Edited by
Luitzen de Boer · Poul Houman Andersen

Operations Management and Sustainability

New Research Perspectives

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"Many companies still wrestle to fully understand the implications of sustainability for their operations and supply chain management practices. This situation is not surprising, given the systemic interdependencies around sustainability. Written by an international team, this book therefore aims to build more comprehensive theory in this area, as well as offering practical solutions. The editors are to be congratulated for having put together such a timely volume."

—Lutz Preuss, Professor of Strategic Management,
University of Sussex, UK

"This is a comprehensive book on an important and highly complex topic. It brings together findings from a variety of research projects in the area of Sustainable Operations Management, employing different methods and theoretical perspectives, and covering different sectors and industries. The book presents an overarching, systems perspective on the topic, providing coherence across the different contributions."

—Annik Magerholm Fet, Vice-Rector and Professor,
Norwegian University of Science and Technology, Norway

"This book provides a helpful collection of sustainable operations management chapters. It will be of interest to researchers and reflective practitioners alike, clustering topics around strategy, theory, practice and capabilities. Acting responsibly on sustainability issues is arguably the biggest challenge facing operations and supply managers, and indeed the world's population as a whole. The book is both timely and relevant."

—Helen Walker, Professor and Chair of Operations and Supply
Management, *Cardiff Business School, UK*

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Sustainable Operations Management (SOM): An Introduction to and Overview of the Book

Poul Houman Andersen and Luitzen de Boer

Dear reader: thank you for taking an interest in our book on sustainable operations management! This is an edited book about what we and our co-contributors believe to be a topical and highly important issue. We also realize that this is an issue with political overtones that may cause divides and heated debates. Despite several global warnings and calls for action with respect to becoming more sustainable, disagreement and even resistance remains towards the call for action towards more sustainability and the urgency for action. The dissent has moved from outward rejection of any

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climate change happening, to a discussion regarding the impact of this change on society (Lomborg, 2010). Currently, the debate revolves around whether we understand how and to what extent the current rate of natural resource exploitation affects global climatic conditions, how much and at what rate it will affect us and which route is the most promising to follow in order to become (more) sustainable. Take the case of the Trump administration, which repeatedly has expressed skepticism towards climate change and has withdrawn the United States from the UN climate negotiations. Consequently, the US presidential administration has removed sustainability from the agenda of political aims for the United States and is currently considering rolling back the greenhouse gas emission policies that were put into action by the former president, Barack Obama. Meanwhile, the depletion of resources and the unintended consequences of unlimited growth in production and consumption are increasingly recognized in other parts of the United States and by stakeholders in other societies in-and outside the United States.

We side with the latter side of this debate. In our view, it takes a considerable amount of human resolve to overlook or ignore the consequences of ongoing depletion of natural resources. We are not alone. In most parts of the world, there is an increasing political and public pressure towards improving sustainability in operations from all levels of society. There is an ongoing mental transition from what Kenneth Boulding (1966) in his famous essay on "spaceship earth" named the "cowboy economy", building on the notion of illimitable plains, where human society can move when the current area's resources are exhausted, towards a "spaceman economy", in which resources must be reproduced and recycled as no resource is really unlimited. Although this high-level notion was formulated more than 50 years ago, there has been little agreement among constituents on how to proceed. Several international organizations have provided evidence with respect to the dire climatic consequences of pursuing the existing depletion patterns and how this is already impacting and will impact on societies of the future. Several of the UNs 17 sustainable development goals, formulated in 2015, speak directly to these issues, emphasizing a precautionary approach to environmental challenges and encouraging the diffusion of environmental-friendly technologies.

This book is written both for researchers exploring sustainable operations management as a research field and for reflective practitioners, seeking more insights into the nature of sustainable operations management. We hope you will find this book both illuminating and useful for grasping the current state of the art in sustainable operations management research. We would also like to take this opportunity to thank the contributors to this book and the many people who have been involved in reading and commenting on drafts to chapters and so on.

1 Background

For most societal actors, but not least for businesses, sustainability has moved from the periphery to the core. According to the most recent global survey conducted by McKinsey & Company consulting firm (2017), nearly 60% of the more than 2400 respondents asked, report that the organizations they work for are more engaged with sustainability issues than they were two years ago. Companies are focusing on sustainability as a way forward, not only to meet challenges but also to transform these into a profitable and competitive advantage. Furthermore, when asked about the top reasons for addressing sustainability, an increasing number (46%) tick off the organization's goals, mission or values. Also, expectations of customers and employees towards the organization rank among the important reasons for the firms, which are more engaged than previously in sustainability. In addition, several sustainable technologies have surfaced and become mainstream or serious alternatives to less sustainable options. This includes for instance technologies related to renewable energy, transportation and recycling, but encompasses also a wide range of technologies, which indirectly helps in supporting the minimization of waste, such as data analytics and automation technologies.

However, it seems that many of the initiatives seen are driven from issues pertaining to risk, to external constraints of businesses (such as tougher regulations) or from customer monitoring. Deploying sustainability as a principle for increasing the profitability of business—either through recouping resources and minimizing waste or by developing new products seems to be seen as less achievable than previously (see Fig. 1.1).

In general, the results from a global survey by McKinsey & Company consulting show that although internal operations is one area where sustainability is formally integrated, companies struggle with integrating

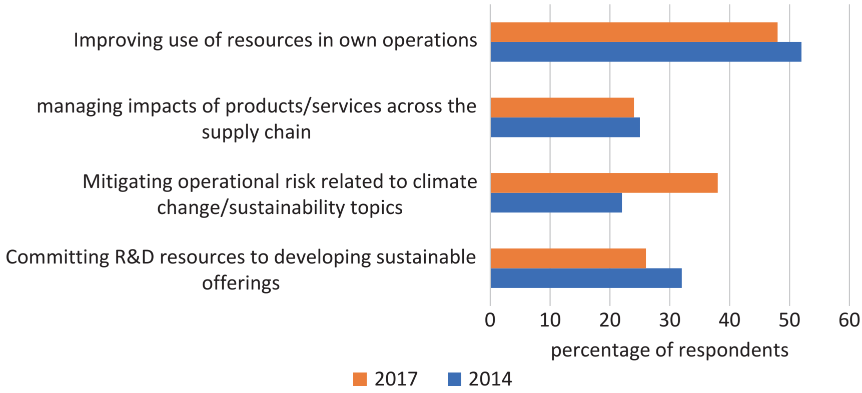

Fig. 1.1 Survey results from the McKinsey Global Survey (2017); N: 2711, representing the full range of regions, industries, tenures, company sizes and functional specialities

sustainability into the operations that extend the corporate boundary, such as procurement and supply chain management. Approximately one out of every four respondents in the survey reported that sustainability was not formally implemented in their company. These findings from the McKinsey survey support the conclusions made by other investigations into the transformation challenges facing companies seeking to develop their abilities within the management of sustainable operations (Loorbach, 2010). Although there is a strong willingness and broad support towards developing more sustainable business models, the challenge of integrating sustainability into the existing way of doing things remains a challenge.

We believe this is the case because transformation towards sustainability is a systemic challenge, calling for fundamental and synchronized changes throughout a widespread network of business actors involved. Rather than seeing sustainability as an organization's quality (i.e. as an organization being sustainable in its internal operations), sustainable operations can be viewed as an ongoing process constituted through the dynamic relationships between organizational elements. As pointed out by Bateson, a strong proponent of systemic thinking and cybernetics, the unit of survival is a flexible organism-in-its-environment (Bateson, 1973, p. 426). Thus, processing for instance the "ocean garbage patches" (the plastic waste found in the oceans) is not simply a question of finding a way to collect and reuse the plastic. Currently, the Great Pacific patch, one of five ocean garbage patches, is estimated to weigh 80 million tons and covers an area three times the size of continental France (Chen et al., 2018). Trying to recycle or even upcycle this amount plastic calls for system-wide adjustments in the global production and consumption network involved in the processing. It is not a question of finding one solution, but rather for a range of different organizations—each occupied in its own organizational niche, to co-adjust behaviors. Hence, not only a single or organization's behavior must change—so must the way this and other organizations relates to their specific context. Rather than seeing all organizations as facing the same challenge or seeing the challenge in the same way, an organization interacts and co-specifies its specific part of reality. Taking this view clearly complicates matters. First, understanding the impact realized from any initiative towards sustainability is not an easy task. There are intended as well as unintended consequences of actions which at first glance may seem as a straightforward way to increase sustainable consumption and reduce the impact on the world's scarce resources. One example concerns initiatives from developing biofuel from renewable sources such as corn, which effectively led to rising food prices and deterioration of soil qualities. Another example concerns the ongoing controversy regarding the sharing economy and whether is actually helps or hurts a sustainability agenda (Frenken, 2017). Second, there is the problem of value creation and value capture from sustainable operations. As pointed out by Beer (1981), viable systems both exist within larger viable systems and may contain viable sub-systems themselves, each interacting with its respective task environment. This is the general notion of recursiveness. Often, business actors do not see clearly the wider context of the system in which they are embedded and how sub- or meta-elements constitute task environments. Hence, for the operations managers at the now defunct company Better Place—which sought to develop a business model for recharging batteries for electric vehicles that could also be part of an intelligent power grid—this turned out to be underestimating the challenges of relating profitably to the niches of car manufacturers and power grid companies. In many ways, the Better Place case is one of operations management myopia—the inability to engage a sufficiently wide lens in trying to understand how attempts to create systemic changes in business operations affects value creation and value capture. The myopic nature of firms—or any viable system for that matter—is well explained by Cyert and March (1963) and can be seen as both a blessing and a curse. On the one hand, and blending in Stafford Beer's terminology, firms need to shield themselves from the overwhelming variety of "disturbances" coming their way. They will primarily act on "evidence based", short-term feedback loops, trying to stick to the current strategy as long as possible (Cyert & March, 1963). On the other hand, firms need to be able to detect (perhaps slowly) failing current solutions and develop new ones in order to reinstate stability for the firm. This requires (at least temporarily) suppressing their entropic, myopic approach and gaining a better understanding of how the firm is embedded in a larger system. (Adner, 2012).

This conundrum calls for further conceptualization and research into the challenges of sustainable operations management. As we see it, the problem of integrating sustainability into the management of operations is a key issue for business to press forward and realize the strategic promises. Furthermore, there is a direct link between Boulding's notion of the "spaceship earth economy" and the way sustainable operations management must be thought of in an organizational and wider business network or "ecosystem" context.

Drawing on insights from complexity theory and cybernetics, it can be argued that the failure to make a transformation from the current economic growth paradigm into a paradigm of resource preservation and reuse relates to the limited ability of the current socio-economic system to engage the interests and concerns of actors beyond narrow profit concerns (Espinosa, Harnden, & Walker, 2008). The traditional systems for governance and control have proven ineffective or weak in creating sufficient participation from economic actors. This is despite growing concerns about the state of the environment in broad areas of society. Hence, trying to install sustainable operations management principles through traditional means, such as controls through installing metrics and measures for performance, is an unengaging exercise, more often than not ending in obscurity. As pointed out several times, complex challenges such as the systemic challenges of transforming an entire production ecosystem tend to become oversimplified and rigid through complex measuring (Ariely, 2010).

An alternative paradigm that may help to embrace complexity and engage actors on multiple levels is developed from Stafford Beer's notion of operational system viability or VSM (Beer, 1981). A viable system is a complex entity capable of maintaining an identity, while engaging in complex exchange with that environment. Hence, the structural coupling between entities comes to the fore in a system perspective and must depart from the particular contextual features of this context, rather than from an abstract notion of "environment". In other words, engaging in system redesigns to achieve sustainable operations calls for understanding the systemic features of the system in question. This differs from other approaches to sustainable operations, which characterizes sustainability as the competence or trait of a single organizational entity.

As briefly touched upon earlier, when discussing the myopic nature and behavior of firms, system viability is obviously closely linked to sustainability: both depart from the notion that organizational entities belong to an environment and that their interactions and structural couplings with this environment co-specify how they interact and in turn co-constitute the reproduction of both organizations and the environmental sub-set they inhabit. Also, both perspectives take into account that the lack of viability of any system means the cessation of that particular form (Espinosa et al., 2008). It follows from a complexity perspective that the different elements that constitute the viable ecosystem must relate to each other in a different manner. Creating sustainable operations must start with the realization among actors that all actions have system-wide ramifications and ongoing collaboration and co-constitution is necessary for the results to gain fruition. Next, widespread self-regulation, with an eye on how actions constitute the reality for an immediate task environment rather than following abstract goals, is probably a second issue. Take as an example of these principles the calls for buying and retailing local organic produce by retailers. Empowering local retail supports local capacity building, increases consumer awareness and commitment as well as reduces the cost of transportation, storage and handling of global goods (Caldwell, 2016). There is a meta-goal stated by the retail organization to increase the number of local suppliers suppling to the store, but obviously, local store purchasers must make considerable adjustments with respect to their context and must participate and negotiate these conditions with central purchasing units. Thus, each retail store is structurally coupled and interacts with its own niche, but all are linked in a more abstract conceptualization of an environment. In order to manage sustainability, a corporate-wide control system must allow for local alignment in the viable systems (here the retail units) while maintaining an overall focus on increasing sustainability. More generally, the managerial and organizational mindsets undergirding sustainable operations management in particular contexts must start from an appreciation of how units interrelate in order to address what is perceived. Business networks comprise resources and activities controlled by different actors. However, they differ with respect to the structural coupling between these and thus also differ in the actors' acknowledgement of what belongs inside and outside the boundaries of a viable system.

The present book builds on our notion that the cybernetic perspective constitutes a powerful way forward for sustainable operations management. However, it is also an acknowledgement that much insight and further conceptualization is needed before it is possible to build momentum for this idea in academic research. When it comes to sustainable operations management, theoretical development is still in its infancy. Paradigmatic closure is too early and there is a need for more theoretical diversity and discussion to avoid premature lock-in.

At the same time, we think grounding these discussions in a broader meta-theoretical framework building on the cybernetic notion of control is a way forward. The design of this book reflects this idea. We have developed a framework based on the contributions, which we believe offers them justice and creates synergy between the contributions. The four parts each reflect what are considered the principal questions for the development of a new management control paradigm vested in complexity or systems thinking. Continuing our use of systems thinking and cybernetics as the overarching perspective for this book, we use de Leeuw's (1976) control paradigm to provide the internal structure of the book. More specifically, we consider the four necessary conditions for effective control as specified by this paradigm, and dedicate a separate part to each condition. Placing ourselves in the role of "controller", aiming to make

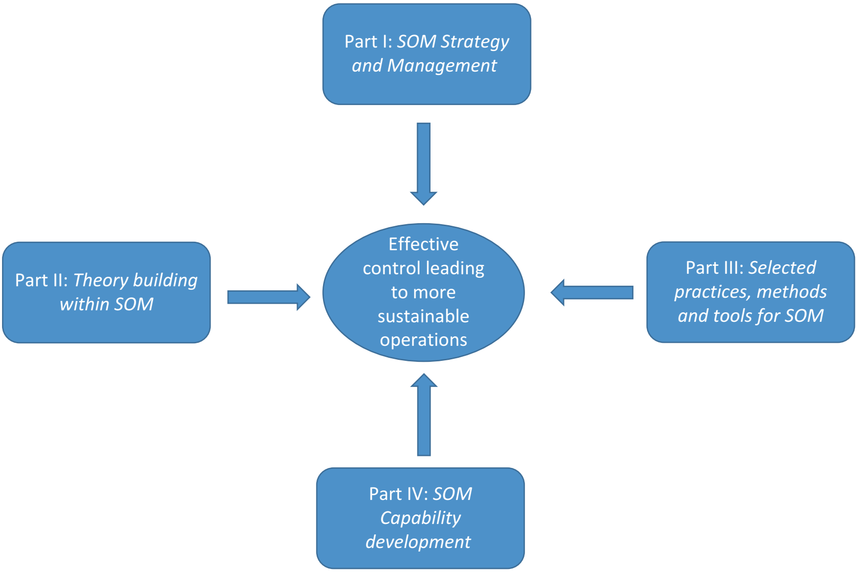

Fig. 1.2 The conceptual relationship between the four parts of the book (building on de Leeuw's (1976) control paradigm)

our operation a more sustainable one, we need to fulfill the following conditions if we are to exert effective control. This model is presented in Fig. 1.2.

1. We need to have a *goal*, guiding us in our control actions. Hence, in the book, we address this condition in the first part of the book, dedicated to *SOM Strategy and Management*.
2. Second, we need *a model of the system* we try to control, helping us to understand how it behaves under certain conditions. Therefore, the second part of the book is dedicated to *Theory Building Within SOM*.
3. Third, we need *information about the state of the operation and its current performance*. Hence, the third part of the book covers *Selected Practices, Methods and Tools for SOM*, supporting the mapping and analysis of current practice.
4. Fourth, we need sufficient steering capability, in order to make progress towards reaching the goal. This condition is addressed in the final part of the book covering *SOM Capability Development*.

The notion of goals as the starting point for the layout of this book builds on the recognition that companies must also take sustainability issues into account in order to ensure long-term success and survival (Hart, 2015; Starik et al., 2017). Thus, in a sustainable business context, strategy and management research builds on more general insights from these disciplines but seeks to apply this in the context of sustainability. The first chapter in Part I outlines the current state of strategy research related to sustainable operations management and the three chapters that follow in this section deal with *the flexibility of environmental regulations, organizational drivers and barriers to circular supply chain operations* and *the strategic impact of inconsistent norms in buyer-supplier relations in the apparel industry*.

In Part II we are concerned with theoretical perspectives, as outlined in the cybernetic framework. Managers need a mental model in order to identify what they seek to influence and control in order to reach these strategic aims. There are also still many avenues to explore and considerable theoretical work to be done in order to further conceptualization and maturation of the field. Although these perspectives share similarities in some respects, they also differ fundamentally in others. The first chapter in this part outlines theoretical developments in the field of sustainable operations management. The remaining chapters in this part are concerned with *business models in the circular economy and the enabling role of circular supply chains, disentangling sustainability-oriented innovation and how it links to environmental sustainability in the aviation industry*. The final chapter in this part concerns *the impact of negative social and environmental events on the market value of supply chain partners*.

Furthermore, as displayed also in the model, Fig. 1.2, some idea of the present-day state of affairs is required to understand the starting point for management measures. This is the theme of Part III. It has also a strong emphasis on pragmatism, predominantly touting technical papers and best-case examples (Seuring & Müller, 2008; Min & Kim, 2012). For this reason, it has been heralded by managers and other practitioners. Much of the current research relating to sustainable operations management has its starting point in reports and studies of practical experiences with sustainable operations initiatives and draws general insights from these. Part III presents studies of the *maximization of retained value of product recovery* *based on circular economy principles, sustainable intermodal train transport, mapping logistics services in sustainable production and consumption systems and finally, the green performance map*.

Finally, dynamic alignment and co-constitution calls for learning and variety in the organizations involved, which is the theme of Part IV. This necessitates ongoing development of capabilities to meet the need for sufficient requisite variety. In this final part of the book, we focus on research that is concerned with the capabilities needed for organizational transition and integration of sustainability as an operations management principle. Part IV presents two contributions, concerned with different aspects of capability development, namely first *linking green supply chain management skills and environmental performance and secondly, information exchange and processing in buyers and suppliers in green public procurement: an absorptive capacity perspective*.

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Part I

SOM Strategy and Management

In the first part of this book, we shall focus on fulfilling the first necessary condition set out in our model for effective control of a sustainable operation practice, outlined in the introduction (see Chap. 1). We are concerned with the process of organizational goal setting. In order to give operations management control measures a sense of direction, some form of strategic goal setting is needed. The notion of goals builds on the recognition that companies must also take sustainability issues into account in order to ensure long-term success and survival. Thus, in a sustainable business context, strategy and management research builds on more general insights from these disciplines but seeks to apply them in the context of sustainability. Much of the debate on strategy formulation and goal setting within sustainable operations management departs from pre-existing models and theoretical perspectives on competitive strategy. However, as also discussed by Poul Houman Andersen in Chap. 2, additional sustainability models have been formulated as well, which seek to emphasize multiple goals for organizational strategy. Each of the three subsequent chapters in this section of the book provides a specific perspective on this issue.

Chapter 3, written by Ramakrishnan Ramanathan, is concerned with the role of environmental regulations. He explores and confirms the hypothesis that operations innovation is significantly higher in firms that face more flexible environmental regulations than in firms that face relatively more inflexible environmental regulations.

The purpose of the following Chap. 4, by Roland Levering and Bart Vos, sheds light on how organizations adopt and implement sustainable practices in order to support the transition towards circular supply chain operations. The research context is a so-called “Green Deal”, a Dutch government-supported program in which over 40 private and public organizations *voluntarily* committed themselves to a transformation towards a circular supply chain model.

The final Chap. 5 in this part by Ulla Normann Christensen is concerned with the set of norms governing the relational exchange between suppliers and buying companies and the changes to these norms brought about by the introduction of sustainability requirements. She finds that suppliers have experienced that the behavior of buying companies has become more transactional. The norm set of buying companies has changed and may be divided into two: a previous set of norms and a sustainability-related set of norms.

2

Sustainable Operations Management (SOM) Strategy and Management: An Introduction to Part I

Poul Houman Andersen

Sustainable operations management (SOM) and strategy concerns the procedures, processes, practices and systems through which firms—individually or organized in wider inter-organizational structures—initiate, create and deliver outputs that are both profitable from a business perspective, using the resources at their disposal while at the same time taking preservation or even improvement of the natural and/or social environment into account. This builds on the recognition, that companies must also take sustainability issues into account in order to ensure long-term success and survival (Hart, 2015; Starik, Kanashiro, & Collins, 2017). Thus, in a sustainable business context, strategy and management research builds on more general insights

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from these disciplines but seeks to apply it in the context of sustainability. Sustainable operations provide an interesting context for exploring further the nature of strategizing. However, concepts and insights emanating from a sustainability focus may also provide important insights to the strategy and management disciplines. Research on the triple bottom line is an influential point of reference for strategizers as well as for strategic research linking to the SOM agenda (Lee, 2004). Another important conversation relates to the crucial link between research on strategic innovation and blueprinting sustainable operation systems with a strategic impact on company identity and operations. Research on strategic innovation and disruption may find disruptive operations management designs not only useful as research areas but they also have the potential to provide insights that fundamentally challenge existing conceptualizations. Understanding the meaning of market disruption as opposed to market discovery, discussed among entrepreneurs and new business venturists, are anchor points.

A fruitful nexus for conversation, mutual inspiration and learning exists among these areas, which the chapters in this part of the book also reflect. In the following, we will provide an overview of the research field before we review the main ideas and contributions more carefully and draw some of the main research trajectories.

1 Sustainable Operations Strategy

There are many approaches to understanding and researching strategy and how this relates to management. The focal points of these designs are typically the current or imagined operations of a single firm but will most often involve a broader network of business actors. In essence, operational strategy departs in operations and does not respect firm boundaries as such. Hence operations management frequently concerns developing a vision and designing a collaborative network of actors capable of managing a flow of resources and activities across multiple organizational boundaries towards the end-user. And sometimes back again. This has several consequences for strategic practice and consequently for theory. A number of issues surface, suggesting the potentially fruitful dialogue between strategy and SOM research. For instance, strategic issues management, understanding how goals are formed, balanced and administered among strategizers in the C-suite (Ansoff, 1980; Dutton & Ottensmeyer, 1987), is a strategy research stream that fits well with the issues and complexities of developing viable business strategies—while taking into account concepts such as profit, people and planet (Elkington, 1994; Savitz & Weber, 2006), creating strategic operational designs that support re- or even upcycling (Braungarth & McDonough, 2009), or lessening the environmental footprint (Esty & Winston, 2006). These issues—and several other—all provide different takes on and starting points to formulating sustainable operations strategy aims.

At their core, the different contributions that can be found to sustainable strategy build on axiomatic, different, theoretical approaches to understanding the competitive drivers of strategy. According to Barney (1986), competitive strategy seems to reflect one of three theoretical approaches to strategic context: (a) industrial organization, with Porter's strategy framework for strategic positioning *vis-à-vis* suppliers, buyers, new industry entrants and substitutes being an ideal example of how this perspective is applied in strategic theory; (b) Chamberlinian economics, which starts from a focus on the unique resources and capabilities of firms and how they may create value differentials, and which is later applied in resource- and capability-based frameworks for understanding strategic differentiation. Several examples of this can be found in the writings from Wernerfelt (1984), Barney (1991) and Grant (1991). Finally, Schumpeterian approaches to strategy assume that strategic entrepreneurship, entailing constant change and disruption of the advantages of incumbents, is the triggering dynamic for understanding (and practicing) strategy.

1.1 Position-Based Approaches

Competitive strategy has made inroads into sustainable operations management. In his original contribution, Porter, taking an industrial organization (IO) perspective, provided a strongly influential definition of the forces shaping strategic conduct (Porter, 1980, 1985). Porter (1991, p. 96) has argued that "the conflict between environmental protection and economic competitiveness is a false dichotomy". From the structural starting point of the IO perspective, environmental regulations can trigger technology upgrading and improve productivity" (Porter & Van der

Linde, 1995). This perspective has been implemented widely in innovation policies as a way for industries to move forward (Nill & Kemp, 2009). Not least, the greening of Chinese energy industries provides testimony (Mathews, 2014). More recently, Porter and Kramer (2011) speak of the creation of shared corporate societal value, extending existing theories and models from industry organization and the position-based school into the sustainability field. The chapter by Ramanathan in this collection speaks to this tradition of research, but also bridges to the resource-based approach.

1.2 Resource-Based Approaches

Moving towards inside-out-based understandings of strategic conduct, the focus of sustainable operations management and strategy is the mobilization, utilization, configuration and reconfiguration of sustainable resources that provide superior and enduring competitive value to business activities (Aragón-Correa & Sharma, 2003). Some contributions even speak of the natural resource-based view (Hart & Dowell, 2011). In an operational context, designing and managing linkages between resources to create sustainability that also provides long-term strategic value for the business is at the core of the subject matter. See also Beske (2012), for a discussion of sustainable operations management in a dynamic capability context.

The creation of superior value from sustainable operations strategies relates to providing superior responses to the ongoing transformation of economic, social and environmental conditions, which are changing business as usual: whether or not these changes concern climate change. Nike pinpoints this well:

> We have a choice. We can move quickly now and prepare to take the initiative and reach the potential in a future sustainable economy.
>
> Or we can wait. Waiting means that we risk being forced to adjust to others' time horizons.
>
> For us the choice is easy. We always play offensive. Therefore, we focus our forces, increase our investments in innovation and look into how we

> can create new and scalable business models that makes it possible to live in a sustainable economy. (Nike Corporation, 2010, p. 23)

The quote above also indirectly highlights defensiveness and offensiveness as two fundamentally different approaches to sustainable operations strategy. A defensive-oriented operations strategy takes in sustainability as a way to mitigate the consequences of changing task conditions and reacting to the changes. Shrivastava and Hart (1995) talk of band-aid solutions to the strategy agenda, where firms through deploying policies are living up to the industry standard but otherwise seek to insulate these initiatives from their conventional business. In this case, the focus is on decreasing long- and short-term vulnerability to climate risk as much as possible, such as reducing exposure to rising sea levels by moving warehouses inland or bringing down carbon emissions by using lighter material in airplanes. An offensive-oriented sustainable operations strategy focuses on how to create value by actively affecting the conditions or identifying and rethinking resource use, thus seeking to change a potential liability (such as the floating islands of plastic found in the oceans) into a potential resource, or the initial establishment of logistics systems for collecting and reusing paper. In such cases, firms adopt "deep change strategies", according to Shrivastava and Hart (1995).

1.3 Disruption-Based Approaches

Another approach, leaning more strongly on Schumpeterian approaches to strategy, sees sustainability operations strategy as one form of creative destruction, chiefly aimed at destroying an incumbent's advantages through disruptive technologies which aim to creating tomorrow's competitive game rather than excelling in the competitive rules in force today (Hart & Milstein, 2003). From this perspective, it is possible to draw on, for instance, Hamel and Ruben's (2000) distribution and categorization of strategic approaches (See also Amini & Bienstock, 2014; Hahn & Scheermesser, 2006). According to Hamel, business strategizers may identify themselves as either rule makers, rule followers or rule breakers. The first and second types represent more conventional (and reactive) approaches to the competitive rules and how sustainability may be applied. Whereas the third type represents the entrepreneurial approach that seeks to create a temporary strategic advantage by undermining the incumbent's advantage, for instance through increasing climate competitiveness. A typology for sustainable operations strategy can be suggested, which provides three types: conventionalists, rule breakers and market makers:

- Conventionalists seek to reduce the business hazards of climate challenges in order to keep the existing business model as intact as possible. One example might be auto makers such as Toyota looking for hybrid engine solutions, in essence maintaining their current operational model.
- Rule breakers are those firms which offensively think of using the changing conditions of their task environment to create new sustainable solutions or seek to establish themselves in such markets. Following from the above example, a company such as Tesla could be seen as an entrepreneur entering into an existing market with a new and viable battery solution applicable to the production of luxury cars and thus competing with conventionalists
- Market makers are firms which literally establish new business models and in effect create new offerings based on a sustainable idea. Strategies for realizing and offering app-based car sharing and co-driving schemes can be seen as an example of actors basically changing the conditions of a market (for instance opening up a private transportation and mobility market for people without driving licenses).

1.4 Explorative Versus Normative Approaches to Operations Strategy

Another main distinguishing characteristic of available theoretical approaches to exploring operations strategy relates to their normative or explorative aspect (Angwin, Johnson, Whittington, Regner, & Scholes, 2017). Strategic perspectives with a prescriptive orientation are concerned with how contexts are best analyzed and how operations strategy is best designed, with respect to achieving growth targets or positioning *vis-à-vis* competing and collaborative firms. These approaches assume a typical understanding of the context such as an industry, a market or a business ecosystem. Several contributions have been made with respect to how sustainability can be accounted for in an operational context: either as a dimension of the task environment for the operational strategy to adapt to, or as a strategic opportunity that can be taken into account by progressively thinking firms that have developed their capabilities in this respect (Dangelico, Pujari, & Pontrandolfo, 2017).

Explorative and descriptive approaches to strategy, on the other hand, are concerned with understanding the interplay between goal setting and organizational or managerial processes such as learning, emergence and sense making. Here, sustainable operations management provides cases and/or initiatives that cause changes in strategic direction and ensuing organizational transitions (Hahn, Preuss, Pinkse, & Figge, 2014).

2 Operations Management

From a sustainable operations management perspective, the focus is on how to—in a resource-efficient and effective manner—effectuate the strategic aims. Operations management is concerned with co-ordinating, integrating and directing the activities and corresponding functions inside and outside the boundaries of the organization that provides the flow which fulfills the requirements of the users/consumers, while paying heed to the sustainability ambitions as formulated in the strategy process. The term is used in sustainability literature "to include environmental management, closed-loop supply chains and a broad perspective on triple-bottom-line thinking, integrating profit, people and planet into the culture, strategy and operations of companies" (Kleindorfer et al., 2005, p. 482).

For many practitioners—and also reflected in the research nexus of sustainability and management—the focus is on the role of management in ensuring organizational transition through change management and leadership. Providing clear definitions of management is an elusive task and we will refrain from a discussion of the various approaches here.

Operations management in the present context concerns designing and directing the overall nature of the operation and how operational strategies are translated into managerial practices and policies. Although operations are evolving into an increasingly strategic function in many firms, recognizing the potential value and contribution from following sustainable policies is challenged by other agendas in the enterprise. Similar to purchasing decisions and management, there is little time for reflection, there is no scale and scope, and incentives and policies are unaligned (Knoppen & Sanez, 2015). A growing part of the literature in this and related fields is dedicated to understanding the practices involved in the transition towards sustainable operations throughout the operations system. This calls for skills in inter-organizational transition and network management as well (Agi & Nishant, 2017). A key concept here is the integration of supplier practices across organizational boundaries. This issue touches directly upon the theme raised by Christensen in her contribution to this book.

3 The Contributions to Sustainable Strategy and Management Presented in This Book

In this part, three contributions to the sustainable operations strategy and management agenda are put forward.

The chapter by Ramanathan (Chap. 3) focuses on the effectiveness of environmental regulations on the strategic conduct of firms. In spite of much research, there is an ongoing debate as to how the effectiveness of regulations can be improved and how individual firms use regulations to their own strategic purpose. In particular, the specific impact of regulations on operations innovation has not yet been studied in detail. Using the resource-based view, the author argues that operations innovation in firms will be affected by the level of flexibility in environmental regulations. He tests propositions on this, using primary survey data from UK firms.

The chapter by Christensen (Chap. 5) addresses the transition challenges involved in developing a certifiable supply network in the apparel industry, which can live up to corporate social responsibility (CSR) expectations. This is a thorny issue for management, given that formal norms challenge the informal norms that have developed for close collaboration in buyer-supplier relationships. On the other hand, a norm change is called for in order to govern CSR initiatives. Challenges arise around how to distribute the burden involved in making this transition effectively and efficiently. Following the norm changes, the author is able to zoom in on the elements creating conflict in the transition processes as supply networks are changing. In this chapter, Christensen delivers important insights into the inter-organizational governance issues of sustainable operations management, which at present is an underdeveloped area theoretically and a highly topical issue managerially.

The chapter by Levering and Vos (Chap. 4) is also concerned with transformation of practices and processes in the inter-organizational realm. The purpose of their chapter is to shed light on how organizations adopt and implement sustainable practices in order to support the transition towards circular supply chain operations. Although research on circular supply chain models is increasing, its actual adoption and implementation is still poorly understood. The research context is a so-called "Green Deal", a Dutch government-supported program in which over 40 private and public organizations *voluntarily* committed themselves to a transformation towards a circular supply chain model.

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3

Flexibility of Environmental Regulations and the Impact on Operations Innovation

Ramakrishnan Ramanathan

1 Introduction

This chapter focuses on a specific aspect of sustainable operations management (SOM)—the role of environmental regulations in improving firm performance—by linking the strategy literature to understand how operations innovation in firms could be influenced by the nature of environmental regulations. There is increasing emphasis by governments to minimize the adverse impact of economic development by devising environmental regulations. Governments and firms spend significant effort and money on environmental regulations and compliance (EEPA, 2005; Karakayali, Emir-Farinas, & Akcali, 2007). Environmental regulations affect operations innovation and operations in firms (Angell & Klassen, 1999; Klassen & Angell, 1998).

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However, in spite of several research studies, there is no consensus until now about the impact of such regulations on firms. There is still debate about how the effectiveness of regulations can be improved and how individual firms can use such regulations to their advantage (Majumdar & Marcus, 2001; Orlitzky, Schmidt, & Rynes, 2003; Porter & van der Linde, 1995; Sitkin & Bies, 1994). Though there are several previous studies in this context (e.g. Pethig, 1975; Porter & van der Linde, 1995; Shrivastava, 1995), unfortunately, there seems to be no study that empirically analyzes the role of regulatory design and firms' operations innovation within a single framework. Our study reported here is motivated by this research gap. By filling this gap, our study will help policy makers when designing environmental innovations and help firms in taking advantage of specific tenets of regulations.

According to a well-studied school of thought, better designed regulations would focus on outcomes but leave decisions on processes or technologies to individual firms (Porter & van der Linde, 1995). It has been argued that more flexible regulations that focus on outcomes encourage the development of innovative ideas, products and processes in firms (Haughton & Browett, 1995; Jiménez, 2005). There is evidence in the literature that environmental performance is strongly related to financial performance when firms face flexible regulations (Majumdar & Marcus, 2001) but the specific impact of regulations on operations innovation has not yet been studied in detail. Due to its focus on efficient use of resources and capabilities by firms to achieve competitive advantage, the resource-based view (RBV) of the firm provides the basis to theorize the links between regulations and operations innovation in firms. With this theoretical support, we argue in this chapter that operations innovation in firms will be affected by the level of flexibility of environmental regulations. That is, if firms face more flexible regulations that focus on outcomes rather than processes, they are able to use their innovation capabilities to achieve the desired results in the most cost-effective way. We then test our proposition using primary survey data from UK firms.

2 Literature Review

2.1 Flexibility of Environmental Regulations and Innovation

Firms are generally considered a pool of resources (Penrose, 1959) and engage in pollution control/prevention activities by utilizing resources and capabilities. According to Loasby (1998), capabilities are a kind of productive resources that are by-products of past activities, but help to make future activities possible. By prudently utilizing available resources and capabilities, firms are able to take advantage of new opportunities. This resource-based view is equally applicable to understanding how firms use environmental regulations as new opportunities, and manage to deploy their resources and capabilities to achieve competitive advantage.

From a simplistic viewpoint, it is possible to imagine that environmental regulations would be harmful to the profitability of firms (as pollution control will cost time and resources) (Christainsen & Haveman, 1981). However, Porter's hypothesis has suggested that properly formulated environmental regulations could have a positive impact on the profitability of firms (Porter, 1991; Porter & van der Linde, 1995). The literature on Porter's hypothesis linking environmental performance to the financial performance of firms often discusses two important requirements for the existence of a positive link: the level of flexibility of environmental regulations and operations innovation capabilities in firms (e.g. Chang, 2011; Osuji, 2011; Porter & van der Linde, 1995; Rothwell, 1992). We discuss these two requirements in more detail below.

Environmental regulations have been generally categorized in different ways by looking at whether they stimulate operations innovation in firms. Flexible regulations stimulate operations innovation in firms while inflexible regulations stifle innovation. For example, Rothwell (1992) has illustrated that firms will not find regulations in which the government imposes a legally enforceable standard will stimulate innovation while those regulations that provide economic incentives and disincentives will help encourage innovation. Operations innovation is stimulated in firms when regulations provide economic incentives via market forces so that firms are able to better exploit their innovation capabilities and encourage entrepreneurship and risk taking (Majumdar & Marcus, 2001; Marcus, 1988; Strebel, 1987). In contrast, operations innovation in firms is stifled when they have no opportunity to exploit innovation, for example, when regulations prescribe excessive procedures and are rule-centric (Eisenhardt, 1989).

2.2 Theory Linking Operations Innovation to Competitive Advantage: The Resource-Based View (RBV) of a Firm from the Strategy Literature

The strategy literature provides a number of theoretical perspectives to understand the functioning of organizations in particular settings. Of these, the resource-based view (RBV) (Barney, 1991) of a firm helps to understand how firms can exploit their internal resources to obtain a sustained competitive advantage (Coates & McDermott, 2002). Since SOM primarily deals with how firms employ and benefit from their operations resources, RBV is a useful lens to study SOM. In this chapter, we utilize this lens to help understand the impact of regulations in driving operations innovation in firms.

The RBV literature shows that competitive advantage is achieved primarily by the application of the bundle of valuable resources at a firm's disposal (Rumelt, 1984; Wernerfelt, 1984). Though different firms can have similar resources, they differ in the way in which they deploy these resources. More proactive firms may seek ways to derive maximum benefits from available resources and be ready to redeploy them in suitable ways when induced by external forces. In contrast, more reactive firms may take longer to decide on the redeployment of resources. In this chapter, environmental regulations are viewed as external forces making firms redeploy their resources. If these regulations provide sufficient flexibility, then proactive firms with more innovative capability will be able to deploy operations resources more innovatively to derive better leverage from the regulations. On the other hand, if the regulations do not provide much flexibility, then firms are not able to deploy resources innovatively to gain a competitive advantage. Thus, if an external pressure (flexible regulation in this case) provides opportunities to exploit internal capabilities effectively, organizations will utilize resources innovatively. For example, Kelman (1961) shows that more flexible regulations encourage firms to move from simple compliance to more intelligent integration. When firms are faced with flexible situations, those with superior innovation capabilities take calculated risks and exploit their available resources more effectively (Marcus, 1988; Strebel, 1987). In contrast, Eisenhardt (1989) highlights cases where inflexible rules and excessive procedures stifle innovation in firms. Recently, the beneficial role of the flexibility of regulations has been highlighted using qualitative (Ramanathan, He, Black, Ghobadian, and Gallear, 2017) and quantitative (Ramanathan, Ramanathan, and Bentley, 2018) studies.

