functions of the organization, and clear connection to economic gains, among other things, as important aspects of integration and mainstreaming of LCM in industry (e.g. Remmen et al., 2007; Sonnemann and Margni, 2015; Strothmann, Bricout, Sonnemann and Fava, 2015).

While advocating for LCM integration, the mainstream LCM literature tends to take a normative stance, with descriptions of the ‘good examples’ of LCM (e.g. Remmen et al., 2007; SLC report, 2016) and prescriptions of how to conduct LCM (see also Paper I). Similar to what Osagie, Wesselink, Blok and Mulder (2016) identified concerning competences for CSR managers, such prescriptions fail to adequately provide knowledge on how to act, as they lack contextualization. LCM researchers tends also to take a functionalistic view on LCM in industry, thus viewing it mostly as a rational process, “resulting in heavy emphasis on standards, tools, databases, and guidelines” (Rex, 2008, p. 55). Rex (2008) instead proposed an ‘interpretative’ approach, as she concludes that the promotion of LCT in industry is as much an organizational and a social problem, as much as a technical one. With such focus, she joins the smaller group of LCM researchers that explicitly draw on social sciences to understand LCM development in industry³. Similarly, Poikkimäki (2006) concludes that a focus on “technologies and quantitative data may not reveal the full importance of interaction and cooperation, or related learning and knowledge creation processes” (Poikkimäki, 2006, p. 126). Therefore, the use of social sciences has been suggested as a promising addition to the field of LCM (Rex, 2008). Already in 2003, Hoffman proposed to include perspectives from the social sciences into the industrial ecology field as a way of gaining increased understanding of environmental management in industry (Hoffman, 2003). The argument was that within industrial ecology focus often turns to technical processes and quantitative analysis, which, according to Hoffman, “leave them poorly equipped to respond to the social aspects of transformational change” (p. 82). Social science would help explain the ‘how, in addition to the ‘what’, identified by quantitative methods (Hoffman, 2003).

³ Referred to as LCT literature, in Paper I. To facilitate further discussions, these two bodies of literature will here be further referred to as ‘mainstream LCM’ and ‘social science-based LCM’ research.

Schmidt (2013) adds to this call for inclusion of social aspects to LCM, by proposing an explicit addition of social practices to the definition of LCM⁴.

The notion that LCM is not a ‘one-size-fits-all’ solution is at this point an often-stated notion (see e.g. Baumann, 2000; Heiskanen, 2000; Rex and Baumann, 2007; Mortimer, 2011; Sonnemann and Margni, 2015; Bey, 2018). However, less is known on *how* LCM is ‘implemented’. Literature on LCA methodology is far more published than is literature on adoption factors for LCM (Mortimer, 2011). In mainstream LCM literature, LCM is often discussed in terms⁵ of ‘implementation’ (e.g. Linnanen, Bostrom and Miettinen, 1995; Hellweg, Koehler and Rebitzer, 2008) or ‘diffusion’ (e.g. Hoffman, 2001). LCM implementation is also discussed in terms of a quality process of planning, doing, checking and acting. As a result, focus turns to choices and actions based on a rational basis, and to the ‘automatic’ spread of ideas or objects (e.g. tools) throughout organizations. This also leads to a perception that with the presence of a (considered) ‘great’ idea and ‘great’ leader presenting the idea, then the implementation will be successful.

However, studies with a social science-based perspective on LCM and the use of LCA has shown that identical implementation recommendations will not be relevant, as organizations are different (even though they operate be in the same sector etc.). Instead, situational adaptation is suggested (see Baumann, 2000; Heiskanen, 2000; Rex and Baumann, 2007). An important factor that influences implementation is how managers interpret the use and application of LCA, which has proven to include a variety of interpretations (Heiskanen, 2000).

Although some have a social science-based and organizational perspective in their research on LCM, and try to understand *how* LCM is practiced, there is still a lack of data on what such practice implies. And as long as LCM literature tends to take a normative approach, favor the ‘good examples’ of LCM, and contain merely generic guides on how to conduct LCM, it will be difficult to understand how LCM is, and can be, practiced. Such knowledge

⁴ Definition by Remmen et al. (2007) (with addition in italics proposed by Schmidt (2013): Life Cycle Management (LCM) is a product management system aiming to minimize environmental and socioeconomic burdens associated with an organization’s product or product portfolio during its entire life cycle and value chain. *As a management concept, LCM includes both formalized structures and social practices within the organization and in its external relations.*

⁵ (or in the sense of)

would provide basis for further development of LCM in industry practice, and improved possibilities of contributing to sustainable consumption and production.

In common for the general LCM literature seems to be an attempt at describing and prescribing how LCM can be done, rather than what the LC perspective really is and what it delivers. The state of LCM literature thus prompts the question of what LCM means in actual practice. Such knowledge could provide empirical insights on the potentials of LCM as means of sustainability practice.

1.2 RESEARCH AIM

The research in this dissertation aims to *explore the management and organization of environmental life cycle management (LCM)*, with the purpose of deepening the understanding of actual practices and underlying aspects related to these practices. This is also an aim that complements the otherwise relatively normative or technical literature on LCM, or on providing the ‘good examples’.

In LCM, *management* can be understood as organizational aspects and issues, as a contrast to technical aspects. However, in management and organization studies (MOS), *management* can instead be interpreted as a practice by managers. Therefore, when discussing organizational aspects and issues in MOS, it is more commonly addressed as *organization*. To put further emphasis on ongoing processes and actions for organizing LCM, rather than a focus only on formal organizations as objects of study, the term organizing has been suggested (Czarniawska, 2009). Studying the actions of organizing help to identify phenomena that occur outside formal organizations, and by which actors in different ways influence the formal structures and processes of organizations (Czarniawska, 2009, see also Brown and Duguid, 1991). In this dissertation, emphasis is placed on the organizational aspects of LCM, rather than on a (top)management practice, although these are sometimes intertwined.

In order to deliver on the aim of exploring management and organization of LCM, attention is turned towards the practice of LCM, which has generated three overall research questions that have guided the studies:

- 1) What initiatives and activities does LCM comprise in actual practice, how do these develop over time, and what is their scope of inclusion?
- 2) What is the role of the actors performing and forming these practices of LCM?
- 3) What are the activities and actions of these life cycle practitioners?

Studying the practice of LCM can thus provide important insights into its potential as a sustainability practice, and *how* such practice is, and can be, developed in MNCs.

1.3 OUTLINE

The aim of this PhD thesis has now been presented, including an introduction to LCM and the status of the life cycle research field. This is followed by a presentation and discussion on the research design and my research process, including an introduction to the practice research field (Chapter 2). Chapter 3 include an elaboration of the answers to the aim and the research questions, by drawing on five papers. This is followed by a concluding discussion on LCM development in industry practice (Chapter 4). Finally, Chapter 5 includes summarizing conclusions and implications.

2. RESEARCH DESIGN & PROCESS

In order to explore the practice of LCM, studies have been conducted both in the field (i.e. industry practice) and on literature. This has resulted in five papers (Papers I-V). Combined, the papers have focused on the overall practice and structure of LCM, the activities associated with LCM, and how these are performed and formed by involved practitioners. Specifically, focus has been on the management and organization of LCM.

The research has been conducted as part of an industry-university collaboration for research on sustainability-related topics. The aim of the collaboration has been to “provide new knowledge that challenges established perspectives and ways-of working with industrial sustainability and conduct research on ways for mainstream business to meet the global challenges of sustainability”. This collaboration generated good access to a MNC⁶, and to empirical material related to the work of LCM of this case company. The case company thus provided a starting site of the empirical field work, where the phenomenon being studied was that of LCM.