Though the literature on environmental management has highlighted the crucial role of flexibility or regulation (e.g. Majumdar & Marcus, 2001; Porter & van der Linde, 1995; Russo & Fouts, 1997), the role of flexible regulation is not unique to environmental management and similar observations can also be found from the extant economics literature, for example, the strong positive impact of flexible labor regulations on job creation (Amin, 2009) and the strong negative impact of inflexible regulations on employment in Brazilian firms (Almeida & Carneiro, 2009).

However, earlier studies often did not explicitly consider the role of operations innovation and the flexibility of regulations together in a single framework. For example, though studies by Brunnermeier and Cohen (2003) and Jaffe and Palmer (1997) focused on environmental regulations and operations innovation, they have not explicitly considered flexibility of regulations. On the other hand, Majumdar and Marcus (2001) considered flexibility of regulations but did not consider innovation. This is a significant research gap and this chapter attempts to address this gap.

Thus, drawing on the resource-based view and previous literature, we propose the following hypothesis.

Hypothesis 1 Operations innovation capabilities are significantly higher in firms that face relatively more flexible environmental regulations compared to those that face relatively more inflexible regulations.

3 Sample Selection and Survey

Data for verifying Hypothesis 1 have been collected via a questionnaire survey among manufacturing firms in the UK. The questionnaire survey was conducted during September 2009–February 2010 in two waves. Initially, 2000 manufacturing firms in the UK were contacted in the first wave but only 125 responses were managed. In the second wave, another 1000 firms were contacted resulting in 50 more responses. However, after deleting unsatisfactory/non-responses, the final sample size was 131. We merged the two waves of questionnaires after satisfying ourselves that there are no substantial differences between the two sets of samples. We further verified that there is no non-response bias (Armstrong & Overton, 1977) or single respondent bias (Doty & Glick, 1998) in our sample.

4 Data Analysis

In this study, for the first time in the literature, we developed a measure of relative flexibility and inflexibility of environmental regulations using data envelopment analysis (DEA). We then employed factor analysis used to develop constructs for innovation in firms. Finally, one-way ANOVA has been used to investigate the variation of innovation. Factor analysis and ANOVA were conducted using SPSS version 21.

4.1 Measures of Flexibility of Regulations and Operations Innovations

All our measures in this study (see Table 3.1) were based on prior literature. The literature on environmental regulations (Majumdar & Marcus, 2001; Rothwell, 1992; Rugman & Verbeke, 1998) provided measures for the flexibility and inflexibility of regulations. Accordingly, the ability to offer economic incentives and disincentives, and the ability to force integration of pollution control into production processes were used as measures of flexible regulations. On the other hand, inflexible regulations

Table 3.1 Measures used in this study and their literature sources

Acronym	Item	Literature sources
EREGINCEN	Company faces environmental regulations that offer economic incentives	Majumdar and Marcus (2001), Rothwell (1992), Rugman and Verbeke (1998)
EREGPEN	Company faces environmental regulations which offer economic disincentives	Majumdar and Marcus (2001), Rothwell (1992), Rugman and Verbeke (1998)
EREGIPC	Company faces environmental regulations which encourage integration of pollution control into production processes	Majumdar and Marcus (2001), Rothwell (1992), Rugman and Verbeke (1998)
EREGSTAND	Company faces environmental regulations which set absolute thresholds	Majumdar and Marcus (2001), Rothwell (1992), Rugman and Verbeke (1998)
EREGSPEC	Company faces environmental regulations which stipulate specification standards	Majumdar and Marcus (2001), Rothwell (1992), Rugman and Verbeke (1998)
EREGEOP	Company faces environmental regulations that can be met by buying end-of-pipe equipment	Majumdar and Marcus (2001), Rothwell (1992), Rugman and Verbeke (1998)
PROCINNO	Company has developed several innovative processes in the past five years	UK and European Community Innovation survey (www.berr.gov.uk), Horbach (2008), Robson and Haigh (2008)
PRODINNO	Company has developed several innovative products in the past five years	UK and European Community Innovation survey (www.berr.gov.uk), Horbach (2008), Robson and Haigh (2008)

were captured using measures such as stipulation of absolute thresholds of pollutants or specification standards, and being forced to use end-of-pipe equipment.

The academic and practitioner literature on operations innovation (e.g. the UK and European Community Innovation survey (www.berr.gov.uk), Horbach, 2008; Robson & Haigh, 2008) provided the measures for operations innovation: introduction of a new or significantly improved (goods or service) product (product innovation) or process engagement in innovation projects not yet complete or abandoned (process innovation).

All the questions are self-evaluated measures using Likert-type scales (1—strongly disagree and 5—strongly agree).

4.2 DEA for Computing Scores on Relative Flexibility of Environmental Regulations

This chapter uses DEA to create multiple groups of firms in terms of how they perceive the level of flexibility in the environmental regulations they face. DEA is a non-parametric method to measure the efficiency with which different decision-making units (DMUs) (schools, hospitals, retailers, etc.) are able to convert their resources (usually called inputs in the DEA literature) to good performance (usually called outputs) (Cooper, Seiford, & Tone, 2007; Ramanathan, 2003). The first paper on DEA appeared in the late 1970s (Charnes, Cooper, & Rhodes, 1978) but thanks to its intuitive appeal, this technique has received the attention of a number of researchers. Over the past four decades, DEA has found a number of applications in various application domains including education, healthcare, manufacturing and retail (Cook & Seiford, 2009). It has had numerous applications in sustainability analysis as well (e.g. Dyckhoff & Allen, 2001; Korhonen & Luptacik, 2004; Sueyoshi & Goto, 2012). Zhou, Ang and Poh (2008) have provided an excellent review of DEA applications in the field of sustainability focusing on energy and environmental issues.

To the best of the author's knowledge, there is only one study in the previous literature where environmental regulations are classified as flexible and inflexible for further analysis (Majumdar & Marcus, 2001). To make this classification, self-judgement has been used by Majumdar and Marcus. Air pollution regulations have been classified as inflexible and solid waste regulations as flexible based on their own interpretation of the regulatory system in the United States prior to 1993. Unfortunately, in the recent UK context, such a categorical classification is not possible. For example, while a majority of air pollution regulations can still be considered inflexible, since some newer air pollution regulations (such as the Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) Regulations 1999 and the European Union-wide Greenhouse

Gas Emissions Trading Scheme Regulations 2003/2005) can be classified as flexible regulations. Hence, in this study, relative flexibility has been captured from the perceptions of our respondents using a Likert-type scale. Three measures (EREGINCEN, EREGPEN and EREGIPC) have been used to capture the flexibility of environmental regulations while three more measures (EREGSTAND, EREGSPEC and EREGEOP) have been used to capture inflexibility. We then employed DEA to combine these measures and develop a score for the relative flexibility of regulations. The three measures of flexibility in regulations are used as DEA outputs, while the three measures of inflexibility of regulations are used as DEA inputs.

Due to the nature of the mathematical formulation, DEA scores always range from zero to 1 (Cooper et al., 2007) with the firm achieving the best outputs by consuming the least inputs registering a score close to 1. Thus, in our analysis, if the DEA score is closer to 1 for a firm, it would mean that the firm perceived that it was subjected to more flexible environmental regulations than inflexible ones. Similarly, a DEA score closer to zero would mean that the corresponding firm felt that it has faced more inflexible environmental regulations than flexible ones.

In order to facilitate further analysis on differing levels of flexibility of regulations, we categorized our respondent firms into three groups based on the DEA scores. Group 1 comprised of all efficient firms with DEA scores equal to 1. Obviously, firms in this group felt that they faced high levels of flexible regulations. There were 84 firms in our sample for this group. Group 2 group comprised firms with an efficiency score below 1 but equal to or more than 0.4. There were 48 firms in our sample for this group. Group 3 comprised all the remaining firms with DEA scores below 0.4. There were only two firms in this group.

4.3 Factor Analysis

We used factor analysis to measure our innovation construct. Results are available in Table 3.2. All the measures had high loadings (above 0.90, which is well above the minimum threshold of 0.5) on the construct.

Table 3.2 Results of factor analysis

Name	Loading	Average variance extracted (AVE)	Cronbach's alpha	Composite reliability
Operations innovation				
• PRODINNO	0.910	83%	0.791	0.906
• PROCINNO	0.910			

Reliability of the construct was measured by Cronbach's alpha and composite reliability. A Cronbach's alpha or composite reliability of 0.65 or higher was used as an acceptable value for internal consistency of the measures (Hair Jr., Anderson, Tatham, & Black, 1998). The Cronbach's alpha of the innovation construct is well above this threshold. Average variance extracted (AVE) value is also high, well above the recommended minimum value of 0.5. These values support the contention that the innovation construct has adequate reliability.

4.4 One-Way Univariate Analysis of Variance (ANOVA)

Recall that we have created three different groups of firms on the basis of the perceived flexibility of environmental regulations they faced. We conducted a one-way ANOVA to examine if operations innovation varies across the three groups, as posited in Hypothesis 1. ANOVA results are presented in Table 3.3. The results suggest that there is a statistically significant (p = 0.038) difference in the operations innovation level in the three groups.

We then attempted pair-wise comparisons of the means but we had to eliminate Group 3 as it only had two sample points. The mean difference between the values of innovation for Groups 1 and 2 was 0.372 (with Group 1 that perceived more flexible regulations registering a higher value) and the standard error was 0.178, resulting in the level of significance (i.e. p-value) of 0.38. Thus, the ANOVA has shown that firms that face more flexible regulations register a significantly higher level of innovation compared to those firms that face more inflexible regulations. Thus Hypothesis 1 is strongly supported by our results.

Table 3.3 Results of one-way ANOVA examining the effect of flexibility of environmental regulations on operations innovation in firms

Source	Sum of squares	df	Mean square	F-statistic	Significance
Between groups	4.237	1	4.237	4.382	0.038
Within groups	125.712	130	0.967		
Total	129.949	131			

5 Discussion and Conclusions

Our ANOVA result has shown clear evidence that innovation (comprising both process innovation and product innovation) is significantly higher for firms that face more flexible environmental regulations compared to those firms that face more inflexible regulations. By doing so, our study has helped extend the debate on Porter's hypothesis (by specifically linking to the notions of innovation and flexibility of regulations). We believe that our study has contributed to the literature via simultaneous consideration of operations innovation and flexibility to render support to Porter's hypothesis.

While much of the literature on Porter's hypothesis focused on the link between environmental performance and firm performance, we have contributed to this literature by focusing on two important underlying requirements, namely flexibility of regulations and innovativeness in firms. In fact, in spite of a large amount of statistical work, there is still inconclusive evidence on whether environmental regulations help improve performance in firms. We argued that the lack of conclusive evidence may have arisen because previous work has ignored the two important issues associated with Porter's hypothesis (Porter & van der Linde, 1995): design of regulations (flexible/inflexible) and the ability and willingness of regulated firms to respond innovatively.

Our contribution in this study lies in linking these two issues: flexibility of environmental regulations and innovation in firms. This is the first study to link these issues as previous studies generally accounted for only either of these requirements but not both. The innovation capabilities and resources of firms was considered by studies such as Klassen and Whybark (1999) and Christmann (2000) whilst the importance of the nature of the regulations under question was examined by Majumdar and Marcus (2001) and Crotty and Smith (2006).

5.1 Policy and Managerial Implications

Using primary data, we have shown that innovation is significantly higher in firms that perceive that they face more flexible regulations compared to firms that perceive that they face more inflexible regulations. This finding has important policy and managerial implications.

The policy implication of our study is that policy makers should continue to develop flexible regulations that focus on outcomes rather than on processes/technologies. Intelligent regulatory design, allowing environmental protection to coincide with a more competitive and innovative manufacturing industry, will help stimulate operations innovation and achieve environmental goals quickly. In the UK, as in several other country contexts, environmental regulations comprise both old (relatively inflexible) and new (more flexible) (Osborn, 1997) aspects. Our findings will encourage policy makers to revise older inflexible regulations to bring them into line with the newer thinking on how environmental policy should develop. This is happening slowly in the UK. For example, older air pollution regulations (e.g. the Environmental Protection Act 1990, Environmental Protection (Prescribed Processes and Substances) Regulations 1991, Clean Air Act 1993) are inflexible but newer ones (e.g. the Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) Regulations 1999 and the European Union-wide greenhouse gas Emissions Trading Scheme Regulations 2003/2005) are more flexible.

Managerial implications of our study highlight that managers should be innovative and exercise a positive, open mind in complying with environmental regulations. The support for our hypothesis shows that managers will find it more useful if they have the opportunity to consult on the design of regulations that help foster innovation. An innovative firm can use the tenets of flexible regulations on its internal capabilities for a competitive advantage by moving to new markets and moving to leaner and greener production processes that reduce energy consumption and material inputs. So managers should work with policy makers in pushing for flexible regulations that allow environmental protection efforts to continue but in a way which does not necessarily penalize all businesses, and then approach these flexible regulations innovatively to their advantage.

In spite of these useful findings, it is important to highlight some limitations of our study. Though we have found that firms with better operations innovation capabilities will be able to exploit the tenets of flexible regulation, inclusion of other important variables may shed further light on this line of investigation. For example, firms with better operations innovation capabilities would invest more in pollution prevention (i.e. the integration of pollution processes in production) rather than end-of-pipe pollution control (Klassen & Whybark, 1999). Stringency of the implementing of regulations will also play an important role in how environmental regulations are impacting on firms. These issues could be studied in more detail in future studies.

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4

Organizational Drivers and Barriers to Circular Supply Chain Operations

Roland Levering and Bart Vos

1 Introduction

In the past decades the scholarly attention to sustainable supply chain management (SSCM) has increased steadily. This attention has so far resulted in a variety of literature reviews which show the development of the field (e.g. Ahi & Searcy, 2013; Ashby, Leat, & Hudson-Smith, 2012; Carter & Liane Easton, 2011; Gold, Seuring, & Beske, 2010; Miemczyk, Johnsen, & Macquet, 2012; Reefke & Sundaram, 2017; Winter & Knemeyer, 2013). Although these numerous literature reviews make various and sometimes contradictory claims, achieving organizational performance measured on the triple bottom line of people, planet and profit (Elkington, 1997) has become progressively the core focus of this stream of literature.

In addition to the burgeoning research on SSCM, the circular economy has emerged as a more recent but related stream of research. The circular economy has been generally defined as "an industrial system that

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is restorative or regenerative by intention and design" (World Economic Forum, 2014, p. 15). For organizations, this implies a transition from applying traditional and linear "take make waste" business models (which are based on an input-throughput-output principle) to implementing sustainable business models based on circular economy principles (wherein output relates back to input).

This transition towards circular supply chain models is challenging since adopting radically new business models implies a need for new organizational practices and processes. This especially holds for inter-organizational collaboration since the critical skills and resources for developing and adopting circular supply chain practices reside increasingly outside organizational boundaries (Lavie, 2006). However, although incentives to engage in circular supply chain operations have been investigated, their adoption and implementation remains scarcely researched (Gregson, Crang, Fuller, & Holmes, 2015; Wagner & Svensson, 2010). Given that organizations nowadays have redirected their attention towards circular supply chain operations, the need for understanding the transition and its accompanying challenges increases.

Additionally, research on SSCM remained primarily descriptive and neglected to contribute to theory development (Hoejmose & Adrien-Kirby, 2012). This is also concluded by Seuring and Müller (2008) who add that not only a sound theoretical background is often missing but that sustainability is regularly viewed as encompassing only the environmental bottom line, neglecting the social and economic aspects. Moreover, Pagell and Wu (2009) argue that the focus of the literature has been on similarities between conventional supply chain management and its sustainable counterpart instead of the differences, in other words what is unique about sustainable supply chain management. The recent special topic forum of the *Journal of Supply Chain Management* addresses the current state of the SSCM literature and argues that *sustainable practices* are the common denominator of the multidisciplinary stream of literature on SSCM (Markman & Krause, 2016). Sustainable practices and the lack of insight as to how they are implemented is also stressed by Despeisse, Mbaye, Ball, and Levers (2012) in the special issue of *Production, Planning & Control* on sustainable manufacturing. They conclude from their literature review that scholarly attention is growing but insights on adoption processes are lacking.

This chapter argues that the notion of the circular economy provides a viable opportunity for SSCM research focusing on the adoption of sustainable practices.

Combining the lack of insight on adopting and implementing circular supply chain operations with the shortcomings of the SSCM literature raises the issue of how organizations and supply chains actually apply circular principles in their day-to-day activities. More specifically, a clear view on drivers and barriers to adopting circular supply chain practices, or more precisely sustainable practices, is lacking. Practices, in this regard, can be understood as social and collaborative patterns of activities. The notion of sustainable practices will be elaborated upon in depth later on.

This chapter aims to shed light on the process of adopting and implementing sustainable practices in order to achieve a circular supply chain. More generally, this chapter contributes to the development of the SSCM literature by gaining insights on the transition towards circular supply management and the implications for inter-organizational collaboration within the supply chain. The chapter aims to answer the following research question: *how do organizations implement sustainable practices and what are the drivers and barriers in the transition towards circular supply chains?*

In the next section, the current state and definitions of sustainable supply chain management literature are discussed, along with an introduction to the concept of the circular economy. In terms of a theoretical foundation (see Seuring & Müller, 2008) the chapter also elaborates on the concept of sustainability and what constitutes a sustainable practice. The methods and results sections present the empirical part of this chapter by means of an exploratory case study of various circular supply chain implementation projects. Finally, the conclusions and discussion state the contribution of this chapter to the SSCM literature and the implications for practitioners wishing to engage in circular supply chain operations along with directions for future research.

2 Theoretical Background

2.1 Current State of SSCM Literature

The fundamental starting point of basically every chapter on SSCM is the notion of the triple bottom line, developed by Elkington (1997), which argues that organizations and supply chains need to balance performance on economic, environmental and social bottom lines. Although in both research and practice the environmental bottom line has been given significantly more attention than its social counterpart, many scholars have studied the influence of those alternative bottom lines on economic performance. Recently, a hierarchy has been proposed, indicating that organizations and supply chains should strive for environmental performance first, social performance second, and finally economic performance in their sustainable efforts (Markman & Krause, 2016). This is also stated (in the same special issue, as addressed later on) by Montabon, Pagell, and Wu (2016) who advocate an ecologically dominant logic, making the case for this prioritization of the triple bottom line in order to make supply chains truly sustainable and not just less unsustainable (Pagell & Shevchenko, 2014).

As stated in the introduction, research on sustainable supply chain management has been burgeoning and so far has resulted in numerous literature reviews focusing on theory development or conceptual integration. Besides literature reviews Delphi studies have also been conducted to advance the field (e.g. Reefke & Sundaram, 2017; Seuring & Müller, 2008). *Production, Planning & Control* attributed a special issue on sustainable manufacturing in 2012, acknowledging the importance of sustainable practices. The *Journal of Supply Chain Management* attributed special issues to SSCM in 2009 (Krause, Vachon, & Klassen, 2009) and 2016 (Markman & Krause, 2016). In the former special issue, Pagell and Wu (2009) refer to SSCM as a theory which has increasingly been taken on by researchers (e.g. Matthews, Power, Touboulic, & Marques, 2016).

Notwithstanding these scholars' efforts to advance the field on SSCM, the stream of literature is far from being a full-fledged theory which, as any useful theory, can address the basic building blocks of theories relating to what, how and why questions (Whetten, 1989). Acknowledging this fact will pave the way for constructive theorizing on sustainable supply chain management (Weick, 1995) in order to deal with current tensions and assumptions in the field (Matthews et al., 2016).

SSCM has been defined in numerous and differing ways. This is mainly due to the multidisciplinary nature of SSCM literature, combining conventional supply chain management, research on sustainability (also from ecological and CSR perspectives), strategic management, and logistics and operations management. This has also been the core focus of Touboulic and Walker (2015) when they discuss the various theoretical underpinnings of SSCM research and definitions. They find that stakeholder theory and institutional theory are the primary theoretical perspectives used to study drivers and barriers of SSCM. In their review of SSCM definitions, they acknowledge that one of the most commonly used definitions is the one from Carter and Rogers (2008, p. 368) who define SSCM as "the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and its supply chains". This definition is deemed appropriate since it incorporates, as many others, the triple bottom line of social, environmental and economic performance, but more importantly also stresses the co-ordination of inter-organizational processes. However, after a careful review of definitions of green supply chain management (GSCM) and SSCM, Ahi and Searcy (2013, p. 339) came up with a new definition for SSCM constituting:

> *the creation of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems designed to efficiently and effectively manage the material, information, and capital flows associated with the procurement, production, and distribution of products or services in order to meet stakeholder requirements and improve the profitability, competitiveness, and resilience of the organization over the short- and long-term.*

One can doubt whether the aforementioned theory requirement of parsimony has been achieved with such an elaborate definition, but it does incorporate 13 key characteristics of conventional SCM and sustainability as identified by Ahi and Searcy (2013). Perhaps the most distinctive contribution of their definition is the voluntary nature of organizational engagement in SSCM. This voluntariness is related to the drivers or incentives for organizations to engage in SSCM, which have been studied quite frequently (in contrast to the actual practicing of SSCM). The prominence of these two SSCM definitions is also emphasized in the recent large-scale SSCM literature review of Ansari and Kant (2017). Another large-scale (empirical) analysis of SSCM incentives is done by Paulraj, Chen, and Blome (2015). They categorize instrumental, relational and moral incentives for organizations to practice SSCM and argue that organizations driven by moral incentives outperform organizations driven by instrumental incentives only. In addition to the elaborate review of Touboulic and Walker (2015), Gopal and Thakkar (2016) focus on the theoretical dispositions of SSCM research, more specifically zooming in on the implementation of sustainable practices. Prior to discussing these practices in more detail, the next section introduces the circular economy concept.

2.2 Circular Economy

Literature on the circular economy (CE) is still in its nascent phase and consists of quite a few Chinese case studies. In China, the CE concept offers enormous opportunities to tackle the country's challenges in areas such as resource depletion, waste reduction and energy consumption (Su, Heshmati, Geng, & Yu, 2013). The Chinese government also put forward a deeper implementation of the CE concept in recent "Five Year Plan" policies (Feng & Yan, 2007; Su et al., 2013). Zeng, Chen, Xiao, and Zhou (2017) study the CE concept in relation to SSCM from an institutional theory perspective and put forward the term "circular economy capability", but without properly defining the concept. As observed by Murray, Skene, and Haynes (2015), the CE concept is also explored in the West and advocated by a number of "think tanks", as illustrated in position papers being published by the Ellen MacArthur Foundation to demonstrate CE's value for European economies (2012, 2013, 2014). Additional practitioner attention has been paid by Lacy and Rutqvist (2016) from Accenture who identify a circular supply chain as one that introduces renewable and recyclable materials for repetitive life cycles in order to increase predictability, control and reduce costs. They view such a circular supply chain as one of five new, circular business models, together constituting a change away from the linear view of growth.

The origins of the CE concept can be traced back to economics and ecology, with quite some debate about its initial conceptualizations (Murray et al., 2015). The circular economy is briefly defined as "an industrial system that is restorative or regenerative by intention and design" (WEF, 2014, p. 15), but more elaborately by Murray et al. (2015, p. 1) as "an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being". This latter definition also addresses one of the key flaws of the concept which is neglecting the social dimension of the triple bottom line and stressing primarily the environmental aspect by decoupling economic growth from resource consumption. Another main issue with the circular economy is that is has not received much scrutiny and has been approached more as a normative ideal instead of a solid academic concept (Gregson et al., 2015). The aim here is mainly to briefly introduce the CE concept, an elaborate description is provided by Murray et al. (2015).

2.3 Sustainability and Sustainable Practices

Being at the core of the literature on SSCM and the circular economy, sustainability has classically been defined by the World Commission on Environment and Development as "the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 8). In addition to this broad definition, scholars have extended the understanding of sustainability by arguing that the triple bottom line notion of Elkington (1997) also implies that the economic aspect is subservient to the social one, which in its turn is embedded in the environmental aspect (Markman & Krause, 2016; Matthews et al., 2016; Montabon et al., 2016). Although much debated, understanding what sustainability is, also leads to acknowledging what sustainability is not: reducing environmental harm, reducing unethical conduct, reducing tradeoffs, and corporate social responsibility (CSR) (Markman & Krause, 2016). Contemporary efforts within supply chains might lead to less unsustainability, but will eventually hinder a more fundamental transition to fully sustainable supply chains (Matthews et al., 2016). This is where Markman and Krause (2016) advocate the macro-concept of *sustainable practices*, which must adhere on the one hand to the triple bottom line and on the other hand to the proposed prioritization of environmental before social and finally economic considerations. This is also pointed out by Carter and Rogers (2008, p. 370): "there are social and environmental supply chain activities that lie at the intersection with the economic bottom line—these are the activities that are defined as sustainable". Still, the question arises what constitutes a sustainable practice? The term practice has been coined by numerous articles addressing SSCM, but where most authors specify various manifestations of those actual practices, none has succeeded in pointing out what is actually meant by a sustainable practice.

On a more conceptual note regarding practices, a distinction can be made between the *opus operatum*, the finished view, and the *modus operandi*, the work in progress (Bourdieu, 1977). Or as Brown and Duguid (1991) label it: canonical and non-canonical practice. The first referring to the way a practice is looked at or often described and the second to the way in which a practice is actually performed and changed, i.e. improvized under the conditions of the task at hand. Narration, collaboration and social construction are identified as central features of a practice (Brown & Duguid, 1991; Orr, 1990). These features indicate that a practice is an inherently social, collaborative way of executing specific task-related activities with a dimension of duality between practice and practitioner. Given that a practice is socially constructed and therefore also bound by cultural aspects, practices may be directed at the supply chain, but inevitably also need to be embedded in the organization (and the practitioners) from which they originate.

Against the background of sustainability and the triple bottom line, a sustainable practice can then be defined as *a social and collaborative pattern of activities directed at respectively environmental, social and economic aspects of either the focal organization or the supply chain*. This definition articulates the nature of a practice, the triple bottom line, and the internal (organization) and external (supply chain) dimensions. The organizational, internal practices can be sustainable product and process design, and the external, supply chain practices can be supplier and customer collaboration (Pagell & Wu, 2009; Paulraj et al., 2015; Seuring & Müller, 2008).

3 Methods

3.1 Research Approach

In line with this chapter's aim to grasp how organizations adopt and implement sustainable practices in their transition towards a circular supply chain, a case study approach using theoretical sampling is deployed (Eisenhardt, 1989; Yin, 1994). Adopting circular supply chain operations constitutes a radical, innovative and far-reaching change for many organizations. Hence, a process approach which focuses on developments over time (Langley & Abdallah, 2011) is suitable for understanding this adoption. Selecting cases was done following Pagell and Wu (2009) who use exemplars, "organizations that are well ahead of their industry on either social and/or environmental performance while still maintaining economic viability" (p. 40). Focusing on exemplars is deemed appropriate since adopting sustainable practices with regard to circular supply models requires a novel and innovative approach to supply chain management.

3.2 Research Context

The research context is a so-called "Green Deal", a Dutch government-supported program in which, so far, over 40 organizations *voluntarily* committed themselves to a transformation towards a circular supply chain model. The Green Deal (GD) entails organizations from a large variety of business environments, both public and private, and profit as well as non-profit. The circular pilots that these organizations conduct are in collaboration with suppliers and call for new supply chain practices. Every participating organization committed itself to conduct at least two circular supply chain implementation pilots. These pilots aim to extend the life cycle of products and the sustainable reuse of waste outputs from core organizational processes. The circular pilots involved reusing the waste output of a healthcare organization, circular office furniture for government agencies, and recycling safety clothing from a manufacturer, amongs various other topics.

3.3 Data Collection and Analysis

Qualitative case studies on those circular pilot projects form the empirical part of this study. Progress of the circular pilots of the participating GD organizations is monitored by means of an online tool which the organizations fill out themselves. The online tool functions as a database for all circular pilots and organizations can fill out the start and end date of the pilot, a description, objective of the pilot, motivation, and an evaluation field. A separate tab is included with encountered issues and relevant milestones. The input of the organizations via this online tool was eventually exported to Excel files and categorized for data analysis. Furthermore, during the quarterly Community of Practice meetings of the GD organizations the researchers had the chance to collect additional data on the circular pilots from the participating (purchasing) managers. These meetings have been especially useful in obtaining more insights into the stories behind the data in the online tool, especially regarding the drivers and barriers as experienced by the participating managers.

Analysis is based on the tool for monitoring the circular GD projects, following the case study approach of Eisenhardt (1989). First, a within-case coding took place to search for manifestation of sustainable practices. More specifically, the focus in the coding process has been on teasing out manifestations of sustainable practices as identified in our theoretical background. These identified practices emerged from the data per case.

Second, a cross-case analysis categorized the identified practices and searched for possible drivers or barriers to implementing those practices. These drivers and barriers of the identified practices can be found in Table 4.1. Finally, a comparison with the current literature provides a more grounded construction of results and contributes to theory development. Results are presented using various exemplar pilot projects. Those were selected by looking at the most elaborate descriptions of projects which contained the highest number of completed fields. Although self-reported, this is deemed necessary in order to show coherent results and enable within-case coding.

Table 4.1 Overview of identified practices and drivers and barriers

Case	Sustainable practices	Drivers (+)/Barriers (–)
1. Corporate safety clothing	• Defining purchasing processes • Managing stakeholders • Communicating organizational interests to achieve transparency	• Economies of scale (–) • Costs (–) • Specification (–) • Stakeholders differing interests (–)
2. Concrete recycling	• Collaborating closely with suppliers • Measuring environmental impact	• Chain collaboration (+) • Certification (–) • Costs (–)
3. IT buyback	• Collaborating closely with suppliers • Developing circular alternatives internally • Monitoring circular agreements through formal contracts	• Contract formulation (+) • Specification (+)
4. Recycled textile	• Communicating organizational interests to achieve transparency • Creating circular logic in the supply chain	• Specification (–) • Suppliers (–) • Internal bureaucracy (–)
5. Circular cable	• Creating circular logic in the supply chain • Developing circular alternatives internally	• Business case (–) • Organizational needs (–) • Costs (–)

4 Results

Figure 4.1 shows the number and type of circular pilots which were registered for the participating GD organizations in the online tool by the end of 2015 and the beginning of 2016. Pilots regarding textile and furniture are most popular, but a large increase can be seen in ICT, machinery and construction pilots. So far, 76 pilots have been registered by the participating organizations, yet not all of them are filled out completely and/or lack sufficient depth of information. After describing the selected exemplar cases and the identified sustainable practices, an overview of the drivers and barriers to implementing those sustainable practices is presented.

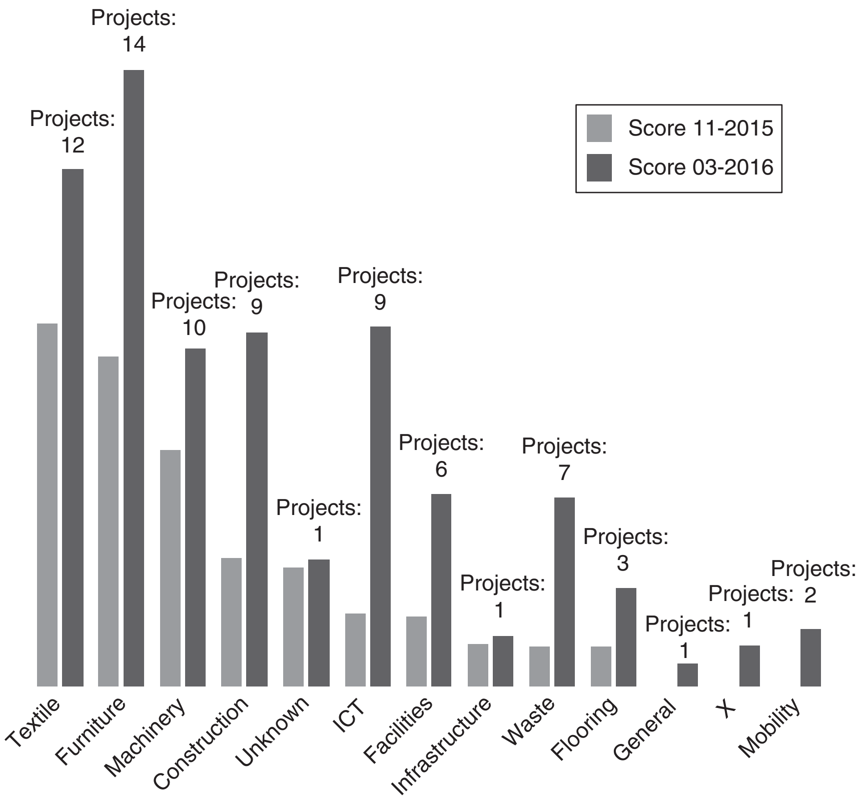

Fig. 4.1 Overview of type of circular pilots

4.1 Description of Selected Cases

Corporate Safety Clothing

The first selected case concerns a consortium of three organizations that collectively initiated a circular purchasing pilot regarding corporate safety clothing. Those organizations were primarily engaged in construction and facilities and shared an ambition to make 40% of the total weight (in kilograms) of purchased corporate clothing circular by 2017. They developed a strategy and action plan to reach this goal and in collaboration with other partners in the chain they formulated a purchasing process for corporate clothing which met circular principles. The organizations were well aware of the challenges of such an initiative and focused initially on safety vests (used for example by road workers) to continue later on with trousers and finally jackets. Experience in one category would then drive development in other categories of clothing. The organizations defined the important elements of the purchasing process and started a trajectory with suppliers who claimed to be able to deliver the circular safety vests. Those vests were made of recycled fibers and included reflectors which could be "microwaved" from the original vests and then reused. However, due to the different requirements from all three organizations and the variation in types of clothing, they struggled to reach the economies of scale necessary to make the endeavor economically viable. Selecting and managing safety clothing was a complex issue in which the various stakeholders had differing interests, such as safety level guaranteed, comfort, price and availability.

The relevant sustainable practices undertaken in this case were defining purchasing processes, managing stakeholders, and communicating organizational interests to achieve transparency, since these represent the social and collaborative activities that were needed and reported in order to establish a common purchasing process between the organizations involved.

Concrete Recycling

The second selected case concerns concrete recycling of a large Dutch municipality. With local infrastructure projects, this Dutch municipality wants to support the circular economy by closing the concrete cycle and creating local employment. It investigated the potential to recycle concrete tiles used as paving material with infrastructure projects. Used concrete from those projects is being processed and instead of purchasing new concrete made from original resources, concrete consisting of a larger part of recycled, "old" concrete granulate is purchased. This not only reduces production costs and the environmental impact, but also results in a lower transportation cost of heavy resources. To accomplish this, the Dutch municipality engaged with multiple suppliers in a so-called "concrete chain management". This inter-organizational institution discussed current forms of contracts between the municipality and the suppliers and the possible use of an environmental cost indicator for concrete. The question arose whether enough suppliers would determine this environmental cost indicator and if it would fit with circular principles. Another issue the municipality encountered was how to manage and co-ordinate this local concrete chain and what role the municipality would take. So far, the result has been a regular consultation between chain partners whose common goal is to improve concrete recycling. Several issues regarding this goal are identified and solved on a regular basis within the boundaries of the concrete chain.

Sustainable practices identified in this case are collaborating closely with suppliers (given the close interaction between the municipality and the concrete suppliers) and measuring the environmental impact (based on the encountered issues regarding a measure tool for environmental impact).

Information Technology (IT) Buyback

The third selected case concerned the buyback of computer hardware (such as monitors and additional video cards) of a large Dutch bank. Several requirements were set for this circular pilot: the reduction of packaging of new hardware was mandatory for suppliers. Next to that, the bank requested suppliers to use their buyback option, in other words they asked their hardware suppliers to come up with a value proposition for their current hardware for reuse or recycling elsewhere. Suppliers had to specify the reuse or recycling of the hardware in their buyback proposal. Suppliers were asked to develop additional circular efforts and this resulted in renewed agreements along the supply chain: manufacturers of the hardware in Asia changed or reduced their packaging.

The drive for this particular circular pilot came from both top-down management as well as bottom-up procurement. Results of this pilot are that the bank experienced the purchasing process as more convenient in comparison to its regular, linear purchasing process. The newness of this pilot created a lot of upfront discussion and evaluation about the desired outcomes and subsequent processes. In particular, the buyback option created less handling and disposal costs for the bank since this was now outsourced to the selected hardware supplier.

Sustainable practices observed in this case are collaborating closely with suppliers (although more was demanded/required of suppliers as opposed to the safety clothing case), developing circular alternatives internally (given that the Dutch bank initiated and developed this pilot internally), and monitoring circular agreements through formal contracts (which relates to the strict relationships with IT hardware suppliers).

Recycled Textile

The fourth selected case concerned the purchase of recycled textile for the Dutch Ministry of Defense. The Dutch government has a large purchasing volume and as such is a major player on the market so can set an example by making a certain percentage of recycled fibers mandatory in work wear and uniforms. To that end, the circular pilot for the Ministry of Defense was intended as an experimental tender to explore the circular possibilities of suppliers. The Ministry chose low-risk products such as overalls and towels for this pilot and conducted a market consultation together with an external organization to explore the issue of functional specification instead of technical specification of the products (the percentage of recycled textile fibers and the quality requirements, for example). The Ministry of Defense experienced difficulties in publishing a supplier tender since functional specification proved problematic for both Ministry purchasers and potential suppliers. Other barriers experienced with this pilot are internal bureaucracy, the requested level of product quality and having a sufficient amount of suppliers to choose from. Despite these challenges, the Ministry managed to address the social dimension of sustainability as well by outsourcing the sorting of its own collected textiles to a so-called “social workplace” staffed by mentally or physically challenged employees.

Summarizing, relevant sustainable practices in this case are communicating organizational interests to achieve transparency (especially given the requested circular ambitions towards suppliers), and creating circular logic in the supply chain. These two practices are closely related to each other but could both be identified in this case description.

Circular Cable

The fifth selected case concerned the development of circular cables from a Dutch energy network conglomerate. This group of organizations has set the goal of purchasing at least 40% of its assets according to circular principles by 2020. As an energy grid controller, this group of organizations is heavily dependent on aluminum and copper for its cables, acknowledging this dependence and the increasing scarcity of these resources. These arguments drove the need for its circular pilot of developing a circular cable (e.g. using recycled plastics and selecting suppliers based on the level of reused aluminum and copper). Various site visits have been conducted by its circular taskforce in its internal supply chain. So far, the pilot is in the research and development phase and has led to an industry-wide initiative for using circular plastics.

The constraints experienced are that a pilot concerning such a core product of this organization requires a significant amount of effort with many internal stakeholders. In addition, the lead time for any circular effects is long. The organization also reported in the online tool that it had difficulty making a clear business case concerning a circular cable.

Sustainable practices identified in this case are creating circular logic in the supply chain, and developing circular alternatives internally, both which are identified in other cases but in a more positive way. Also based on input from the GD community of practice meetings it became evident that the amount of stakeholders and long time horizon created barriers to establishing circular logic either internally or in the larger supply chain.

4.2 Cross-Case Analysis: Identified Sustainable Practices and Drivers/Barriers

An overview of the identified sustainable practices, drivers and barriers in the five exemplar cases is summarized in Table 4.1. A first interesting observation from the five cases is that the same concepts can act as either driver or barrier to implementing the sustainable practices. For example, where specification in the IT buyback case proved to be a driver (+), specification acted as a barrier (−) in the recycled textile case and the corporate safety clothing case. In the IT buyback case, specification concerned only a minor adjustment to internally developed circular alternatives for the reverse logistic flow of packaging material. In the corporate safety clothing case and the recycled textile case, specification related respectively to novel inter-organizational purchasing processes and a fundamentally different way of specifying (functional as opposed to technical). In both cases, the specifications deviate from traditional practices far more than the slight adjustments in the IT buyback case. This made the difference between either driving or hindering the implementation of sustainable practices.