Due to this industry-university collaboration, it was possible to study the case company over a longer period of time (2011-2018), which, in turn, provided a possibility to study the *development* of LCM practice at the company. As I began, I first studied LCM-related activities and initiatives based in a corporate context (Papers I-III). The focus in Paper I is on specific corporation and the practitioners involved in organizing LCM. In Paper II, the sociology of translation is used as a way of describing and analyzing the process of LCM changing over time at the case company, via the practitioners and objects of LCM. As the LCM practice at the case company developed, I had also the possibility to study a product chain LCM collaboration, including also additional product chain actors (both companies and practitioners) (Paper III). In Paper III, the scope of study covers still the case company, but it included also practitioners in different corporate functions in other multinational corporations (MNCs) part of the product chain. This was possible since the LCM practice of the case company extended also into a product chain coalition for LCM. The LCM practice

⁶ For purpose of anonymity, the company in question is referred to as the ‘case company’ in this cover thesis (and as the ‘Company’ in Paper I, and as ‘ManuCorp’ in Paper II).

studied in these three papers has thus evolved from LCM efforts centered in an individual company, towards LCM extended into a broader product chain coalition with multiple companies in a product chain, following the evolving LCM practice of the case company. This is also the order in which the papers are appended in this dissertation.

These three studies have been complemented with two broader studies of LCM (Paper IV-V), in the sense that one of them (Paper IV) focuses on the life cycle practitioners in several MNCs⁷, whilst the other (Paper V) include desktop research on the different types of LCM that exists. With these two papers (Paper IV-V), I had the possibility to conduct a broader synthesis on aspects of LCT and LCM throughout industry. This also provided additional context for the individual corporate LCM practice or in a product chain LCM coalition in paper I-III. Figure 1 illustrates the scope and focus of the five papers, relative to a life cycle perspective.

⁷ Based on a compilation of empirical material from several previously conducted studies of LCT/LCM in industry.

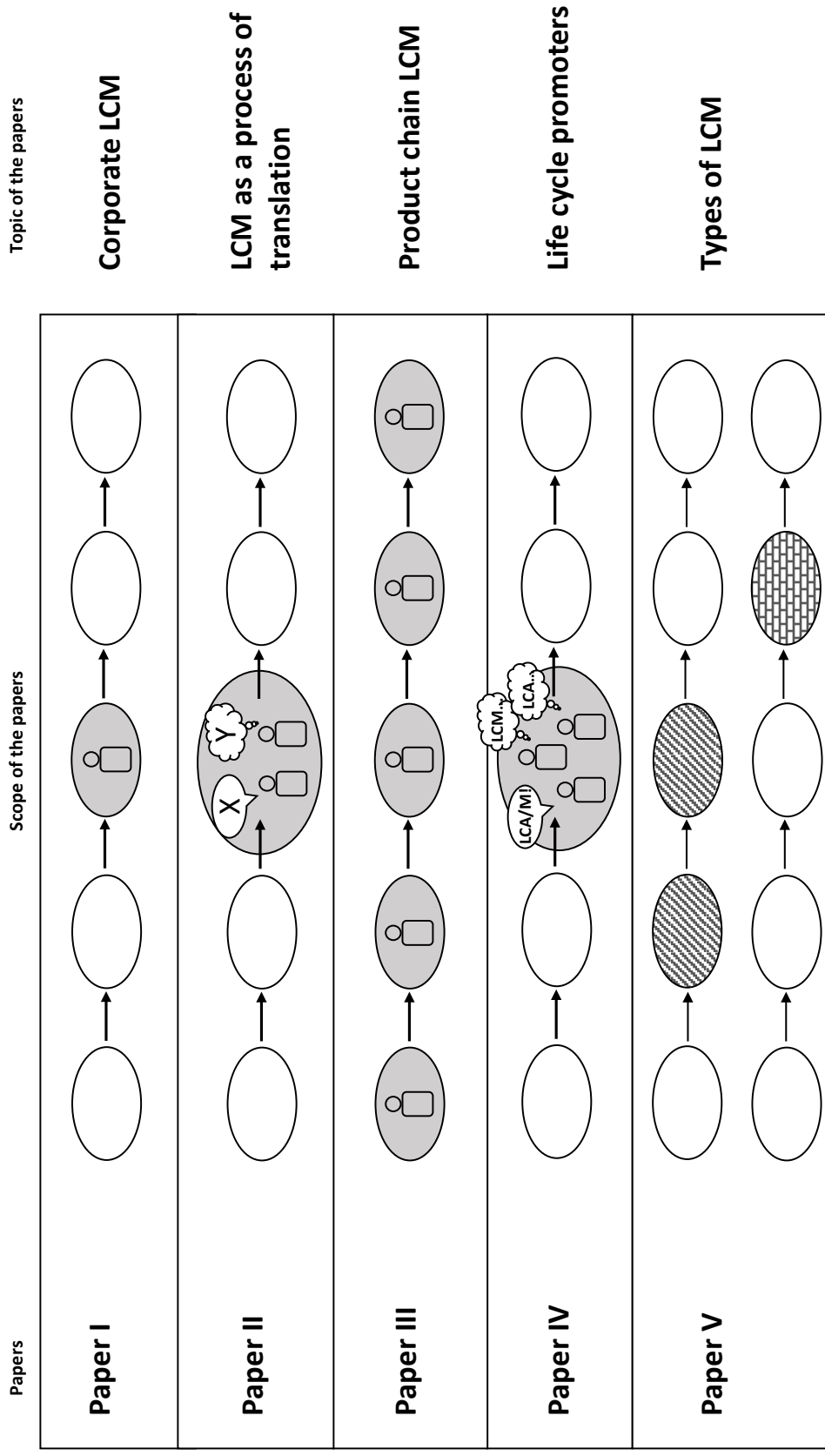


Figure 1. Visualization of the scope of the appended papers, relative to a life cycle perspective, and the topic of each paper. Explanation: ovals indicate companies in different product chain positions, arrows indicate material flow, actors indicate a focus on practitioners, grey areas indicate scope of each paper, and different patterns in ovals indicate a variety of different types of LCM.

2.1 THE RESEARCH PROCESS

While starting my research in the field of LCM, I began by trying to get a sense of the field. Reading the literature on LCM, I was surprised by the lack of detailed studies of what LCM actually meant in the industry, specifically concerning aspects of management and organization. LCM literature instead emphasized tools for LCM, and normative prescriptions of how LCM could be applied. My interest in practice of LCM thus grew from the lack of detailed studies on the everyday activities of achieving LCM in practice. With that grew also my interest in conducting research that focused on the practice of LCM, and the people involved in organizing LCM in an industry context.

The framework of my research has been that of LCM, in the sense of a broad management concept entailing holistic environmental management in the product life cycle. In order to understand and interpret this practice, I have taken an interdisciplinary approach, where I have combined a focus on the holistic environmental management of material/product flows in a product chain perspective, with a use of perspectives and methods from management and organization studies. With such an approach to LCM research, it is possible to explore *how* LCM is practiced in the setting of MNCs. By studying practice, it provides new ways of understanding and explaining social and organizational phenomena, as organizations are seen as an everchanging ‘bundle of practices’ (Nicolini, 2012), rather than understating organizations as stable entities and as a result of planned processes. This interdisciplinary approach in environmental science and management sciences is not without difficulty, as different research fields adhere to different methods, approaches, and underlying logics (see Baumann, 2009). Terms, such as ‘management’ and ‘practice’ for example, are viewed differently depending on the theoretical perspective used. Different sets of terminology is one example where misconceptions have sometimes appeared in discussions between scholars from different fields. However, by using perspectives and methods from management and organization studies, it provided a way of better understanding the practice of LCM, and a way of providing new (organizational) perspectives into the field of LCM. As such, my approach can be described as similar to a socio-institutional perspective in sustainability transition research in which focus is on how, for example, routines, power, and interests influence sustainability change. On the contrary, with instead a socio-technical

perspective (using e.g. multi-level perspective, or the technology innovation systems perspective) focus turns more to emergent technologies and innovation policy (Loorbach, Frantzeskaki and Avelino, 2017).

In order to explore the practice of LCM, I have tried to “capture, describe and explain the logic of practice” (p. 11), which is proposed as the basis of interpretative and constructivist management research (Czarniawska, 2014b). As such, I have tried to study the activities of practitioners in managing LCM (see Nicolini et al., 2003), as opposed to conducting studies of the ‘organization’ and organizational structures as such. Brown and Duguid (1991) warned that with focus mainly on structure, and formal work practices, rather than on the details of actual activities, there is a risk of not understanding the success or failure of an organization (Brown and Duguid, 1991). Instead, they argued, that actual activities of practitioners are what in the end ensures organizational success or failure (Brown and Duguid, 1991). Additionally, Czarniawska (2009) states that by concentrating only on ‘organizations’ instead of ‘organizing’ there is a risk of missing important phenomena taking place (Czarniawska, 2009). With an objective approach to organizational science, focus turns to power and authority of top management, studied mainly with quantitative measures (see Hatch, 2002, on the different perspectives within organizational theory). In contrast, an interpretative approach provides a basis for understanding not only what LCM includes in practice, but also how this practice is conducted.

2.2 A ‘PRACTICE TURN’ IN LCM RESEARCH

As my interest lies in the everyday activities of LCM, I turned to a practice approach (e.g. Whittington, 1996, 2006; Nicolini et al., 2003; Nicolini, 2012). The key word here is ‘practice’ (see Nicolini, Gherardi and Yanow, 2003; Whittington, 2006; Nicolini, 2012). However, practice is a term that can hold different meanings in everyday language and in theoretical discussions. It can, for example, be thought of as industry practice, or as an epistemological perspective, or as a specific research approach. As the terms refer to slightly different things, it brings with it a risk of confusion. In the following sections, ‘practice’ will

be discussed from different perspectives. All of these meanings of practice have, however, been considered in my research approach.

A practice-based epistemology

Different perspectives on epistemology entails different assumptions on knowledge creation, knowledge sharing, and learning. For proponents of a *practice-based perspective*, knowledge is considered as embedded in human activity, inseparable from people and their practice (Orlikowski, 2002; Nicolini et al., 2003). Sharing of knowledge is thus considered a social process (Boland and Tenkasi, 1995). Therefore, *knowing*, as a verb, is by some considered a more appropriate expression than *knowledge* (e.g. Orlikowski, 2002).

A *practice* perspective can be considered a counter-perspective of an *objectivist perspective* on knowledge⁸ (Hislop, 2005/2009), in which knowledge is instead valued mainly as *explicit* and accessible knowledge⁹ (Davenport and Prusak, 2000). Knowledge is thus viewed as being able to be separated from people by codification (Nonaka, 1991), and then possible to be transferred as information, texts, codes, or similar (Nonaka, 1991; Zack, 1999). Knowledge sharing is thus seen more as a process where a ‘transmitter’ sends information to a ‘receiver’ (see Boland and Tenkasi, 1995). The focus with this type of perspective often turn to finding ‘the right tools for the job’ (Clarke and Fujimura, 1992). However, proponents of a practice-perspective argue that ‘best practice’ in one context might not be ‘best’ in another context (Diedrich, 2004). Instead, knowledge and learning need to be considered in its specific and local context (Orlikowski, 2002). Moreover, ‘information’ is not considered to stay unchanged as it is ‘transmitted’. Rather, ideas are instead viewed as interpreted and changed along the way as people translate them in new contexts and based on their different backgrounds (Czarniawska and Sevón, 1996).

A practice approach in research

With a practice-based approach in research, the focus turns to the activity and agency of individuals (Nicolini, 2012), rather than on tools or structural processes. Practice studies

⁸ Similar divides exist, see e.g. Cook and Brown (1999), on the divide between the *epistemology of possession* and the *epistemology of practice*.

⁹ Positivism is the basis of this perspective, implying a focus on objectivity and measurements (Hislop, 2005/2009).

often entail rich empirical data (Nicolini, 2012) and by using this richness of data, the practice-perspective is presented as a promising way of studying knowing and learning in organizations (Nicolini et al., 2003). However, there is “no such thing as unified practice theory or practice-based approach”, Nicolini et al. (2003, p. 12, see also Nicolini, 2012), proclaimed. Instead, it is suggested as a ‘package’ of different methodological approaches (Nicolini, 2012), and different traditions (e.g. with a focus on communities of practice, the sociology of translation, interpretative research, culturally and historically oriented research) (Nicolini et al., 2003). Practice studies are thus not of a specific sort, rather, a mix of methods appropriate for a focus on what is going on in practice.

A ‘practice turn’, similar to that suggested in strategy research (Whittington, 2006), is here suggested as a way of bringing valuable insights to the field of LCM. This would give preference to the practitioners and activities of LCM and provide a contrasting view on LCM as for example focusing on organizational structures and tools and ‘best practice’ guides. Whittington (1996, 2006), advocated a practice turn in strategy research (i.e. in Strategy-as-Practice), and applied the specific terms *practice*, *praxis* and *practitioners*. *Practitioners* are explained as those who make, shape and execute strategies, by their activities (i.e. *praxis*, such as meetings, presentations, informal talks), and while drawing on *practice* (i.e. shared routines of behavior for the specific context) (Whittington, 2006). In order to explore the practice of LCM, the ‘nitty gritty’ details (see Chia, 2004; Whittington, 2006) of organizing LCM practice are thus in focus in this dissertation.

A practice ‘package’

The practice definition by Whittington (2006) mainly provided extended guidance in Paper III. However, overall, LCM practice in this dissertation refer to a focus on activities and actions on LCM in industry practice. A practice-based perspective provides a valuable way of understanding activities of learning, knowing, and acting (e.g. Whittington, 1996, 2006; Nicolini et al., 2003; Nicolini, 2012). Therefore, I have used different practice-related methods and perspectives in my research in order to explore empirical phenomena. Through these different ways, I provide rich data on the activities and LCM practice of the field, as a way of enriching knowledge on LCM development in industry.

Paper I included a praxiography, focusing on the practice and phenomenon of LCM. The term praxiography is put forth by Mol (2003) for descriptions of description of practice, and as such it provides an alternative to the contested view on ‘case studies’. The term case studies have been argued to generate many misunderstandings. The popular definition by Yin (1994), where a case study is understood as the study of a contemporary phenomenon, is contested by for example Czarniawska (2014a), who instead argue that many of the famous case studies are not studies of contemporary phenomenon, but instead historical case studies of studied phenomena.