The sustainable practices and the drivers or barriers to their implementation identified in the exemplar cases are aggregated in two ways: an internal dimension consisting of cost and co-ordination, on the one hand, and an external dimension consisting of collaboration and suppliers on the other hand. This is visualized in the data structure of Fig. 4.2. The internal dimension is focused on the interior processes of the focal organization whereas the external dimension is focused on the supply chain in order to address environmental and social dimensions whilst taking into account the economic bottom line.

The aggregated internal (cost, co-ordination) and external (collaboration, suppliers) dimensions are grounded in the literature. De Bakker and Nijhof (2002) stress that organizational capabilities for sustainable supply chain management relate to the internal dimension (i.e. the interior processes of the focal organization) and the external dimension (i.e. the larger supply chain). For both these dimensions the focal organization needs capabilities to implement new, sustainable practices. Seuring and Müller (2008) point out that the general acknowledged barriers for sustainable

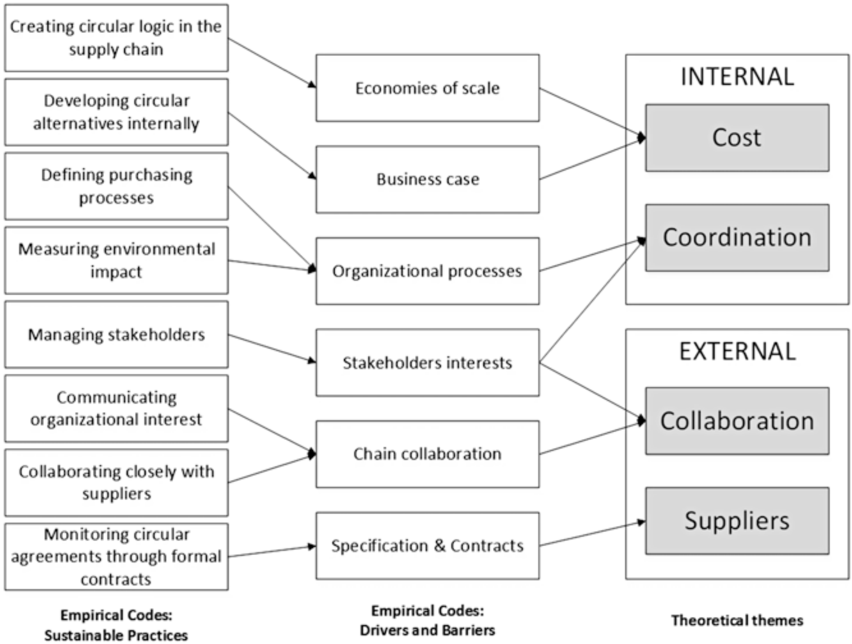

Fig. 4.2 Data structure of empirical codes and aggregated dimensions

supply chain management in the literature are cost, co-ordination and communication. Evidence on the cost was found in three out of five exemplar cases (see Table 4.1), the co-ordination barrier was observed more indirectly through issues with combining stakeholders interest with the focal organizations' own processes, whereas communication did not manifest itself clearly in the data. In addition, collaboration emerged as the externally oriented counterpart of co-ordination. However, when suppliers were not primarily the object of this collaboration in the supply chain (for instance if the focal organization collaborated more closely with customers) they could still pose a significant barrier to implementing sustainable practices when they were not able or willing to specify or monitor sustainable aspects of the collaboration. For example, in the recycled textile case the functional specification proved difficult not only for the focal organization but also for the relevant suppliers. More specifically, the focal public organization ran the risk of not being able to choose from the minimum amount of suppliers necessary, in which case it had to cancel the tender. Therefore, suppliers were added as an additional external theme besides collaboration.

5 Discussion

The results of this chapter corroborate the work of Seuring and Müller (2008) and show the value of studying circular adoption processes in more detail. Moreover, conceptually our findings on sustainable practices are in line with the more general observations of Brown and Duguid (1991), stating that a practice is a social, collaborative way of executing specific activities. In this way, our research contributes to providing a more theoretical foundation for studying sustainable practices, going beyond the more descriptive listing of practices found in the current literature.

The finding from the five cases that the same concept can act as a driver or a barrier to making the transition to a circular supply chain is highly interesting. Both practitioners and academics tend to view drivers and barriers as separate entities and treat them as such. However, our research shows that drivers and barriers are empirically intertwined and much more difficult to disentangle. This leads to the question of under what conditions certain aspects will act as either a driver or a barrier. More specifically, the link between our empirically identified barriers and drivers and the theoretical themes, as shown in Fig. 4.2, warrants further research. The identified interplay between drivers and barriers is bound to cause different dynamics in the transition towards circular supply chains. This fits neatly with one future research direction proposed by Touboulic and Walker (2015, p. 35), the one on implementation processes. This type of research should increase our understanding of how organizations adapt to their evolving environment through internal and external processes.

Besides focusing more on circular processes, future research might address the differences between regular SCM processes and related practice adoption with the more novel, circular processes of SSCM and their sustainable practices. It is likely that path dependent processes, which hinder the development of truly sustainable, or at least more circular, supply chains are at play (Montabon et al., 2016).

Given the voluntary nature of the Green Deal in which the organizations participated, it is remarkable that a significant proportion of the organizations struggled (or refused) to fill out an online monitoring tool for their circular pilots. This observation might point towards more salient issues of uncertainty and risk regarding innovative and radical changes in organizations while making the transition towards circular supply chain operations. This will be input for future research since it is the intention to keep tracking the circular pilots of the Green Deal organizations. It will be interesting to see if barriers and practices shift over time when different aspects of the adoption process become important to stakeholders.

6 Conclusion

This chapter answers the call for more research on the radical and innovative applications of circular supply chain models (Pagell & Shevchenko, 2014). Circular supply management implies a drastic break from traditional SCM practices and, as such, this chapter explores which new, sustainable practices organizations need for future, circular supply management.

The case findings show how sustainable practices in circular supply projects relate within the focal organization to cost and co-ordination and in the larger supply chain to collaboration and suppliers. More specifically, our chapter adds to the emerging body of knowledge on circular supply chain management in various ways.

First, the voluntary nature of the Dutch Green Deal Circular Purchasing program is no guarantee of a smooth implementation of circular pilot projects. The case evidence reveals that some GD organizations have not managed to start their committed pilots whereas others have not been very co-operative in sharing their progress via the monitoring tool.

Second, the distinction between drivers and barriers is not always clear-cut. Hence, in transitions towards circular supply chains it is essential to unravel the interplay between relevant entities in such processes.

Third, the Green Deal feature of Community of Practice meetings is very helpful in fostering an open dialogue on the (lack of) progress in the circular supply chain pilots. These meetings have been instrumental for both researchers and practitioners to become informed about more or less successful practices in circular transition processes.

In conclusion, the aim of this chapter is to show how organizations adopt and implement sustainable practices in order to achieve a circular supply chain; along with possible drivers or barriers. This chapter illustrates the process of adoption and defines the concept of a sustainable practice as propagated by Markman and Krause (2016). As such, future research on circular supply chain operations should be better equipped to understand the more fine-grained and detailed processes involved in adopting sustainable practices and to foster the development of sustainable supply chains.

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5

Inconsistent Norms in Buyer-Supplier Relations: A Study of Sustainability Introduction in the Textile and Apparel Industry

Ulla Normann Christensen

1 Introduction

Sustainable sourcing has been on the operations and supply chain management research agenda for more than a decade and is among the most popular topics in the field today. Meanwhile, companies have developed a range of methods and tools for managing sustainable sourcing, which has grown to be an integrated part of their operations and purchasing strategy. Both in practice and in the sustainable operations and sourcing literature, we still see examples of these methods not always having the desired effect. Unruh (2013, p. 17, 18) asks the question, "*Can this issue be resolved without our company's involvement or materially faster with our company's involvement?*", and answers by indicating that if the answer to the question of whether the sustainability issue or the challenge can be solved without the company's involvement is negative, this indicates that

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the company has crucial responsibilities and risks. If the answer to the question of whether the problem can be resolved significantly faster with the company's involvement is positive, this indicates that the management responsible for the company's sustainability issues should explore whether a strategic answer is warranted. This chapter explores aspects that are essential to management in companies, when working with strategy development in the context of sustainability and sourcing, to enable managers to understand the interplay between goal setting and managerial processes. The chapter is based on the textile and apparel industry where the sustainability challenges are extremely high.

Back in the 1980s, the textile and apparel manufacturing in Denmark was no longer competitive compared to low-wage regions like Asia and Eastern Europe, and the industry began outsourcing production to those regions. With no contracts, close relationships developed over time based on orders, trust and commitment, leading to a set of governance mechanisms of relational norms (Ivens, 2006); mutual expectations to the relationships thus arose (Lampel & Shapira, 2001; Macaulay, 1963).

Soon after the millennium, buying companies in the textile and apparel industry started imposing demands on suppliers' handling of social and environmental issues. With the introduction of sustainability requirements, the behavior of buying companies became more transactional or discrete as a result of requirements (e.g. contractual-based codes of conduct and requirements of sustainability-related certificates). There has been a tremendous increase in buying companies pushing for the implementation of these contractual-related issues and buying companies have equally become increasingly eager to monitor suppliers' activities.

The study in this chapter investigates the norm set existing in the buyer-supplier relationship and explores the possible changes to this caused by the introduction of new assessment/contractual-based sustainability requirements. Norms play a significant role in understanding business exchanges (Ivens, 2002) and have been identified as an important antecedent to relationship outcome variables (Ivens, 2006). Furthermore, business exchange research has studied relational and contractual norms extensively (Gundlach & Achrol, 1993; Macneil, 2000). Norm theory describes the set of norms that determines the behavior in the present exchange as well as in the future exchange relationship (Blois & Ivens, 2007). Exchange theory states that the norms governing commercial exchange behavior in contractual relationships are clearly different from the norms governing relational exchange (Kaufmann & Stern, 1988).

The study sheds light on how the shift or change in buying companies' behavior from purely relational to a combination of relational and transactional has affected existing industry norms and suppliers' perception of the change in norms. The following double research question guides the investigation into this matter: "*What norms determine current behavior by buyers and suppliers in the textile and apparel industry and how have these norms developed over time*?" To answer this question, 30 suppliers/manufacturers were interviewed about their perception of applied norms. In addition, they were asked how buying companies manage sustainability.

This chapter contributes to the literature by demonstrating the change in norms developed in the textile and apparel industry and adopted by suppliers and buying companies to guide their relational exchanges over many years; a change occurring concurrently with the emergence of supplier sustainability requirements.

The result of this behavioral change is a gap between the already established norms and the norms that have arisen as a result of the introduction of sustainability-related requirements. Buying companies somehow operate to parallel norm sets, one for normal exchanges characterized by relational norms, and one for sustainability initiatives where the exchange is purely contractual. The development of these two concurrent but inconsistent norm sets confuses suppliers and makes it difficult for them to interact with buying companies. This considerable gap between the existing norms and the new sustainability-related norms has not been documented before and therefore represents a contribution to extant literature on business exchange.

The chapter is structured as follows. First the theoretical background is introduced, followed by a description of the methodological process applied to the research conducted. The chapter subsequently presents the findings and discusses relevant excerpts of the data that reflect emerging concepts. Finally, a conclusion is drawn and limitations and managerial implications outlined.

2 Theoretical Background

2.1 Norms in Transactional vs. Relational Exchange

An exchange occurs when resources are transferred from one party to the other in return for resources controlled by the other party (Blois, 2002). In terms of transactions, the literature has drawn heavily on theories of transaction costs and contract law. With transaction cost theory, Williamson (1985) distinguishes between market, hierarchy and hybrid governance whereas Macneil (1980) with contract theory focuses on contract norms and shared expectations of behavior ranging from discrete to relational. Depending on the type of exchange transaction between buyers and suppliers, different forms of contracts are appropriate (Ivens, 2002). The difference between the various forms of contracts is defined by the existence of a discrete transaction or transactions occurring over a period of time; relational transactions (Ivens, 2002; Macneil, 1978). Almost three decades ago, Dwyer, Schurr, and Oh (1987) argued that business exchanges were going through a change from the anchor point of discreteness towards more relational exchange. Dwyer et al. (1987) also claimed that the change away from discreteness was due to the establishment of reliable teams of suppliers, and that this strong supplier base was dependent on the nature of the relational contracts between buyer and supplier.

Relational contracts are based on trust, meaning confidence in the predictability of one's expectations (Luhmann, 1979; Zucker, 1986) or in another's goodwill (Ring & Van de Ven, 1992).

Because of the recognition of more co-operative governance strategies, much academic focus in the field was slowly drawn towards relational governance strategies (Griffith & Myers, 2005). It became an accepted premise that the reliance on legal contracts alone was frequently insufficient (Rai, Keil, Hornyak, & Wüllenweber, 2012). Whereas the discrete transaction is governed by classical and neoclassical contract law, where actors project all aspects of a transaction into the future with a formal written contract, relational contract law explicitly focuses on the problems caused by continuing business relationships and is based on the principles of norms (Ivens, 2002); mutual norms produced by trust in inter-personal interactions when dealing with uncertainty (Homans, 1961).

Norms can be described as either discrete or relational (Macneil, 1985). Discrete norms are about the expectations exchange partners have about the individual or competitive interaction (Lambe, Spekman, & Hunt, 2000). A specific property of relational norms is that they guide behavior so as to maintain the system or the relationship as a whole and restrict behaviors that promote the objectives of individual parties. Relational norms inherently confer protection against exploitative use of decision rights (Heide & John, 1992) and reduce the risk of opportunistic behavior (Ouchi, 1980). Depending on where an exchange lies on the discrete-relational spectrum or continuum, the applicable norms change (Blois & Ivens, 2006). Some of the norms are intensified at one end and others at the other end.

2.2 Specific Norms

In exchanges where goals are ill-defined, norms represent important social and organizational vehicles of control. They create a general frame of reference, order and standards that guides and assesses appropriate behavior in uncertain situations, where contracts are often incomplete and legislative means may undermine the continuation of the relationship (Cannon, Achrol, & Gundlach, 2000). This implies that the acceptance of norms by the parties engaged in exchange is required in order to render such exchanges effective (Cannon et al., 2000). Heide and John (1992, p. 34) define norms as "*expectations about behavior that are at least partially shared by a group of decision makers*".

Contractual norms represent shared expectations regarding behavior, ranging from discrete to relational, in contractual and relational exchanges respectively (Durif & Perrien, 2008; Macneil, 1980). The relational exchange school mentions that contracts are arrangements left incomplete to allow the players flexibility to adjust to environmental changes (Macneil, 1978). Instead of making complete contracts, parties prefer to formulate common goals in a rough and open manner to allow easy and fast adaptation to changing conditions. For this reason, Macneil (1980) asserts the overwhelming importance of norms as governance mechanisms in business relations.

Macneil (1980) proposes a *common* set of norms for the governance of exchange processes. He first suggested nine norms (Macneil, 1980), but later (1983) developed a tenth and changed the label applied to one of the original nine, resulting in a set of 10 common exchange norms. When used as standard norms of governance, these norms reflect shared expectations and informally create a structure for business relationships (Macneil, 1980). The 10 common contract norms are: *role integrity, reciprocity, implementation of planning, effectuation of consent, contractual solidarity, creation and restraint of power, flexibility, harmonization with the social matrix, propriety of means, and restitution, reliance, and expectation interests* (linking norms) (Blois & Ivens, 2007). Such a framework of norms is of course helpful when considering governance issues and when analyzing the actual interaction between suppliers and buyers. But how do these norms differ from one other? Macneil does not provide an ultimate and definite list of which norms are most relevant in business relationships (Ivens, 2006), and he also notes that: "*This cake can undoubtedly be sliced in many ways*" (Macneil, 1980, p. 40).

Because this study explores the interaction between buyers and suppliers, the list of norms found in Ivens' (2006) review of 34 marketing scholar papers on relational exchange theory and the use of norm constructs as variables in a large variety of models, has been used for this study. Ivens (2006) documented 10 norms, where some were treated conceptually and some were also empirically tested. The norms were: *long-term orientation, role integrity, planning, reciprocity (mutuality), solidarity, flexibility, information exchange, conflict resolution, restraint in the use of power, and monitoring behavior* (Ivens, 2006).

The 10 norms from Ivens (2006) can be placed on a continuum suggested by Lambe et al. (2000) and based on Macneil's (1980) conceptualization of exchange (see Fig. 5.1). Their (Lambe et al., 2000) bifurcation of the continuum consists of transactional exchange as being least relational on the left side and relational exchange as the most relational of all exchanges on the right side (Lambe et al., 2000).

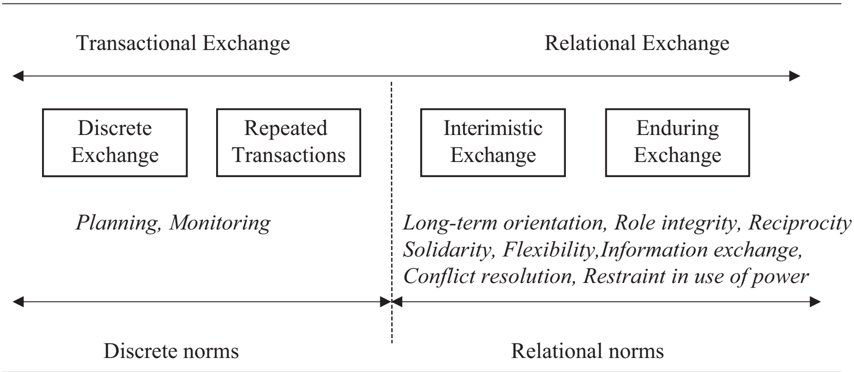

Fig. 5.1 The norm and exchange continuum adapted from Lambe et al. (2000)

The figure illustrates that the norms of planning and monitoring, which serve to guide parties in agreed-upon exchanges, are at the transactional end of the exchange continuum (Macneil, 1985, note 187; Tuusjärvi & Möller, 2009). The transactional exchange is divided into discrete exchange and repeated transactions with discrete exchange being one time or "one shot" (Lambe et al., 2000; Webster, 1992). Even though both forms are essentially non-relational, repeated transactions point more towards the relational because of the greater opportunity to develop a relationship.

The remaining norms are within the relational exchange on the exchange continuum, which is divided into interimistic and enduring exchange. Interimistic exchange requires a relatively high level of co-operation but time pressure allows for fewer interactions and makes it less relational than enduring exchange (Lambe et al., 2000). Norms like reciprocity, role integrity, solidarity and long-term orientation clearly belong to enduring exchange while the position of the remaining relational norms is more vague, but should clearly be classified as relational on the exchange continuum. Both transactional and relational norms can move on the exchange continuum and change depending on the individual kind of exchange (Blois & Ivens, 2006). Furthermore, some norms appear to be partially over-lapping (Achrol, 1997; Cannon et al., 2000; Heide & John, 1992).

2.3 Violation of Norms

Defining bilateral expectations in buyer-supplier relationships, relational norms provide critical governance mechanisms in that relationship (Heide & John, 1992). When expectations of norms are bilateral, they can serve as a governance mechanism and safeguard against opportunistic behavior (Berthon, Pitt, Ewing, & Bakkeland, 2003). Bilateral expectations can also contribute to trust and commitment in the relationship between the buyer and the supplier. Furthermore, the existence of relational norms in a dyad is seen as an indicator of the harmony of both parties' interests, which, in turn, also reduces the risk of opportunistic behavior (Ivens, 2006; Ouchi, 1980). Such norms can also serve as a general protective mechanism against deviant behavior (Stinchcombe, 1986).

Most research dealing with shared norms has looked at what happens when one party either violates or conforms to the norms. This chapter deals with a situation where the set of norms adopted by each party has actually deviated over time, resulting in a situation where the parties now follow sets of norms that are not entirely consistent. In extreme cases, which may actually be hard to imagine, one party may follow transactional norms while the other acts according to relational norms. Obviously, distrust and opportunistic behavior can emerge from this situation. General expectations and deviations from expected behavior and the violation of norms may, however, also form the basis of conflicts among parties of a relational exchange (Ivens, 2006). Ivens (2002) also states that if a gap opens between two parties' respective interpretations of the same norm, ineffective co-ordination of the exchange relationship can be the consequence. Furthermore, if the gap becomes unacceptable for one party, co-operation may cease. Violations of norms can therefore affect the overall atmosphere of the relationship in terms of the power dependence between the companies, the state of conflict or co-operation, and the overall closeness or distance of the relationship as well as the companies' mutual expectations (Ford, 2002).

In established exchanges, violation normally occurs as single deviations from agreed upon sets of norms. For different reasons, one party steps outside the established set of norms. Though having negative repercussions, this also triggers a social process of repair or of bringing the exchange back into balance. This chapter deals with norm asymmetry (Lampel & Shapira, 2001) and situations where more serious norm set gaps emerge in established exchanges. Such situations are more critical because they mark a larger gap between the parties and are more difficult to resolve. This asymmetry and gap emerge when the behavior of the buying companies changes relative to the type of established exchange (Cropanzano & Mitchell, 2005), which produces a surprise that may disrupt the exchange. A change in behavior has been shown to produce surprises in business exchanges (Tähtinen & Blois, 2011). Cambridge Dictionary defines surprise as: "*An unexpected event, or feeling caused when something unexpected happens*" (Cambridge Dictionary, n.d.). A change could, for example, be the deviation from a common set of norms, and the gap caused by this deviation. Lampel and Shapira (2001, p. 600) states that: "*a strategic surprise occurs when an actor switches from behavior that reinforces cooperation to one that expresses the intent of extracting concessions*". If it is not possible for the surprised company to find one acceptable reason to justify the behavior of the other party, the surprise may amplify and emotional experiences change to anger and frustration (Tähtinen & Blois, 2011). Thus, such norm changes are also highly relevant from a managerial perspective, because of the need to introduce change into business exchange, but without compromising the relationship. If the changes in norm set are not build on trust and shared expectations the risk of opportunistic behavior can arise. Trust, is concerned with the degree to which norms influence behavior when there are no incentives or sanctions to act as constraints. Such incentives include an increased supplier profit or at least higher paid prices in the light of the sustainability requirements and initiatives. It has been argued that no rational actor should trust without clear evidence of incentives or sanctions to back promises, thus promoting trust (Dasgupta, 1988; Williamson, 1993).

3 Methodology

The research question is exploratory, thus requiring a methodology that is appropriate for delving deep into how suppliers perceive the existing norms and the change, caused by the introduction of the sustainability-related norm set. An exploratory interview design was chosen and 30 semi-structured interviews were conducted with textile and apparel industry suppliers in India, Bangladesh and China. The countries selected are from three of the largest textile and apparel-producing countries exporting to Denmark (Database Eurostat, 2012). A semi-structured interview guide was developed around a number of topics to allow the participating suppliers to express their perspectives and perceptions of the sustainability-related relationship with the buying companies and their requirements and initiatives regarding sustainability compliance. In each interview, there was also room for discussion about issues not covered in the interview protocol, that the participants considered relevant (Yin, 2003). To answer the research question, managers or plant owners of the various suppliers were interviewed. Each interview was carried out face-to-face, in English, with an average length of 41 minutes. All interviews were recorded and transcribed verbatim. The suppliers were assured beforehand that personal and company names would not be used, to ensure anonymity. Taking this approach made it possible to gain insights into how the suppliers perceived the sustainability-related norm set and how the norm set has changed.

The data analysis was conducted following Charmaz's (2014) coding framework. According to Charmaz (2014), coding should be conducted in at least two phases: initial coding and focused coding. Initial coding helps to identify the variables of importance and sticks closely to the data, moving the coding towards later decisions about defining core conceptual categories. Initial coding is done line-by-line, word-by-word or incident-by-incident (Glaser, 1978). After having established some strong analytic directions through the initial coding the focused coding can help synthesize and explain larger segments of data (Charmaz, 2014). During focused coding the adequacy of the most significant and/or frequent earlier codes are determined by thoroughly examining the large amount of data.

The data coding of this study was conducted iteratively. Each case was individually coded and the results were discussed with a research colleague to assure consistency. During the initial coding, a within case (Eisenhardt, 1989) analysis was performed very close to the data. The purpose of the initial coding was to identify and understand the norms present in the supplier-buyer relationship in the textile and apparel industry. The 10 norms discovered by Ivens (2006) were used as a conceptual framework in this within-case analysis to help reduce the data and for data management (Miles & Huberman, 1994). During initial coding, color codes were applied (Kähkönen & Virolainen, 2011) subject to classification of the 10 different norms. During this initial coding phase it became obvious that it would not be possible to find evidence for all of Ivens' (2006) 10 norms in the data. Four norms with strong evidence and three with weaker evidence were found in the data. Strong evidence means that evidence was found in a major part of the interviews; with minor evidence the norms were found in fewer interviews (see Table 5.1).

During the focused coding stage, the codes with the seven found norms were all reviewed and examined for their adequacy. Through an iterative process, concrete detailed quotes were studied gaining further detailed insights in terms of the norms that were present in the data (Strauss & Corbin, 1994). In this phase, the coding instances were analyzed and interpretations with respect to the study's research questions were made. Notes and analytical documents were drafted and connected to form a clear chain of evidence (Barratt, Choi, & Li, 2011).

Table 5.1 Appearance of norms in the data

Norms with strong evidence	Appearance	Norms with weak evidence	Appearance
Role integrity	17	Long-term orientation	4
Reciprocity	22	Information exchange	6
Solidarity	10	Restraint in the use of power	5
Monitoring	22		

4 Findings

Seven of the 10 norms (Ivens, 2006) were found in the interview data analyzed. With the aim of showing the gap emerging in the set of norms for buyer-supplier relationships as a result of sustainability-related requirements, findings for each of the seven norms will be presented and elaborated below. The four norms with strong evidence will be elaborated individually, and the norms with weaker evidence will be elaborated together.

4.1 Role Integrity

The first analyzed norm was *role integrity*, which refers to maintaining multidimensional and complex roles in a business relationship and ensuring proper and adequate behavior from each party in the exchange (Ivens & Blois, 2004). This investigation sought to uncover the suppliers' perception of the behavior expected from the buying companies. One of the first things that became evident in terms of the role integrity norm was the change in the role and behavior of the buyers caused by sustainability-related issues.

The role as a *buyer* remains intact with regards to normal exchange, including for example ordering and product-specific issues and general *responsibility* for the normal exchange. But the role in connection to sustainability aspects of the exchange deviates, because it does not cover *responsibility* for sustainability-related issues. Many buyers do not adopt a holistic approach to the purchasing of products while meeting sustainability requirements. Because buyers see sustainability as a requirement which is separate from the normal business exchange, this frustrates suppliers, who do not distinguish between the two. Suppliers believe that the buying companies do not provide help regarding sustainability issues and therefore leave the responsibility up to suppliers. This is in contrast to the help that suppliers are used to getting from buyers in a normal exchange. Most respondents argued that buyers are most often ready to answer questions or send out quality controllers to help the suppliers. But this differs when it comes to sustainability. As one Chinese supplier states: "The customers don't come for compliance, only for orders—they don't care about sustainability". Nevertheless, sustainability is still demanded by buying companies. A supplier from Bangladesh states that buyers simply ask: "Can you produce at this price or not?" He continues: "Customers will not listen to how we are producing". An Indian supplier stated: "To the customer it (sustainability) is just a standard—it has nothing to do with the production, it has nothing to do with the quality, and nothing to do with the costing of the product. The customer just wants the approved audit report—that's it".

The two roles are also often evident in situations where the buyer asks for faster delivery, requiring the supplier to work overtime. At the same time, however, buyers impose sustainability requirements that do not permit overtime, indicating that a buyer's typical role in the purchasing process is changing as a result of sustainability requirements. The consequence is that a buyer's behavior and role when it comes to normal product exchange is different from his or her behavior and role when it comes to sustainability issues and the suppliers find this duality of roles difficult to comprehend, resulting in the buyer losing integrity.

4.2 Reciprocity

Reciprocity may be defined by the expectation of each party to get something back for something given, the exchange of which is not necessarily evenly divided between the two parties (Blois & Ivens, 2007; Macneil, 1985, note 88). When interpreting suppliers' perceptions of this norm, many examples were found where suppliers are frustrated about the issues of sustainability. In terms of sustainability, suppliers consider the requirements imposed by buying companies relevant. As suppliers need to allocate considerable resources for implementing and investing in sustainability, while rarely receiving help or contributions from buyers, the sustainability requirements also go against the reciprocity norm.

An Indian supplier expressed it this way: "I do not completely disagree with the whole system. I think it helps us as well to improve our standards, but I think we have to draw a line. You know you cannot just make things difficult for no reason—if they want this thing [as an] extra why don't they contribute?" When posing this question in the interviews, "Are the customers willing to pay higher prices due to sustainability?", a supplier from Bangladesh answered: "Totally negative, NO!" Another Chinese supplier stated: "Of course not. Customers always want something for free" and an Indian supplier said while laughing: "I wish; I wish that would happen".

Because buyers again separate the product-related part of their business from the sustainability-related part, they do not believe it is their responsibility to contribute to the costs of sustainability by paying higher prices, which is considered as a matter of course for suppliers. As one Chinese supplier states: "The customers like the sustainability concept, but they do not want to pay for it. They say that it is not their business; it is not the buyers' problem because they have their budgets". As the suppliers consider the business of supplying products and sustainability two sides of the same coin, this is hard for them to understand.

Overtime work is also an issue related to the norm of reciprocity. Even if this is a result of their own demands for shorter lead times, buyers are not willing to pay extra for overtime work though their own sustainability requirements require them to do so. So, even though suppliers accept sustainability-related requirements, they do not see reciprocity as a matter of "giving and taking". The data show a relatively large gap between the reciprocity norm in relation to normal product exchange and the reciprocity norm in relation to sustainability-related issues.

4.3 Solidarity

Solidarity, or contractual solidarity, is the third dominant norm found in the data coding. Solidarity is the norm of maintaining an exchange and operating within a set of rules accepted by the majority of the society in which the exchange takes place (Ivens & Blois, 2004), and solidarity is developed by emphasizing common responsibilities and fellowship (Achrol, 1997). The findings show that the suppliers perceive the norms the industry has developed based on long-standing collaborations as applicable to doing business with the buying companies.

Indicating *how* to act, under which rules and which behavior to comply with, these norms are followed by both parties. However, in the last 5–10 years, these norms have changed on the part of the buying companies.

The product exchange relationships still exist as before, but as a result of imposing sustainability requirements suppliers no longer feel that the solidarity norm is being followed. Suppliers would like to maintain long-standing collaborations and exchanges, but find it hard to see that the exchange is based on solidarity when sustainability-related issues are involved. At the same time, most buying companies have always demonstrated solidarity and an understanding of what is achievable in normal product exchange, again lending evidence to the deviation in norms.

When it comes to the requirements for sustainability, there is a lack of understanding. An Indian supplier stated: "We do not get any support at all". Also, the fact that sustainability-related requirements have been imposed without any adaptation to the cultures or society in which the exchanges take place causes frustration as the exchanges follow the norms existing in the buying companies' own society. As stated by an Indian supplier: "Requirements should be country related. What happens in China is very different from what happens in India or Bangladesh".

The solidarity norm is very general. It could be argued that maintaining the exchange can be influenced by, for example, the perception of reciprocity and monitoring behavior. One may wonder if there is any solidarity when buyers are unwilling to share or contribute to sustainability-related costs or help with sustainability-related problems that are a result of the sustainability requirements imposed by themselves. As sustainability-related requirements have increased, solidarity in the exchanges has declined.

4.4 Monitoring Behavior

The final norm backed by strong evidence in the data is *monitoring behavior*. This refers to the ex-ante and ex-post control or supervisory actions present in business relationships (Noordewier, John, & Nevin, 1990). The findings regarding the suppliers' perceptions of this norm are based on most of the interviews. No sign was found in the data to indicate that suppliers did not accept monitoring activities, and the suppliers' relationships with buying companies have always been subject to monitoring. Hence, monitoring is perceived to be part of the normal exchange.

However, the findings also show that suppliers now feel that this monitoring activity, specifically with regards to sustainability, has somehow got out of control. The suppliers indicated that there were too many different standards to comply with; standards imposed by various customers as well as by the countries where the customers are based. With almost similar requirements for sustainability compliance, all the different standards have resulted in countless numbers of audits and, consequently, high costs.

In addition, most monitoring activities are carried out by various third-party auditing companies, creating many discrepancies between the auditors and the suppliers. Some of these discrepancies are a result of auditors having their own rules and agendas and showing an attitude of control and disregard when they enter supplier premises. A supplier from Bangladesh stated: "The book is saying what we should do, but they (third party) are not looking at the convenience or what is practically possible. At today's audit they might say something and at tomorrow's audit, some other rules are in force". In addition, the data show that there is quite a number of unethical behaviors in the sustainability auditor business, as some auditors can easily be paid off to gain approval of an audit report. A Chinese supplier stated: "No factory is 100% compliant—but sometimes we might have to give the third party some good wine or cigarettes". More generally, another Chinese supplier stated: "Nine of 10 certificates in China are bought with money under the table".

Compared to the monitoring activities in place before the introduction of sustainability requirements, monitoring has become more aggressive and the monitoring behavior is not in line with suppliers' perception of appropriate monitoring, which was previously occurring in accordance with a relatively relational norm. The difference in perception of the monitoring norm is mainly a result of the disappearance of the relational aspect. Previously, when monitoring aimed to control product quality, control was performed by the buyer or the buying companies' own employees. Today, sustainability control is mostly performed by third party auditors or people from the buying companies' sustainability departments, and they rarely encourage relational exchange.

4.5 Norms with Minor Evidence

The first of the three norms for which there is only some evidence in the data is *restraint in the use of power*. This refers to the expectation that no actor will apply his or her legitimate power against the partner's interest (Ivens, 2006). The findings related to this norm mainly concerned customers, who very often use their power to put pressure on the suppliers regarding sustainability compliance. This is done either by directly imposing sustainability requirements or by threatening to find another supplier if the requirements are not accepted or fulfilled. As such, there is no gap here between the normal product exchange and the sustainability exchange since buying companies in both cases use their power both to push prices and try to attain sustainability compliance.

The second norm with weak evidence in the data is *information exchange*. Information exchange may be explained by the parties' readiness to proactively provide all information useful to the partner (Heide & John, 1992). When it comes to sustainability-related issues, some suppliers indicated that there is a lack of communication from buying companies, and suppliers are frustrated that they cannot communicate with buyers regarding sustainability; communication is reduced to a written code of conduct, and the suppliers are instructed to communicate with the third-party auditor. One Indian supplier stated: "There is no communication with the customers—they are only demanding. They suggest to us what to do. It is not a two-way communication". And a Chinese supplier said: "We would like to talk to the customers and find solutions regarding compliance together instead of only demands". Another Chinese supplier stated: "We would like it if they (the buying companies) could come and see if, for example, a part of a correction plan from the third party is really important or if we can work for a solution". But this is often a problem because buyers who visit the supplier do not have the sustainability-related expertise or capability to help the supplier. This means that suppliers are asked to communicate with the third-party auditors, who work exclusively according to standards and regulations and not according to what is optimal for the supplier and the relationship.

The final norm with weak evidence is *long-term orientation*, referring to an economic actor's desire to maintain the exchange and his or her utility of having a long-term relationship with a specific exchange partner (Ganesan, 1994; Ivens, 2006). Most of the 30 suppliers have had long relationships with many of their customers, but when it comes to sustainability requirements, the utility of the long-term relationships seems hard to identify. Some of the suppliers appeared resigned in their search and hope for help from buying companies. It was only in four of the interviews that the long-term orientation norm was indicated and, in those cases, the norm referred to the normal product exchange relationship. Suppliers prefer close co-operation and a good relationship, and so do buying companies. But when it comes to sustainability-related issues, relationship and close co-operation is secondary.

Figure 5.2 provides a picture of the deviation and the gap that has emerged in the norm set between the normal product exchange relation-

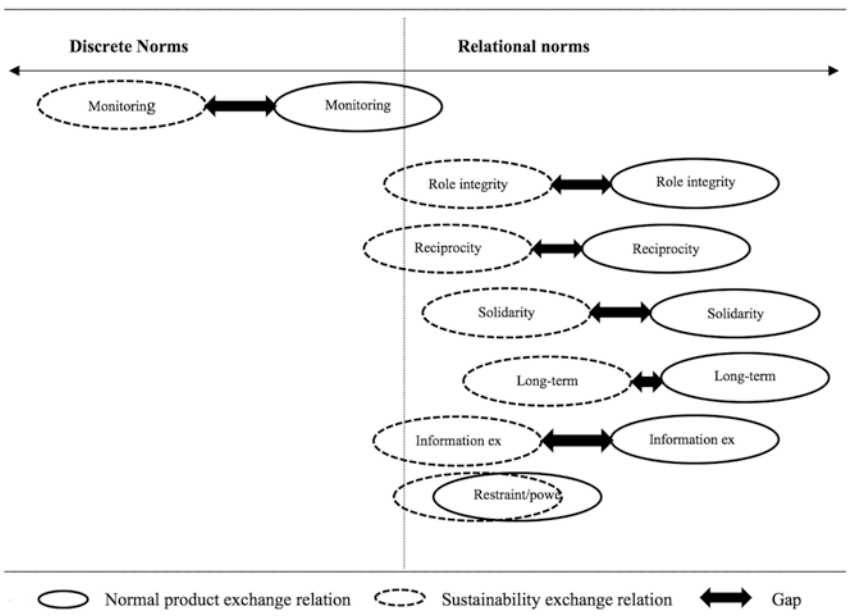

Fig. 5.2 The gaps between norms in a normal product exchange relationship and a sustainability exchange relationship respectively

ship and the sustainability exchange relationship. Although many studies use operationalized norms, norms are difficult to actually investigate and measure (Blois & Ivens, 2006), therefore the positioning of the norms will of course be an estimate made from the findings of the analysis.

5 Discussion

The purpose of this study was to look into the set of norms present in the textile and apparel industry and to see how this set of norms has changed over time. Of the 10 norms defined by Ivens (2006), we found evidence in the data for seven norms that could clearly be distinguished in the suppliers' perceptions of their customers' behavior and where inconsistencies have occurred with the introduction of buyers' sustainability requirements. These inconsistencies are between norms noted by the supplier when inquiring about sustainability-related issues, and norms that have guided the exchange between suppliers and buying companies for many years. The findings show that the exchanges have changed over the years and now reflect a dual norm set guiding the buying companies' behavior.

Sustainability-related transactional behavior does not match the already-established relational norms, which frustrates suppliers as relational norms used to guide their relationships with buying companies. The challenge in the relationship today is that suppliers still broadly see co-operation as the norm, while the buying companies separate the normal product exchange from sustainability requirements. While the product exchange remains relational, buying companies are in this way adopting a new set of more transactional norms for the sustainability-related part of the exchange. This leads to a situation where the norms are no longer mutually respected in the relationship. A similar change in the set of norms from a purely relational exchange to a more transactional exchange has been documented as a *surprise* to the supplier (Lampel & Shapira, 2001).

Although such change has gradually emerged over the past 5–10 years, the fact that the norms and the behavior of the buying companies have changed so much has come as a surprise to the suppliers. The suppliers now find themselves in a position where the buying companies are taking advantage of the very process that perpetuates the relationship (Lampel & Shapira, 2001). In the sustainability-related exchange, buying companies have adopted new norms, but traditional norms have now also moved in another direction. If we look at these seven norms in the transactional-relational exchange spectrum (Blois & Ivens, 2006), we can see a change or drift. Before the sustainability-related requirements took effect, the five relational norms of *solidarity, reciprocity, role integrity, long-term orientation and information exchange* were placed towards a relational exchange, relatively far to the right of the spectrum. The findings show that these norms have now moved to the left of the spectrum towards transactional exchange (see Fig. 5.2). Also, before the introduction of sustainability requirements, the transactional norm of *monitoring* behavior was already to the left of center, but has now moved a major step closer towards purely discrete exchange. The buyers' norms are no longer primarily adapted to the relational exchange as it is evident that their behavior has become more transactional in relation to sustainability-related issues.

Conceptually, this discrepancy in type of exchange and behavior is illustrated in Fig. 5.3, which shows that a specific type of exchange is associated with a certain behavior and thus a certain set of norms. When a change occurs in an exchange, this will automatically cause a change in the set of norms, leading to inconsistency and a mismatch in the relationship. Exactly as we see in this study, the existing relational exchange of products is challenged by the transactional behavior caused by sustainability-related requirements (Cell 2).

		Type of behavior	
		Relational	Transactional
Type of exchange	Relational (normal product)	Cell 1: Match Relational behavior In a relational exchange	Cell 2: Mismatch Transactional behavior In a relational exchange
	Transactional (sustainability)	Cell 3: Mismatch Relational behavior In a transactional exchange	Cell 4: Match Transactional behavior In a discrete exchange

Fig. 5.3 Adapted from Cropanzano and Mitchell (2005)

The findings revealed that the buying companies are combining transactional- and relational-based governance mechanisms but without considering existing norms and mutual agreements with suppliers—and probably without even realizing themselves that this is what they are doing.

This empirical research contributes to the literature by documenting the phenomenon of norm deviation over time, where one party (buying company) adopts a transactional norm set for one part of the exchange (sustainability initiatives), while maintaining another relational norm set in the normal exchange generating a gap between buyer and supplier norm sets and causing rather severe norm violations. The empirical research shows that the mismatch in behavior and type of exchange clearly confuses and surprises suppliers and at the same time creates a large gap in the respectively normal product exchange norm set and the sustainability-related exchange norm set, which has not previously been demonstrated by research.

6 Conclusion

This chapter has explored suppliers' perceptions of the norm set existing in their relational exchange with buying companies in the textile and apparel industry. Furthermore, the chapter has explored the suppliers' perceptions of the buying companies' behavior in relation to sustainability-related issues and how they have developed a new set of norms. Based on the findings, it can be concluded that there is a growing gap between the pre-existing set of norms governing the buyer-supplier relationship and the set of norms developing in relation to sustainability issues. This gap could be the result of buying companies making use of transactional governance mechanisms such as codes of conduct, certificates and increased monitoring activities. In addition, the buying companies' separation of the normal product exchange and the sustainability-related exchange pushes the exchange norms, as perceived by suppliers, in a more transactional direction as far as sustainability exchange is concerned. This serious gap, or deviation, in the set of norms, and the buying companies' behavior, causes surprise and frustration for suppliers. With the mismatch in behavior, this frustration might affect trust and common expectations of the established relationship and may impede the possibility of compliance for suppliers. As stated by suppliers, another consequence of this deviation of norm interpretation is ineffective co-ordination of the sustainability-related exchange relationship.

Although interesting results were found in this study, some limitations may provide directions for future research. One limitation to this general study was its exclusive focus on the suppliers' perception of the sets of norms existing in the exchange between them and the buying companies. To compare the perceptions of two sides of the dyad, it would have been interesting not only to investigate this unilateral perception but also to look into buying companies' perception of the norms. Second, by only analyzing one specific industry the researcher has renounced a broader analytical generalization for in-depth exploration (Vedel & Ellegaard, 2013). Future research could therefore test the findings in other industries and possibly other countries and cultures.

7 Managerial Implications

It is very important for buying-company managers to recognize and embrace the concept of sustainability in their business (Kumar & Christodoulopoulou, 2014) and in that connection to ensure supplier sustainability compliance. Buying-company managers must be aware of the gap between the original product-oriented norm set and the norm set that also exists in connection with sustainability-oriented activities. They must be aware that they cannot isolate sustainability from the rest of the business—thus creating two norm sets. By doing so, they can damage the relationship, as having two norm sets confuses and frustrates suppliers. Suppliers pointed out many times in this study that they find buying companies' methods and the results of these to be unfair. This perception can greatly affect the possibility of sustainability compliance. In connection to supply chain initiatives, Frazier et al. (1988) state that the fairer a deal (initiative) is, the higher the chances of success. Mutual expectations in the relationship regarding the sustainability-related requirements stipulated by the buying companies are hard to spot in the data, which results in suppliers' lack of willingness to comply. The literature also shows that the misalignment of expectations in the relationship may lead to exactly those supplier reactions seen from the data. Dwyer et al. (1987), Ring and Van de Ven (1992, 1994) and Frazier et al. (1988) express that parties who are willing to discuss expectations have a greater possibility of a good relationship. It is, therefore, important for buying-company managers to understand that they must treat product exchange together with sustainability requirements. By this attention and an understanding of the effect such a gap has on the relationship and thus on supplier compliance, buying-company managers must develop strategies which allow them to work with suppliers and develop the relationship for the desired sustainability compliance. Overall, buying-company managers, and especially the buyers who are in contact with suppliers, should collaborate more directly with suppliers, in parallel with running assessment-based governance mechanisms, since the fitting of relational norm governance strategies across culturally diverse supply chain partners could provide performance enhancement (Griffith & Myers, 2005). A stronger relationship could encourage suppliers towards sustainability compliance.

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Part II

Theory Building Within SOM

In Part II we are concerned with theoretical perspectives, as outlined in the cybernetic framework. Managers need mental models in order to identify what they seek to influence and control in order to reach these strategic aims. There are also still many avenues to explore and considerable theoretical work to be done in order to further the conceptualization and maturation of this field.

Chapter 6 by Poul Houman Andersen outlines theoretical developments in the field of sustainable operations management. Although these perspectives share similarities in some respects, they also differ fundamentally in others. The remaining chapters in this part are concerned with different discussions that in different ways all link back to theory building within the field.

In Chap. 7, written by Batista, Bourlakis, Smart and Maull, offers theoretical propositions that describe fundamental features of a circular supply chain archetype in terms of scope, focus and impact. A discussion of key "circularity" aspects of business models provides a practical illustration of both the theoretical concepts addressed in the chapter and real-life business examples of circular economy praxis.

Chapter 8, written by Nishant, Choudhary, Liu and Goh, contributes to the theoretical understanding of sustainability driven innovation (SOI), and in particular the environment specific form (ES-SOI). Their research is empirically grounded in the technology-intensive aviation industry and their analysis results in different, distinct types of ES-SOI.

The final chapter in this part, Chap. 9, is written by Mauro Fracarolli Nunes, and develops new insights into how the stakeholder perspective can be applied in a supply chain context, and by doing that, raises important questions about the applicability of classic stakeholder theory in such a context. The work is based on an analysis of 15 negative social and environmental events, and the market value of 82 involved companies.

6

Theory Building Within Sustainable Operations Management (SOM): An Introduction to Part II

Poul Houman Andersen

This part of the book concerns theoretical developments in the sustainable operations management (SOM) research field. Sustainable operations management is a growing research field with clear and distinctive roots in organizational and managerial practice, linking to mainstream research on operations management (Angell & Klassen, 1999; Pagell & Shevchenko, 2014). It has also a strong emphasis on pragmatism, predominantly touting technical papers and best-case examples (Min & Kim, 2012; Seuring & Müller, 2008). For this reason, it has been heralded by managers and other practitioners (Joas, Theobald, McGuinness, Garzillo, & Kuhn, 2013). The route from research results to the practical implementation of concepts in business seen in examples such as the use of life-cycle assessments and cradle-to-cradle principles in public purchasing policies is relatively fast.

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An early contribution to the SOM research field includes Roy and Whelan (1992), who provided an ideal "best case" example of recycling electronic waste through value chain collaboration and emphasized the role of co-operative dialogue across the parties involved. Similarly, Lamming and Hampson (1996) reported from case studies in several industries. But whereas the contributions from prescriptive case studies and other normative contributions are of much relevance to sustainable practice, the socio-economic theoretical base of SOM is rather underdeveloped and not sufficiently discussed in the literature (Blok et al., 2015; Halldorsson, Kotzab, Mikkola, & Skjøtt-Larsen, 2007). Furthermore, some would claim it is also imbued with moral thickness, which sometimes makes normative prescription stand in the way of achieving insights about the true state of environmental affairs (Lomborg, 2003). We subscribe to a different view here, embracing the unfolding debate and accepting that both observable facts and assigned values must be part of the discussion.

Given the success of a pragmatic approach to SOM, it is a sensible question to ask: why engage in theory development discussions in a field where studies of practice seem to be both predominant and successful? Until recently, concepts like biosphere and ecosystem have been almost absent from business research (Gladwin, Kennelly, & Krause, 1995). We think there are good reasons to discuss theoretical perspectives in relation to further development of SOM. Any manager, student or researcher concerned with SOM implicitly or explicitly builds on existing ideas about sustainability, operations and management. These ideas are rooted within a certain theoretical perspective, with particular focus points as well as blind spots, which restricts theorizing. This leads to a form of collective myopia in a certain field, where, in retrospect, obvious ways of reframing a situation—for instance, identifying waste as a potentially valuable resource—are overlooked by the dominant perspective. Take as an example the missing focus on recycled paper as a potential resource. It was only late in paper and pulp production that industrialists realized paper recycling could be a potentially valuable resource (Strasser, 2000). Thinking in the entrepreneurial processes that leads to identification of new value-creating opportunities from reusing what earlier was considered as waste partly illuminates the value of applying a novel perspective to enhance sustainability. For instance, some would claim that our current understanding of sustainability and how to lessen the environmental footprint of current manufacturing practices, and bring the natural environment back to some form of order, rests on a false assumption about the nature of the natural environment, based on the Holocene (Villumsen, Johnson, & Lema, 2017).

The Holocene denotes the geological epoch following the last ice age, according to the International Chronostratigraphic Chart of the International Commission on Stratigraphy. It is noted that only during the Holocene has the biosphere, possessing attributes dependent on climate, hydrology, soils and organisms, taken on familiar shapes (i.e. with forests, lakes, rivers, grasslands and so on) (Villumsen et al., 2017). The Holocene has been a period with a stable climate with regular rainfall patterns. This is widely believed to have helped, and maybe preconditioned, the development of human civilization. The Holocene stability is ending as human activities such as production, consumption and transportation are increasingly affecting the biosphere. Some of the consequences for nature and for human societies depending on natural resources are climate change on a global level, habitat destruction (especially by deforestation), soil degradation, and overexploitation of many abiotic as well as biotic resources. It has been proposed that we are entering into the Anthropocene (Crutzen, 2002). According to the geological definition, the Anthropocene denotes a geological epoch in which human societies have become a planetary force, comparable to volcanism, tectonism, glaciation and weathering, making all ecosystems Anthropogenic. The Anthropocene is the age of Man, when humans take control over nature and establish a sustainable and equitable stewardship of Earth's ecosystems for optimal functioning. Clearly, thinking of the natural environment as being controlled by human activity opens new avenues of understanding and quite new research questions, belief systems and schools of thought relating to the end goals and functions of SOM.

1 Embracing Theoretical Plurality in Sustainable Operations Management

Thus, the development and explicit recognition of theoretical pluralism should be encouraged within SOM. Rather than lament or withdraw from theoretical multiplexity, we hope many researchers will embrace this diversity of theoretical perspectives. First, exploring different theoretical perspectives not only identifies novel ideas and areas of scrutiny, but also makes decision makers aware of the assumptions upon which their current theoretical perspectives are built. We understand better the underlying assumptions and ideas of a theoretical perspective and how they shape the questions and frame the issues practitioners deal with. Understanding makes it easier to assess both the strengths and limits of current theorizing. Second, but related to the first point, realizing that there are other ways of seeing reality and engaging other assumptions and conceptual lenses makes it possible to view practical problems from new angles, come up with new framings and apply new ideas to existing problems. Furthermore, it might make it easier to communicate with others, as it will be easier to understand their perspectives and the respective arguments and desired lines of action. An interesting example is provided by Angell and Klassen (1999), who provide two different perspectives on sustainability available in the literature: one seeing sustainability targets as an additional restraint, where the focus is on how operations can be successfully buffered from environmental demands and one perspective focusing on sustainability as an integral component of the operations, and see these as a potential lever of performance. (For an elaboration of this second perspective, see also the much-cited contribution by Porter and Linde (1995).

In the fields of supply chain management (SCM), purchasing and supply management (PSM) and operations management (OM) there are already several literature reviews available, which as a side issue also provide some insights into the theoretical underpinnings of the field and in particular how theories from other fields can be applied and fruitfully developed within these contexts. There is a reasonable consensus around the phenomenon to be explained—the explananda. Ahi and Searcy (2013) identify 12 unique definitions of sustainable supply chain management, but also shows that they have a number of traits in common: a focus on economic and social aspects and a keen interest in understanding the co-ordination of activities (or flows) across organizational boundaries. Seuring and Müller (2008, p. 1700) offer a definition of SCM, which has also gained some influence with respect to theory building in the SOM area, defining sustainable supply chain management as “the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social into account, which are derived from customer and stakeholder requirements”.

In this sense, the SOM perspective differs from other approaches to understanding the environmental impact, such as product stewardship and other life-cycle assessment studies or cost-benefit considerations. These types of studies typically treat organizational behavior as embedded in a wider system comprised of several interacting parties (Karna & Heiskanen, 1998; Öberg, Huge-Brodin, & Björklund, 2012). The conceptual contribution on business models in the circular economy by Batista et al. in this part of the book provides a nice example. In this contribution, the focus is on the reliance on supply chain capabilities in order to perform in a circular economy. By addressing and differentiating the notion of value and how this links back to supply chains, interesting insights with respect to the development of value propositions in a circular economy context are provided. Other studies tend to focus on the dyadic level, scrutinizing the relationship between a focal company and its first-tier suppliers (Schöggl, Fritz, & Baumgartner, 2016). In contrast, an interdependent, network or systems-based approach takes into account both the direct and indirect effects of actors initiating or changing behaviors. In this sense, SOM has novel insights to offer. Some of the most influential perspectives include transaction cost theory, the resource-based view, principal-agent theory and business network approaches (Halldorsson et al., 2007). Other perspective, less influential but still of importance, include political economy and dynamic capabilities among others. There are plenty of relevant presentations that systematically scrutinize how these theoretical angles influence perspectives, approaches and puzzles.

Sustainable operations management as a field is obviously also drawing from these broader theoretical fields. However, at the same time, SOM seeks to explain other aspects as well that relate to operations becoming sustainable or managing operations inside a sustainability regime. Within this frame of understanding, Seuring (2011) reviews a number of literature reviews made with an eye to establishing the current theoretical status of the field and points to "a few examples of deliberate theory building" (Seuring, 2011, p. 472).

Theories which address barriers and triggering events, (inter)organizational adaptation and transformation come to the fore (Seuring & Müller, 2008). In many ways sustainable operations represents a systemic challenge in the sense that it is hard to capture and understand the many co-adjustments needed throughout a network of organizational actors in order to make a real and enduring impact. There are several contributions discussing stakeholder pressure towards changing practices in the focal company, responsible for design and direct interface with the customer (Cramer, 2003; Roberts, 2003). Additionally, theory-building literature discusses the pressure from the focal company (and stakeholders) towards other members of the supply network (Boyd, Spekman, Kamauff, & Werhane, 2007). This literature is linked to contributions discussing adaptation issues. Literature that concerns how organizations adapt to external fiat are increasingly used within research and is providing a new lens for understanding the issues faced. One important theoretical perspective is institutional theory, which is focusing on the processes of organizational legitimacy and what organizations do (or not do) in order to conform to regulations, social cognitions and expectations in society. Related to this, but with a different approach to understanding how pressure is exercised on focal organizations (and their suppliers), is stakeholder theory which, at its core, applies the balancing and reciprocity of diverse human interests. The triple bottom line framework, around which many discussions concerning the definition of sustainability in SOM revolves, draws its core ideas and assumptions from stakeholder theory approaches. The chapter by Nunes in this part of the book makes an interesting contributing to this discussion. While it has been a core axiom and a common belief in many studies of stakeholders' influence on sustainability issues, that bad publicity regarding a company's environmental impact would affect stakeholders' value assessment of that company (and thus be reflected in the stock market) Nunes' study shows surprisingly small effects with respect to this.

Second, still more literature seeking to understand better the organization and management issues related to SOM seeks to bridge to areas such as change management and (inter)organizational transitions. Only recently has literature concerning organizational transition been applied to understand OM issues (Omar, Davis-Sramek, Fugate, & Mentzer, 2012). These perspectives provide insights with respect to the organizational and inter-organizational challenges faced by change agents seeking to bend or even break with existing practices within and across organizational boundaries. One issue concerns the capabilities of firms with respect to greening supply chains (Busse, Schleper, Niu, & Wagner, 2016) and managing sustainable supply networks (De Bakker & Nijhof, 2002). Another issue concerns the barriers faced by focal firms seeking to transform their supply network. Obviously, discussions on innovation tie in with the notion of organizational and systemic transition. In the contribution by Nishant et al. in this part, a study of sustainability-oriented innovation in the aviation industry and how this links to achieving environmental impact is presented. The authors of this paper present an empirically grounded typology of sustainability-oriented innovation with a focus on environmental sustainability.

Hopefully, this brief overview of the theoretical fault lines of SOM and how they tie in with a broader theoretical debate on sustainability issue within the business, organizations and management literature has provided a backdrop for reading and digesting the three chapters in this part of the book.

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7

Business Models in the Circular Economy and the Enabling Role of Circular Supply Chains

Luciano Batista, Michael Bourlakis, Palie Smart, and Roger Maull

1 Introduction

As a response to climate change regulations, the rising costs of raw material acquisition and the environmental impact of by-products and waste disposal processes, over the past decade organizations have been

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systematically implementing business models to extend the life cycle of products, components and useful waste outputs (Lovins & Braungart, 2014). Business initiatives in this direction typically involve the conservation of materials by taking products, components, by-products and waste back into further production and commercial cycles through reusing, remanufacturing and recycling processes for as long as possible (EM Foundation, 2012). Such a market trend represents a key principle of the circular economy, which advocates production systems that are restorative by purpose, shifting product value chains from linear ("cradle to grave") to circular ("cradle to cradle") cycles (Webster, 2015).

A fundamental feature of business models in a circular economy is therefore their capability to implement circular value chains that maximize resource efficiency. This is possible through reducing primary extraction processes and minimizing disposal activities in which valuable resources leak out of the economy.

Reducing primary extraction and disposal activities requires prolonged use of materials. This can be achieved through businesses models that involve the design of products with higher durability and reparability features. Other business models involve the implementation of restorative processes where value is created via product reuse, product remanufacturing (i.e. renewing of products) and recycling of by-product and waste materials (Lovins & Braungart, 2014).

In a wider context, circular economy business models may involve complex networks of organizations that generate new economic value through the continuous exchange of resources (e.g. cascading of materials across firms). This is facilitated by innovative technologies and supply chain ecosystems (Dervojeda, Verzijl, Rouwmaat, Probst, & Frideres, 2014; Genovese, Acquaye, Figueroa, & Koh, 2017) that enable product-service offerings and industrial symbiosis initiatives linking organizations across different sectors of the economy (Chertow, 2007; Sarkar, 2013).

Although the circular economy concept has gained increasing prominence in academic, practitioner and policy circles, its actual enactment is still limited and fragile (Gregson, Crang, Fuller, & Holmes, 2015). The transition to a circular economy based upon restorative design, production involving reverse cycles, cascading processes, and cross-sector collaborations beyond traditional supply chain boundaries (Crowther & Gilman, 2014; Dervojeda et al., 2014) requires a more comprehensive understanding of the "circularity" features of business models. In this context, the increased complexity and expanded scope of "circular" supply chain operations and their role as enablers of circular economy business models also deserves a better understanding.

More specifically, there is growing recognition of the benefits promoted by new business initiatives in the circular economy and their potential to drive growth and productivity with the basis on economic, social and environmental sustainability imperatives (Preston, 2012). However, little is currently understood about the eco-innovative features representing "circularity" aspects of business models in the circular economy and the enabling role and fundamental characteristics of "circular" supply chains. Important questions emerging in this context are: what are the key "circularity" features of business models implementing circular economy praxis? How do they enable prolonged circulation of resources? What are the enabling roles of "circular" supply chains? What are the fundamental characteristics of a circular supply chain archetype?

This chapter addresses the issues above by presenting key theoretical and practical aspects underlying circular economy business models and related supply chain systems shaping the circular economy. The chapter is organized as follows. In the next section, we highlight core restorative aspects of business models in the circular economy and the enabling role of supply chain operations. This is followed by the presentation of fundamental aspects of a circular supply chain archetype. In the sequence, illustrative business cases are briefly presented and discussed in the light of the core restorative processes they implement and the role of related supply chains enabling the circular flows of materials. We conclude the chapter by summarizing its contributions and suggesting directions for future research.

2 Restorative Aspects of Circular Economy Business Models

There is a growing body of literature shaping the philosophical paradigm of the circular economy, establishing the theoretical and practical foundations that place "triple bottom line" sustainability as an inherent aspect of production systems and the economy as a whole. The strong emphasis on the sustainability capabilities of organizations is driving the market logic for businesses and the way they operate in the economy (Lacy & Rutqvist, 2015; Lovins & Braungart, 2014; Preston, 2012).

The call for a more sustainable economy is not new—see for example the works of Giarini and Stahel (1989) and Daly (1996). There is however an unprecedented favorable alignment of technological, political and social factors that are enabling an effective transition to a circular economy (EM Foundation, 2012). This economic landscape is paving the way for business model innovations that maximize societal and environmental benefits without detriment to economic benefits. Some of the key aspects of productive systems in the circular economy are (Lacy & Rutqvist, 2015; Webster, 2015):

1. The creation of closed-loop systems where waste to disposal processes are minimized through reusing, repairing, remanufacturing and recycling processes;
2. The emphasis on delivery of functionality and experience (value in use), rather than product ownership;
3. Management approaches that built upon collaborative or shared consumption models.

The aspects above can be translated into practical features of business model innovations that are mainly aimed at extending the lifespan of products (Bocken, Short, Rana, & Evans, 2014; Lovins & Braungart, 2014). This can be achieved through: (1) minimization of product replacement processes through reuse, repair or remanufacture activities; maintenance of stock value through service-life extension activities; (2) goods are sold as services; "utilization value" replaces "exchange value"; and (3) achievement of higher materials efficiency through shared utilization of goods.

In essence, these aspects represent restorative and regenerative capabilities of business models, i.e. their capacity to **restore** (impart new life and vigor, promote recuperation) and **regenerate** (recuperate to a new, usually improved, state) materials (Esty & Simmons, 2011). As both concepts entail the "recuperation" or recovery of materials for further use, for simplification we will use the terminology "restorative" to also refer to the "regenerative" capabilities of organizations and related supply chain operations.

By definition the circular economy refers to an economy that is restorative by purpose, in which products, components and materials are kept in the economy at their highest utility and value in the long term (Webster, 2015). This fundamental principle underlies the business features mentioned above, positing a critical importance on the restorative capabilities of businesses. It also implies that the restorative capabilities of a business model can be purposefully designed.

Thus far, the existing circular economy literature does not specify what constitutes the restorative capability of a business. To address this issue we draw on the notion of purposeful design from an operations management perspective (Brown, Bessant, & Lamming, 2013), which conventionally recognizes that design can involve the design of a product, the design of a process, and the design of a supply chain. This three-level stratification offers a helpful conceptual basis to distinguish the restorative capabilities that can be implemented by new business models in the circular economy. More specifically, we imply that the restorative capabilities of circular economy business models can be purposefully designed at the level of the product, the process and the industry. Hence, by making linkages with restorative features of products, processes and industry, we specify the following "circularity" capabilities of businesses at three levels:

1. *At product level*: This level refers to physical features of products that allow life expansion and restoration, such as reparability, durability, upgradability and recyclability attributes (EU Commission, 2015);
2. *At firm level*: This level refers to restorative processes that take place in an organization, such as reusing, repairing, reconditioning, refurbishing, remanufacturing and recycling processes. The All-Party Parliamentary Sustainable Resource Group (APSRG) differentiates these processes as follows (APSRG, 2014):

   (a) *Reusing*: Simple reuse of a product, with no modifications;
   (b) *Repairing*: Simple fixing of a fault, with no guarantee attached to the product as a whole;
   (c) *Reconditioning*: Adjustments made on a product's components in order to bring it back to working order, but not necessarily to a "like-new" state;

(d) *Refurbishing*: Large aesthetic improvements to a product, which may bring it to a "like-new" state, but with limited functionality improvements;
(e) *Remanufacturing*: A series of manufacturing activities on an "end-of-life" part or product, in order to bring it to a "like-new" state that may involve improved functionalities;
(f) *Recycling*: Transformation of a product's materials into raw materials for use in new products.

3. *At industry level*: This level refers to restoration through cascading of used materials and renewable resources between firms, engagement in waste and by-product synergy systems, sharing of resources and infrastructure, and involvement in industrial symbiotic processes across diverse organizations (Chertow, 2007; EU Commission, 2015).

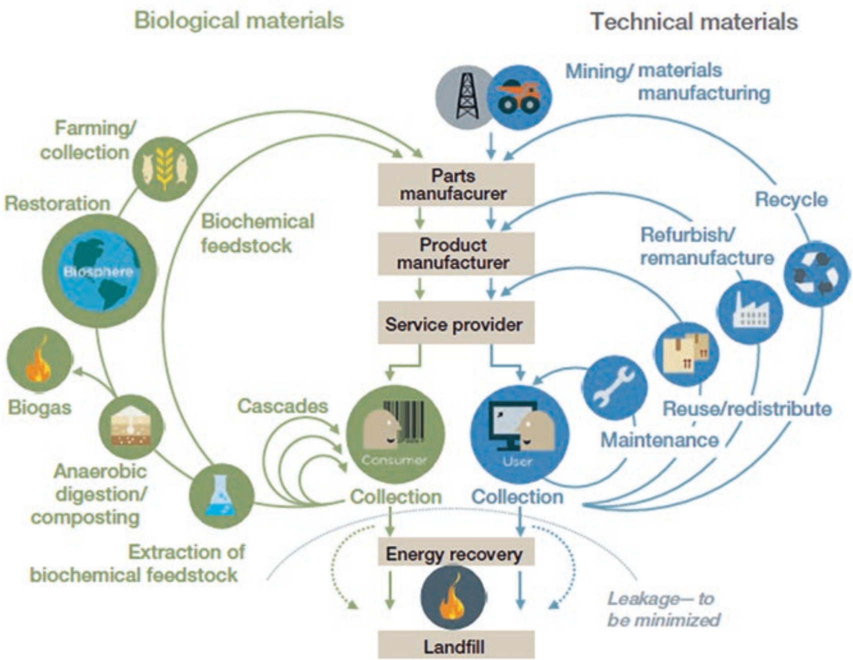

Fig. 7.1 Restorative value chains in the circular economy (WEC, 2014)

The aspects described above are embedded in Fig. 7.1, which shows that restorative (circular) value chains can take place to recover two generic types of materials: biological and technical.

An important aspect of the circular flows shown in Fig. 7.1 is the expanded complexity of the supply chains involved. In practice, the circular flows in restorative value chains are enabled by supply chains that implement material flows from consumption points to production points. This is typical of reverse logistics and closed-loop supply chains. However, it is not necessarily the case of circular supply chains, as the restorative loops may not involve "returns" to the focal company. Rather, they may involve forward loops (open-loops) comprising an alternative circular flow of materials. This expanded scope of supply chain operations in the circular economy calls for further theoretical considerations, as discussed in the following sections.

3 Enabling Role of Supply Chains

It is essentially important to understand the wider implications of circular economy business models to supply chain operations. From a simplistic point of view, supply chains tend to be thought of as primarily "linear" structures, where products flow from one organization to another and eventually to an end user. Research on supply chain management has evolved from linear supply chain perspectives to include multiple and overlapping relational linkages in complex business networks in which firms are embedded—see the supply chain configurational perspectives discussed by Srai and Gregory (2008) and Pathak, Wu and Johnston (2014).

The design of supply chain operations that encourage the flow of products back into productive systems has reignited research on reverse logistics and its role in enabling business sustainability (Beh, Ghobadian, He, Gallear, & O'Regan, 2016; Jalil, Grant, Nicholson, & Deutz, 2016; Loomba & Nakashima, 2012; Parry, Brax, Maull, & Ng, 2016). Despite enabling reverse flows, we argue that the reverse logistics narrative is insufficient to address the wide scope of restorative processes and related supply chain configurations that occur in the circular economy. For instance, in some cases the circular flows of products, components and materials are enabled by forward-feeding flows into further production processes external to the focal organization. “Circular” flows therefore can comprise reverse (closed-loop) flows as well as forward (open-loop) flows of products, components and other materials, such as by-products and waste. We therefore imply that circular supply chains refer to logistics and supply chains implementing closed-loop and/or open-loop flows inherent in the restorative processes of organizations.

Figure 7.2 illustrates potential restorative flows enabled by circular supply chains in the context of a circular economy idealization. The figure shows that restorative processes may comprise closed-loop flows which refer to reverse flow of materials involving organizations **within** the supply chain of a focus company (Fig. 7.2a). Other flows may involve cascading of materials through forward open-loop flows linking organizations **across** other supply chains comprising other organizations (Fig. 7.2b). This extended scope of the circular supply chain concept encompasses all supply chain loops implementing the restorative flows a business model can implement. This view allows a more structured characterization of the complex mix of restorative supply loops supporting circular economy business models.

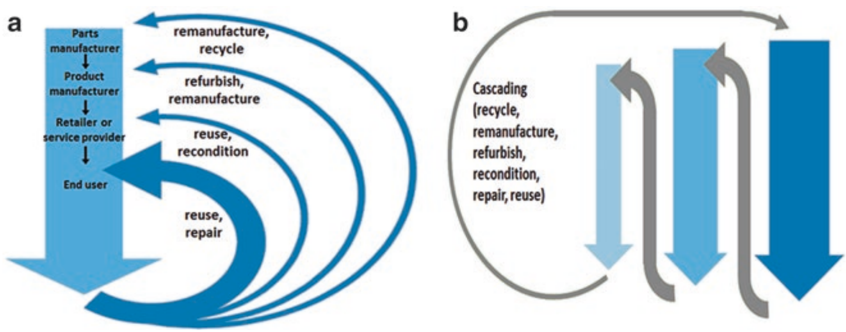

Fig. 7.2 Restorative flows enabled by circular supply chains (EM Foundation, 2014). (a) Closed-loop flows (within a supply chain), (b) open-loop flows (across supply chains)

4 Theoretical Antecedents of Circular Supply Chains

Over the past few decades, sustainability issues concerning supply chain operations have gradually occupied a more prominent space within the wide spectrum of managerial topics addressed by academics, practitioners and policy makers (Carter & Liane Easton, 2011). The growing number of studies in this field has created a substantial body of literature in which four sustainability narratives of supply chains have emerged, namely: **reverse logistics**, **green supply chains**, sustainable supply chain management (**SSCM**) and, more recently, **closed-loop supply chains**.

In general, it is possible to associate these narratives with specific emphases regarding the notion of "circularity" in supply chain operations. Govindan and Soleimani (2017) and Govindan, Soleimani and Kannan (2015), for example, point out that reverse logistics is usually associated with supply chains that enable products to flow back into corporate operations, minimizing the flows to landfill waste. Green supply chain research is particularly associated with a strong emphasis on reducing environmental and ecological impacts of product/process design and development. Sustainable supply chain management (SSCM) engages broader corporate governance and management of social responsibility issues concerning supply chain operations. Finally, closed-loop supply chains are associated with approaches that simultaneously consider forward and reverse supply chain operations.

A problematic aspect concerning these four sustainability narratives of sustainable supply chains is the lack of conceptual distinction in relation to their restorative aspects. They largely overlap in many of the phenomena they address, to the extent that some scholars refer to them interchangeably and studies consider reverse, green and close-loop aspects synonymously under a wider SSCM perspective (Carter & Rogers, 2008; Seuring & Müller, 2008; Walker & Jones, 2012).

Overall, there is a substantial body of literature on reverse supply chains linking **reverse logistics** with sustainability issues. Such linkages can be identified in research published more than two decades ago. For instance, Pohlen and Farris (1992) developed a model of the reverse logistics channels used in recycling processes of plastics, in which they include restorative processes involving collection of recyclable material and retro-manufacturing (use of recycled commodities in manufacturing processes). From their point of view, reverse chains for recycling are mainly industry-led initiatives where customers play a more passive role. They recognize, however, that shifting responsibility for recycling within the channel and determining the role of the consumer are key areas where the channel efficiency and structure of the reverse logistics can improve.

A fundamental "circularity" notion of reverse logistics refers to its role to implement the movement of materials from consumers back to producers. This is embedded in its very definition, as described by Rogers and Tibben-Lembke (2001, p. 130), who define reverse logistics as:

> *the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal.*

Besides recycling, over the years, researchers have been considering reverse logistics perspectives related to other alternatives to disposal processes such as reuse, repairing, reconditioning and remanufacturing (Agrawal, Singh, & Murtaza, 2015; Cannella, Bruccoleri, & Framinan, 2016; Khor, Udin, Ramayah, & Hazen, 2016). This expanded scope of restorative processes associated with reverse logistics represents a shift from the predominant focus on single products collected and recovered as a whole to wider reverse logistics perspectives that consider multiple products and related spare parts (Tahirov, Hasanov, & Jaber, 2016). In many cases, returned items are disassembled for the recovery of useful components that can be used in different restorative processes, after which products are introduced back into the market (Lai, Wu, & Wong, 2013).

The expanded scope of reverse logistics perspectives led to different sustainability narratives of supply chains, such as green, sustainable supply chain management (SSCM) and closed-loop views. The **green perspective** puts more emphasis on environmental issues concerning supply chains. For van Hoek (1999), the partial and fragmented contributions of reverse logistics research failed to address the application of value-seeking and proactive approaches to more "green" supply chains. Other authors, however, do not see green approaches as a departure from reverse logistics perspectives. For instance, Tahirov et al. (2016) see reverse logistics as an important component of green supply chains and the "green" approach to managing supply chains implies a managerial integration of material and information flows throughout the supply chain to satisfy customer demand for environmentally friendly products and services.

By definition, green supply chains involve traditional supply chain management approaches with the additional "green" component, which includes managerial practices such as green purchasing, green distribution, green manufacturing, eco-design, etc. which lead to improved environmental and economic performance (Green, Zelbst, Meacham, & Bhadauria, 2012). Typical restorative processes such as recycling, repairing, remanufacturing and so forth are studied from green supply chain viewpoints which usually involve broad perspectives of analysis (Büyüközkan & Çifçi, 2012; Dües, Tan, & Lim, 2013; Mishra, Kumar, & Chan, 2012).

Although the green supply chain narrative has considerable overlap with the **SSCM** narrative (Glover, Champion, Daniels, & Dainty, 2014; Wu, Ding, & Chen, 2012), it remains essentially narrower in scope (Ahi & Searcy, 2013). While the former has a predominant focus on the environmental dimension of sustainability, the latter extends the environmental perspective to include social and economic perspectives that, together, allow more comprehensive triple bottom line approaches to supply chain management (Beske & Seuring, 2014; Fabbe-Costes, Roussat, Taylor, & Taylor, 2014). This aspect is acknowledged by Ahi and Searcy (2013, p. 339), who define SSCM as the:

> *creation of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems designed to efficiently and effectively manage the material, information, and capital flows associated with the procurement, production, and distribution of products or services in order to meet stakeholder requirements and improve the profitability, competitiveness, and resilience of the organization over the short- and long-term.*

Differently from the narratives mentioned above, the **closed-loop** narrative is concerned with the appropriate logistics and supply chain structures to support forward and backward flows of products. The restorative flows of materials considered by this narrative overlap significantly with the reverse logistics narrative discussed above. However, the reverse logistics and closed-loop perspectives of supply chains are fundamentally different in scope and opportunity for innovation. A primary notion is that while reverse logistics focuses on the reverse flows of materials from the point of consumption to the point of origin, closed-loop supply chains consider forward and reverse supply chains simultaneously (Govindan & Soleimani, 2017). In other words, a closed-loop supply chain combines forward and reverse supply chains to cover entire product life cycles from cradle to grave. This fundamental aspect is reflected in a classic definition provided by Guide and Van Wassenhove (2009, p. 10), who define closed-loop supply chain management as the:

> *design, control, and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time.*

Fahimnia, Sarkis, Dehghanian, Banihashemi and Rahman (2013) make an explicit link between the closed-loop narrative and restorative circular processes by stating that closed-loop supply chains incorporate reverse logistics systems designed to manage the flow of products or parts destined for reuse, recycling, remanufacturing or disposal. Das and Posinasetti (2015) also connect the closed-loop narrative with restorative models that include reprocessing of end-of-life products and disposal of unusable parts. They also link the closed-loop idea with product recovery through refurbishing and repairing options, and materials recovery through recycling processes.

The closed-loop supply chain narrative is closely related to the notion of "circular" supply chains, which assume a broader agenda of product life cycles in order to include post-production stewardship. In this sense, circular supply chains entail integrated supply chain models in which product returns from end consumers go through recovery operations such as reuse, repairing, reconditioning, remanufacturing or recycling and are integrated back into forward supply chains (Genovese et al., 2017). According to Krikke, le Blanc and van de Velde (2004), recovery flows may be enabled by either the original supply chain through closed-loop flows back to the supply chain of the focus firm or in alternative supply chains through open-loop flows into other forward supply chains. This forward-feeding aspect is directly associated with the "open-loop" feature of closed-loop supply chains. Nasir, Genovese, Acquaye, Koh and Yamoah (2017) view such a combination of closed and open loops as a "quasi-closed" supply chain system in which the boundary of green supply chain management is extended to incorporate the circular economy principle of continuous circulation of resources.

Overall, although the literature indicates academic research with direct references to "circular" (or the idea of circularity) in supply chains, its characterization still remains a marginal venture in the field of supply chain operations management. There is indeed a lack of a conceptualization of what constitutes a "circular supply chain" in the context of a circular economy ideal. Thus far, due to associations with restorative and regenerative processes, the reverse and closed-loop narratives offer useful contributions towards theoretical frames that link sustainable supply chain operations research with circular economy principles and praxis. By considering reverse and forward flows, the closed-loop supply chain narrative in particular offers a useful starting point to represent what might be constructed as a circular supply chain operation. However, the closed-loop narrative remains insufficient because it does not address wider post-production and stewardship operations espoused by the grand idealization of a circular economy, such as the supply chain operations supporting waste flows and by-product synergies linking organizations across diverse industrial sectors. This calls for a sustainable supply chain narrative that connects more adequately with the broader industrial ecosystem involving flows of products, by-products and useful waste. We address this deficiency in the next section, where we introduce a conceptualization of a circular supply chain archetype that integrates and builds upon core features of the supply chain narratives discussed thus far.

5 Fundamental Aspects of a Circular Supply Chain Archetype

In this section we introduce a conceptualization of a circular supply chain (CSC) archetype we developed in previous research (Batista, Bourlakis, Smart, & Maull, 2018). The research included a content-based literature review of the antecedent narratives discussed in Sect. 4 in order to specify a CSC archetype that takes into account the wide spectrum of restorative and regenerative flows advocated by the circular economy. We integrate the dominant features of the antecedent narratives (reverse, green, SSCM and closed-loop) to provide a more comprehensive and theoretically sound basis of a circular supply chain.

The "closed-loop" narrative provides a helpful perspective to represent key circularity aspects of circular economy business models. However, we should be mindful that its propositions tend to emphasize reverse (closed-loop) flows, even though "open-loop" flows are also part of the "closed-loop" narrative. Our view is that embedding "open-loop" flows into the broader conceptualization of a "closed-loop" supply chain may appear counter intuitive, undermining understanding and the accurate representation of the circularity features of the supply chains supporting circular economy business models.