In general, case study research has been claimed to hold many misconceptions (see Flyvbjerg, 2006; Czarniawska, 2014). For example, that case studies imply only qualitative research, or that the site of study is the ‘case’ (Czarniawska, 2014). Instead Czarniawska (2014a) explain that there are also quantitative case studies, and that a phenomenon can be studied at several locations in parallel, or several phenomena studied at one location (Czarniawska, 2014a). Additional suggested misconceptions are provided by Flyvbjerg (2006), including the perception that case studies cannot be used for generalizations, and therefore would be less valuable, among others. Instead he argues that that such knowledge can still be “enter[ed] into the collective process of knowledge accumulation in a given field or in a society” (Flyvbjerg, 2006, p. 227), and that case studies provide instead possibilities for ‘thick’ descriptions of data. “Thicker, not thinner, descriptions are the aim of good social science” Nicolini (2012, p. 215) proclaimed, while also stating that social science is about providing “a richer and more nuanced understanding of the world, and not offer simplified answers to complex questions” (p. 215).

Paper II is also designed as a single ‘case’ study, as is common for qualitative research (see Silverman, 2011). Depth of data is here favored over generalizability. The aim was to study how an idea of a life cycle perspective traveled and was interpreted and changed over time in one organization. The concept of translation, a key concept in understanding organizational change according to Czarniawska and Sevón (1996), is applied in this study.

Paper III is conducted as a product chain organization study (PCO), in which the life cycle approach is used to inform the scope for an organizational study of a product chain (Baumann, 2012). This means that the product material flow is what guides the choice of

which companies or organizations (i.e. the specific product chain) to be studied, and that organizational and managerial aspects are in focus, rather than a main focus on environmental information being structured according to technical processes (Baumann, 2012). The conducted PCO involved a focus on practitioners, practice and praxis (see Whittington, 1996, 2006), when studying a LCM coalition including multiple product chain actors.

Paper IV focused on the practitioners in several MNCs, and their activities and challenges, by making use of a *knowledge accomplishing framework* (Kuhn and Jackson, 2008). The framework is based in social practice theory and was developed as a methodological guidance on studying knowledge and problem-solving in organizations (Kuhn and Jackson, 2008). In the current research, it provided a way of analyzing the acts of life cycle practitioners (more specifically, that of LC promoters) trying to promote the life cycle approach in industry. With such a systematization based on several case studies of LCT in industry, this generated an enhanced possibility of drawing generalizations from the collected material.

In Paper V, focus is on the variety of different types of LCM practice that exist. By using purposive sampling for difference (Seawright and Gerring, 2008; Emmel, 2013), it was possible to assemble a collection of cases that captures a great variety of LCM in industry and society. This practice review provides an overview of the LCM field and its varieties and differences. From this collection of cases, it was possible to create a map of different categories of types of LCM that exist, and to take a first step towards theorizing LCM practices.

Over all, I have applied methods related to the interpretative research stream, specifically collecting empirical material through interviews, observations and document studies. An abductive approach has been applied, moving in-between ‘field and desk’ in an iterative process (Czarniawska, 2014a).

With this research, I have tried to illustrate what a ‘practice turn’ (see Whittington, 2003; Knorr Cetina, Schatzki and Von Savigny, 2005; Whittington, 2006) in LCM can look like. Through these detailed accounts of LCM on how LCM is actually organized and managed within MNCs, I hope to contribute to an understanding of what LCM means in practice.

3. PRACTITIONERS AND ACTIVITIES ORGANIZING LCM

In order to explore management and organization of LCM, five studies of practice have been conducted. These have focused on LCM practice in industry, the practitioners of LCM, and the activities that these practitioners perform that thus form the LCM practice. In the following text, the aim and the research questions of this dissertation will be further explored by drawing on the abovementioned papers.

3.1 LCM IN PRACTICE

LCM tend to be presented as a general concept, or as many and very specific cases of LCM, in the literature. These cases show a great variety in how LCM comes about and the purpose of pursuing LCM. A systematic analysis of a variety of different cases of LCM showed many and quite distinct *types* of practices of LCM (Paper V). The twelve identified types of LCM comprised of: 1) Company domino; 2) Bricolage; 3) Chance encounters; 4) Parallel product offers; 5) Strategic brace; 6) Product chain roundtable; 7) Building from scratch; 8) Mining waste; 9) Product service systems (PSS); 10) Consumers as prosumers; 11) Policy patches, and; 12) Product chain governance. This classification in different LCM types shows that a variety of LCM practices exist. It also shows that the idea of LCT gets associated with common action logics (e.g. product differentiation, resource security) in business and society, producing different LCM practices. Talking about LCM as a generic concept can therefore be misleading, as this current classification (Paper V) shows that the idea of LCT can produce many types of environmental management of the product chain. The twelve identified types of LCM can be understood as instigated by one of three types of actors; companies, consumers, or government agencies. This distinction between business-based, ideologically-oriented and governance-type LCM provides a start for a LCM typology (and thus also a progression from a classification).

Even when studying a single company, multiple LCM practices are found. Paper I revealed a range of LCM-related initiatives and activities, examples being: working with the upstream product chain (e.g. environment, health and safety (EHS) audits and energy management related to suppliers), the downstream product chain (e.g. developing, launching and

promoting a sustainability portfolio of products), and working within own facilities and production (e.g. using environmental management systems (EMS), developing design for environment processes (DfE), conducting EHS activities and remanufacturing). Some initiatives related explicitly to LCM, such as new sustainability strategies taking a life cycle approach, whilst others were referred to as environmental or sustainability initiatives. Together, these initiatives covered most of a conceptual product chain and can therefore be understood as LCM-related initiatives. The case company exhibited several of the types of LCM identified in Paper V, both within what is here referred to as *corporate LCM* (i.e. *bricolage* and *parallel product offers* – Paper V), and also, over time, *product chain LCM* (referred specifically to as *product chain roundtable* in Paper V).

The life cycle perspective comprises a perspective of the whole product chain, yet LCM typically takes place in a firm-centered context, meaning that LCM is driven by actions mainly by one company in the product chain¹⁰. Several of the papers of this thesis focus on this firm-centered LCM practice¹¹. However, throughout the progression of the studies, the case company entered into a product chain collaboration on LCM. As part of this development, there was an opportunity to study this extended LCM practice, which resulted in Paper III. This practice consisted of a new type of LCM practice where companies in different positions in the product chain initiated and developed an industry LCM initiative with the aim of continuously improving sustainability practices throughout their industry supply chains and improving the efficiency in the sustainability analysis of the upstream product chains. This collaborative product chain LCM practice thus differs from the more usual corporate LCM practice, in which individual companies in the product chain engage in LCM activities. In this case, product chain LCM¹² also comprised elements of Company domino (specific type of LCM identified in Paper V), as all member companies decided to use a sustainability assessment tool with which their suppliers could be assessed according to their sustainability performance. Company requests for suppliers to be assessed were directed towards the supplier sales function from the customer purchasing function, thus creating a domino effect type of LCM (since the initiative consisted of customers and

¹⁰ This type of company is often referred to as the 'focal' company, e.g. in the sustainable supply chain literature (see e.g. Seuring and Müller, 2008).

¹¹ See also conceptualization between corporate LCM and product chain LCM in Paper III.

¹² More specifically referred to as Product chain roundtable in Paper V.

suppliers in different parts of the product chain and reached further upstream the product chain with their customer requirements).

By studying the development of LCM at the case company over time (Paper II), it was possible to gain knowledge on changes in practice over time. In Paper II, the emergence and sophistication of LCM at the case company was traced over time, drawing on the sociology of translation. The sociology of translation considers ideas to exist and move in organizations not only by their ‘magnificence’, or by the ‘force’ of the launch process itself¹³, but by the fact that people ‘pick up’ on an idea and act upon it, thus energizing it. In this process, they translate the idea to fit into their own context. This means that ideas *travel* and *change* through the people who act upon them (Czarniawska and Sevón, 1996).

Studying, describing, and analyzing LCM as a process of translation, it was possible to trace LCM development. What was later referred to as ‘LCM’ by the case company entered the company as a new practice of conducting LCA studies. Results from these studies would later show that hotspots for environmental impact were located both upstream (i.e. energy carriers) and downstream (i.e. energy use and carbon dioxide emissions located at their customers) the company’s product chains. Some ten years after the first published LCA reports, the company developed and launched a sustainability strategy, mostly due to efforts of the CEO, and his realization that sustainability was an important issue to deal with. However, there were problems of gaining recognition of the strategy in the organization, mainly due to questions of the actual meaning of the strategy. This generated yet another development – the launch of a sustainability portfolio. The portfolio was stated to be a result of the LCA studies showing that customers held a large potential to decrease energy use and pollutant emissions by changing their components to instead use products of the company’s new sustainability portfolio. Alongside this development, the increased interest in environmental performance of products made possible several LCA studies of company products, with the aim of providing a basis for learning and knowledge building. As part of the development of the sustainability portfolio, the use of LCA studies also increased further

¹³ The sociology of translation can be seen as a contrast, and a critique, of the more traditional diffusion theory of innovation (see e.g. Rogers, 1995, on the diffusion theory of innovation) (see Latour, 1987, for a criticism of the diffusion literature).

still. This generated a need to develop the LCA methodology into an adapted version, to facilitate better and quicker environmental studies of products.

The life cycle idea thus continued to develop as a practice, but also as a vocabulary: from a focus mainly on 'environment', towards 'sustainability', followed by explicit claims of 'LCM' in, for example, annual reports. 'Management of language' thus proved an important way in which LCM gained momentum in the company. The use of this new vocabulary also implied that the life cycle idea gained enough recognition and legitimacy in the organization for it to be used in internal and external communication.

In this process of LCM development, an important factor was that the translation of the life cycle approach was influenced by already existing and institutionalized objects, such as an existing focus on energy reduction and use, and a practice of measuring and calculating. The life cycle approach was interpreted into this context, which is *how* it was made relevant in the specific organization. The study showed that LCM developed through a process of translations, rather than being implemented through planned change and then diffused in the organization.

In all, these papers on the practice of LCM (Papers I-III and Paper V), show a variety of LCM practices that exists. It also shows that the life cycle idea gets associated with different business logics, and therefore made relevant. Being able to discuss LCM as different varieties of practices provides a collected and enriched LCM vocabulary, which helps to concretize LCM development and show its many options and challenges.

3.2 LIFE CYCLE PRACTITIONERS

A practice of LCM is built by the practitioners of LCM, constantly performing and forming this practice by their activities and their interpretations of life cycle findings and their significance for the specific organization. However, the relevance of these practitioners has not been apparent in the mainstream LCM literature. From the current studies represented in Paper I-IV, the importance of the life cycle practitioners stood out, as they formed an emergent strategy of LCM by their interests, perceptions and their assiduous efforts to

promote and develop LCM in their organizations. The practitioners of LCM (i.e. those practitioners employing a LC perspective, irrespective of the official titles) comprise of a range of roles and managers, such as LCA specialists, LCM project managers, supply chain managers, and environmental/sustainability managers. Some of these practitioners more explicitly took on the role of an ‘life cycle (LC) promotor’, acting as change agents and going beyond specified job descriptions (Paper IV). By doing so, they developed organizational skills to weave LCM into their organizations, also engaging and attempting to influence numerous and organizationally dispersed activities.

LCM involves not only practitioners that take a life cycle perspective, but also managers in different roles and with different titles that come across LCM in different ways. Paper III contains a description of a product chain collaboration for LCM¹⁴, where managers from departments for Sustainability, Purchasing and Sales, collaborated on LCM.

Here, Sustainability managers proved to hold an important role, as they shared several of the rationales for product chain LCM with the other manager roles, while differences were found in rationales expressed by Purchasing and Sales managers. Sustainability managers thus had a broader perception of sustainability and LCM than managers from other functions. This implied that they had the potential to bridge and thus facilitate discussions between managers from several departments.

Paper III also showed that that the majority of Sustainability managers expressed a wish to learn from joint LCM collaboration. As such, they saw a need and a possibility of learning by engaging with practitioners from companies in other product chain positions. The studied industry LCM initiative was thus considered a possible forum for such interaction and learning, and a possibility to engage with practitioners from other companies.

This wish to collaborate internally, and to meet and discuss with peers, also showed in Paper I. As life cycle practitioners were dispersed organizationally and geographically across the MNC, it was perceived as difficult to meet face to face (apart from occasional yearly gatherings). Even for those practitioners who were geographically close to colleagues in the same field, there were perceptions of lacking a comprehensive overview, both of the ‘map’

¹⁴ Referred specifically to as *product chain roundtable* in Paper V.

of life cycle practitioners, as well as of the ongoing LCM activities. A more explicit focus on developing such forums and dedicated LCM arenas, thereby complementing the focus on integration of LCM into existing tools and processes, could thus be a way of facilitating LCM development in this setting.

By using the sociology of translation (Paper II), it was possible to describe and analyze LCM development over time, as it was influenced by the interests and interpretations of individual practitioners, and groups of practitioners. LCM at the case company came to involve an increasing number of employees with different roles (extending that of the LCA practitioner), situated at different levels and in several organizational units. Teams at different locations in the organization collaborated on LCM, for example concerning the development of a sustainability portfolio. Although, some worked with life cycle related calculations, whilst others worked more with strategic issues. With this collaboration, a web of human and non-human actors (e.g. written and visualized strategies, concepts, images) was formed, which together formed the emerging practice of LCM at the case company.

In all, a focus on practitioners proved important for organizing LCM, in that they hold an important role in translating and shaping the development of LCM. In these studies, LCM did not appear as a grand idea, implemented by an influential leader. The studies showed instead how life cycle (LC) practitioners adapted LCM to make it relevant for the specific organization and for other practitioners in the organization, and how they are important in bridging discussions and collaboration between corporate functions. It also showed that internal and external collaboration on LCM proved an important activity for the LC practitioners. The role of the many LC practitioners (in different roles), and their interests and interpretations, should not be overlooked when discussing LCM ‘implementation’, but need to be considered and given attention in discussions on LCM. This role proves yet more influential in light of the conclusion that one of the main difficulties of LCA adoption is the transformation of LCA results into management guidelines (Testa, Nucci, Tessitore, Iraldo and Daddi, 2016).

3.3 LCM ACTIVITIES

Studying practitioners provides insights not only on overall practice (such as LCM-related initiatives and programs), it also provides detailed insights into their everyday activities (i.e. praxis); challenges, and what opportunities exist for LCM in the company (Papers I-IV).

By studying one case company over a longer period of time with different research design and with different perspectives, it was possible to bring to the fore details on activities of organizing LCM. From Paper I, it becomes clear that life cycle practitioners experienced the need of integrating sustainability and LCM into company divisions and organizational levels, and for other organizational members to take ‘ownership’ of these issues. Three different routes for such integration were identified: 1) by integration into existing tools; 2) by working around certain organizational levels when needed; and 3) by the use of networks for sustainability practitioners. The latter was also identified as a potential for further possibilities of facilitating LCM management at the case company.