In addition, the closed-loop narrative tends to focus more on the flows of main products, to the detriment of by-product synergies and useful waste flows. This is evident in the definition of closed-loop supply chain management provided by Guide and Van Wassenhove (2009), who, as previously mentioned, point out that closed-loop supply chains support value creation systems derived from entire product life cycles and related returns. Following from this, we suggest that the fundamental distinction between the "closed-loop" and the "circular" supply chain perspective lies in the **scope** and the **focus** of their associated value chain systems. We hence derive the following propositions:

Proposition 1 *Circular supply chains represent an expansion of the closed-loop narrative of sustainable supply chains in terms of scope and focus of the value chain systems they consider.*

In terms of **scope:**

Proposition 2 *Circular supply chains extend the boundaries of closed-loop supply chains by taking into account post-production stewardship to include forward-feeding flows into alternative supply chains.*

In terms of **focus:**

Proposition 3 *Circular supply chains support sustainable value chain systems derived not only from products and their end-of-life returns, but also from associated by-product synergies, services and waste flows.*

These fundamental propositions help us to specify a **definition of a circular supply chain**, as follows:

> *The coordinated forward and reverse supply chains via purposeful business ecosystem integrations for value creation from products/services, by-products and useful waste flows through prolonged life cycles that improve the economic, social and environmental sustainability of organizations.*

Based on the definition above, we can infer that circular supply chains entail the integration of the main linear supply chain with additional restorative supply chains supporting the implementation of circular economy production ecosystems. The linear supply chain refers to the mainstream forward supply chain of new products produced by organizations. The restorative supply chains refer to two distinct restorative streams: (1) the reverse supply chains involving closed-loop cycles of products (returns) and components back to the organization in focus; and (2) the forward open-loop streams supporting cascading flows of materials to organizations outside the linear supply chain (Dervojeda et al., 2014; Krikke et al., 2004; Tahirov et al., 2016). This comprehensive supply chain configuration is illustrated in Fig. 7.3, which represents a generic **archetype of a circular supply chain** comprising the material flows previously mentioned. In the figure, the **primary materials** are the raw materials used in the production of products derived from primary resources. The **recovered materials** are the **returned** products, parts,

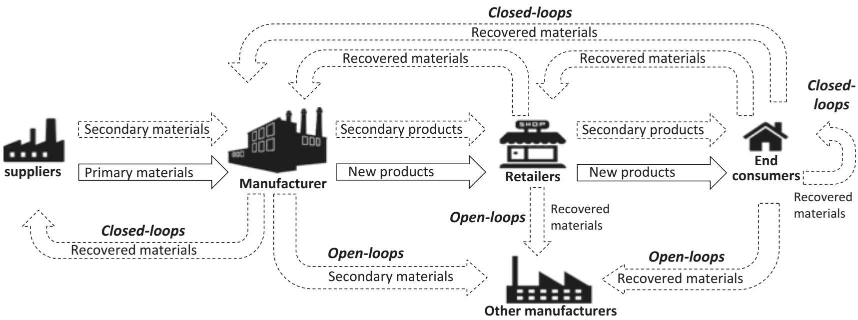

Fig. 7.3 A circular supply chain archetype

components, as well as by-products and waste that flow back as input materials for further production processes. The **secondary materials** are recovered materials that were processed to be used as feedstock for the production of **secondary products** (e.g. repaired, reconditioned, refurbished, remanufactured or recycled products), which do not necessarily present inferior quality.

The supply chain archetype in Fig. 7.3 points out distinct restorative loops inherent in circular supply chains. A fundamental aspect to highlight here concerns the peculiar aspects of the recovery loops that take place at different levels, and involve different actors, across the supply chain. For instance, the loops downstream, particularly the ones at "end consumer" level, typically involve product reuse (a subject largely discussed under the "sharing economy" theme) and product repair initiatives. By their turn, remanufacturing processes usually involve loops linking consumers downstream with manufacturers upstream.

These loop differentiations are important because they are claimed to have different levels of "resource efficiency" in terms of their impact in the context of a circular economy (Stahel, 2010). That is, although all possible restorative and regenerative loops enabled by circular supply chains are important, the "inner loops", i.e. the ones downstream in the supply chain, are claimed to be the ones that generate less environmental impact because they require less reprocessing of materials (Dervojeda et al., 2014; Stahel, 2010). We formally elaborate on this notion by suggesting the propositions below:

Proposition 4 *In a circular supply chain, inner loops involve restorative and regenerative processes that minimize (re)processing of materials/resources.*

Therefore,

Proposition 5 *Circular supply chains should be designed to maximize restorative and regenerative processes downstream.*

We state these propositions herein in a formal and explicit manner with the intention of building theory through a cumulative logic process (Hoon, 2013) to provide a novel contribution for a wider audience from distinct disciplines. Thus, our definition and propositions represent conceptual building blocks that aggregate fragmented ideas into formal and explicit explanations (Meredith, 1993). In doing so, our insights add to the growing body of knowledge in the field.

In conceptual terms, "circular supply chain" should be considered as a collective term for the co-ordinated integration of forward and reverse supply chains, as indicated in the definition of circular supply chain proposed. More specifically, a circular supply chain comprises a series of supply chain processes which are expected to improve the lifespan of products and enable core restorative and regenerative processes being implemented by business model innovations that aspire to circular economy ideas (Lovins & Braungart, 2014; WEC, 2014). The forward and reverse flows can be implemented through the concerted integration of traditional (linear) and restorative supply chains. To facilitate understanding, Fig. 7.4 provides a logically structured representation of the "traditional-restorative/forward-reverse" supply chain integrations that may take place in a circular supply chain.

We finalize our discussion by summarizing the fundamental premises concerning a circular supply chain archetypal form in terms of sustainability, design and value chain composition:

- *Sustainability*: It expands the closed-loop perspective of supply chains by considering value creation chains derived not only from products and related end-of-life returns, but also from by-products and useful

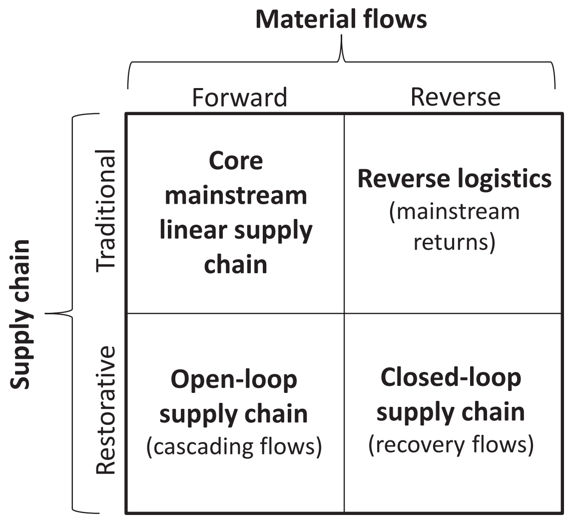

Fig. 7.4 Structured integration of component supply chains in the wide circular supply chain archetype

waste flows recovered from reverse or forward cascading chains. It involves a triple bottom line approach to improve the economic, social and environmental sustainability of organizations.

- *Augmented design complexity*: It requires coordinated integration of the traditional linear supply chain with restorative supply chains supporting the implementation of restorative processes involving forward and reverse flows. Furthermore, it may involve several loops of recovery materials for a number of different restorative processes (e.g. reuse, repairing, reconditioning, refurbishing, remanufacturing, recycling and cascading).
- *Downstream design*: In terms of resource-efficiency, circular supply chains should be designed to favor restorative processes downstream.
- *Value chain composition*: It comprises traditional (linear mainstream) and restorative supply chains involving forward and reverse value chains of primary and secondary materials.

6 Business Model Initiatives Towards the Circular Economy

Business model initiatives towards the circular economy seek to incorporate a "triple bottom" line (economic, social and environmental) sustainability approach to the market by taking into account a wide range of stakeholder interests, including maximization of societal and environmental benefits, rather than economic gain only. To provide a practical perspective of the subject, we draw from secondary data some business cases that implement one or more of the restorative processes discussed above. The cases provide illustrative examples of circular economy business practice. In this section, we focus on the value creation dimension represented by the restorative capabilities of the business models considered.

The creation of "value" is a key feature of a business model. As defined by Baden-Fuller and Morgan (2010), a business model is the logic of the firm, the way it operates and creates value for its stakeholders. Osterwalder and Pigneur (2010) expand on this by defining the business model as the rationale of how a firm generates, distributes and captures value. They specify three fundamental dimensions of value creation:

1. *Value proposition*: Product and service features that aggregate value to stakeholders;
2. *Value delivery*: Key activities, resources and partners that operationalize the value proposition; and
3. *Value capture*: The cost structure and revenue streams of the business.

To narrow down the discussion of the illustrative cases, from the three dimensions above we consider the value proposition and the value delivery aspects of the business models. We also emphasize the "sustainability value" inherent to those two value dimensions. In other words, we present the value proposition and value delivery of the business models in terms of the restorative processes they implement. Such processes represent the "sustainability value" a business model creates. For the circular economy, the sustainability value of a business model should be intrinsic to its value proposition and value delivery is implemented through the restorative processes a business carries out.

6.1 Case 1: Reparability and Durability Values

Fairphone (www.fairphone.com) is a social enterprise whose restorative capability is mainly centerd on the restorative features of its product: a mobile phone. The product was purposefully designed to have high durability and reparability. This enables the concentration of restorative cycles downstream in the supply chain, close to the end user.

To achieve high reparability value the Fairphone has a modular architecture that allows easy disassembly and assembly of its components. Such modularity enables the phone's electronic sub-systems (modules or parts) to be easily accessed, repaired and replaced. Most of the phone's modules were also designed with further modular construction techniques in order to allow reparability at a more granular level, with varying levels of complexity.

The repair process was also designed to allow access to the phone's components by the users themselves, without requiring advanced technical skills. For example, the display unit does not require a tool to be removed; it can be unclipped. Other components can be removed with the use of a single screwdriver and the screws that connect them to the phone's chassis are color-coded for easy matching with the specific areas they fit.

The phone's durability was designed with the aim of longevity. For example, the phone does not require users to add extra layers of protection to keep phones safe from the elements and accidental drops. The display unit is secured to the phone through a strong magnesium frame. The phone's outer shell is an integral part of the phone that acts as a protective case that is fully replaceable.

The Fairphone business model as a whole was built as a movement towards fairer electronics, including its supply chain. In order to minimize the social and environmental impact of its product, the company works closely with manufacturers who invest in the well-being of their employees. They also use as many recycled materials as possible, without compromising the durability aspects of the product. Finally, they favor suppliers that support local economies and source raw materials mined from conflict-free mineral areas.

6.2 Case 2: Remanufacturing Value

Caterpillar is a large corporation that manufactures heavy machinery such as construction and mining equipment, diesel and natural gas engines, industrial turbines and diesel-electric locomotives. The company has been developing its restorative capability through remanufacturing processes. Its "Cat Reman" unit is a business model with an emphasis on a component recovery program which is implemented in nine locations around the world, employing over 3600 people (APSRG, 2014).

The company has been increasingly designing products with components that are intended to be remanufactured a number of times. A typical Caterpillar product can have 10% of its components remanufactured. The company's ability to remanufacture at low cost and high quality allows it to provide the same warranty for remanufactured engines as for new ones (EM Foundation, 2012).

Caterpillar also implements the "value in use" proposition advocated by the circular economy through its "product as a service" offers, in which the company retains ownership of the products and their associated value. The company has embedded remanufacturing cycles in this type of service, this way increasing its profit margin by replacing products before they break and rebuilding them with a mixture of new and remanufactured parts.

Overall, as materials account for most of the company's costs, remanufacturing allows greater business advantage for the company over their competitors. The circular supply chain supporting the remanufacturing loops is sustained through a returns incentive scheme. By offering economic incentives for the return of used parts, the company ensures that a high percentage of core material is sent back for remanufacture.

The environmental benefits of Caterpillar's remanufacturing initiatives are significant. The company has calculated that remanufacturing a cylinder head allows reduction of greenhouse gases by 61%, water use by 93%, energy use by 86% and waste sent to landfill by 99% when compared to producing a new part (APSRG, 2014).

6.3 Case 3: Reuse Value

Collaborative consumption is a typical example of a business model whose sustainability value is based upon products reuse. Offering a compelling alternative to traditional forms of buying and ownership, the restorative capability of these models is the implementation of reuse cycles through systems of organized sharing, bartering, lending, trading, renting and swapping of products over time (Botsman & Rogers, 2010).

For example, Airbnb.com has implemented an online platform for a peer-to-peer market where people can rent their spare rooms. This online marketplace idea also applies to the facilitation of reuse cycles for resources such as parking spaces, cars, general goods, skills and services between individuals, who may be both suppliers and consumers (Barnes & Mattsson, 2016). From a supply chain point of view, collaborative consumption models can be seen as business models that facilitate the creation of circular supply chains which enable reuse cycles at the level of end users.

In the Airbnb business model, on one side of the supply chain (upstream) are local people who have spare rooms and on the other side (downstream) are people looking for reasonably priced accommodations with the added benefit of local knowledge. Trust is built through rating systems profiling suppliers and users and it is up to the suppliers to determine if they want to host a guest. User guests can decide if they want to rent a room based on photos of the property, detailed profile of the hosts, and previous users' reviews. Airbnb also acts as a "trusted intermediary", providing a secure payment system through which guests make reservations using a credit card or PayPal account and hosts are paid in full 24 hours after a guest has checked-in.

The Airbnb business model has expanded far beyond the initial idea of a marketplace for spare rooms. Capitalizing on this emerging form of socio-economic collaboration, the collaborative consumption model implemented by Airbnb also enables the rent of tree houses, offices, boats, igloos, villas and even castles (Botsman & Rogers, 2010).

7 Conclusion

In this chapter we have introduced some conceptual propositions that provide useful theoretical foundations for a better characterization of the restorative capabilities of business models in the circular economy. We have also developed key theoretical foundations characterizing circular supply chains and the restorative loops and processes they enable.

By taking into account relevant actors in circular value chains, the chapter points out business model innovations that reinforce the transition towards a circular economy and better positions supply chain operations into the circular economy context, this way providing a more structured and up-to-date contribution to the wider debate on how operations and supply chains meet the challenges of sustainability.

The theoretical aspects here developed provide a coherent explanatory basis for the key questions set in the introduction above, which we briefly answer as follows:

- What are the key "circularity" features of business models implementing circular economy praxis?
- The circularity features represent the restorative capabilities of a business model. From an operations management perspective, they refer to an organization's capacity to recover products, by-products and waste that can be used in further production processes, this way enabling prolonged circulation of resources. Such capability creates sustainability value to stakeholders that are intrinsic to the value proposition of the business.
- How do they enable prolonged circulation of resources?
- This can be achieved at three levels: (1) at product level (i.e. products designed with recoverability features and less dependent on primary raw materials); (2) at process level (i.e. implementation of reusing, repairing, reconditioning, refurbishing, remanufacturing, or recycling processes); and (3) at industry level (i.e. implementation of recovering processes though cascading flows across organizations in diverse sectors).
- What are the enabling roles of "circular" supply chains?
- Circular supply chains enable and support the implementation of the recovery processes mentioned above, including cascading flows across

industrial sectors. This entails the integration of the main linear supply chain with additional restorative supply chains supporting the implementation of circular economy production ecosystems. The implementation of circular supply chains is intrinsic to the restorative capability of circular economy business models.

- What are the fundamental characteristics of a circular supply chain archetype?
- Circular supply chains represent an expansion of the closed-loop narrative of sustainable supply chains in terms of scope and focus of the value chain systems they consider. In terms of scope, they extend the boundaries of closed-loop supply chains by taking into account post-production stewardship to include forward-feeding flows into alternative supply chains. In terms of focus, they support sustainable value chain systems derived not only from products and their end-of-life returns, but also from associated by-product synergies, services and waste flows. In a circular supply chain, inner loops involve restorative and regenerative processes that minimize (re)processing of materials/resources. Therefore, circular supply chains should be designed to maximize restorative and regenerative processes downstream.

The theoretical fundaments introduced in the chapter were illustrated by a brief presentation of business model cases that provide real-life examples of circular economy practice. The cases presented in this chapter are far from covering the full range of circular economy business models being currently developed. For example, there is a growing number of businesses implementing restorative processes based on by-product and waste material synergies involving recycling through industrial symbiosis collaborations. Future research may want to discuss these business models and related supply chains in the light of the concepts introduced here.

The circular economy advocates a certain "resource efficiency" hierarchy for the restorative loops discussed in the chapter, claiming that "inner cycle" loops are where the circular economy can add most value, in other words the smaller the loop, the more profitable and resource efficient it is (Dervojeda et al., 2014). Although there is a coherent logic in this assertion, future research to confirm its validity is welcomed.

An in-depth discussion of the configurational perspectives of circular supply chains and the network of actors they involve in different restorative business models is also an important area calling for further research. As Bocken et al. (2014) point out, sustainability value is not created by firms acting in isolation, but by a group of actors acting together through formal and informal arrangements. The business models in which they are involved comprise a wider set of stakeholders that necessitates a broader value-network perspective that takes into account the collaborative ties for implementing the restorative capabilities required by the circular economy.

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8

Disentangling Environment-Specific Sustainability-Oriented Innovation: Insights from the Airbus-Boeing Duopoly

Rohit Nishant, Alok Choudhary, Hung Yao Liu, and Mark Goh

1 Introduction

Sustainability-Oriented Innovation (SOI) is defined as "making intentional changes to an organization's philosophy and values, as well as to its products, processes or practices, to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns" (Adams, Jeanrenaud, Bessant, Denyer, & Overy, 2016: 2). It differs from general innovation in its focus on social and environmental values. With SOI's increasing importance and popularity, it is important

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to answer a critical question: what does SOI consist of? Focusing on one of SOI's major components, we consider disentangling environment-specific SOI (ES-SOI) as our first step towards answering that critical question. The existing literature also prompts the need for a detailed investigation of the various types of ES-SOI, in general, to help researchers comprehend, analyze, and explain complex realities as thoroughly as possible. To address this research gap, our primary goal is to develop an empirically grounded understanding of ES-SOI. More importantly, this research seeks to investigate if the ES-SOI conceptualized in recent research is adopted in practice and as a result, extends our understanding of ES-SOI in particular and SOI in general.

With a growing concern over global warming and climate change, firms are increasingly expected to improve their environmental sustainability, either by optimizing resource consumption or by increasing resource efficiency. These actions help such firms to reduce further environmental footprint measured in terms of carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions. In other words, firms are recognized as a part of the solution, instead of being the problem, to facilitate environmental sustainability (Simanis & Hart, 2009). At the core of this solution lies the ES-SOI, which can reduce the environmental footprint of firms' operations. Studies such as Adams et al. (2016) conceptualize SOI as innovations that create social and environmental value beside economic value. ES-SOI is a subset of this broader conceptualization of SOI with a specific focus on generating environmental value. Research in the domain of environmental sustainability emphasizes the role of changes in technology, processes and product as key to achieving the goal of environmental sustainability.

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Sustainability has been the topic of research for over three decades (Bansal & Hoffman, 2012). Past studies on corporate sustainability have often invoked theoretical frameworks such as Hart's quadrant (1997) and theoretical lenses such as the natural-resource-based view (NRBV). NRBV, as well as Hart's quadrant, emphasizes clean technology and process improvement in the form of pollution prevention and product stewardship (Hart & Dowell, 2011) as ways to achieve the goal of environmental sustainability. Besides the theoretical frameworks that emphasize different dimensions of sustainability, there has been an ongoing conceptual development of SOI (Adams et al., 2016). We follow those studies that conceptualize SOI and contend that ES-SOI manifest in a firm's processes and products are instrumental to environmental sustainability. Our main goal in this study is to empirically investigate if the conceptualization of ES-SOI as observed in the existing literature is evident from a firm's innovations.

As for the empirical context, we investigate the aviation sector. If the aviation sector, which is worth US$606 billion annually, were a country it would rank twenty-first in the world in terms of gross domestic product. However, the aviation sector is also responsible for 2% of all human-induced CO_2 emissions or about 12% of CO_2 emissions from all transport sources (ATAG, 2017). Consequently, firms in this sector face institutional pressure to engage in activities that reduce the sectoral carbon footprint and develop environment-friendly products and processes. Therefore, the aviation sector serves as a suitable candidate for our analysis. In addition, the aviation sector being a technology-intensive sector presents an opportunity for firms to innovate. Hence, studying this sector helps us to examine the upper bound of the ES-SOI phenomenon.

Our contribution is threefold. First, we develop an empirically grounded understanding of ES-SOI. Some studies have proposed typologies for innovation such as Hipp and Grupp (2005), Damanapour (2014), and Roscoe, Cousins, and Lamming (2016) to develop an understanding of SOI. However, these studies are conceptual and are not empirically grounded. Besides, they focus on SOI in general. In contrast, we examine the ES-SOI practices in particular and use empirical methods to disentangle ES-SOI and analyze whether the ES-SOI practiced by firms is consistent with the conceptualizations of broader SOIs, as proposed in prior studies. The proposed ES-SOI typology enhances our understanding of SOI by delineating its construction and boundaries. This contribution also responds to a recent call by scholars such as Adams et al. (2016), who highlighted the need for an empirical understanding of SOI, in general, to further appreciate organizational behavior, and Girotra and Netessine (2013), who encouraged the empirical examination of SOI in the operations management domain.

Second, we further deliberate on how the various types of ES-SOI observed in our empirical setting might impact environmental sustainability. The outcome of this investigation would assist practitioners in decision making, especially on their prioritization of the ES-SOI practices. Finally, we also consider various theoretical frameworks that could help us develop a comprehensive understanding of ES-SOI. Research has often argued for the salience of context in organizational behavior (Johns, 2006). Recognizing this, we contextualize our study in a unique empirical setting. The findings from this study can offer insights for other technology-intensive sectors, which are slowly replacing the conventional manufacturing sectors.

This chapter is organized as follows. First of all, we introduce the context and the need for our proposed research. Next, we survey the extant literature to identify the existing research gaps. After that, we present the research methods used for our exploratory analysis. In the next section, we present our results on the ES-SOI analysis and the link between ES-SOI and environmental sustainability with a short discussion. The chapter concludes with some limitations of our study and directions for future research.

2 Literature Review

The past three decades have seen a plethora of studies in the domain of sustainability (Bansal & Hoffman, 2012). A number of these studies often focused on establishing the linkages between environmental sustainability and financial performance, and have reported mixed findings (Sarkis et al., 2011). An extensive review of the existing literature revealed that there is a dearth of studies on SOI in general and ES-SOI in particular. Besides, there are limited studies on the ES-SOI and environmental sustainability linkage. Earlier studies, which focus on SOI, suggest that SOI is related to product, process and organizational innovation. Like sustainability, SOI is a multi-dimensional concept comprising of environmental, social and economic dimensions. In particular, the ES-SOI is focused on the environmental dimension. However, there is a lack of empirical research related to the ES-SOI. This creates a research gap that needs to be addressed and justifies our focus of empirical research on ES-SOI. Moreover, studies on SOI have restricted their focus to a narrow range of innovations such as products and technologies (Adams et al., 2016). Such a focus is too broad. Environmental sustainability, however, is focused on aspects such as emissions, water and waste. Consequently, there is a need to pay specific attention to ES-SOI.

Previous studies examining SOIs have highlighted three SOI dimensions, namely, technical/people, insular/systemic and stand-alone/integrated (see Fig. 8.1) (Adams et al., 2016). The innovation focus could be on people or technology (Baumann, Boons, & Bragd, 2002). In contrast to *technology-centered* innovation, *people-centered* innovation views innovation as a complex construct that involves the interplay between people, policies, and systems. *Insular innovation* is focused on specific firms to address the issues and concerns relevant to them. In contrast, *systematic innovation* has implications beyond the firm's boundary, on the wider socio-economic system (Baumann et al., 2002). *Stand-alone innovation* would be restricted to a specific department or function in a firm, whereas integrated innovation would comprehensively and seamlessly extend across the firm.

Since SOI dimensions are focused on innovations in general, we argue that there is a need to enrich our understanding of ES-SOI beyond dimensions identified in the SOI studies. We empirically examine the ES-SOI practices of firms. Specifically, we examine if there are any salient charac-

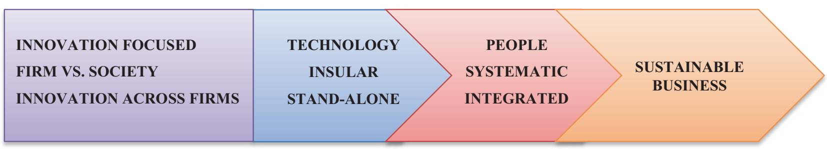

Fig. 8.1 Different SOI dimensions (Adapted from Adams et al., 2016)

teristics associated with ES-SOI. The rationale is that nuances such as the salience of specific natural resources in different innovations would not be visible in the broader SOI-focused classifications such as the stand-alone or integrated innovations above. This negligence would conceal a key aspect, namely, natural resource accounting, which could be salient in ES-SOI.

Studies such as Adams et al. (2016) have also identified a need to recognize the salience of specific contextual elements and nuances in SOI. The above-mentioned limitations of the existing literature motivate the use of secondary databases, application of different methodologies, and focus on a specific sector to develop a better understanding of ES-SOI.

3 Research Approach

3.1 The Aviation Sector

We contextualize our study in the aviation sector. The aviation sector makes an interesting testbed, as this sector relies heavily on innovations. As discussed, the environmental footprint of this sector necessitates ES-SOI.

There are two main civilian aircraft manufacturers, Boeing and Airbus (EADS). These two companies effectively make the aviation sector a duopoly (Datamonitor, 2008). Indeed, Boeing and Airbus account for about 88% of single-aisle deliveries forecast for 2016–2035 (Flight Global, 2016). In addition, the aviation sector is highly technology intensive, for reasons of safety, cost and product development. Constant innovation is needed to bring to bear on the final products made by Boeing and Airbus to ensure that the airlines receive environmentally smarter and socially acceptable aircraft. Thus, it is reasonable to focus only on Boeing and Airbus, and overlook other small players such as Embraer. The ES-SOI in the aviation sector would have a significant influence on sectoral emissions and resource consumption.

3.2 Data

The data used in this study are mainly unstructured qualitative data from archival reports from different sources. In particular, we use the sustainability reports from Boeing and Airbus as well as their responses to the

Carbon Disclosure Project questionnaire. We also use the Advisory Council for Aviation Research and Innovation in Europe reports, WIPO's PatentScope database, and the *Aviation Week* archives. Nevertheless, our analysis is primarily concentrated on the sustainability reports.

3.3 Analysis

To disentangle the ES-SOI, we adopt both manual coding and text-mining techniques to ensure the robustness of our analysis. For manual coding, one of the authors manually analyzed the participating firms' ES-SOI practices and classified them according to their characteristics (e.g., product/process innovation and focus areas).

For the text-mining qualitative technique, we utilized centering resonance analysis (CRA). First, we analyzed every innovation description using CRA to find out the influential keywords. We retained innovations with a focus on environment as our study is centered on ES-SOI. Thereafter, we used CRA to classify the different ES-SOI into thematic areas. Each theme reveals distinct characteristics of the ES-SOI innovations. We specifically applied hierarchical cluster analysis based on CRA to classify the ES-SOI reported by our sampled firms. CRA analyzes text by finding the main concepts and terms based on their "betweenness" centrality. More details of this technique can be found in Corman et al. (2002). The hierarchical cluster analysis classifies the texts into clusters based on the similarity or resonance between different texts, which reflect the various innovations.

4 Results

Our preliminary empirical analysis comprises the following steps: we first examine sustainability reports and other unstructured data sources as mentioned in Sect. 3.2. We study specific instances of a firm's ES-SOIs and analyze their specific characteristics. We follow up with the reflection of the linkage between specific ES-SOI with different aspects of environmental sustainability. We examine the various theoretical lenses that could explain ES-SOI. We also investigate whether or not our empirical analysis extends these theoretical lenses, or perhaps there is a need to develop new theoretical lenses to better understand ES-SOI.

4.1 Manual Coding

To disentangle the ES-SOI, we analyzed various reports from 2007 to 2014, spanning eight years of public data. Following Montabon, Sroufe, and Narasimhan (2007), and Tate, Ellram, and Kirchoff (2010), we specifically focused on the changes in processes and products that targeted improving environmental performance. We begin by highlighting the insights gleaned from Boeing first, and then move on to Airbus. Our manual coding reveals the following practices adopted by Boeing.

> *Boeing's newest airplanes, the 787 Dreamliner and the 747–8, exemplify the company's dedication to* ***environmental design*** *innovation. …—the 787 is designed for the environment with an impressive 20 percent improvement in* ***fuel use*** *and … reduction in* ***carbon dioxide emissions*** *compared … airplanes.* (Boeing Sustainability Report, 2009)[1]

Boeing focused on design innovation with the specific objectives of improving fuel efficiency and reducing carbon footprint. Such an innovation focus is externally oriented to improve the environmental sustainability of the airline. Moreover, Boeing has started focusing on the control systems used by the air-traffic controllers. While the focus is still external, the innovation is centered on the non-aircraft manufacturing activities.

> *Boeing has tested enhanced* ***air traffic control systems*** *at major airports in …* ***annual fuel consumption****. … airlines would reduce* ***annual emissions*** *… urge governments to update aging air traffic control systems.* (Boeing Sustainability Report, 2010)

[1] Firms publish their sustainability reports under various titles such as environment report and CSR report. Reports by major firms often follow Global Reporting Initiative (GRI) guidelines.

More recently, Boeing has been focusing on new milestones such as next-generation technology (e.g., space technology). Thus, Boeing's focus on innovation has enlarged from design to next-generation technologies.

> *Boeing is building a better planet thanks to innovations such as the world's first all-electric propulsion satellite. The all-electric propulsion design of the 702SP (small platform) satellites gives customers new flexibility and **next-generation technology** for increased performance, more affordable launch options and the ability to nearly double payload capacity*. (Boeing Sustainability Report, 2014)

Furthermore, Boeing is focusing on internally focused innovations such as combining lean practices with process improvement to reduce its carbon footprint.

> *Our commitment … environmental improvement … from expanding ISO 14001 certification to additional sites and subsidiaries to finalizing clean up at 12 remediation sites, to continuing to implement **Lean + innovations** to **reduce waste** and improve business performance*. (Boeing Sustainability Report, 2010)

In comparison, Airbus is also focusing on innovation on several fronts. One of the internal-focused innovations in Airbus is the use of robotics and automation technology.

> *A concept called 'Future Factory' is bringing major … Robots, under direct control of workers using virtual reality technology, will execute assembly tasks in …. Airbus plans to use these 'cobots'—an acronym for 'cooperative-robot'—from the end of 2015 on the A380 programme. **Three-dimensional printing** is being developed… cutting waste, production time and costs*. (Airbus Sustainability Report, 2014)

Like Boeing, Airbus is also focusing on products that reduce the airlines' carbon footprint. Airbus is focusing on eco-efficiency and materials that are more efficient. As a long-term vision, it is also focusing on high-speed air travel.

"*Advances in materials … making aviation more eco-efficient. In 2014, Airbus Group Innovations unveiled a new process for creating lightweight hybrid-construction materials. The Stingtech process … Thanks to this technology, a jetliner's reinforcing stringers and approximately 50% of its strengthening frames should no longer be necessary…*" … "*High speed concepts: the vision of* ***high-speed, low emissions*** *transport … long-term goal. The Group is working … international research organisations … ground-breaking hypersonic flight technology at speeds of up to Mach 6. The collaboration builds on the Group's ZEHST (Zero Emission High-Speed Transport) concept, a visionary high-speed commercial aircraft … three hours.*" (Airbus Sustainability Report, 2014)

Thus, the manual coding reveals a wide gamut of innovations used in the aviation sector.

4.2 CRA Analysis

We extended our manual analysis with CRA analysis. CRA has been utilized in past studies in the domain of sustainable OM such as Tate et al. (2010). We first explored hierarchical cluster analysis to discover clusters of ES-SOI (if any) in the various innovations conducted by Boeing and Airbus.

Our analysis has identified three clusters in our datasets. The reader may wish to note that each cluster corresponds to a specific ES-SOI reported by the responding firms. The CRA algorithm identifies three clusters based on the similarity or resonance score, and the distance between the clusters as the optimum number of clusters.

Hence, there are several unique types of innovation. Since our hierarchical clustering analysis has revealed clusters in the text data, we now identify the key themes, which are observed in the clusters. These themes are coherent groups of words that are observed in different groups (clusters) of documents. We used CRA to identify the key themes. We observed that distinct words correspond to different clusters. For instance, for one cluster, the key theme was to focus on fuel. For another cluster, the key theme was to focus on technology such as propulsion technology. For the third and final cluster, the focus was on specific components of an aircraft such as engines.

Table 8.1 Identification of key terms and themes in different innovations by CRA

Words		Pairs	
Fuel	0.61122	Fuel | research	0.299
Research	0.24462	Fuel | sufficient	0.107
Sufficient	0.1754	Fuel | development	0.067
Quantity	0.12097	Fuel | industrialization	0.064
Centre	0.12097	Fuel | sustainable	0.063
Group	0.11358	Fuel | low	0.056
Development	0.11022	Fuel | biomass	0.048
Industrialization	0.10517	Fuel | numerous	0.038

We further examined the various influential word pairs for different groups of unstructured data sources (see Table 8.1 for influential words in the cluster focused on fuel). For instance, we found that fuel is the most influential word for one cluster, and the influential word pairs include fuel in combination with the other words. The influential word pairs indicate that ES-SOI related to fuels focus on reducing fuel quantity. The analysis of words related to technology indicates a focus on technological solutions to improve fuel and energy efficiency, and subsequently reduce the carbon footprint. The analysis of words related to aircraft components indicates a focus on specific aspects such as engine and aircraft design to improve the overall carbon footprint.

Broadly, our analysis suggests that ES-SOI innovation is focused on reducing resource consumption and increasing resource efficiency.

The findings from CRA reinforce our findings from manual coding, which indicated that there are several innovations focused on fuel. Manual coding also showed that there are several innovations focused on technological improvement. We also observed that there is an increasing focus on specific aspects such as aircraft design. There also seems to be a focus on the life cycle approach towards aircraft manufacturing. Apparently, concepts such as Design for Environment (DfE) have been adopted by the firms. In this way, the application of multiple methods leading to similar findings demonstrates the robustness of our results.

5 Implications for Research and Practice

Past studies conceptualized SOI along three dimensions and proposed dichotomous classifications such as technology or people oriented, stand-alone or integrated, and systematic or insular innovations. Our exploratory analysis suggests that ES-SOI can be approached from distinct perspectives such as resource consumption and resource efficiency. Another perspective, which is also evident in ES-SOI, is the design perspective as firms are focusing on DfE. Approaching ES-SOI from these perspectives could extend our understanding of ES-SOI more comprehensively as delineating ES-SOI solely into technology or people oriented solutions, could obfuscate the intertwined linkage between technology and people orientation. Even a technology-oriented ES-SOI would require people orientation to achieve the goal of environmental sustainability. Technology-oriented SOI in the absence of people orientation could fail to achieve success in meeting the environmental sustainability objective due to poor adoption and execution by various stakeholders such as the employees. We also did not observe the predominance of stand-alone innovation. This phenomenon could perhaps be attributed to the characteristics of the studied sector. Our findings thus indicate that we can develop our understanding of ES-SOI in the technology-intensive sector by focusing on specific resources that these ES-SOI target. Firms are increasingly focusing on integrated solutions and innovations. Consequently, a specific focus on the targeted resource could help comprehend the salient characteristics of ES-SOI in a better manner. Given the complexity of modern supply chains and strong relationships between the original equipment manufacturers (OEMs) (here Boeing and Airbus) with their suppliers, the innovations, in general, are expected to be relatively less insular. The aviation sector has high safety and technological requirements, which necessitate strong relationships and interdependencies. This also results in the strong potential for spillovers. Research focusing on systematic and insular innovation dichotomy could approach innovation from the supply chain relationship perspective to understand the rationale underlying the dominance of one form of innovation over another.

To summarize, our preliminary analysis suggests that approaching ES-SOI from the resource perspective could enhance our understanding. However, we also recognize that (1) this study is exploratory in nature, and (2) we extend the conceptualizations of SOI to focus solely on the aviation sector. This sector is technology intensive, and will grow to become a more popular mode of transportation in the future.

The distinct focus of the three clusters that emerged in our analysis could also have different consequences regarding environmental sustainability. The ES-SOI focused on fuel would help firms specifically in reducing the carbon footprint of fuel consumption directly. In contrast, technology-focused ES-SOI would have an indirect impact on the carbon footprint. The third cluster of ES-SOI would influence the carbon footprint through reducing the negative consequences of the complete life cycle of the aircraft.

We recognize that the ES-SOI and ES linkage could certainly be driven by clean technology investments, but the focus on organizational and human capital related aspects must not be overlooked. It is in the interest of practice that managers have the final say in determining how the continuum of innovations should be navigated given the availability of resources.

Broadly, the technology orientation of ES-SOI in the aviation sector indicates that such innovation could be categorized as clean technology. Due to an inherent focus of specific instances of ES-SOI on reducing the carbon footprint and approaching the products from life-cycle perspectives, they can also be sub-categorized as pollution prevention and product stewardship.

6 Concluding Remarks

In this chapter, we use the example of two major players in the aviation sector to highlight the need for a better understanding of appropriately marrying SOI with environmental sustainability. However, we hope that the outcome of our research can help develop a better understanding of the state of play in the ES-SOI and environmental sustainability domains.

Our study has its limitations. It is contextualized in one unique sectoral setting. Therefore, the findings of this research cannot be readily generalized to other sectors. Nevertheless, our study could reveal the nuances associated with ES-SOI, and therefore contributes to our understanding of this emerging phenomenon. It extends the existing studies such as Adams et al. (2016). Future research could specifically focus on distinct resources as they emerge as the key focus of ES-SOI.

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9

The Impact of Negative Social/Environmental Events on the Market Value of Supply Chain Partners

Mauro Fracarolli Nunes

1 Introduction

Corporate social responsibility (CSR) comprehends the belief that firms hold commitments to society beyond the creation of wealth for investors. Within this concept, along with environmental protection, the interests of a larger group of stakeholders must be taken into account in the development of businesses (Carroll, 1999). In order to certify that they operate under sustainable practices, firms have increasingly sought to be well ranked on their performance in CSR policies, as "governments, activists and the media have become adept at holding companies to account for the social consequences of their activities" (Porter & Kramer, 2006, p. 1). Beyond that, several actions may be adopted by firms in the building and management of corporate social and environmental reputations, not necessarily coherent with real sustainable operations (Fracarolli Nunes & Lee Park, 2017).

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From a sustainable supply chain management (SSCM) perspective, such issues have gained considerable relevance as the field has evolved from stand-alone research in social and environmental debates into a real CSR agenda (Carter & Easton, 2011). The development of outsourcing strategies (Quinn & Hilmer, 1994) and the exponential increase in the complexity of production, distribution and consumption networks that followed made more urgent the better understanding of the tangles of direct and indirect relationships created. Due to this operational intricacy, pressing sustainability issues such as the employment of modern slavery, child labor, deforestation and general pollution, among others, may remain concealed, with the perception of their responsibility diluted through the many parties involved from raw material to consumption. In this set, the effects of firms' actions and decisions may be analyzed within an extended perspective, considering the eventual repercussions for direct stakeholders, but also for stakeholders of stakeholders. While this task must demand a theoretical effort in the design of convoluted relations of immediate and more distant counterparts, empirical investigations of the extended impact of sustainability-related issues must help clarify the actual relevance attributed to such matters by distinct groups of stakeholders. The present study concentrates then on the analysis of the consequences for the market value of a firm of a negative social/environmental event occurring in (or caused by) a member of its supply chain. The objective of the study is thus better represented by the following research question: *do investors negatively react to announcements of negative social/environmental events related to a supply chain partner?*

The event study method is indicated to conduct such a test as it allows for the perception and measurement of market value creation/destruction due to any new information available about firms. Through the examination of 15 cases, the variance of the market value of 82 supply chain partners was assessed at three levels of analysis: (1) individually, considering the isolated effect of each event on each partner; (2) combined effect through supply chains, comprehending the gathered effect of events on all supply chain partners identified; and (3) general effect of negative social/environmental events, measuring the overall impact of such events through the whole sample.

The study intends to offer theoretical and practical contributions. Regarding the former, it is relevant as it contributes to the operations management literature by addressing the link between sustainability matters and stakeholders' assessment. Beyond that, through the proposition of both the *supply chain extended stakeholder model* and the concept of *incidental stakeholder*, it also subsides the emergence of new questions around the critical role of stakeholder theory in sustainable operations management (SOM). As for the practical contribution, the study offers empirical evidence that might be useful in guiding and valuing the importance of SSCM decisions, specifically on what relates to the potential impact on the market value of indirectly associated firms.