Tracing the integration of LCM over time (Paper II) enabled the discovery of similarly other important aspects in the organization of LCM. In the process of translating the life cycle approach into meaningful activities and practices, humans and their different interests, objects, and serendipity played an important part in forming LCM. The life cycle perspective, in this case, manifested itself first as a collaborative LCA practice (conducting LCA studies with academia) which was then interpreted and translated further into several different life cycle related ideas and objects. This gave attention to both upstream and downstream parts of the product chain, thus creating a bricolage of LCM (identified type of LCM in Paper V). It allowed the organizational members to tackle LCM as different parts of a whole, while maintaining and relating these to the holistic life cycle idea. It also enabled the concretization, visualization and spread of the life cycle idea, via the objects of LCM (such as written strategies, presented images). LCM also gained relevance in the organization by being related to existing corporate logics, in this case the company business idea on energy use and an established practice of calculations and measurements. Associations were thus created between what was new (i.e. the life cycle perspective), and what was already established and institutionalized. This way, the life cycle idea was adapted to the specific organizational context of the case company.

Unplanned and unintended events also formed the LCM development (Paper II) (e.g. the development of a sustainability portfolio, as a result of the reactions to the sustainability strategy), showing how serendipity also formed the LCM development as different translations took place. This thus contrasts the view of LCM implementation as a planned, diffused, and largely unchanged activity or object.

The life cycle practice of the case company later expanded from mainly a corporate-based LCM practice to also include development of a practice of product chain LCM, in collaboration with other industry actors in different product chain positions (Paper III). As the case company got invited to a newly formed industry LCM initiative, there was a possibility to study LCM as a collaboration between multiple product chain actors. The study covered companies in different product chain positions, and practitioners in different corporate functions. As product chain LCM is a fairly new type of LCM practice, this raised questions concerning the rationales and challenges for corporations to extend corporate LCM towards product chain LCM. Studying this practice showed a broad range of rationales for engaging in product chain LCM, related both to self-interest in the company and a shared interest in the product chain. The perceived importance of the ‘business case’ was identified as both the most important rationale and challenge, expressed by all practitioner roles and at all product chain positions. It proved to be important both for the respective companies, but also jointly for the product chain coalition. Results demonstrated that companies saw the possibility of demonstrating a joint business case of the product chain, and thus a way to compete based on the joint actions of LCM in the product chain. Moreover, the results showed that, on the whole, that member companies of the initiative shared many rationales and challenges for product chain LCM, independent of product chain position, and even though the companies who were part of the study had different previous experiences with LCM activities. This indicates that the joint initiative provided a good ground for collaboration.

Throughout the study of LCM at the case company, integration of LCT and LCM into the organization was a major effort of life cycle practitioners. Sometimes this was on their own accord, sometimes it was a company or business initiative. While working for greater interest in and adoption of the life cycle perspective in the company, LC promoters looked for various

ways to adapt the life cycle approach to the business situation at hand. Previous LCM studies have identified that adoption of LCM in the industry depends upon its situational adaptation to the organizational context (see e.g. Baumann, 2000; Heiskanen, 2000; Baumann and Rex, 2007; Mortimer, 2011). However, little is known about the specifics of this adaptation. In Paper IV, life cycle activity in six MNCs was examined, and eight categories of problem-situations typically encountered by LC promoters were identified. These included: 1) Trying to create interest for LCT in the company; 2) Trying to gain a mandate to do LC work in the company; 3) Trying to identify other parties in the company interested in LC efforts; 4) Attempting to create LC efforts that blend in operationally and can be adopted in the organization; 5) Seeking to generate a widespread engagement with LCT throughout the company; 6) Seeking legitimacy for LC efforts; 7) Trying to relate the LC approach to the company business logic, and; 8) Attempting to extend the LC approach beyond the corporation and engage with product chain actors. These eight categories represent different situations when the organizational appropriateness of the LC approach is at stake and to which responses tailored to the organization are put forward by a LC promoter. The results bring to the fore the ubiquity of organizational and creative problem-solving by LC promoters, and depict the development of LCM as an emergent practice, rather than an implementation process. Key to this emergent process was the knowledge developed through the numerous, and organizationally dispersed, creative problem-solving practices of LC promoters. Moreover, the acts of LC promoters involved predominantly knowledge *development* (i.e. through instruction or improvisation) through innovative and collaborative activities, rather than pertaining to more standard knowledge *deployment* (i.e. through information transmission or information request). Through these practices, LCA results and the LC perspective were tailored to be made relevant to business management.

Enriched understanding of actual LCM-related activities provides insights into practice (see Whittington, 2006), and provides knowledge on the activities that forms the development of the organization (see Brown and Duguid, 1991). With these papers (Papers I-IV), it was possible to explicate the activities and praxis of LCM. By doing so, the perceived importance of the business case for LCM is identified, as well as the focus on integrating LCM into corporate practice. ‘Situational adaptation’ was further concretized within these studies,

showing the assiduous efforts of promoting LCM, and applying creative problem-solving in doing so.

4. LCM DEVELOPMENT

In the introduction, it was pointed out that an urgent sustainability transition is required (Wijkman and Rockström, 2012; Rockström, 2015; Ripple et al., 2017), and that industry have an important role in this transition (Welford, 2003; Howard-Grenville et al., 2014; Blok et al., 2015). In this, LCM has been suggested to be a holistic environmental management approach which can help us shift towards sustainable development (e.g. Remmen et al., 2007; Rebitzer, 2015; Sonnemann and Margni, 2015). With such claims, it becomes relevant to explore what LCM implies in practice, and its potentials for sustainability practice. It also becomes relevant to discuss the way in which LCM development takes place, as mainstream LCM literature depict it mainly as a process of implementation.

4.1 IMPLEMENTATION AND DIFFUSION OR TRANSLATION AND ADAPTATION

In general, within the LCM literature, LCM is described as an approach that must be adapted to the organizational context (see e.g. Baumann, 2000; Heiskanen, 2000; Rex and Baumann, 2007; Mortimer, 2011; Sonnemann and Margni, 2015; Bey, 2018). However, less has been known on *how* LCM is adapted. With the current studies, it was possible to explicate the activities and praxis of LCM, thus concretizing LCM development. By studying the practice of LCM, it was possible to gain knowledge on how practitioners manage and organize LCM. This showed that the work of LC practitioners included the assiduous efforts to, in different ways, integrate, promote and adapt LCM to their specific organizations. This demanded knowledge on life cycle related issues, as well as organizational knowledge of the practitioners, in order to find suitable ways of adapting LCM to different organizational issues and functions. LC practitioners conducted many problem-solving activities. These were mainly activities of a *knowledge development* character (see Kuhn and Jackson, 2008), rather than pertaining to ‘deployment’ of information and knowledge. This means that LCM activities involved new ways of working. Adoption and adaptation of LCM showed to be dependent on *possible* activities, rather than on rational choice for the best place of implementation. In this work of LCM development, the life cycle idea was made relevant

through being connected to already existing corporate logics and/or institutionalized practices, thus adapting LCM to the specific organization, and in turn facilitating the uptake of LCM in the organization.

Collaboration and communication between corporate functions is also considered important in LCM (see e.g. Linnanen et al., 1995; Fava, 1997; Hunkeler et al., 2003; Remmen et al., 2007; Strothmann et al., 2015; Bey, 2018). By studying how practitioners manage and organize LCM, collaboration proved to be an important aspect also in the current studies. The studies added detailed accounts on how collaboration and communication were practiced in industry. LC practitioners were found to seek support and possibilities of learning and knowledge sharing in common LCM forums and initiatives. It was also observed how LC practitioners held potential for bridging discussions and collaboration between corporate functions, and possibly in discussions with managers from different parts of the product chain.

From the current studies, it was observed that LCM include a wide variety of LCM practices, both within a single MNC, and in relation to other companies. This variety in LCM seems to be connected to the different corporate logics that the life cycle idea becomes associated within different organizations, thus resulting in different LCM types. However, LCM development can also be influenced by unintended and unplanned events, thus also influencing the outcome of LCM development. In all, the results show an emerging practice, resulting from a bricolage of practitioners, activities, and the development and use of different life cycle related objects (i.e. strategies, images, tools, etc.).

When discussing development of LCM in industry, mainstream LCM literature often refer to LCM ‘implementation’ and ‘diffusion’; sometimes with these specific terms (see e.g. Hoffman, 2001; Linnanen et al., 1995; Hellweg et al., 2008), but otherwise often described in the sense of top down implementation and automatic diffusion of ideas. The results of the current studies provide an alternative perspective on LCM development as implemented and diffused in an organization. The results do not show LCM as being implemented mainly as a top down process, pushed by an important ‘leader’, where the life cycle idea is then diffused within an organization (based on the fact that it is a great idea in itself, which therefore eventually will gain requisition in the organization). Instead, the results show LCM as a

process of interpretations and translations which develop and change LCM at the hands of actors in the organization that pick up on the idea and as it is promoted and adapted by LC practitioners. By understanding LCM development as a process of translation (see Czarniawska and Joerges, 1996; Czarniawska and Sevón, 1996, 2005), it brings attention to the fact that ideas are interpreted and changed as they travel in an organization, rather than being constant innovations that are diffused by, for example, a project leader. Instead, the interests and interpretations of individuals influence how innovation is translated and interpreted, and while doing so, they energize the idea to continue its development and process.

The relevance of this difference in the perspective of implementation is an enhanced understanding of *how* LCM is organized, as a complement to the understanding of how it could or should be organized. LCM implementation can thus be guided by more than ‘laundry lists’ of important aspects to consider (see Osagie et al., 2016) and the presences of critical success factors of LCM (see Paper I). It also provides a different set of implications for LCM practitioners.

4.2 LCM AS A SUSTAINABILITY PRACTICE

LCM is claimed to hold many possibilities as sustainability practice, for example, as an analytical framework for ecological thinking (Ehrenfeld, 1997), as a guiding logic for action (Heiskanen, 2002), and as a key for unlocking the circular economy (see Colens, 2017). From the current studies of LCM practice, LCM can be considered as a way to advance and extend CEM. Such extended perspective results in a holistic view on environmental impact in the product chain perspective. With a broadened view on environmental impacts and management, LCT and LCM provides possibilities for decreased environmental impacts. For practitioners working with environment and sustainability, it can provide motivation. Concern for the planet and for society is an aspect often important for them, and LCM thus provides a way of extending environmental management to include more aspects, and care for the whole product chain.

LCM as a form of sustainability practice is still developing, and creating new possibilities and challenges. In the current studies, the development from corporate-based LCM to also a practice of product chain collaboration for LCM was studied. This implies a new type of coalition where companies collaborate, rather than relying mainly on contracts. Such coalition implies a joint initiative and joint possibility to influence the sustainability of the product chain. Participants identified many rationales for such collaborations, for example, as means to jointly influence suppliers, competitors, and to compete with the help of new types of business cases, both for the respective companies but also jointly for the product chain as a whole. Results showed that companies saw the possibility of demonstrating a joint business case of the product chain, and thus a way to compete based on the joint actions of LCM in the product chain. Moreover, the results showed that, on the whole, member companies of the initiative shared many rationales and challenges for product chain LCM, independent of product chain position, and even though the companies part of the study had different previous experiences with LCM activities. This indicates that the joint initiative provided a good ground for collaboration.

With a life cycle perspective, companies often gain knowledge on their product chains and the different actors involved in these chains (e.g. Kogg, 2003; Afrane et al., 2013). It is also a way to more clearly identify links between a company and its use of natural resources and emissions of pollutants (e.g. Ehrenfeld, 1997; Boons, 2000). However, there are also certain difficulties and/or risks of LCM, from a corporate perspective. In identifying environmental impacts along one's product chains there are risks of finding a cause and effect chain between an environmental problem and a company product, which could result in lack of sales of that product (Boons, 2000). And by altering products, rather than processes, based on such knowledge, companies might need alter product design, thus generating higher costs of research and development (Boons, 2000). If using the life cycle perspective as basis for rebuilding or shaping product chains to become more sustainable, this can lead to these product chains becoming more complex, including more and new actors (Kogg, 2003; Afrane et al., 2013).

However, from the study of the STI (Paper III), it was clear that the participants shared many of the rationales of taking part in LCM collaboration and saw a need and interest in learning

more about such collaborations. The collaboration also implied that participants had to compromise. Nevertheless, the collaboration in the product chain related to the STI was a new way for companies to engage in their product chains that differed from their usual contract-based interaction. Such life cycle-related engagement and LCM might be even more relevant in the soon-to-be future, as sustainability challenges threaten to reshape company supply chains and related resources (see Howard-Grenville et al., 2014).

The life cycle perspective opens many avenues for companies that see the possibilities of working with LCM. However, also the companies that are not interested in taking part in such work, are influenced, or will be, as more and more external regulations and initiatives take a life cycle perspective (e.g. ISO 14001, the Dodd-Frank Act, the UN Guiding Principles on Business and Human Rights, the 17 SDGs). In doing so, they also push the limits for company responsibility in a product chains perspective. The life cycle perspective thus influences companies both from a regulatory perspective, and in relation to corporate innovation and business opportunities.

4.3 REFLECTIONS AND FUTURE STUDIES

In order to increase the knowledge of how LCM is practiced, the use of social sciences and a more interpretative approach to LCM research has been suggested (e.g. Rex and Baumann, 2008; Rex, 2008). By having an interpretative approach, and a focus on practice, attention turns towards the actual activities of practitioners of LCM, rather than a focus on the organization as such, or on the (top)management of the organization. This opens for insights on *how* practice is performed (see e.g. Nicolini et al. 2003; Whittington, 1996, 2006; Czarniawska, 2009; Nicolini, 2012). By using a social science approach to understanding sustainability transitions, and by also placing emphasis on how, for example, routines, power, and interests influence sustainability change, the current research can be described as a *socio-institutional* perspective on sustainability transitions (Loorbach et al., 2017).

The five papers in this dissertation have in different ways attended to the concept and practice of LCM. The conducted studies have focused on LCM both as a corporate-based practice and as a collaborative product chain practice. The individual case company was thus studied as a

single case, but also as an actor in a product chain collaboration. In addition, the case company was also studied in relation to an overview of types of LCM, and the acts of LC promoters were analyzed as part of a larger set of LC promoters and their activities to promote LCT and LCM in industry. This generated a possibility to conduct a broader synthesis on aspects of LCT and LCM throughout industry. This also provided additional context for the papers of individual corporate LCM practice. The case company was also studied over time, both by a translation study, but also by being able to study the progression of a product chain LCM collaboration.

As is common for an interpretative research approach, the empirical material is based mainly on interview material, document studies and observational studies (Silverman, 2011). As practice studies, it could be argued that they could have included more substantial amount of observational material than I have mastered in these studies, although I did consider conducting a longer ethnographic study, including extended observations and possibly shadowing. Although, such an ethnographic study would demand quite some efforts by the studied practitioners. In hindsight, such an approach would also have been relevant, as it could bring additional value to the understanding of LCM in industry practice. Future studies of management and organization of LCM could be designed as ethnographic studies, with the aim of gaining rich empirical data. However, I have tried to design those studies that I have thought it possible for me to conduct. As such, I have been pragmatic during my studies and tried to obtain windows of observations where possible. Moreover, I have tried to let my curiosity have a play in guiding my direction of studies. I have also been open to suggestions by the case company, as I have thought it valuable to conduct studies of interest to industry, but also as this might influence the time and efforts that they could make available during my empirical field work.