Following this introduction, the investigation is arranged into six further sections. The literature review proposes an integrative discussion on the main arguments of stakeholder theory, on the developments in the literature on SSCM and on the efficient market hypothesis, as well as on the main criticisms of the latter (behavioral finance, institutionalism and the nature of investors). The subsequent section presents the proposition of a theoretical framework and the hypothesis of the study, both developed from the assimilation of previous debate. In turn, the method and sample section approaches the event study methodology as well as the sampling procedures adopted, succeeded by the results, discussion, conclusion and limitations and suggestions for future research.

2 Literature Review

2.1 Stakeholder Theory

In contrast to more "shareholder-driven" understandings of the nature and objectives of firms (e.g. Friedman, 1970), stakeholder theory builds on the assumption that the practice of business must have the attention to values as one of its fundamental concepts (Freeman, Wicks, & Parmar, 2004). Accordingly, it would invite managers to explicit the way they intend to run operations, particularly regarding the sort of relationships they seek to build with related parties. Through this prism, the meeting of corporate aspirations would be more virtuous, as, in the vision of the authors, "truth and freedom are best served by seeing business and ethics as connected" (Freeman et al., 2004, p. 364). In a way, this call for recognition of and effective concern for all inter-related parties (Freeman, 1994) may be seen as a theoretical basis for the concept of sustainability in business, as further discussed ahead.

Nevertheless, although the notion that organizations count on stakeholders has been extensively incorporated, the definition of who or what indeed constitutes one has been the subject of a rich and sometimes confusing debate, with terms such as stakeholder, stakeholder model, stakeholder management and stakeholder theory being employed in remarkably distinct forms (Donaldson & Preston, 1995). In that regard, Windsor (1992) highlights prevalent variations in the approaches, orbiting around broader and narrower perspectives. Within the first cluster would be the perception defended by authors such as Freeman and Reed (1983), for whom the notion of stakeholder would refer to those individuals or groups who may influence and/or be influenced by organizational accomplishments. Similarly, Freeman's (1984) "now-classic definition" (Mitchell, Agle, & Wood, 1997, p. 856)—that "a stakeholder in an organization is (…) any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984, p. 46)—would be particularly generous once, beyond leaving the notion of stake and potential stakeholder unequivocally open to be fulfilled by nearly any actor, it also posits the perception of stakes as being possible in both an uni- and a bidirectional sense (Mitchell et al., 1997). Accordingly, from this point of view the only agents excluded from eventual stakes would be those simultaneously unaffected by organizations and incapable of affecting them. Arguably more circumscribed perspectives, in turn, would lie in the notion of stakeholders as an adequate label for factions considered essential to the continued survival of organizations (Stanford Research Institute, 1963).

By linking the idea of stakes to risk, Clarkson (1994) offers a more compressed interpretation (Mitchell et al., 1997). Inner to his view, in face of their awareness and risk propensity, stakeholders shall be roughly classified as either voluntary or involuntary, offering what seems to be a distinction around the level of activeness or passivity one may have in relation to the operations of a company. More specifically, while the former would be delineated as those stakeholders who "bear some form of risk as a result of having invested some form of capital, human or financial, something of value in a firm", involuntary ones would be those indirectly "placed at risk as a result of a firm's activities" (Clarkson, 1994, p. 5). Besides the considerations over the definition and classification of stakeholders, a discussion of stakeholder theory from a processual perspective is also useful. In this way, according to Donaldson and Preston (1995), contrary to the previously conventional input-output view in which investors, employees and suppliers are understood as sources of inputs directed to firms, which then process them into output to customers, within the stakeholder model, all actors holding legitimate interests in an enterprise would expect benefits, in a way that there should be no prioritization of the interests of one group over the others. More than the consideration of a broader set of actors, the angle proposed features two-way exchange flows between firms and their respective stakeholders. Figures 9.1 and 9.2 below illustrate these different conceptualizations.

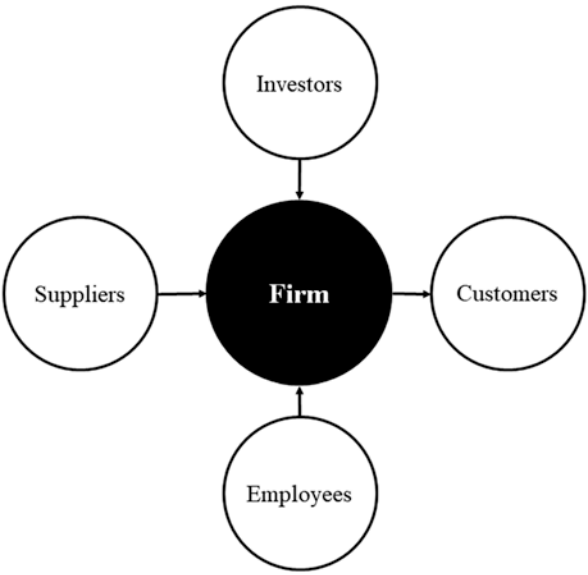

Fig. 9.1 Conventional input-output view. Source: Adapted from Donaldson and Preston (1995)

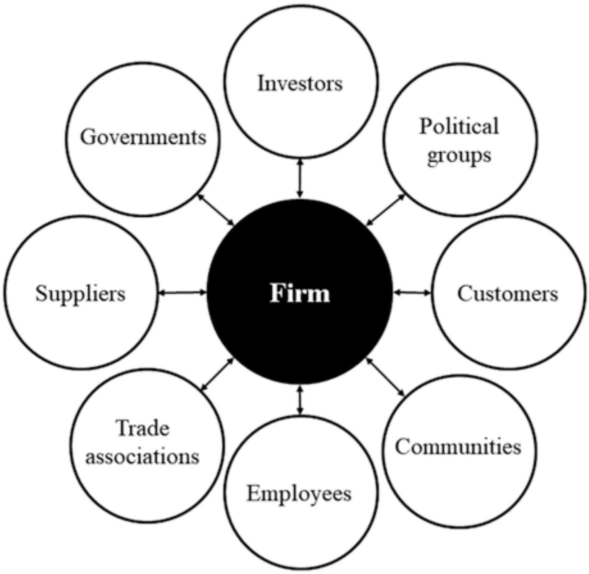

Fig. 9.2 Stakeholder model. Source: Adapted from Donaldson and Preston (1995)

The recognition of firms' relations and links to their numerous counterparts represents a key element of the ongoing investigation, as stakeholder theory offers the main postulates not only for the discernment of these ties, but also for their differentiation in terms of objectives. In addition to offering a visual perspective of the social architecture in which firms are embedded, the main arguments of the theory—along with the structure of the stakeholder model—may be seen as central to the development of SOM. Among other things, the reasoning would systematize firms' need to simultaneously meet the demands of a wide range of publics, which, coherently with Elkington's (1997) triple bottom line approach to sustainability, could be delimited in distinct social, environmental and economic perspectives.

Although pivotal to the relations of stakeholders and firms *per se*, the stakeholder model could possibly profit from a theoretical development encompassing the relation between firms and their eventual *incidental stakeholders*, here defined as the stakeholders of stakeholders, which, as such, may not be aware of their links with other companies, or even not consciously willing to take the risks associated with such a subsidiary connection. Aiming to offer additional guidance in that direction, the relation between firms composing supply chains and their direct and indirect counterparts (i.e. *incidental stakeholders*) are further addressed next within a SSCM perspective. The debate is markedly pertinent to the development of both the theoretical proposition and the hypothesis of the study.

2.2 Sustainable Supply Chain Management: The Link Between Firms, Partners and Stakeholders

Supply chains have been traditionally understood as arrangements of companies organized around the efficient flow of materials (La Londe & Masters, 1994), information, products and services (Mentzer et al., 2001), bringing the latter two to markets (Lambert, Stock, & Ellram, 1998). As pointed out by Mentzer et al. (2001), the basic grouping configuring a supply chain would consist of at least three elements: a firm, a buyer and a supplier. In this way, direct supply chains would account for the alignment of these three players, while extended ones would include suppliers of immediate suppliers and customers of immediate customers. Although nearly innate to the current comprehension of supply chains, the depiction of players and the links between them is helpful in the comprehension of contemporary matters firms forming these arrangements have faced. Corporate social responsibility issues, for instance, have been particularly critical, mainly for companies inserted in global configurations. With the emergence of several cases of negative social/environmental events in supply chains, ranging from accusations of environmental damage to forms of modern slavery, CSR policies managed in buyer-supplier relationships have been openly discussed, in both the traditional media and social networks. In this way, sustainability matters, once marginal in the supply chain debate, have now become part of its mainstream, including what has come to be known as the study of SSCM (Pagell & Shevchenko, 2014). In their quest to meet the demands of societies, firms, municipalities and countries have invested in the improvement of their processes around green procurement (Michelsen & De Boer, 2009) and socially responsible purchasing (Worthington, Ram, Boyal, & Shah, 2008), among other SSCM practices.

As observed by Nidumolu et al. (2009, p. 2), "not surprisingly, the fight to save the planet has turned into a pitched battle between governments and companies, between companies and consumer activists, and sometimes between consumer activists and governments". Within this logic, the discussions around CSR would encompass a much broader and more complex debate than that confined to the single firm, as all the chain partners may potentially affect each other in this regard. Yet, considering that partners may simultaneously hold joint and opposing goals (Ellegaard & Andersen, 2015), the link between CSR and supply chains may emerge in apparently much more discreet ways. As specific industries (e.g. the fashion business) have largely relocated their production from economically developed areas to low-labor-cost zones, important "unsustainability symptoms" may arise on both sides. Beyond causing sudden unemployment among the unskilled workers of the deprecated areas, the transfer usually relegates newly employed personnel to precarious conditions of work (De Brito, Carbone, & Blanquart, 2008).

Tragedies such as the Rana Plaza Collapse, in which thousands of workers died (Hoskins, 2015), are contained in this category, as well as the fires in Bangladesh factories, which also victimized hundreds of people (Bajaj, 2012). These sorts of cases and events, along with those within an environmental context, offer the opportunity to test whether a given group of stakeholders (i.e. investors) negatively reacts to eventual disrespect or losses caused by firms to other groups (e.g. employees, communities), either directly or diffusely. Moreover, the approach also allows for the evaluation of investors' responses to sustainability issues in the condition of *incidental stakeholders* of the firms responsible for social and environmental failures. In this sense, the approach is expected to offer insights into the critical role of stakeholder theory in SSCM and SOM as a whole. In advancing this debate, the following section concentrates on developments in the literature on the efficient market hypothesis and the adjustment of stock prices to new information. The discussion presents an additional basis for the comprehension of how negative social/environmental events may possibly impact the market value of supply chain partners.

2.3 Efficient Markets Hypothesis: The Adjustment of Stock Prices to New Information

The idea of efficiency seems to indicate the best possible way in which something may be accomplished, in terms of either minimized use of time and resources or any other related factor. In this way, the concept is employed in the most distinct fields of study, generally in relation to the ideas of readiness and competence. From an operations management angle, for instance, it is classically used in themes such as the assessment of logistics performance (e.g. Clarke & Gourdin, 1991), inventory management (e.g. Småros, Lehtonen, Appelqvist, & Holmström, 2003) and supply chain management (Kärkkäinen, 2003), among others. From a sustainability landscape, in turn, the idea of efficiency is usually related to the optimum use of water (Rogers, De Silva, & Bhatia, 2002) and energy (Ayres, Turton, & Casten, 2007), along with a broad debate around the responsible use of other inputs, the generation of waste, as well as the general consequences of human activities for societies and the environment.

When it comes to the functioning of stock markets and the adjustment of stock prices to new information (Fama, Fisher, Jensen, & Roll, 1969), the concept of efficiency assumes a particularly prominent aspect in the present study, as, depending on its fortitude as a premise, the beliefs around shareholders' reactions may be considerably distorted. Within this reasoning, the finance literature disposes capital markets as efficient in cases where they fully and correctly represent all pertinent information in the determination of security prices (Malkiel, 1989). From this perspective, as observed by Beechey, Gruen, and Vickery (2000), prices would be expected to be invariably coherent with "fundamentals", or the logical and economic reasoning supporting their formation.

Based on these underlying conceptions, Fama (1970) proposes the division of work on market efficiency into three groups: weak-form tests, semi-strong-form tests, and strong-form tests. While the first would relate to the assessment of past returns as predictors of the future, the second and third respectively refer to the speed with which the announcement of public information is reflected in prices and the possibility of investors holding private information which may not be fully reproduced in market figures (Fama, 1991). In reviewing this classification, the author evolves the idea into a more comprehensive division: (1) tests for return predictability, (2) event studies and (3) tests for private information. In this way, in its strong version, the efficient market hypothesis would represent "the simple statement that security prices fully reflect all available information" (Fama, 1991, p. 1575), while in "a weaker and economically more sensible version", information would be reflected in prices to the limit where the marginal benefits of such inputs would not outrun their marginal costs (Jensen, 1978).

Despite its prominence and arguably broad acceptance, the efficient market hypothesis is not free of criticism. Westerlund and Narayan (2013), for instance, highlight that some of its predictions on the joint behavior of spot and future prices are not supported by most empirical evidence. Authors such as Basu (1977), in turn, stress the considerable questioning around the validity of the rationale, as, among other issues, many scholars would claim that prices are actually biased concerning the price-earnings (P/E) ratios of securities, for example. Fama (1970, 1991) partially refutes these criticisms, evoking what he calls "the joint-hypothesis problem", according to which market efficiency all alone would not be testable. Instead, it would be inescapably evaluated alongside equilibrium or asset-pricing models. From this angle, there should be ambiguity in the eventual findings of anomalous behavior of returns, as it would not be evident whether they are indeed due to market inefficiency or to poor market equilibrium models. Nevertheless, in comparison to the other classifications, the implications of event studies for market efficiency would be less controversial, as they would narrow the distinction between market efficiency and equilibrium-pricing matters (Fama, 1991). Still, rooted in a semi-strong form of the efficient market hypothesis, event studies would offer the most direct and supportive evidence around efficiency, and for this reason are adopted in the present investigation.

2.4 Behavioral Finance, Institutionalism and the Nature of Investors

Beyond the critics already addressed, severe arguments have been put forward to challenge the rationality premises underpinning the efficient market hypothesis. Among the most significant questioning in that sense would be those within a behavioral finance perspective, which, as pointed by Barberis and Thaler (2003, p. 1053), "argues that some financial phenomena can plausibly be understood using models in which some agents are not fully rational". Within the distinctions of the field of traditional finance would be the general recognition that the human brain processes information through shortcuts and emotional filters, also called "psychological biases" (Nofsinger, 2016). Depending on the myriad forms such psychological biases may assume, investors could be argued to hold a considerable level of heterogeneity on what relates to their decision-making processes and reactions.

Yet, it is also possible that the behavior of individual investors may come to significantly, or at least partially, differ from that of institutional ones, such as pension funds, for example. From this angle, while advances in behavioral finance might be particularly useful to analyses concentrated in the first group, institutional and sociological logics may add relevant insights to the investigation of behavior patterns and anomalies of the latter. Gompers and Metrick (1998), for instance, contend that institutional investors tend to have preferences for securities holding greater market capitalization, liquidity and book-to-market ratios, as well as lower returns for the preceding year. Ferreira and Matos (2008), in turn, add that, beyond the preferences for the stocks of large firms, institutional investors would also be inclined to hold shares of firms with relatively higher levels of governance. Apart from these and other issues more directly related to the financial characteristics of businesses and managerial practices, less straightforward circumstances are also argued to influence the decisions of institutional players. In this way, Goetzmann, Kim, Kumar and Wang (2014) show the impact that weather-based indicators of mood might have on institutional investors' decisions, as cloudier days would increase the perception of overpricing and thus the propensity to sell.

It is also possible that certain frames happen to be useful in the analysis of the investment decisions of both individual and institutional sets. Jun (2016, p. 487), for example, highlights the clout that socially responsible investing (i.e. "investment strategy that incorporates environmental, social and governance (ESG) issues in the decision-making process") may exercise on the two groups, representing an additional concern to that solely focused on financial aspects. Nevertheless, independently of the nature of these influences, it seems reasonable to recognize the relevance that psychological, social and institutional factors may have in the reaction of distinct categories of investors. From this angle, although the current investigation is grounded on the premises of the efficient market hypothesis, the literature discussed in the present sub-section contributes to the recognition of its limitations, notably around the discernment that investors may not be seen as a homogeneous class.

3 Theoretical Framework and Hypothesis Development

Considering the theoretical background discussed in the previous section, the present study counsels that the inter-relation between the stakeholders of different firms may be conjunctly analyzed in an integrating and, perhaps, more embracing theoretical proposition. In this way, alike Donaldson and Preston's (1995) stakeholder model, it seems that Mentzer et al.'s (2001) conception of direct supply chains places companies as central in relation to their near environment, at least on what relates to the trade of their inputs and outputs. While buyers and suppliers would be firms' immediate counterparts, from an extended view (i.e. extended supply chains), buyers of buyers and suppliers of suppliers (as well as all their own related counterparts) would represent *incidental stakeholders*, as previously defined in the present study. This design suggests that, although these *incidental stakeholders* do not share immediate interfaces with firms, they may also be affected by their attitudes in an indirect manner. Such a rationale then theoretically supports the developments of the *supply chain extended stakeholder model* depicted in Fig. 9.3, where the firm's stakeholders are presented in black and its *incidental stakeholders* in white:

The *supply chain extended stakeholder model* accounts for the prolonged consequences that the acts, behaviors, events, facts, crisis, fails, successes or virtually anything concerning a given firm may cause not only on its direct stakeholders, but also on the stakeholders of its immediate upstream and downstream partners. The development is based on the idea that, within supply chain contexts, the counterparts of firms may be grouped as first-, second- and third-order stakeholders, and so on. While the first

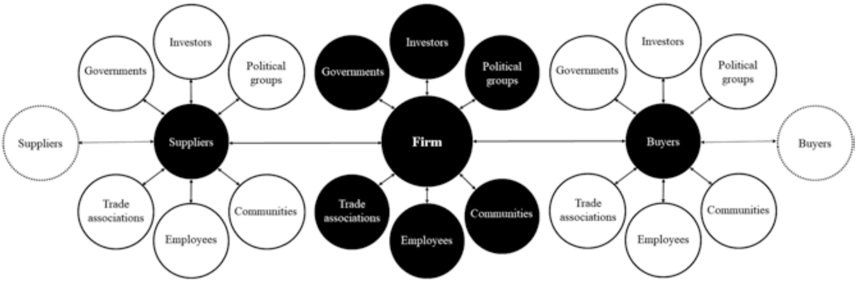

Fig. 9.3 The supply chain extended stakeholder model

order addresses the traditional stakeholder model, the second relates to the stakeholders of direct buyers and direct suppliers. The third order, in turn, regards the stakeholders of buyers of buyers and those of suppliers of suppliers. Simplistically, from the second-order stakeholders on, the indirect stakeholders of a firm would be classified as incidental. Likewise, more than one-way paths, the influence that the stakeholders of a given firm shall exercise on other firms within this net is also lengthened, what is illustrated by each of the two-way arrows in the framework. Within this reasoning, even if stakeholders and firms are not directly linked to each other, it is possible that they end up affecting one another, as they belong to a broader interconnection. While the framework is grounded on the first two topics discussed in the literature review, its alignment with the efficient market hypothesis subsidizes the development of the study's hypothesis:

H1: Investors negatively react to announcements of negative social/environmental events related to a supply chain partner.

The hypothesis is tested on three distinct levels: (1) the impact of each negative event on the market value of each supply chain partner identified; (2) the overall impact of each negative event on the conjunction of corresponding supply chain partners identified; and (3) the general impact of negative social/environmental events. While the first and the second levels aim to provide evidence on specific cases (i.e. offering a detailed assessment of the impact of specific events on specific partners and specific supply chains), the third level of analysis seeks to provide initial evidence for a possible generalization of the expected results of negative social/environmental events. The following section details the sampling procedures for the identification of the 15 different cases considered and the event study method applied, as well as its specificities to the conduction of each level of analysis.

4 Method and Sample: The Event Study Methodology

The event definition represents the initial task in the conduction of an event study and is divided into two main steps: the definition of the event of interest and the identification of the event window, defined as "the period over which the security prices of the firms involved in this event will be examined" (Campbell, Lo, & MacKinlay, 1997, p. 151). For control purposes, seven different event windows are examined. In this study, the definition of events was based on the disclosure of sustainability and CSR failures in supply chain contexts from January 2005 to September 2015. The relatively long period considered (more than 10 years) aims to capture both recent and earlier events, lessening eventual contextual or time bias in the results. In this way, the electronic databases of 10 international newspapers and magazines were chosen as the object of the sampling procedure: the *New York Times* (www.nytimes.com), *Washington Post* (www.washingtonpost.com), *Guardian* (www.theguardian.com), *Telegraph* (www.telegraph.co.uk), *The Economist* (www.economist.com), *Financial Times* (www.ft.com), *Le Monde* (www.lemonde.fr), *El País* (www.elpais.com), *O Estado de São Paulo* (www.estadao.com.br) and *Clarín* (www.clarin.com). Aiming to select negative social and negative environmental events, the following words were applied in the search tools offered by the websites: "buyer", "catastrophe", "child labor", "client", "corporate social responsibility", "customer", "failure", "global warming", "hazard", "human rights", "protest", "pollution", "infraction", "servitude", "supply chain", "supplier", "sustainability" and "tragedy".

In face of the results of this initial search, the following steps of the sampling procedure consisted in reading the news collected in full, segregating cases into negative social and negative environmental events and identifying source companies and supply chain partners. Considering the objectives of the study and our methodological choice, companies that did not have the prices of their shares publicly disclosed were necessarily discarded from the final sample. Table 9.1 below briefly presents the 15 cases analyzed.

Daily closing prices adjusted for dividends and splits were collected from the website Yahoo Finance (see http://finance.yahoo.com). A measure of abnormal returns is required for the appraisal of the impact of the event (Brown & Warner, 1980). The method most often used for the estimation of normal returns (*ex ante*) in event studies is the market model proposed by Fama (1970) (Agrawal & Kamakura, 1995). Abnormal

Table 9.1 Analyzed cases, respective nature and number of suppliers

Case number	Case name	Nature of the case	Source company	Number of suppliers
1	Palm Oil—Unilever	Environmental	Multiple palm oil suppliers	2
2	Palm Oil—Nestlé	Environmental	Multiple palm oil suppliers	2
3	BP Oil Spill	Environmental	British Petroleum	6
4	Zara Brazil	Social	Small local suppliers	1
5	Foxconn	Social	Foxconn	12
6	Junking the Jungle	Environmental	Asia Pulp Paper	1
7	Bangladesh Fire	Social	Small local suppliers	6
8	Child Labor	Social	Multiple local suppliers	1
9	Zara Argentina	Social	Small local suppliers	1
10	Rana Plaza Collapse	Social	Small local suppliers	16
11	Pegatron	Social	Pegatron	1
12	Licence to Kill	Environmental	Multiple palm oil suppliers	3
13	Palm Oil—P&G	Environmental	Multiple palm oil suppliers	5
14	CP Foods	Social	CP Foods/Small local suppliers	5
15	Volkswagen Fraud	Environmental	Volkswagen	20

returns are then considered as the difference between actual and normal ones and are analyzed in the form of cumulative abnormal returns (CARs) for individual firm analysis and cumulative average abnormal returns (CAARs) when more than one company is considered for a given case (see Brown & Warner, 1980; Campbell et al., 1997, for further references).

5 Results

The first analyzed event window (D-1, D0) shows that, among the 82 firms studied, 80 did not demonstrate significant negative returns at the 99% or 95% significance levels. In the second event window (D0, D1), none of the 82 firms yielded negative returns at the 99% significance level, and 81 also did not find confirmation for negative abnormal returns at the 95% significance level. The third event window (D0, D2), in turn, displays 78 non-affected companies at the 95% significance level. However, the analysis of the 99% significance level with two companies (Borg Warner and Plastic Omnium, both in Case 15–Volkswagen Fraud) could possibly indicate negative reactions. For the fourth event window (D-1, D1), 81 companies did not present negative abnormal returns at the 99% significance level.

Similarly to the results found in event window 2, the fifth event window (D-1, D5) shows that 79 companies did not present negative reactions. At the 99% significance level, the fact that two firms (Apple in Case 8–Child Labor and Honeywell in Case 15–Volkswagen Fraud) yielded negative abnormal returns might suggest that negative reactions were detected for these companies. In the sixth event window (D-2, D2), 78 out of the 82 assessed companies did not present significant negative abnormal returns. Once more, at the 99% significance level the negative returns detected in two firms (Apple in Case 8–Child Labor and BorgWarner in Case 15–Volkswagen Fraud) might suggest a possible reaction.

Finally, the last and wider event window (D-5, D5) captured no reaction from 78 companies at the 95% significance level. However, at the 99% significance level, the negative abnormal returns detected in two companies (Sears in Case 7–Bangladesh Fire and Honeywell in Case 15–

Volkswagen Fraud) may also point to the possibility of a negative reaction. Table 9.2 below summarizes the findings, presenting the companies for which significantly negative market value losses were observed as a result of the negative social/environmental events considered.

Even though a compilation of all results indicates some negative effects, the majority of the firms studied (74 out of 82) did not demonstrate negative CARs in any of the event windows considered. The results suggest that, in general, investors do not react to negative social/environmental events in supply chains, as no significant negative CARs were detected in 74 companies. However, market value penalization observed in eight companies suggests that further analysis may be useful, especially for case 15–Volkswagen Fraud, which concentrated five companies in this situation.

As previously discussed, the second level of analysis aims to detect the effect of a given event through all the buyers and suppliers identified (i.e. the whole supply chain). However, some cases (e.g. cases 4, 6, 8, 9 and 11) count on only one identified buyer/supplier. For this reason, this level of analysis concentrates only on those cases in which two or more supply chain partners were found, as the analysis of single firms coincides with the first level of analysis discussed above. None of the cases presented statistically negative CAARs.

For the third level of analysis, the overall impact of negative social/environmental events is assessed. Table 9.3 below presents the calculated CAARs and their respective statistics for each period considered. None of the CAARs calculated presented statistical significance, meaning that the

Table 9.2 Summary of results

Case number	Case	Company	CAR	t-stat	Statistical evidence
Case 5	Foxconn	Google	–9.22%	–1.99	95%
Case 7	Bangladesh Fire	Sears	–43.73%	–4.12	99%
Case 8	Child Labor	Apple	–12.21%	–4.92	99%
Case 15	Volkswagen Fraud	Magna	–4.90%	–2.15	95%
Case 15	Volkswagen Fraud	BorgWarner	–8.73%	–4.27	99%
Case 15	Volkswagen Fraud	Honeywell	–5.56%	–2.80	99%
Case 15	Volkswagen Fraud	Siemens	–2.05%	–2.18	95%
Case 15	Volkswagen Fraud	Plastic Omnium	–8.44%	–3.03	99%

Table 9.3 CAARs for the seven event windows

	CAAR	t-stat
Event window 1	−0.09%	−0.04
Event window 2	0.01%	0.00
Event window 3	0.01%	0.01
Event window 4	−0.27%	−0.11
Event window 5	0.38%	0.09
Event window 6	−0.16%	−0.05
Event window 7	−0.04%	−0.01

negative social/environmental events analyzed did not impact the market value of supply chain partners when observed through this view. The results suggest that, in general, investors do not react to negative social/environmental events in supply chains, as significant negative CAARs were not detected in any of the seven different event windows considered. In other words, the market value of supply chain partners was not penalized by the announcement of negative events of social/environmental practices held by chain partners.

6 Discussion

We first assess the cases that relate to environmental practices. Cases 1–Palm Oil Unilever, 2–Palm Oil Nestlé, 6–Junking the Jungle, 12–Licence to Kill and 13–Palm Oil P&G demonstrate various similarities, as they all comprehend environmental accusations by Greenpeace around deforestation in tropical areas (Blewitt, 2014; Golgowski, 2012; Mainwaring, 2011). Beyond that, they also share the fact that the market value of the companies involved did not cause significant negative reaction in any of the event windows considered. This corroborates the idea that damages to corporate image or to reputational matters do not affect the market value of firms. Also related to environmental issues, the BP Oil Spill case (Case 3) did not cause negative reactions for any of its supply chain partners. Moving along to workforce conditions, despite several protests around the globe, the considerable attention from the traditional media to the tenth case (i.e. Case 10–Rana Plaza collapse) and the great impact it had on social networks (Hahn, 2017), none of the companies linked to the episode suffered market value losses. That possibly means that, from an operational perspective, the incident may have been interpreted as presenting no major impact on the firms involved, as the production addressed in the sweatshops could arguably be easily and rapidly redirected to other suppliers.

The Bangladesh Fire (Case 7), in turn, showed that out of the six supply chain partners linked to the case, only Sears saw its market value negatively impacted. It is possible that a higher portion of Sears' production was concentrated in the factory. Nevertheless, the analysis of the case did not allow for such conclusion. Previous to the event day itself, Sears' market value already presented abnormal behavior, with high volatility. Even though the fourth case (Zara Brazil) is also within the fashion business, unlike the cases discussed above, it does not relate to a tragedy with a high death count. Moreover, it focuses on a single company, instead of diverse supply chain partners. The absence of negative reactions from investors to slavery practices suggests that reputational issues were not relevant for them either. Zara's case in Argentina (Case 9), linking the company to poor working conditions in the country (Root, 2014), holds great similarity to the case in Brazil (Shankar & Das, 2015). The results of the empirical study were the same, with investors presenting no negative reaction to the disclosure of such practices.

In the Foxconn case (Case 5), out of the 12 companies analyzed, only Google presented a negative reaction from investors. Unlike the other 11 companies, Google's most representative relation with Foxconn is not around electronic goods manufacturing. Instead, both companies are close research and development partners in the field of robotics, with Foxconn being responsible for new product development (Luk, 2014). It is possible that investors perceived a greater threat to this kind of long-term partnership, presumably more sophisticated and riskier.

Similarly to the Foxconn case, the announcement of extreme working conditions in China in Case 11–Pegatron did not trigger any reaction from Apple's investors. The Child Labor case (Case 8) carries the particularity that Apple itself announced severe abuses of working conditions in several of its supply chain partners (Gupta & Randewich, 2013). This may have led investors to anticipate operational problems, as the companies involved carried out a significant portion of Apple's production (mainly in China). Moreover, investors' negative reactions may also have been driven by the expectation that compensation would have to be paid, as the case concerned a large number of employees. Another possibility is that higher control costs were expected, as Apple announced multiple measures to be adopted in that respect.

Case 14–CP Foods brought to light the announcement of extreme working conditions, human traffic, slavery, torture and death of employees (Fishwick, Hondal, Kelly, & Trent, 2014). Yet no negative reaction from investors was detected in the case. Finally, and more recently, Volkswagen Fraud (Case 15) is the most representative case of a negative reaction from investors. Five out of the 20 identified supply chain partners presented significant losses in their market value. Volkswagen is a relevant client of many of these firms (Bolduc, 2016; Tomesco, 2015), which may reflect investors' concerns about their sales being seriously affected. Despite not comprehending the objective of the study, in order to provide an additional perspective on this case, the same event study analysis was conducted to test the impact of the event on the market value of Volkswagen itself. The results show that the company suffered harsh market value losses (significant at the 99% confidence level) in event windows 2, 3, 4, 5, 6 and 7, as follows (Table 9.4).

The gravity of the market value loss in the company may be an additional factor for the comprehension of the impact its supply chain partners experienced.

Table 9.4 Event study for Volkswagen

	Event window			Event impact		
	Number of days	Initial day	Final day	Estimation window	Calculated CAR	t-stat
Event window 1	2	D-1	D0	200	−0.31%	−0.209
Event window 2	2	D0	D1	200	−17.71%	−12.000
Event window 3	3	D0	D2	200	−30.39%	−16.769
Event window 4	3	D-1	D1	200	−17.76%	−9.825
Event window 5	7	D-1	D5	200	−27.61%	−9.974
Event window 6	5	D-2	D2	200	−30.43%	−13.006
Event window 7	11	D-5	D5	200	−27.29%	−7.839

7 Conclusion

The present study proposed the assessment of investors' reactions to negative social/environmental events within supply chains contexts. In other terms, it investigates whether stakeholders of a company are affected by and/or react to sustainability issues related to a chain partner. Along with the discussion of the pertinent facets of stakeholder theory, such hypothesis is supported by the literature on SSCM and the efficient market hypothesis. Likewise, the link between firms and their *incidental stakeholders* is depicted in the form of the proposed *supply chain extended stakeholder model*. These developments theoretically support the idea that sustainability failures in business levels may destroy value not directly observable to stakeholders. Over the identification of 15 cases, the variation in the market value of 82 supply chain partners was analyzed. The results suggest that, in the majority of the assessed companies (74/82), no statistically significant reaction was detected.

Each case was individually analyzed. Considering operational consequences, the results show that cases concentrated on small suppliers (i.e. small source firms) did not cause a negative reaction from investors. In other cases, in turn, despite the source, firms were expressive in transactional volumes, operations do not seem to have been severely affected, and this did not translate into major consequences for partners. A second category refers to those cases where the source firms concentrated a strategic portion of supply chain partners' operations, with some of the identified supply chain partners being markedly penalized (e.g. Volkswagen Fraud). The delimitation of these two categories suggests that investors' decisions may not be directly based on the social/environmental consequences of firms' operations for stakeholders. Instead, as long as no major operational consequences emerge, investors' positions remain apparently unaffected. Although logical within a profit-oriented rationale, results happen to be surprising and somehow counterintuitive to initial expectations.

As discussed throughout the study, sustainability, CSR and SSCM seem to be not only valued by stakeholders, but also worthy of considerable investment by companies in the construction of positive associations in that direction. Moreover, most of the cases discussed received great media attention, linking large firms to cases of extremely poor working conditions, social abuse and environmental damage, among other negative consequences of their operations. This unfavorable publicity is expected to cause reputational damage to companies, as they would be linked to a lack of respect for nature and human rights. The results, however, suggest that damage to corporate images, identities or reputations around the sustainability of firms does not seem to be relevant to investors, or at least did not cause a re-evaluation of the fair stock price of the analyzed firms. The outcomes deserve deeper appraisal, as they could potentially present a new perspective on stakeholders' expectations and values towards firms.

From a theoretical perspective, the results may present a questioning of the main arguments of stakeholder theory. This means that the concern of firms around their operations may not be directly related to the consequences suffered by the environment, clients, employees, communities and society in general. The value creation logic would be stronger in that sense. This would be aligned with the mainstream SOM literature, which ultimately searches for the sources of competitive advantage and differential performance among firms, supporting shareholder-oriented approaches rooted in more classical economics literature. In a nutshell, once more the results suggest that investors' decisions might be mainly driven by profit maximization, and that negative social/environmental events in supply chains in general do not affect them. However, due to the limitations of the present study, such conclusions count in its own shortcomings. In that sense, it would not be possible to say that investors do not value sustainability at the business level, as they may have perceived the negative events discussed as punctual failures, not related to the policies and practices normally employed by firms. In order to assess their actual judgement of the issue, further research would be necessary. The limitations in question as well as the suggestions for future research are better addressed in the final section.

The study contributes to the SOM literature, providing empirical support for the joint assessment of sustainability issues and the analysis of the effects that members of supply chains may cause to each other, a promising and still underdeveloped field of research. In this sense, although the results—when jointly analyzed—do not suggest such an effect, they do not invalidate the *supply chain extended stakeholder model* proposed, as it may serve as a theoretical basis for future research. In fact, it may prove useful in the theorization of multiple sorts, linking firms and their diverse direct and *incidental stakeholders*. This contribution ultimately adds to the development of OM literature and stakeholder Theory itself. All in all, the main conclusion of the study is that, apparently, investors do not react to negative social/environmental issues in supply chains. Therefore, the answer to the research question proposed—do investors negatively react to announcements of negative social/environmental events related to a supply chain partner?—is no, as the results do not allow for the rejection of the null hypothesis.

8 Limitations and Suggestions for Future Research

Despite its contribution, the present work has limitations, which, on the one hand might represent constraints to its improvement, but on the other hand provide convenience for future research. In this way, despite allowing for the direct measure of effects, the concentration of the investigation on market-value data limits the perception of more subtle aspects, such as the reasons for the (lack of) reactions observed. Qualitative research conducted with different groups of investors could be useful in advancing such comprehension. Beyond that, as previously addressed, other groups of stakeholders could be assessed, as well as the effects of negative social/environmental events on dimensions other than market value (e.g. corporate images, identities and reputations). These distinct approaches would be likely to contribute to the testing and development of the *supply chain extended stakeholder model*, and to the conceptual reinforcement of the notion of *incidental stakeholder* as valid paths to treat similar issues.

In addition, overcoming the restriction to the analysis of sustainability-related events is also very profitable. More than stretching the scope and contributing to similar comprehensions in other areas, the eventual recognition of the similitudes and idiosyncrasies of negative social/environmental events in relation to cases of distinct natures may greatly contribute to a better comprehension of the influence of sustainability matters on stakeholders' perception, contributing to the SOM debate as a whole, as well as to the other aspects treated in the present work.

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Part III

Selected Practices, Methods and Tools for SOM

In this third part of the book we shall focus on fulfilling the third necessary condition for effective control of an operation with a view to making it more sustainable, namely being able to gather and analyze information about the current state of the operation and the inputs entering into it.

Each of the four chapters in this part provides a certain method or tool for fulfilling just that condition, albeit in different ways and based on different perspectives.

Chapter 10, by Ripanti and Tjahjono, takes circular economy (CE) as the main perspective and provides a methodology for formally describing and modelling different recovery options, calculating retained value, in particular when using cannibalization as one of several product recovery options.

Next, in Chap. 11, Raitasuo, Bask and Rajahonka consider the important topic of intermodal transport. They develop a framework which may assist in mapping and analyzing what drives the choice of different modes in the logistics sector.

In Chap. 12, following the contribution by Raitasuo et al., Gruchmann, De La Torre and Krumme also consider logistics operations, but focus on the role of the end-consumer. They apply a technique called participatory systems mapping (PSM) to map and analyze the dynamic interactions between customer behavior and logistics service design.

Finally, in Chap. 13, Shahbazi, Wiktorsson and Kurdve develop and present a methodology called the “Green Performance Map”, which can be used for measuring material efficiency at different organizational levels by monitoring material consumption and waste generation.

10

Maximizing the Retained Value of Product Recovery Based on Circular Economy Principles

Eva Faja Ripanti and Benny Tjahjono

1 Introduction

The circular economy (CE) is a concept that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value, distinguishing between technical and biological cycles (EMF, 2013). Boulding (1966), Kneese, Ayres, and D'Arge (1970), Stahel and Reday-Mullvey (1981) and Pearce and Turner (1990) are some of the researchers that have initiated research in CE. The area of CE is as extensive as the redesign of global production and consumption systems which combine environmental, resources, technology and consumer demand (Preston, 2012).

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CE principles have been described by researchers such as Pintér (2006), Yong (2007), Geng, Fu, Sarkis, and Xue (2012), the EMF (2013), and Stahel (2013). However, they formulated CE principles at the strategic level, even though CE principles need to be implemented at the operational level, for instance, in product recovery (PR), involving activities such as repair, refurbishment, remanufacturing, cannibalization and recycling. CE principles have been reformulated methodically in product recovery activities (Ripanti, 2016).

Furthermore, Ripanti (2016) described several CE principles such as economic optimization, maximization of retained value and leakage minimization. Maximization of retained value is applied to product recovery (PR) activities which are repair, refurbishment, remanufacturing and cannibalization. In providing a clear explanation of the process of maximizing retained value in PR, a specific case and product need to be chosen as an example. A personal computer (PC) is selected as a product example case.