Studies of management and organization of LCM as a coordinated product chain practice are rare, and more studies of that type are necessary, specifically where empirical data gathering extends beyond a single company (see Seuring and Gold, 2013). Paper III takes such a study approach. However, additional studies of product chain LCM practice could cover other product chains and/or other collaborations. If possible to organize, such studies could include interviews with a broad range of practitioners, including several functions and from multiple

companies. More such studies would be very relevant from a LCM research perspective, as it could provide a broad knowledge base on collaborative product chain LCM.

Along with a product chain LCM study, an additional suggestion for design of study include dual LCA/LCM study, where an LCA study is conducted of a product, whilst also studying the organization of LCM along the product chain actors, and the possible coordination of LCM between the product chain actors. Possibly, such study could generate valuable insights for both researchers of LCA *and* LCM, as well as for practitioners of LCA *and* LCM, since insights can be generated on environmental impact and on the possibilities of improving management of such impact along the product chain.

The advantages of the approaches that I have taken is that I have gained rich data on the management and organizing of LCM. Not all of the data can be directly applicable to other contexts, as situations change between organizational context, and since practitioners might translate issues in different ways. However, this current research does bring to light the importance of a management and practice focus in life cycle *management* (see Baumann, Lindahl, Scandeliuss, Schmidt and Sonnemann, 2017).

By giving preference to studies of LCM practice, and specifically on the management and organization of LCM, the current research adds a complementary perspective to the mainstream LCM literature and contributes with accounts on the actual practice of LCM in industry, along with the underlying aspects of these practices. This has resulted in a concretization of LCM as a concept and the development of an enriched vocabulary, which in turn provide practitioners and researchers with an increased possibility of understanding, discussing and further influencing LCM practice.

5. CONCLUSIONS & IMPLICATIONS

In this dissertation, the practices of LCM have been studied in different ways and from different perspectives. The results show the assiduous efforts of LC practitioners in integrating, adapting and promoting LCM in their organizations, and their importance in bridging discussions. This can be identified as a practice of creative problem-solving through a process best understood as translation. Adaptation depended much on *possible* activities, rather than on rational choice for implementation. In this, LCM was made relevant by being connected to existing corporate logics and practices, in turn facilitating the uptake of LCM. The results thereby generate a better understanding of developing industry LCM practice.

Overall, the current research on LCM provides accounts on LCM in industry. It provides concrete examples of praxis and practice, and a better understanding of the management and organization of LCM. It contributes with a concretization of LCM as a concept and an enriched LCM vocabulary. These provide possibilities for enhanced communication and practice, both in research and in industry practice. It also contributes with a practice turn in LCM research, complementing the frequent focus on tools and planned processes for LCM. Additionally, it provides an alternative perspective to LCM implementation, one of a process of LCM development based on a series of translations by practitioners that interpret and change LCM as the development evolves. The relevance of this difference relates to the ‘*how of implementation*’, that is, on the richer understanding of the nitty gritty details of everyday activities for the organizing of LCM.

Suggestions for future research on LCM include more studies that take a practice perspective, and studies that, for example, target LCM in specific product chains, possibly as combined LCA/LCM studies. Additionally, studies of LCM innovations and its relation to business, rather than as a self-regulatory practice, is suggested.

The variety of types of LCM that exists and the efforts and paths of integrating and adapting LCM identified in this research are aspects relevant to consider both in future research, in education for future practitioners of LCM, sustainability and LCA, and for practitioners.

5.1 IMPLICATIONS FOR PRACTITIONERS

Understanding LCM development as a process of translation and situational adaptation, instead of a process of implementation and diffusion, provides alternative implications for practitioners. Further acknowledging the translation process as a process influenced by individual interpretations and different interests creates solid foundations for understanding the adoption of new ideas and in adapting LCM in the organization. By taking part in interpretations and translations of other practitioner in different functions (e.g. in workshops or in other discussions on LCM), life cycle practitioners can understand how LCM is interpreted, influence how colleagues perceive sustainability-related issues and provide examples on how LCM provides opportunities or challenges for different parts of the organization. Viewing LCM development as a process of translation thus provides the possibility of going beyond ‘implementation’ and ‘diffusion’, to instead engaging actively in understanding interpretations and translations of LCM elsewhere in the organization (Paper II). Such participation can strengthen LCM uptake in the organization. Additionally, active participation by sustainability managers (or similar) in LCM discussions between different corporate functions, or even in product chain collaborations, can facilitate LCM uptake by their possibilities of bridging and translating sustainability issues in communication with practitioners from different corporate functions and along product chain issues (Paper III).

In the integration of LCM it is important to apply organizational, as well as life cycle, knowledge. By using knowledge of the organization (and possibly also of other organizations relevant to collaborate with), LC practitioners can find new ways of collaborating and new people or functions to collaborate with. Relevant here is to view LCM development as an ‘art of the possible’, rather than a rational change process. This provides practitioners with guidance and reassurance on how to proceed with LCM development in their specific organization (Paper III).

The current research has concretized activities on *how* LCM can be adopted, integrated and adapted to a specific organization. Such mapping provides guidance for practitioners on possibilities of how to act. Either by focusing on different areas, such as, integration into:

- 1) tools and structures;
- 2) through networks, and/or;
- 3) through circumventing certain organizational structures) (Paper I),

and/or by focusing on different aspects of life cycle promotion, such as:

- 1) trying to create interest for LCT in the company;
- 2) trying to gain a mandate to do LC work in the company;
- 3) trying to identify other parties in the company interested in LC efforts;
- 4) attempting to create LC efforts that blend in operationally and can be adopted in the organization;
- 5) seeking to generate a widespread engagement with LCT throughout the company;
- 6) seeking legitimacy for LC efforts;
- 7) trying to relate the LC approach to the company business logics;
- 8) attempting to extend the LC approach beyond the corporation and engage with product chain actors) (Paper III).

Relevant in the situational adaptation of LCM is the connection of LCM to existing corporate logics and already institutionalized practices. By such adaptation, the adoption of LCM can be facilitated (Paper II, V), in that it becomes relevant for the organizational members, and therefore help to enroll these in the development of LCM. Neither should the use of different objects be underestimated as ‘tools’ for creating discussions and spreading ideas. Tools, in this sense, refer not only to use of LCA, KPIs and similar, but to the use of images, strategies and other ways of illustrating a new life cycle related idea. LCM practitioners are also helped by an enriched LCM vocabulary (e.g. provided by the identification of the 12 different types of LCM) in being able to discuss it within their organization more articulately, further enabling them to better generate ideas on LCM activities to develop, initiate and organize (Paper V).

Moreover, internal and external collaboration proved important within the current studies. Therefore, creating specific life cycle networks could provide support for LC practitioners, provide overview of existing LC practitioners, facilitate knowledge sharing and learning, and provide an overview of LCM related activities (Paper I). Also, extending corporate-based LCM practice into some form of product chain collaboration for LCM could generate important learnings for LC practitioners, as well as possibilities of building valuable business cases for the product chain as a whole, additional to corporate-based business cases based on the product chain LCM collaboration. It also provides good basis for positively influencing supply chain actors (Paper III).

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