This research purpose is to provide a formulation to maximize the retained value of product recovery. In achieving its purpose, some objectives will be defined: (1) identify the requirements and parameters of the product recovery; (2) justify the suitable treatment for product recovery; and (3) quantify the economic and functional values of recovered product in a mathematical formulation.

This research is organized into five sections after this introduction, which outline the general reasons for conducting the research: literature review describing product recovery and CE principles; methodology, describing the research context and method; results, describing the embedding process of CE principles into product recovery; a discussion raising the issues surrounding this research; and a conclusion answering the research aim.

2 Literature Review

2.1 Product Recovery

Thierry, Salomon, Nunen, and Van Wassenhove (1995) illustrated a flow of the integrated supply chain where one of the parts of the flow is product recovery management (PRM). PRM was described by Thierry et al. (1995) as the management of used and discarded products/components/

materials where the objective is to recover economically and ecologically maximum retained value. PRM also was described by Klausner, Grimm, and Hendrickson (1998), Fleischmann, Krikke, Dekker, and Flapper (2000), and Guide et al. (2003). Klausner et al. (1998) focused on the strategic PR activities (repair, refurbishment, remanufacturing, reusing, recycling and disposal). Fleischmann et al. (2000) described the PR chain where there are two directions (forward and reverse flow). The process is started from the supply, production and distribution in which a product can be used, and the reverse flow process can be started from a used product that can be collected, selected, reprocessed and redistributed until the product can be reused, or the choice is made to dispose of it. Guide et al. (2003) emphasized that PR refers to the parts and materials in the returned product that could possibly be recovered.

Thierry et al. (1995) classified some PR activities such as repair, refurbishment, remanufacturing and cannibalization, where they described the limitations of each activity. The disassembly level of repair, refurbishment, remanufacturing and cannibalization is related to the product level, module level, part level and selective retrieval of parts respectively. Repair was described by King, Burgess, Ijomah, and McMahon (2006) as a minor correction when the product is still under warranty. Refurbishment has requirements when the product can fulfill the manufacturing standard (White & Naghibi, 1998). Similar to White and Naghibi (1998), Vorasayan and Ryan (2006) described refurbishment as a product that has been undertaken and verified by the manufacturer and can work as a new product. Remanufacturing was identified as the process of restoring used products to become new products using several steps, for example refurbish and clean to obtain the same as, or better quality (i.e. up to a new product standard) (Lund, 1983). Cannibalization was described by several researchers such as Cravens, Piercy, and Low (2002) who illustrated a framework for a proactive cannibalization that responds to changing customer value in the process of building appropriate innovation strategies for the new competitive and technological environment. Thierry et al. (1995) viewed cannibalization as a process of disassembling and recovering parts, resulting in the usable parts or components being recovered, and the unusable parts being recycled or disposed-off.

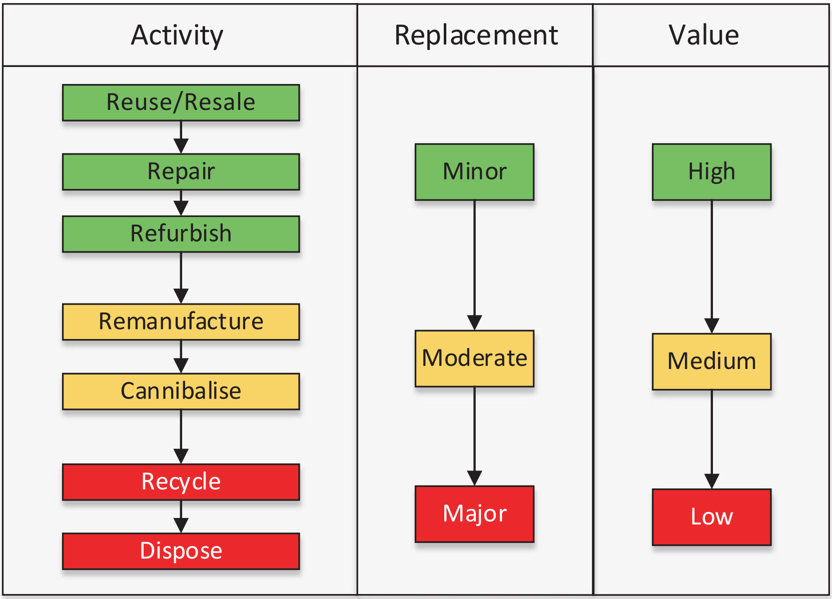

Fig. 10.1 Product recovery based on the replacement level (Ripanti, 2016)

In addition, cannibalization is considered as the most significant activity before sending the product/material to be recycled. Cannibalization is placed as moderate on the replacement level (Thierry et al., 1995). Logically, the retained value of the product is still valuable at the medium value. The level of replacement is illustrated in Fig. 10.1. The figure is divided into three parts (activity, replacement and value).

2.2 Circular Economy Principles

A principle means "*a fundamental truth or proposition that serves as the foundation for a system of belief or behaviour, or for a chain of reasoning*" according to the *Oxford English Dictionary*. CE principles are identified to ease the understanding and implementation of CE. Researchers (e.g. EMF, 2013; Geng et al., 2012; Pintér, 2006; Stahel, 2013; Yong, 2007) have introduced CE principles. Stahel (2013) described CE as being about economics, whose principles include: 1) the smaller the loop, the more profitable and resource efficient it is; 2) loops have no beginning and no end; 3) the speed of the circular flows is crucial; 4) continued ownership is cost efficient; and 5) CE needs a functioning market.

The EMF (2013) has argued that the five principles include: (1) *design out waste*, (2) *build resilience through diversity*, (3) *work towards using energy from renewable sources*, (4) *think in system*, and (5) *thinking cascades*. Geng et al. (2012) considered CE as *an accounting system* in an economy, where the inputs of a process are equal its outputs. Yong (2007) considered reduce, reuse and recycle (the 3Rs) as the principles to implement CE. Then, Pintér (2006) derived the fundamental principle of *mass balances*, with material flow analysis and accounting being used as an input-output analysis mechanism.

The reformulation of CE principles was conducted by Ripanti (2016), leading to several CE principles such as: economic optimization, aiming to achieve the production and consumption, service and supply of money, so that a resilient economy can be created; maximization of retained values, aiming to retain products or components that over time decline in value, by creating a suitable treatment system so that the values can be prolonged; and leakage minimization, upholding the avoidance of loss of opportunities to maximize the cascaded usage period of (1) biological materials and the inability to incorporate the nutrients back into the biosphere due to contamination, and (2) technical materials that are lost due to loss of materials, energy, components and materials that are not (or cannot be) recovered. Ripanti (2016) also classified the formulation into three parts: principles, intrinsic attributes and enablers (see Table 10.1).

Table 10.1 Configuration of circular economy principles (Ripanti, 2016)

Principles	Intrinsic attributes	Enablers
1. Cascade orientation	7. Systems thinking	13. Technology-driven
2. Waste elimination	8. Circularity	14. Market availability
3. Economic optimization	9. Built-in resilience	15. Innovation
4. Maximization of retainedvalue	10. Collaborative network	
5. Environmental consciousness	11. Shift to renewable energy	
6. Leakage minimization	12. Optimization of change	

2.3 Methodology

The research methodology was constructed based on the research context which embeds one of the CE principles (maximizing retained value) in the product recovery of the personal computer. The literature review was the dominant method for conducting this research. The literature review was conducted by preparing a literature search strategy. Using search engine databases (e.g. Google Scholar, Scopus and IEEE), a literature search was conducted. Publications including journals, conference papers, technical reports and books were used to develop this research. The literature review was initially conducted to enrich the understanding of CE and PR and to find the strong link between them. Within the literature review, the identification of requirements and parameters of PR are identified. The identification was conducted by collecting cases from articles, then the articles were compared to conclude in logical thinking. The analyzing process was continued to produce a treatment of PR in a rule. The last process is applying CE principles to PR, where the detailed process is described further. The research methodology is illustrated in Fig. 10.2.

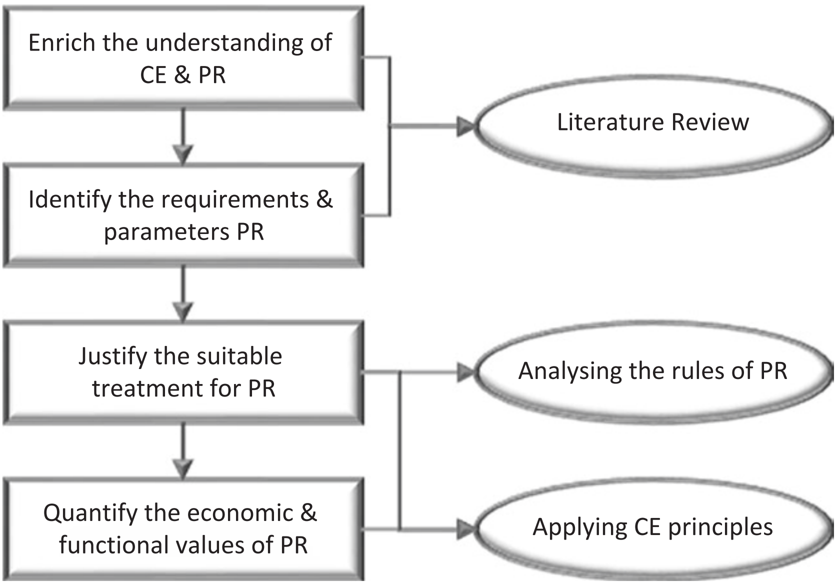

Fig. 10.2 Research methodology

3 Results

3.1 Embedding CE Principles into Product Recovery

The processes of embedding CE principles into product recovery have been described by Ripanti (2016) in a series of steps (see Fig. 10.3). First, the embedding process is initiated by determining the selected product. Then, the general PR activities are identified. There are nine general activities in PR: transportation, collection, assessment, classifying, repair, disassembling, reassembling, storing and testing (Ripanti, 2016). In fact, each different product has different specific PR activities: for example remanufacturing activities for the electronic product are an initial diagnosis, erasing data, disassembling, cleaning, inspection, replacement of worn parts with new ones, reassembling, software installation, consumable refill and a final check (ERN, 2016). When comparing the general

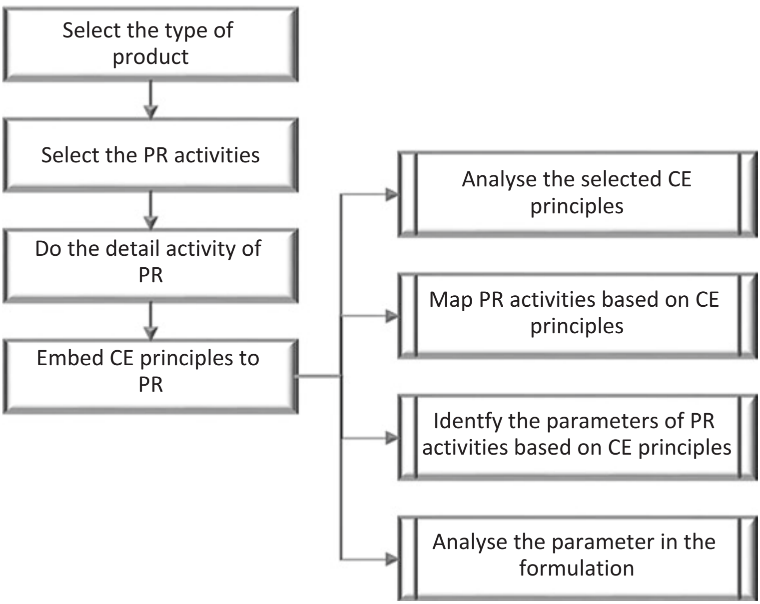

Fig. 10.3 Embedding CE principles into product recovery

PR activities and remanufacturing activities for the electronic product above, basically there are different terms for some activities, but the activities are similar. The process can be applied to all PR activities. However, selecting the PR activities depends on the quality of the returned product. The process of applying or embedding CE principles into PR activities has the following steps: analyzing the selected CE principles; mapping PR activities based on CE principles; identifying the parameters of PR activities based on CE principles; and analyzing the parameter in the formulation.

A personal computer (PC) and one of the PR activities—cannibalization—were taken as an example of this research. The selected activities of cannibalization are assessing, disassembling and testing. There are two purposes to maximizing the retained value of a PC. They are (1) the maximum number of reused parts and (2) the maximum number of cannibalized products. First, the number of PC parts needs to be identified. For example, a PC consists of 11 parts. By identifying the same unit of the product (e.g. part/material/product), it is possible to optimize the retained value, and whether to cannibalize, recycle or dispose. Identifying the number of parts will be standard in calculating the retained value of the product. For example, a collection point collected 100 PCs with diverse qualities. The level of PC quality needs to be assessed. The next step is the process of assembling some parts and classifying the parts into the same part and quality. The last process is calculating the parts that have been classified. After ascertaining the number of possible parts to be cannibalized, the parts need to be assembled to become a new cannibalized PC. Then the cannibalized PC needs to be tested to ensure that its quality meets the relevant product standards.

Moreover, the detailed process describes the rules that are needed. To maximize the value of the retained product that can be increased, the calculation process in the *second rule* has one rule base (see Rule-base 3.1); where it defines that the product/part can be assembled, if it meets the condition. In the assembling process, the reusable product will be collected in the same classification; here also it is possible to repair several parts so that the number of the reusable parts can be increased. The calculation process will also calculate the final result of the retained value part/product functionally and economically, where the percentage can be obtained by comparison to the previous value of the retained product. The calculation process can be conducted by using equations.

To provide a clear description we use the example of three collected PCs (collected by the collection centre), each with a different quality. Via the processes in the first rule—assessing, disassembling and calculating the reused parts—the quality of each PC's parts can be categorized into two; "**can be used**" and "**cannot be used**" parts that are indicated by 1 and 0 respectively (see Table 10.2). Table 10.2 illustrates the result of assessing, disassembling and calculating the reused parts of 11 collected PCs. **P1–P11** indicate the 11 parts of each of the three PCs, **PC1–PC3**, collected by the collection centre.

To fulfill **the first rule**, which is calculating the maximum number of reused parts or the maximum number of the retained value in functional *max*(*funReVal*), we can use Eq. (10.2). The number of reused part or *funReVal* of collected product is described by Eq. (10.1).

$$funReVal = \sum_{1=1}^{m}\left(\sum_{j=1}^{n}\frac{Part_j}{n\times m}\right)_i \qquad (10.1)$$

where:

m = number of collected products

n = number of part per product

The objective function is:

$$\max\left(funReVal\right) = \max\left(\sum_{i=1}^{m}\left(\sum_{j=1}^{n}\frac{Part_j}{m\times n}\right)_i\right) \qquad (10.2)$$

Table 10.2 The result of assessing, disassembling and calculating the value of the parts

	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8	P 9	P 10	P 11	Total parts/PC
PC1	1	0	1	1	0	0	1	1	1	1	1	8
PC2	1	1	0	0	1	1	0	1	1	1	1	8
PC3	1	0	0	0	1	1	1	1	1	1	0	7
Total each part	3	1	1	1	2	2	2	3	3	3	2	

To maximize the number of the cannibalized product we need to follow a condition that is described in the rule-base statement below:

```
Do
       Check p[i]
      If (∀p[i] ≥ 1) then
           nCanPro + +
  End if
      Next(p[i])
  Until p[i] = 0).
  Rule-base 3.1. Pseudo code for calculating the
number of the cannibalized product
```

Rule-base 3.1 means that to cannibalize one product, all the availability of the used part of the product should be *at least one*. If the condition ($\forall p[i] \geq 1$) is fulfilled, the number of the cannibalized product (*nCanPro*) increases. The counting process *will be terminated* when *one used part* is *zero*.

Table 10.1 shows that the number of reused parts for PC1, PC2 and PC3 is respectively 8, 8 and 7. By using Eq. (10.1), the retained value of the product should be:

$$funReVal = \frac{23}{33} = 0.67$$

For this case, this means that the retained value of the collected product (after the process of assessing, disassembling and calculating the reused parts) is 0.67. It can be assumed, that **0.67** (or 67%) is a "functionality retained value" (*funReVal*). If, for the assumption, the functionality retained value of all collected products is zero, then 67% of the product function can be retained.

Furthermore, based on Rule-base 1, the cannibalized product that can be produced is one PC. The price of the cannibalized product and the price of all other remaining used parts can be used as an "**economic retained value**". For example, if the justified price of the cannibalized product is X, the justified price for all other remaining used spare parts is

Y, and the assumption of the market price of the specific product is Z, then the "economic retained value" can be calculated by using Eq. (10.3):

$$ecReVal = \frac{X + Y}{Z} \tag{10.3}$$

For example, if the justified price of one PC is £100 and the justified price of all remaining used parts is £100, then the market price of the PC (with the same specification) is £600. So the *ecReVal* for this case is **0.33** (or 33%). If, for the first time (when the collection center collected the product) the retained value of all collected product (by considering the depreciation value) is only £60 (or 10%, for example), the process of cannibalization has successfully **increased the economically retained value of the product by 23%** (33%–10%) approximately.

The total retained value of the product in functional and economic terms can be calculated by using Eq. (10.4). So, the total retained value of three collected PCs is 50% after facing maximizing retained value processes.

$$totalReVal = \frac{funReVal + ecReVal}{2} \tag{10.4}$$

$$totalReVal = \frac{0.67 + 0.33}{2} = 0.5$$

The results above provide the opportunity to maximize retained value in the product cannibalization operation through rules and processes. The generic formula to maximize the retained value for all activities in PR, Eq. (10.5), can be used. Where, *i* represents the type of PR activities (i.e. collect, assess, disassemble, reassemble and test), *n* characterises a number of PR activities (e.g. *n* is four), and $totalReValue_{PR}$ symbolizes total retained value for all PR activities.

$$totalReVal_{PR} = \frac{\sum_{i=1}^{n} totalReVal_i}{n} \tag{10.5}$$

3.2 Discussion

Maximizing retained value as one of the CE principles is adopted from Ripanti (2016) and describes an attempt to keep material longer in circulation. This research describes the detailed process involved in the implementation of maximizing retained value into PR. The implementation chooses a PC as the example of the cannibalized product. There are three main processes for embedding or application. They are identifying the activities in PR (in this case for the cannibalization activity) for a PC, identifying the parameters of PR (cannibalization activity) for the PC, and quantifying the maximum cannibalized product based on the decision and available parameters. The decision here is related to the availability of parameters, for example to increase the economic or functional retained value. The main contribution of this research is an approach to embed or apply the maximizing retained value as one of the CE principles that are implemented in PR (the cannibalization activity) for a PC. To enable an easier understanding of the explanation, this research uses some assumptions and examples. In addition, the CE principles are used as a basis in this research: maximizing the retained value is one of the CE principles and the process of embedding followed the embedding process of CE principles into PR.

4 Conclusion

This research provides some rules that could potentially increase the maximum retained value of the used product functionally and economically. The rules and processes might not be simple, but offer some advantages, such as the increased number of reused parts and cannibalized product through assessment and testing.

Maximizing the retained value is one of CE principles that provides a suitable treatment so that the values of the product can be prolonged. This research is embedding the CE principle into product recovery (cannibalization activity) for a PC product. The activity and the product have been chosen to provide clear information regarding the embedding process. This research described how the retained value can be maximized.

The process needs to follow the general guide of embedding CE principles into product recovery. However, a PC has a specific process in which it also needs to be adjusted. The maximizing formulation that has been provided in this research asserts that adopting CE principles can increase the retained values of the product's economic and functional value.

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Sustainable Intermodal Train Transport

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1 Introduction

Environmental issues are gaining increasing attention among industry, the public, associations and government representatives. Transportation is one of the sectors that emits most greenhouse gases worldwide (EC, 2001), and road transportation emissions are increasingly annually (EC, 2009). In 2012, total goods transport activities in the EU-28 (the European Union (EU) comprises 28 member states) amounted to an estimated 3768 billion ton kilometers (tkm), of which road transport accounted for 44.9% and rail accounted for only 10.8% (EC, 2014).

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Despite positive developments in some markets, the modal share of rail freight in Europe has decreased from 11.5% to 10.2% since 2000 (SWD, 2012).

Decreasing the amount of road transport and substituting it with other more environmentally friendly transport modes is one way to reduce the negative environmental impacts of transport (Janic & Vleugel, 2012). Intermodal road–rail solutions have been proposed as a promising way to reduce CO_2 emissions (EC, 2001; Flodén, 2007) as rail-based intermodal transport emits less CO_2 than truck-only transport, regardless of the type of locomotive (Kim & Van Wee, 2008). Intermodal transport is defined by the European Conference of Ministers of Transport (EC, 1997) and the United Nations as: "*The movement of goods in one and the same load unit or vehicle by successive modes of transport without handling of the goods themselves when changing modes*". However, the terms intermodal transport, multimodal transport and combined transport are often used interchangeably (Eng-Larsson & Kohn, 2012).

Despite the EU's efforts to promote sustainable transport options, rail transport services continue to be seen as an unattractive alternative to road transport. Therefore, the aim of this chapter is to examine how the share of rail-based intermodal transport can be increased in the EU. Specifically, the study takes the institutional theory perspective to identify from the literature the possible drivers to categorize the main external and internal drivers that could support a shift from road to rail. Then, it uses a developed framework to gain insights into and reflect on the key drivers and their importance. The analysis uses qualitative data collected from logistics service providers (LSPs) operating in Finland.

Our study aims to contribute to literature, theory and practice. First, we aim to contribute to the current literature by adopting and extending the discussion of the drivers of rail-based intermodal transport. Moreover, the study aims to contribute to the current sustainable operations management (OM) literature by focusing on a less-studied aspect of sustainability: rail-based intermodal transport (see e.g. Kleindorfer, Singhal, & Wassenhove, 2005; Wilkinson, Hill, & Gollan, 2001). The study contributes to theory by applying the institutional theory approach to the intermodal transport context. Practical implications include providing insights to policy makers concerning how to increase the use of intermodal rail transport.

The chapter is organized as follows. First, we provide a literature review of intermodal transportation and identify several possible drivers affecting the use of intermodal transportation. Based on this literature review, we propose a holistic framework for possible drivers of rail-based intermodal transport. Thereafter, the methodological approach is presented, followed by an analysis of the empirical data. In the conclusions section, a number of ways to increase the share of intermodal transport in Europe are postulated. Finally, several avenues for future research are suggested.

2 Literature Review

Drivers for sustainable development can be either external or internal to a company. In this chapter, we take the institutional theory approach to identify the external factors that impact companies' sustainable development. This approach helps to extend our understanding of the factors beyond companies' organizational boundaries (see e.g. DiMaggio & Powell, 1983; Jennings & Zandbergen, 1995; Lai, Luna, Wong, & Cheng, 2011; Scott, 1987), as there is a link between organizational and institutional dynamics (Jennings & Zandbergen, 1995). Institutional theory focuses on the role of institutions in society and in the process by which items become institutionalized (Scott, 1987). This theory identifies three institutional mechanisms that have a high impact on companies' managerial decisions: coercive, mimetic and normative isomorphism (DiMaggio & Powell, 1983).

Coercive drivers include regulations and their implementation. It has been found that regulation has a great impact on companies' environmental management practices (Diabat & Govindan, 2011; Jennings & Zandbergen, 1995). Earlier findings are in line with findings from the shipping industry; for example, Lai et al. (2011) propose that shipping firms tend to espouse green practices when they encounter regulatory requirements. *Mimetic* means that companies may adopt practices from companies that have been successful in environmental practices. Pressures to adopt or mimic rail-based intermodal transport could come from customers (i.e. the key companies from the supply chains or networks) and/or from other companies in transport chains. This is in line with Guler, Guillen, and MacPherson (2002), who note that companies are more likely to mimic the practices of the networks to which they belong. *Normative isomorphism* is linked to professionalization, and sources for this include education and professional networks (DiMaggio & Powell, 1983). Thus, universities and other institutions impact the development of organizational norms among managers and other staff (DiMaggio & Powell, 1983).

Drivers for sustainable development can be categorized in several different ways. In the context of environmental supply chain management and green supply chain management, Walker, Di Sisto, and McBain (2008) divided drivers into external and internal categories. External drivers were then sub-divided into five categories: regulatory, customers, competition, society and suppliers. Internal factors were grouped under the topic of being organization-related. Delmas and Toffel (2004) noted that external pressures come from shareholders, competitors, industry associations, government, consumers and activists. In the context of a chip manufacturer, Trowbridge et al. (Trowbridge, 2001) identified customers, investors and non-governmental drivers as external drivers and a willingness to improve risk management and supplier collaboration as internal drivers.

Regarding transportation, a customers' choice of transport mode is made in the logistics and supply chain context and is driven by several factors, which Eng-Larsson and Kohn (2012) have grouped into three categories: external pressure (e.g. environmental legislation, customer requirements, increasing fuel prices), business strategy/policies, and logistics strategy (internal motives impacted by external pressures). In rail-based intermodal transport and our research context, the regulatory framework comprises the EU and government levels. Regarding customer requirements, Delmas and Toffel (2004) noted that customer expectations are an important motivation to apply environmental management practices. This is in line with Lai et al. (2011), who proposed in the context of shipping companies that customer requirements significantly impact the adoption of green practices. Increasing fuel prices could be seen as an economic driver in transportation that could have implications for choice of transport. In addition, infrastructure and standards-related issues (Bontekoning, Macharis, & Trip, 2004) are external drivers that affect the availability and flow of transport.

In the following, we examine in more detail the possible external and internal drivers of intermodal transport found in the extant literature. Based on the above research, we have divided external drivers into four overarching groups: economic drivers, regulatory drivers, infrastructure and standards, and customer demands. We analyze findings related to internal drivers as one group, in line with Walker et al. (2008). Our aim is to develop a holistic framework of drivers that could positively impact the development of rail-based intermodal transport.

2.1 Economic Drivers

The literature identifies two kinds of economic drivers: fuel prices and a lack of truck drivers. First, increasing oil prices can increase the attractiveness of intermodal transportation, largely because they negatively affect road transport. Maggio and Cacciola (2009) estimated that global oil production will reach its maximum between 2009 and 2021. They pointed out that it is necessary to take preventative action to avoid dangerous economic and political crises. Though the price of oil is currently low, this situation is likely to change in the future. Macharis, Van Hoeck, Pekin, and Van Lier (2010) compared whether fuel price increases can increase the market area of intermodal terminals to the same degree as the full internalization of external costs from transport. Their results suggest that fuel price increases can increase the market area of intermodal terminals in Belgium, but that the internalization of external costs is still a more powerful tool in stimulating a modal shift. Although these findings support the EC's idea that transport costs should be related to the true impact on the environment, Macharis et al. (2010) acknowledged that modal choice does not depend on price as a single factor. Therefore, studies employing other factors (e.g. time, reliability) are needed to develop a more comprehensive view of the phenomenon. One such factor could be the shortage of truck drivers in the EU, which is expected to become a severe handicap in the road haulage market when a large number of drivers retire (EC, 2012b). It has also been forecasted that a lack of truck drivers, together with the application of the EU Working Time Directive to mobile workers, reduces delivery flexibility. This application of the directive on working hours, which stipulates an average working time of 48 hours and an absolute maximum of 60 hours, will reduce the feasibility of long-distance road transport. However, it will not affect rail transport, where average working times typically do not exceed 48 hours (Tsamboulas, Vrenken, & Lekka, 2007). Naturally, this is an economic factor that could increase the attractiveness of rail transport.

2.2 Regulatory Drivers

Regulatory pressures to support sustainable development can take various forms, such as stricter environmental legislation, taxes and the opening of the railway markets. Switzerland's 28-tonne road regulation limit (where most EU countries allow 40 tonnes or more) and its prohibition on circulating during night hours are examples of how regulations can be used to advance the market share of rail transport (Rudel, Tarola, & Maggi, 2005). Switzerland finally had to abandon its 28-tonne limit in response to pressures from neighboring countries. Consequently, Switzerland introduced a mileage-related heavy vehicle fee and built a set of rail tunnels through the Alps (Seidelmann, 2010). This approach to pricing freight traffic and financing new infrastructures has gained popularity among policy makers in Europe (Rudel et al., 2005). For example, Germany has implemented forward-looking transport regulations by introducing the MAUT (a German road tax) and driving bans during the weekends and public holidays. In Italy, Campisi and Gastaldi (1996) studied whether a pollution tax could stimulate a modal shift from road to rail. By evaluating substitution elasticities, they were able to verify that pollution taxes can affect modal choice. Their study concluded that pollution tax could influence the transport mode choice without significantly hurting economic growth. Still, Campisi and Gastaldi (1996) noted that factors other than cost also affect modal choice. Furthermore, although driving bans and fines could be effective in limiting road transport, a pollution tax seems to be fair solution, since it internalizes some of the negative externalities of road transport. This internalization of external costs was also suggested by Macharis et al. (2010).

Several studies have investigated the market opening of rail freight services both in and outside the EU (e.g. Everett, 2002; Jensen, 1998; Jensen

& Stelling, 2007; Motraghi, 2013). Markets for rail freight services were fully opened to competition in the EU in January 2007, but the shift is occurring slowly. The EC's fourth railway package is a new effort to reform the EU's rail sector, which is still dominated by state-owned railway businesses that control both the tracks and the trains. Sweden and the UK have been the European frontrunners in railway sector deregulation and reorganization. In a longitudinal econometric study, Jensen and Stelling (2007) found that the competition has lowered costs in Sweden. Ten years prior, Jensen (1998) suspected that the opening of the Swedish railway would produce significant costs. However, deregulation is not merely a European phenomenon. In Australia, the deregulation of the rail sector has dramatically altered the transport market, forcing transport operators to restructure and refocus (Everett, 2002). Everett (2002) evaluated the impact of rail sector deregulation on transport operators and concluded that deregulation is sparking a shift from traditional rail transport operators towards market-oriented, third-party service operators that offer comprehensive transport solutions. This should also benefit customers, since one of the obstacles to train transport has been that such transport is not able to provide door-to-door solutions.

Despite efforts to encourage competition, Finland has remained one of the few EU countries whose freight transport network is operated by a single state-owned railway company. However, two additional companies are preparing to launch freight transport operations. In 2011, the Finnish Transport Safety Agency issued safety certificates to private companies Proxion Train Oy and Ratarahti Oy. Future years will show how the railway sector changes in response to new operators entering the market. Finnish railways use same track gauge as Russia, offering an opportunity for the efficient distribution of Russia's extensive raw materials (Hilmola, 2007) via the Trans-Siberian Railway (TSR) to the Asian Markets (EC, 2012a).

2.3 Infrastructure and Standards

Well-functioning infrastructures and commonly defined standards are both external drivers that can affect the feasibility of intermodal transportation. First, the demand for transport services may be stimulated by rail infrastructure expansion. Gorman (2008) evaluated the allocation of public funds to support the burgeoning freight transportation needs in the United States and found that approximately one-quarter of truck freight could be handled at a 25% lower cost if the rail infrastructure necessary to support it existed. Gorman (2008) did not take the superiority of rail transport over road transport as a given; rather, his research sought to identify the level of socially optimal public investment in road and rail. He concluded that converting road investments to rail investments offers substantial societal returns, but that these societal benefits may not be reached without public sector involvement. In Europe, large sums have already been invested in rail infrastructure development. The TEN-T (Trans-European Transport Networks) policy was launched to achieve a highly efficient European transport network with strong core rail arteries (EC, 2013). Other European initiatives have promoted the harmonization of track gauge and the creation of an interoperable international network (Laird, Nellthorp, & Mackie, 2005). Furthermore, the Baltics have promoted the use of rail transport to create an alternative North-South railroad, which could ease congestion in Germany (Lewis, Semeijn, & Vellenga, 2001) and increate the Baltic States' trade volumes with other EU countries (Kovacs & Spens, 2006).

Infrastructural interoperability is a key element of intermodal transportation, meaning that well-functioning terminals and trans-shipment techniques could increase the use of intermodal transport. Developing intermodal infrastructure (e.g. terminals, transfer points and freight freeways) is one way to support progress. The EU has promoted the idea of "Rail Freight Freeways", which are international rail corridors running across several EU Member States. Such freeways should work as "one-stop shops", such that a firm can purchase a single timetable slot from A to B even when the points are in different countries. It has been suggested that next-generation terminals optimized for intermodal transport could significantly improve the cost-to-quality ratio of intermodal transport (Bontekoning, 1999). Similarly, Macharis and Bontekoning (2004) noted that the infrastructure of rail–rail or barge–barge terminals is similar to that of road–rail and road–barge terminals; however, the layouts of such terminals differ and terminals do not necessarily have facilities to handle trucks.

Traffic jams and congestion add to the cost of transporting cargo by road. This creates an opportunity for intermodal transport, in which main hauls are made by train. Van Schijndel and Dinwoodie (2000) explored congestion as a driver of modal shifts by surveying Dutch transport companies to investigate whether congestion-induced delays are sufficient to stimulate a switch in freight mode from road to intermodal. A vehicle cost simulation based on this survey attributed 7% of transport costs to congestion, increasing the attractiveness of intermodal transport and other solutions.

According to Bontekoning et al. (2004), despite the importance of standardization, studies on intermodal rail transport are scarce. They note that there is a great deal of variation among load units, rail cars and truck–trailer skeletons. They also call for more research on the topic, since greater standardization in transportation chains could reduce costs. The standardization issue is already drawing attention in the EU, where the widespread use of Europallets (80–120 cm) instead of ISO pallets (100–120 cm) on the European mainland has given rise to the utilization of pallet-wide containers with an inner width of 2.44 m instead of the standard 2.34 m. To further optimize unit loads, the EU is supporting the concept of an European intermodal loading unit (EILU) (Notteboom & Rodrigue, 2009), which would allow two European pallets to be placed in containers side-by-side. However, achieving a consensus concerning standardization among all actors in the intermodal transport chain can be difficult. For instance, the EILU is facing opposition from maritime shipping lines, which have accumulated investments in current equipment (Notteboom & Rodrigue, 2009).

The EC (1997) has argued that, to improve transport policy measures in a competitive market, intermodal statistics providing details on the volume and structure of transport flows are needed. The EC has also suggested that targeted projects for research and technological development can promote the development and use of new technologies, services and productivity levels in the EU (EC, 1997). On several other occasions, the EU has emphasized the role of research and promoted significant intermodal research initiatives (e.g. framework program, Marco Polo, etc.). Furthermore, the EC has declared that since intermodal transport is more data-intensive than conventional transport, the Information Society's role in transport is of crucial importance. Therefore, the use of information and communication technologies (ICT) could be key to efficient and customer-oriented intermodal transport services. The European Commission (EC) has also stated that information systems needed to provide information (e.g. timetables, operators, terminals, average prices, average transit times, etc.), allow bookings and reservations of space and services and enable contracting (EC, 1997).

2.4 Customer Demands

The environmental demands of transport buyers and final customers also create external pressures that can increase the share of intermodal transport. Hibbitt and Kamp-Roelands' (2002) study of 187 large European companies found that nearly all (91%) of the companies had implemented a corporate environmental policy and that the companies leading this effort were found in Norway and Sweden. Björklund's (2005) findings from Sweden's food and forestry sectors suggest that companies consider environmental aspects when they are purchasing transport services. Furthermore, organizations in all sectors feel the pressure to engage in environmentally friendly supply chain practices (Green, Morton, & New, 1996; New, Green, & Morton, 2000). Small companies are particularly likely to experience customer pressure (Hall, 2001). The increased environmental demands from stakeholders force businesses to pay attention to the environmental consequences of their operations, including their transport methods. All of these factors can increase the attractiveness of intermodal rail transport.

2.5 Internal Drivers

Internal drivers are related to the organization itself. Based on the literature on intermodal transport they can be broken into two categories: new technologies and new business models. In recent years, significant improvements have been made in terms of the production efficiency of intermodal services (Bontekoning et al., 2004). Woxenius (1998) and Bärthel and Woxenius (2004) suggested that the break-even distance of intermodal transportation could change drastically with the use of alternative technologies and/or better planning and management. Wolf and Seuring (2010) suggests that as large LSPs and their customers increasingly refer to technological developments when asked for their environmental improvements, it will be interesting to identify the barriers to the widespread application of global positioning system systems, radio-frequency identification technologies, modern fleets, etc.

Trip and Bontekoning (2002) identified a need for innovative bundling models and next-generation terminals to promote intermodal transportation. Furthermore, though innovations increasing speed and reliability for perishable and high-value goods transported over long distances are needed, it is also necessary to shorten transport times for rail hauls and trans-shipments, as well as to provide a higher frequency of services for short distances (Bontekoning & Priemus, 2004; Bontekoning et al., 2004). Another way to increase the use of road–rail solutions could be to develop new business models and related services. Lehtinen and Bask (2012) suggested that the role of LSPs is likely to grow over time, while operators (i.e. rail, shipping and trucking companies) are likely to increasingly focus on their basic function: transport.

2.6 Summary of the Literature: The Framework

Figure 11.1 collects the findings of the literature review and presents the framework that guides our empirical study. The framework groups the various internal and external drivers of intermodal transport identified in the broad set of literature. Based on institutional theory, we have divided the external drivers into three overarching groups: economic and regulatory drivers, infrastructure and standards, and customer demands. Internal drivers are analyzed as one group, and they comprise new business models and technological solutions.

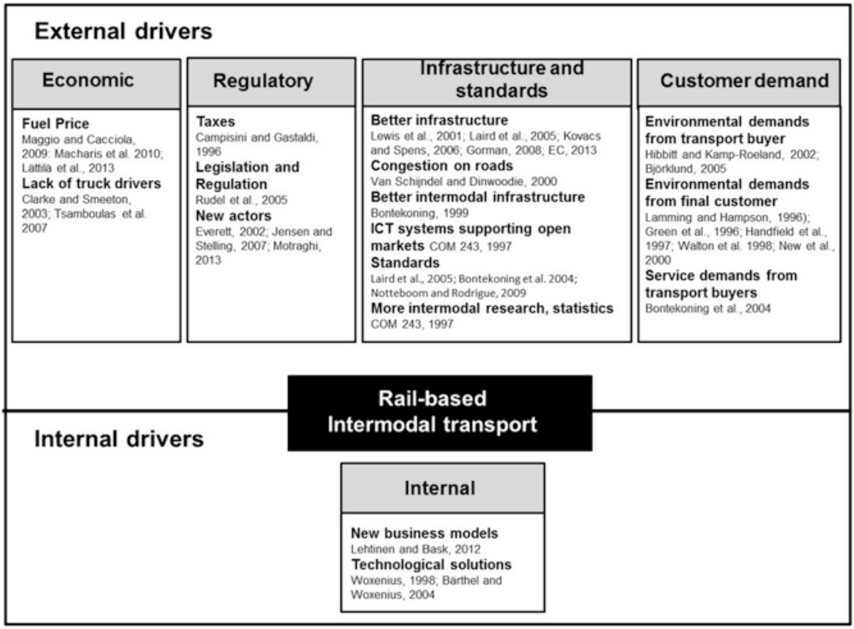

Fig. 11.1 Framework of possible drivers supporting the development of rail-based intermodal transportation

3 Method

The study's research problem and objectives form the starting points for the choice of the research methods (Ellram, 1996; Näslund, 2002). Supply chain phenomena are often complex; therefore, a single-method research approach is typically not adequate to fully understand them. One way to increase multidimensional research insights is to use methodological triangulation: that is, to use more than one method simultaneously (Mangan, Lalwani, & Gardner, 2004).

In this research, our aim is to determine what drivers could increase the use of intermodal transport in the EU from the perspective of Finland. To identify the main drivers, we use a research strategy that combines a literature review with a qualitative interview using open and scaled questions (Frankel, Näslund, & Bolumole, 2005; Voss, Tsikriktsis, & Frohlich, 2002). Together, these methodologies offer a greater understanding that each method could achieve alone (Barnham, 2012). Based on the findings of the previous section, in which we took a holistic approach to review the current literature (with a focus on drivers of intermodal rail transport) and developed a framework for further analysis, and with the help of multiple case study results, this study aims to develop initial insights into and reflections on the key drivers in rail-based intermodal transport.

The empirical data were collected from 14 LSPs operating in Finland. Saturation expectations were in line with those proposed by Guest et al. (2006). The sample was selected based on contextual drivers (e.g. location, operations in Europe, possibility or use of rail-based intermodal transport). A semi-structured interview protocol including open and scaled questions was used to ensure feedback on all of the drivers identified in the literature. The interviewees included chief executive officers (CEOs), logistics managers and legal counsels. Some interviews included two individuals from the same company. The selected companies represented LSPs from various stages of the intermodal transport chain in order to develop a holistic view of rail-based intermodal transport, which involves both LSPs and operators (rail, road and sea carriers). The companies' fields of operation included auto carriage, food carriage, special transport, forwarding, bulk transport, transport of parceled goods, logistics, shipping, stevedoring, container transport, rail traffic, tank transport, thermo transport, air transport, transport packing, distribution, ship owners, warehousing, loading and discharge, transportation services, conveyance of goods, transportation companies, courier service, mailing service, foreign transportation and waterborne traffic. To exclude the smallest companies, companies were required to have annual turnovers of at least 2 million euros (with some companies exceeding 200 million euros annually).

The selected companies were contacted first by e-mail and then by telephone. The interviews were conducted on the premises of the case organizations. To avoid bias, each interview was held by two or three members of the research team (see e.g. Eisenhardt, 1989). On average, the interviews lasted 1 hour 50 minutes. An interview guide was given to the interviewees before each interview. At the beginning of each interview, there was a discussion based on the questionnaire's open-ended questions. Next, the scale questions were discussed. The same interview guide was used for all companies, but a few clarifying changes were made after the first interview. The interviews were recorded, and transcripts were made based on the recordings. During the data collection, reliability was addressed through both the interview guide and the development of a database (Ellram, 1996; Manuj & Pohlen, 2012).

We report all relevant interview comments related to the drivers. We also conducted a cross-case comparison among the companies to identify common views and examined the drivers based on their answers to the scaled questions. Since the sample was relatively small, the emphasis was on the qualitative analysis. Furthermore, since the aim was to identify the key drivers of intermodal transport, a qualitative analysis was considered to provide new knowledge about the topic, which has not previously been studied in the Finnish context. Instead, since we were interested in gaining insights about a broad set of drivers, some of which were from sources other than the literature on intermodal transport, we used a qualitative analysis. After the transcripts were collected, the data from each case were organized under different drivers. This enabled us to draw conclusions concerning which of the drivers were major driving forces of intermodal transport. We were also able to recognize those drivers that the interviewees did not consider essential.

4 Results

To collect information on the backgrounds of the case companies, we asked the respondents to describe the services their companies currently offered. Of the 14 respondents, eight said that they use rail–truck transport in the EU (excluding Finland), and three regularly used domestic rail–truck connections in Finland. Furthermore, four interviewees stated that their companies occasionally used train connections in Finland. The single train connection used in Finland was from Helsinki to Oulu, which is located in Northern Finland. Furthermore, two companies used rail links in Finland and other parts in Europe. Within continental Europe, rail transport to Italy, Austria, Germany and Switzerland were the most common. Intermodal freight transport by rail and truck to Italy was particularly popular; eight of the respondents said that they use intermodal rail services when transporting freight to Italy. One option for this type of transport is a block train traveling from Lübeck to Verona. Italy can also be reached from Rostock or Travemünde. One company used a train from Travemünde to transport 70% of its volume. Furthermore, another company used the train connection when transporting containers from Milano to Rotterdam. These results reflect the fact that intermodal transport in Italy has been increasing continuously in recent years (Debrie & Gouvernal, 2006).

4.1 Drivers of Future Intermodal Transport

The results suggest that the respondents perceived the main drivers of future intermodal rail-truck combinations to be: increased fuel prices, taxes and a better rail infrastructure. In the following sections, we will take a look at these different drivers, which we have grouped into five categories: external economic drivers, external regulatory drivers, external infrastructure drivers, external customer drivers and internal drivers. Inspired by institutional theory, these groups illustrate the different forces influencing the purchase of intermodal train transport. At the end of this section, Fig. 11.2 presents our revised framework of drivers for the development of rail-based intermodal transportation.

External Economic Drivers

Increased *fuel prices* were perceived to be the most important driver for intermodal transport. The respondents were unanimous in stating that increased fuel prices are a significant/very significant driver of intermodal rail transport. Therefore, we have placed this driver in the category "with higher importance". However, some respondents expected that increased fuel prices would increase the price of rail freight transport. This should not be the case, since the majority of the EU's railway lines are electrified (e.g. Finland: 51.9%, Germany: 58.8%, Italy: 70.7% and the Netherlands: 76.1%) (EC, 2012a); thus, rail freight prices should rise much slower in response to increasing crude oil prices. Furthermore, according to Macharis et al. (2010), when the oil price increased between 1999 and

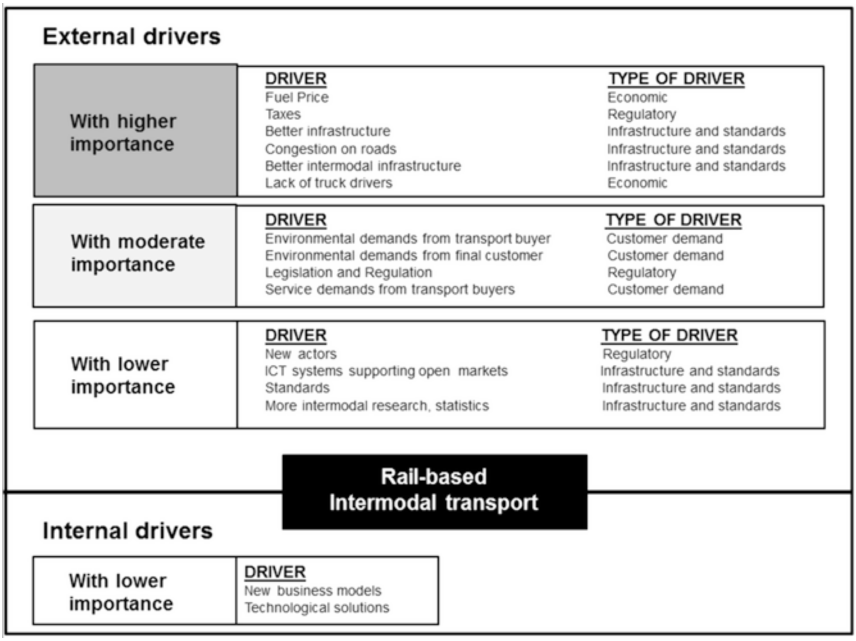

Fig. 11.2 Importance of drivers for increasing the share of rail-based intermodal transportation based on the case study

2000, it had no influence on the price of electricity in Belgium. Furthermore, the interviewees saw increased *congestion on roads* to be an opportunity for intermodal transport, but only if there was not simultaneous congestion on the railways. One interviewee noted that railroad congestion is related to economic activity: for example, in 2007, railroads were congested, and slots in Europe were tight. However, due to the current economic situation, the competitiveness of rail transportation has decreased, and slots are no longer tight.

Most of the respondents also considered a *lack of truck drivers* to be an important driver of intermodal transport. We have placed this driver in the category "with higher importance". As one respondent noted, there is already a lack of truck drivers in Europe, and this shortage will only increase in the coming years. However, there were also a few respondents who did not perceive the lack of truck drivers to be an important driver of a modal shift, and one actually said that there is an oversupply of truck drivers. Furthermore, one of the respondents said that he did not believe there would ever be a shortage of truck drivers, since there are plenty of drivers in Eastern Europe and since the number of available truck drivers increases each time the EU takes in new member countries.

External Regulatory Drivers

Most of the respondents perceived *tax* issues to be an important driver, suggesting that the introduction of, for example, pollution taxes could drive the usage of intermodal transport. Since opinions concerning the importance of taxation were unanimous, we have placed this driver in the category "with higher importance". Our results support earlier findings concerning the power of political instruments (Campisi & Gastaldi, 1996; Macharis et al., 2010; Tsamboulas et al., 2007). However, one respondent mentioned that when MAUT (the German road tax) was introduced, railway operators increased their prices as well. In addition, one interviewee mentioned that Switzerland supports every transport unit going through Switzerland by train. This kind of incentive scheme may help policy makers increase the attractiveness of rail transport.

Legislation and regulation was placed in the category "with moderate importance", since opinions concerning the importance of this driver varied. Most of the interviewees felt that legislation and regulation could have some importance, but there were also several opposing views. One interviewee said that the EC's programs (e.g. the Marco Polo program) have significantly increased the share of intermodal rail transport. Another respondent pointed out that regulation in the form of a driving ban can affect the viability of intermodal solutions, since driving bans (e.g. during the weekends and on holidays in Germany) increase the feasibility of trains as an alternative. Since modern-day truck drivers' driving hour restrictions are strict, it may actually be faster to use intermodal transport than to truck freight by road. With regard to liability issues (e.g. responsibilities for delays and cargo damages), most of the respondents felt that there were no problems with the current state of the industry.

In recent years, the EC has been inviting new actors into the railway market via market openings. Several respondents argued that the availability of intermodal transport in Finland is very limited, since there is only one major player operating trains. Still, the respondents did not call for new actors to enter the Finnish railway market, which was surprising. Instead, though the respondents were worried about the lack of rail services, they did not consider new actors to be a quick solution to the problem.

External Infrastructure and Standard Drivers

Most of the respondents perceived a *better rail infrastructure* to be a significant driver of a model shift. This indicates that infrastructure improvements could drive the expansion of rail transport. For this reason, we have placed this driver under the category "with higher importance".

Respondents pointed to the limited capacity of current railroads as a problem. One respondent said that railway passenger traffic volumes are so high in Central Europe that there are not enough slots available for freight traffic. The solution could be to build an independent rail infrastructure for freight traffic.

Our findings support the earlier findings of Gorman (2008), who suggested that truck freight could be handled at a lower cost if rail infrastructure to support it existed. Finland has suggested the development of a long-distance Rail Baltica route to support intermodal transport in the future. As one interviewee said: "if there were rails in the Baltics, we would use them". Rail Baltica is one of the EU's TEN-T rail transport construction projects linking Finland, the Baltic States and Poland. The public sector strongly supports Rail Baltica in all three Baltic States, but a lack of collaboration is impeding its progress (Laisi & Saranen, 2013). Furthermore, since the Baltic States follow the gauge of 1524 mm, while Poland follows the standard gauge of 1435 mm, there are issues of interconnectivity. As one interviewee noted: "If the Baltics had the same standard gauge, it would be nice to carry trailers by train from Tallinn". The interviewees also suggested that *better infrastructure for intermodal transport* is needed to increase the interoperability of different modes and infrastructures. Intermodal infrastructure includes terminals, transfer points, freight freeways running across several EU member states, etc.

The interviewees did not see *ICT systems supporting open markets* (e.g. prices, timetables, bookings, etc.) as a critical factor supporting the growth of intermodal transport. One respondent said that there had been some attempts to implement such systems, but that the companies offering these kinds of services have not succeeded; therefore, the issue is no longer relevant. The interviewees also did not see *intermodal research and statistics* as important drivers. This was an interesting result, since the EU has recently emphasized the role of research and promoted significant research initiatives supporting intermodal research (e.g. framework programs, Marco Polo). Third, most of the respondents did not see the importance of *standardization*, which was also somewhat surprising. This finding could be in line with the results of Bontekoning et al. (2004), who noted that, despite the significance of standardization, studies on the subject are scarce. This would indicate that the importance of standardization is not widely understood. Furthermore, reaching standardization agreements among all actors in the intermodal transport chain can be difficult, since different actors have accumulated investments in different types of equipment. Thus, it may be that no one in the transportation chain wants to admit that there are problems with current standards. In fact, only one respondent said that different loading unit standards should be made more similar to trailer standards. Some interviewees noted that 45 ft. long containers are becoming increasingly popular in Europe. One interviewed ship owner said that 80% of the containers his company purchased last year were 45 ft. long. These containers have the same capacity as trailers, which make them competitive. However, another respondent said that containers can only compete with trailers if they are not only 45 ft. long, but also pallet-wide. Furthermore, though 45 ft. containers are gaining more popularity in Europe, many vessels are not designed to carry them, which could limit their implementation.

External Customer Demands

Environmental demands from transport buyers and *environmental demands from final customers* were considered to have some influence, but were not seen as the most significant driving forces in the expansion of intermodal logistics services. We placed these drivers in the category "with moderate importance". Several of the respondents felt that even though their customers were interested in environmental issues, they were not willing to pay extra for sustainable alternatives. In other words, LSPs' customers demanded sustainable transportation, but only if it could be provided at no extra cost. One respondent stated that, before the economic downturn, there was an increasing emphasis on environmental issues; however, this trend halted at the beginning of the recession, and customers are now increasingly focused on economic viability. Another respondent similarly said that responsibility decreases during hard times.

Internal Drivers

Our results suggest that internal drivers do not drive the expansion of intermodal rail transport. Therefore, we have placed these drivers in the category "with lower importance". First, *new business models* were not perceived as a major driver of rail-based intermodal transport. One respondent said that no new business models have emerged in the past 10 years. Furthermore, most of the respondents did not perceive *technological solutions* to be an important driver. Interestingly, one respondent who said that new technological solutions are not relevant represented a company that had recently developed an innovation that significantly increased loading efficiency.

4.2 Summary of Results: Refined Framework

The results are summarized in Fig. 11.2, which groups the drivers into different categories based on their importance. Drivers with higher importance are all external drivers. By contrast, internal (i.e. organization-related) drivers had a lower overall impact. The most important drivers were: fuel price, taxes and a better train infrastructure. Some of the external drivers had moderate importance, meaning that opinions regarding their importance were mixed, and some had low importance. Furthermore, since the company discussions identified no additional drivers, we believe that our framework includes an extensive set of drivers.

Institutional theory identified three institutional mechanisms having an impact on companies' managerial decisions: coercive, mimetic and normative isomorphism (DiMaggio & Powell, 1983). Our findings indicate that coercive pressures are more important than mimetic and normative isomorphism when aiming to increase the share of intermodal rail transport. Most importantly, coercive pressures emerged from external drivers such as economic, regulatory and infrastructure.

5 Discussion and Conclusions

In this study, we have examined how the share of rail-based intermodal transport including rail legs could be increased in the EU from the perspective of Finland, using data collected from the logistics sector in Finland. As a result, we have identified a number of drivers that could increase the use of truck–rail combination transport, which we have grouped into five categories: external economic drivers, external regulatory drivers, external infrastructure drivers, external customer drivers and internal drivers. These categories illustrate the different forces that influence the use of rail-based intermodal transport. Based on our findings, LSPs are interested in increasing their use of intermodal transportation with a rail-leg, but they need more support and incentives. The main drivers of intermodal rail transport are: *increased fuel prices, taxes* and *a better rail infrastructure*. Although rising fuel prices were perceived by our interviewees as a main driving force of intermodal transport, some respondents believed that increasing fuel prices would also increase the price of rail transport. Since the majority of the EU's railway lines are electrified, rail freight prices should increase much less than increases in crude oil prices. One interesting finding was that LSPs see environmental taxes and fuel prices as primary drivers increasing the share of intermodal transport. In other words, LSPs are calling for more regulation. This sends an important message to the EC: if it wants to see a switch to intermodal transport and more sustainable transport, it needs to use power that is coercive.

The results of this study are in line with Borowy (2013), whose work provided an interesting example of how an economy can quickly adapt to a lower availability of non-renewable energy supplies under external pressure. To cope with fuel shortages, regulators can use innovative measures to reduce the need for fuel-intensive transport.

Based on our literature review and findings from the data, we have proposed a framework of external and internal drivers of rail-based intermodal transport for further testing (Fig. 11.2). The findings suggest that external drivers are more important than internal ones with regard to increasing the share of intermodal rail transport. By taking an institutional theory approach, we can conclude that most external drivers are coercive pressures. However, little is known about the roles of mimetic and normative pressures in the intermodal transport context. This indicates a need for future research. Our literature review and interview findings also provide some preliminary indicators of the most important drivers for increasing the use of rail-based intermodal transport in Europe from Finland's perspective. Since no additional drivers were identified during the company discussions, we expect that all key drivers have been recognized and made available in the extant literature.

Flyvbjerg (2006) suggests that a detailed analysis supports the generation of hypotheses for testing with a larger number of studies. Thus, based on our literature review and preliminary data findings, we suggest the following five hypotheses:

H1 There are external economic drivers that support the use of rail-based intermodal transport.

H2 There are external regulatory drivers that support the use of rail-based intermodal transport.

H3 There are external infrastructure and standards drivers that support the use of rail-based intermodal transport.

H4 There are external customer drivers that support the use of rail-based intermodal transport.

H5 Internal drivers are less important than external drivers in supporting the increase of rail-based intermodal transport.

Our results contribute to the intermodal transport literature and to the literature on institutional theory. First, previous studies of intermodal transport have typically focused on one driver at a time (Campisi & Gastaldi, 1996; Macharis et al., 2010; Van Schijndel & Dinwoodie, 2000). By considering multiple drivers simultaneously, our study provides a more comprehensive view of the phenomenon. Second, previous studies of intermodal transport have not employed an institutional theory approach. As far as we know, our study is the first application of institutional theory in the intermodal transport context.

Our study has important managerial implications. Specifically, our results may help LSPs switch to more environmentally friendly freight transport services. Since external drivers are more important than internal drivers in the adoption of intermodal transport, it seems that LSPs are conforming to external pressures in their decisions regarding the use of different transport modes. Our results suggest that LSPs tend to be more reactive than proactive in adopting intermodal rail transport. If LSPs wish to influence external forces beyond their organizational boundaries, they could try to play a more proactive role. The results could also inspire LSPs by showing that Finnish LSPs are interested in environmental issues and intermodal transport options.

This study has also significant policy implications. Specifically, the results should be useful to policy makers attempting to manage increased freight transport and identify ways to increase the use of intermodal road–rail transport. First, our results suggest that environmental taxes could increase the use of intermodal transport. Second, since the interviewees saw increasing fuel prices as a main driver of intermodal transport, this could be used as a policy measure to stimulate a modal shift. However, since higher taxes and prices change only the relative attractiveness of the intermodal rail option and do not enhance the efficiency of the transport system, it is essential that the rail infrastructure should be improved before other political measures are taken. This approach will ensure that a sufficient infrastructure to support the modal shift exists. Therefore, rail infrastructure development should be the first priority of politicians.

Like any study, our study has certain limitations. First, since the study was conducted in the Finnish context, its results may not be directly applicable to other EU countries. Furthermore, our study identified only coercive pressures affecting the use of intermodal transport. These limitations indicate several avenues for future research. First, the drivers of purchasing in each of the four areas should be tested with broader set of LSPs in one or several European countries. Second, further research focusing on mimetic and normative pressures in the intermodal transport context should be conducted. In addition, since our study investigated the perspective of LSPs, future research could investigate the perspective of shippers and then compare the two viewpoints. Similarly, since the respondents in this study said that their customers were interested in environmental issues but seemed unwilling to pay extra for environmentally friendly transport, it may also be interesting to further explore the customer side.

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12

Mapping Logistics Services in Sustainable Production and Consumption Systems: What Are the Necessary Dynamic Capabilities?

Tim Gruchmann, Gustavo De La Torre, and Klaus Krumme

1 Introduction

In recent years, logistics service providers (LSPs) had to respond to the increasing demand for sustainability of their stakeholders (Carter & Jennings, 2002). To meet this demand, LSPs can either reduce their ecological and social impacts in the supply chain, for example by building alternative supply chain infrastructures, implementing technological innovations and improving working conditions (Chapman et al. 2003; Lieb & Lieb,

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2010), or support the sustainable transition of other supply chain members. In this vein, it has also been recognized that end consumer behavior influences sustainability performance along the supply chain (Vitell, 2015). Consumers might exert this influence by supporting sustainable logistics strategies with their monetary "votes" (e.g. Shaw, Newholm, & Dickinson, 2006) or by changing their own consumption behavior, such as using an ecological alternative to reach the supermarket. In this context, consumers can also be understood as agents carrying out meaningful practices (Sedlacko, Martinuzzi, Røpke, Videira, & Antunes, 2014). Accordingly, the interdependence between corporate social responsibility (CSR) and so-called consumer social responsibility (ConSR) is referred to as shared responsibility which requires mutual support and co-operation (Schmidt, 2015).

To support responsible actions, there is a demand for sustainable production and consumption systems and, in this vein, appropriate capabilities considering the related effects of ecological and social trends as well as shifts in consumption patterns. To do so, sustainable supply chain management (SSCM) (cf. Carter & Easton, 2011; Seuring & Müller, 2008) can promote the analysis of sustainability gaps at LSPs, in particular corrections in operational management practices as well as policy improvements in sustainable production and consumption systems. Although SSCM mainly focuses on the manufacturer and retailer (Huemer, 2012) rather than favoring the LSP perspective, a sustainable logistics management can also be subsumed under SSCM literature. Hence, this study intends to facilitate the knowledge about sustainable supply chains for a needed sustainability transition in and across integrated systems of production, supply and consumption.

Taking into account dynamic capabilities (DCs) theory, critical supply chain actors, in particular LSPs, will be examined in the study at hand to realize a conceptual integration beyond the level of the focal company. In this context, the use of participatory systems mapping (PSM) (Sedlacko et al., 2014) opens new perspectives for system alternatives with enhanced sustainability performance and operational efficiency. Thereafter, implications can be derived concerning specific SSCM DCs to facilitate supply chain innovations in terms of infrastructure development as well as operations management practices. In detail, this research analyses the dynamic interactions of consumer behavior and sustainable logistics services and contributes to theory by improving the understanding of the LSPs' role in sustainable production and consumption systems. Accordingly, the following research question guided our study:

How can LSPs contribute to creating sustainable production and consumption systems and, at the same time, support more sustainable consumption patterns?

To answer this research question, several workshops with relevant stakeholders following the principle of triple helix stakeholdership (business practice, public management and policy as well as science) (Etzkowitz & Leydesdorff, 2000) were conducted, which included the use of participatory modeling and systems thinking brainstorming techniques. These research activities are embedded in the research project "ILoNa" (**I**nnovative **Lo**gistics for SustaiNable lifestyles).[1] The general objective of this research project is to investigate the interlinkages between innovative logistics services and sustainable lifestyles. Here, the research project analyzes production and consumption systems and related supply chain configurations in a participatory way to construct alternative and sustainable business options for LSPs. In addition, the study at hand is grounded in some of the results reported by Melkonyan, Krumme, Gruchmann, and De La Torre (2017). Here, Melkonyan et al.'s (2017) relevant findings are interpreted and extended through the theoretical lens of DCs.

Accordingly, the structure of the study is as follows: Sect. 2 describes the relevant literature streams regarding theory building in SSCM, while Sect. 3 gives an overview of the methodological approach of PSM. The related literature towards system dynamics (SD) modeling and causal loop diagrams (CLDs) is described in detail in Sect. 4. Next, Sect. 5 describes the results of the conducted PSM workshops, while Sect. 6 discusses the derived CLD against selected theoretical SSCM frameworks. The last section concludes the main findings of the study by providing an outlook on future research perspectives accordingly.

2 Theory Building in SSCM

In the past two decades, social and environmental issues found their way into supply chain research, stressing the importance of co-operation among companies to maximize profitability while minimizing environmental impacts and maximizing social well-being at the same time (Carter

[1] "**I**nnovative **Lo**gistik für **Na**chhaltige Lebensstile" in German.

& Rogers, 2008; Pagell & Wu, 2009; Seuring & Müller, 2008). In contrast to the traditional supply chain management (SCM), which is usually intended to focus on economic performance, SSCM is characterized by the explicit integration of environmental and social objectives which extend the focus of the economic dimension to the triple bottom line (TBL) as suggested by Carter and Rogers (2008). Starting from a rather holistic and broad analysis of SSCM literature at the beginning of research in this field, recent publications concerning SSCM tend to focus on sub-bodies of the discipline. Hence, the detected literature gaps and the expressed future research directions of general literature reviews led to an increased research interest in social aspects of SSCM. Answering the increasing demand for addressing social aspects in SSCM in recent years, Yawar and Seuring (2017) as well as Quarshie, Salmi, and Leuschner (2016) provided literature reviews linking SSCM and CSR improvements. Even though there have already been answers to the calls for strengthening the robustness of developed frameworks and for promoting the building of more comprehensive theory in (S)SCM, the need for theoretical grounded research in SSCM is still not saturated (Matthews, Power, Touboulic, & Marques, 2016; Quarshie et al., 2016; Touboulic & Walker, 2015). Especially, the practical integration of concepts of sustainability and SCM is seen as the biggest challenge. Here, Hanke and Krumme (2012) criticized a missing reference of SSCM theory building to the conceptual achievements of sustainability science and advanced sustainability definitions and state a dominant orientation on (less helpful) weak sustainability models such as the TBL. In this vein, Matthews et al. (2016) even argue that the omnipresent assumption of achieving economic, environmental and social goals at the same time needs to be reassessed to build an alternative theory. Following Halldorsson, Kotzab, Mikkola, and Skjøtt-Larsen (2007), Carter and Easton (2011) as well as Touboulic and Walker (2015), most theoretical studies on (S)SCM use popular theories from other disciplines such as stakeholder theory (cf. Freeman, 1984), institutional theory (cf. DiMaggio & Powell, 1983), transaction cost theory (cf. Williamson, 1975) as well as the resource-based view (RBV) (cf. Barney, 1991) and natural resource-based view (NRBV) (cf. Hart, 1995; Hart & Dowell, 2011). Taking into account the underlying theories, their suitability for the proposed research question is discussed in the following.

With regards to stakeholder theory and institutional theory, both theories stress the influence of stakeholders and other parties as drivers for (S)SCM (Quarshie et al., 2016; Touboulic & Walker, 2015). Although DiMaggio and Powell (1983) originally talk about organizational fields tending towards homogenization, most authors tend to use this theoretical lens to emphasize the role of large buyer firms in the supply chain. Due to their strong organizational and strategic view, stakeholder theory and institutional theory might not explain fully how LSPs can adopt further logistics and supply chain practices promoting more sustainable consumption patterns. Considering transaction cost theory, this theory stresses efficiency gains and cost reduction by entering interorganizational arrangements, in particular through co-operation with external partners (Halldorsson et al., 2007). Due to the high impact of logistics services on the economic firm performance, logistical activities have been mainly studied from a transaction cost perspective to achieve low-cost logistics services (Mentzer et al., 2001) and customer satisfaction through inventory availability, on-time deliveries and less product failure (Esper, Fugate, & Davis-Sramek, 2007). Therefore, the transaction cost perspective with its emphasis on leveraging the efficiency of logistics services might even be obstructive in reaching holistic sustainability goals.

Regarding RBV and NRBV, these theories focus on the competitive advantage that can be derived from managing resources as well as (sustainability-related) competencies (Touboulic & Walker, 2015). In particular, the NRBV perspective on the contingent nature of resources and capabilities allowed researchers to draw specific links between environmental and financial performance (Hart & Dowell, 2011). Although Hart's (1995) key strategic capabilities of pollution prevention, product stewardship and sustainable development foster the environmental pillar of the TBL, the LSPs' impact on the environmental performance of a company and supply chain is distinct. Based on these theories, the concept of DCs was derived from transferring the RBV and the NRBV into a dynamic environment (Beske, 2012). Dynamic capability theory aims to explain how companies can achieve a temporary or even long-term competitive advantage in dynamic markets (Eisenhardt & Martin, 2000; Teece, 2007; Teece, Pisano, & Shuen, 1997). However, the research on DCs in sustainability management and particularly in SSCM is relatively

Table 12.1 SSCM-related DCs

SSCM-related DC	Description
Knowledge management	Knowledge management includes the acquisition of new and the evaluation of current knowledge by the supply chain members (Defee & Fugate, 2010). From a LSPs' perspective, routines to generate, access and assess information about the sustainability impact of logistics services will contribute to improve the reliability of LSPs' sustainability performance (Yawar & Seuring, 2017). Moreover, the development and adaption of new technologies and practices may be eased.
Partner development	Partner development involves all activities to qualify supply chain partners to fulfill their (sustainability) responsibilities (Seuring & Müller, 2008). In this vein, the LSP business partners on the horizontal and vertical levels should be able to decide on the adaptation towards a more effective sustainability strategy of the supply chain.
Supply chain reconceptualization	Another set of routines deals with the reconceptualization describing the change of supply chain wide business models (Beske et al., 2014). Here, the transformation of the supply chain in line with a strategic reorientation of single members, particularly LSPs, might reduce the focal firm orientation and the competitive pressure (Gruchmann, Schmidt, & Pyankova, 2016).
Co-evolution	Co-evolution is characterized by improved relationships of single supply chain members leading to more efficient collaboration and co-operation among the partners (Eisenhardt & Martin, 2000). In particular in dynamic and complex supply environments, co-evolution might lead to a certain equilibrium in the system (Choi, Dooley, & Rungtusanatham, 2001). In the automotive industry for instance, when the original equipment manufacturer develops a supplier as a first-tier supplier, this action in turn creates a whole new set of second-tier suppliers who will deliver to this new system supplier.
Reflexive control	Reflexive control contains the comparison and evaluation of the supply chain functionality (Beske et al., 2014). Here, the setup of key performance indicators reliably measuring the social performance (Yawar & Seuring, 2017) of LSPs would support a transparent communication among SC members (Gruchmann et al., 2016).

Sources: Beske (2012) and Beske et al. (2014)

young, although it has accelerated in the past few years because of its prevalence for purposefully changing business environments (Helfat et al., 2009). Recently, Amui, Jabbour, de Sousa Jabbour, and Kannan (2017) reviewed the literature on corporate sustainability and DCs stating that this research area needs to be further explored by using qualitative and quantitative methods. To build on DC theory, the empirical results presented in this chapter are analyzed abductively based on the conceptualization of SSCM practices and DCs proposed by Beske (2012) and Beske, Land, and Seuring (2014). Table 12.1 presents an overview of the SSCM-related DCs accordingly.

3 Participatory Systems Mapping

To understand the connection between logistics services and sustainable production and consumption systems, a systems thinking approach for integrating complex issues of the TBL is required (Krumme, 2016). Therefore, the PSM method was adopted to facilitate knowledge transfer, based on participatory modeling and application (Sedlacko et al., 2014). PSM generally aims to develop and analyze CLDs to provide insights into a particular issue, while using a facilitated group process to connect the mental models of participants through structured discussions (Sedlacko et al., 2014). To answer the proposed questions with the help of PSM, participants work in groups and follow a pre-defined script over a certain period of time guided by a moderator. This is to enable participants to become familiar with the CLD syntax and the given problem itself, and gives them the opportunity to discuss the scope and delineation of the topic. In the next phase, participants are instructed to determine causal connections to establish cause-effect relationships between the variables, followed by an attempt to lead back these effects directly to the causes (creating feedback loops). The main task during this phase is accordingly the identification of relevant variables in the system. Thus, the mappings in the second phase are based on suggestions from the participants to incrementally add and connect new variables to the CLD. This often leads to group discussions about causal connections and the corresponding supporting evidence. During the process, the participants experience effects of combined feedback loops, identify cascade effects (if present) and take new standpoints on emergent systems behavior. Through the inclusion of participants from different disciplines, the groups have the opportunity to obtain new input and are able to test the impact of the models and knowledge gaps. Therefore, knowledge sharing and breakthroughs usually take place in the discussions. These learning outcomes seem to originate mainly at the level of implicit knowledge (where mental models are normally located), and they leave only a few explicit traces in the memory of the participants in the evaluation of the usefulness of the exercise. During the third phase, still open knowledge gaps are identified in order to ascertain where further research is necessary to complete and specify the CLD. To summarize the integrated approach using the methods mentioned, Fig. 12.1 graphically shows the described phases:

While Sedlacko et al. (2014) use PSM in the field of sustainable consumption, the study at hand intends to contribute to theory by using PSM in the field of SSCM and sustainable logistics to facilitate more sustainable consumption patterns (including feedbacks as typical for mutual relationships). Accordingly, the exploratory method of PSM was carried out to develop (advanced) CLDs, based on the modeling language of qualitative SD modeling in conjunction with the concept of SSCM as a theoretical foundation of the study.

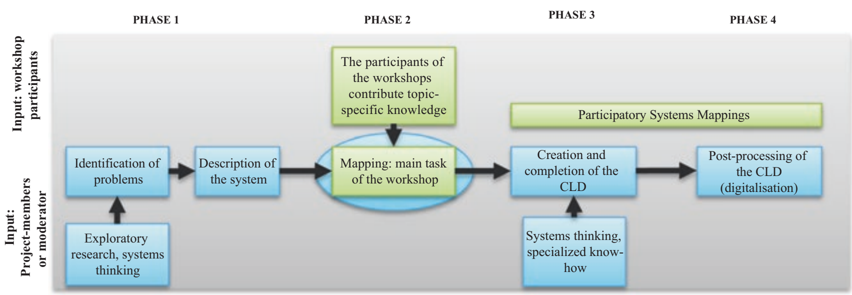

Fig. 12.1 Applied methodology of causal diagrams and participatory system mapping

4 System Dynamics Modeling

To operationalize systems thinking methods such as PSM into SD modeling has a rich tradition not only in a sustainability context, but also for decades in traditional SCM (Tako & Robinson, 2012). Here, SD modeling is seen as a tested instrument to analyze problems of dynamic complexity in a wide range of settings (Sterman, 2000). Forrester (1968, 1977) was the first author who scientifically described SD modeling; namely as "*the investigation of the information-feedback character of industrial systems and the use of models for the design of improved organizational form and guiding policies*" (Forrester, 1977, p. 13). Moreover, Wolstenholme (1990), who incorporates the quantitative simulation concept, provides an extended definition. He defines SD as a "*rigorous method for qualitative description, exploration and analysis of complex systems in terms of their processes, information, organizational boundaries and strategies; which facilitates quantitative simulation modelling and analysis for the design of system structure and control*" (Wolstenholme, 1990, p. 3). Interpreting these definitions, SD modeling leads to a profound understanding of complex issues and systems as well as its circumstances. Sterman (2006) calls these issues "needle-in-a-haystack problems" when complexity arises from finding the right path between a high number of possibilities. Accordingly, SD modeling deals with the non-linear behavior of complex systems over time (Morecroft, 1992) aiming to describe systems with the help of qualitative and quantitative models, but also to understand how feedback structures determine systems' behavior (Coyle, 1996). So far, SD modeling has established itself as a computer-aided simulation method. Here, feedback structures should be actively created and decision-making rules should be derived from the knowledge learned through simulation. Following Davis, Eisenhardt, and Bingham (2007) SD simulation is also increasingly used as a methodology for theory development. Particularly for longitudinal and non-linear processes, simulation can help to build a more comprehensive and precise theory from so-called simple theory (Davis et al., 2007).

Although CLDs are not part of the original process described by Forrester (1977), they are one of the most important qualitative modeling methods (Coyle, 1996; Sterman, 2000). Generally, CLDs comprise a set of nodes and edges, which consist of a set of variables connected by arrows denoting the causal influences among them. Here, a feedback loop contains two or more related variables that relate back to themselves. These relationships can be either positive or negative. In this context, CLDs fill the knowledge gaps in SD models to gain a sense of non-linear systems behavior based on feedback structures, and identify assumptions and underlying mechanisms in mental models (Sedlacko et al., 2014). Therefore, CLDs can be considered as the basis for simulation modeling. They fulfill additionally the central task of bringing people closer to the understanding of systems in the sense of "systemic thinking" (Coyle, 1996). However, CLDs are expressed in a formal language which needs practice to be understood properly (Forrester, 1968). Thus, it is recommended to translate the participants' statements into the CLD syntax in order to avoid misunderstandings. CLDs are excellent not only for the fast capturing of hypotheses to explain the dynamics of a model, but also for communicating relevant feedback responsible for, at first sight, "hidden" problems concerning the system (such as counterproductive rebounds or back-fire effects). They identify the most relevant feedback loops of a system, which are used to describe basic causal mechanisms hypothesized to generate a reference type of a system's behavior over time (Sedlacko et al., 2014). Although CLDs demand to capture a system in its whole complexity, they still simplify reality to provide the ability to focus on specific issues.

5 Workshop Results

For systematically creating results, a workshop platform integrating various perspectives of the experts in the field of sustainable logistics, production and consumption was established following the principle of triple helix innovation (Etzkowitz & Leydesdorff, 2000). Within this platform, the trends in logistics services and consumption affecting the sustainability of production and consumption systems were analyzed and discussed with representatives of LSPs, consumer advice agencies and academics within several conjoint workshops (Melkonyan et al., 2017). The workshops were based on the key aspects linking logistics services and sustainable consumption patterns which have recently been explored by

Gruchmann et al. (2016). These key aspects contain in particular Last Mile[2] (LM) configurations, sharing economy solutions and raising consumers' awareness of logistics services. In this vein, the main task of the PSM workshops was to map the actors, success factors, challenges and strategies towards implementing sustainable logistics services in sustainable production and consumption systems in a joint manner in order to investigate relevant variables and their causal connections.

5.1 LM Configuration

Within the workshops considering the LM configuration, the participants differentiated between two types of consumer lifestyles (Melkonyan et al., 2017). The first lifestyle was defined as group of consumers who work full-time and have limited time for grocery shopping (for instance young and employed parents). Accordingly, these consumers need to plan their shopping activities carefully. In this context, the workshop participants saw online distribution channels such as "Click & Collect"[3] (C&C) as well as home delivery services as an attractive distribution channel for this group, mainly due to possible time savings. Operating within online retailing channels, LSPs have the best opportunity to interact directly with consumers, and vice versa consumers can place their demand for more sustainable LM configurations more easily (Gruchmann et al., 2016). The participants argued that the classical parcel delivery services are not sufficient to achieve a higher LM sustainability performance. Instead, a more personalized parcel delivery including value-adding services, such as the handling of complaints, should be offered to increase convenience. The participants also warned that parcel pickup concepts like C&C present a business model to bypass the challenges in the LM to

[2] The LM serves as "meeting point" of retailers, LSPs and consumers. In the literature, the LM is seen as the most expensive part of the supply chain (Schliwa, Armitage, Aziz, Evans, & Rhoades, 2015) and accountable for a large proportion of total CO_2 emissions (Edwards, McKinnon, & Cullinane, 2011). Furthermore, the LM is one of the most complex parts of the supply chain, due to tight delivery time windows and a growing number of small orders (Kull, Boyer, & Calantone, 2007; Punakivi, Yrjölä, & Holmström, 2001).

[3] C&C integrates online and stationary distribution services into a hybrid channel. Here, the consumer may order online while pickup, return or exchange of goods stays in-store.

the consumer. Hence, performance with regard to sustainability aspects depends strongly on the mobility preferences of consumers (Gruchmann et al., 2016). In contrast, the second lifestyle was defined as consumers who do not invest time in pre-consuming, but rather in the shopping activity itself, seeking to be inspired by the product offers on the market (e.g. elderly people). For this consumer group, conventional "brick and mortar" retailers still seem to be the most relevant distribution channel. Additionally, the participants argued that communication about sustainable mobility patterns is very important for this second group of consumers. Hence, the inclusion of consumers' consumption and mobility preferences, also in the configuration of a conventional distribution channel, is crucial to achieve a better sustainability performance in the LM.

5.2 Sharing Economy Solutions

From the workshop participants' perspective, the concepts of the sharing economy[4] have potential for a more sustainable configuration of supply chains in general and the LM in particular. Considering these solutions of a sharing economy, freight shipping services conducted by consumers themselves, especially in the LM when consumers indicate the location of goods available for pickup and delivery, are seen as an interesting trend from a sustainability point of view. In line with these crowd logistics concepts, it is possible to pick up or drop off goods on the way back from work for a small reward and at the same time achieve a positive effect on sustainability. These sharing concepts have been particularly highlighted by the workshop participants since the LM efforts can be reduced significantly. Thus, sharing economy solutions could weaken the price pressure due to more logistical advantageous configurations on a local level.

[4] Botsman and Rogers (2011) identified a growing consumer interest in shared consumption which is facilitated by innovations in information technologies. Here, shared consumption has the potential to raise awareness of ecological and social aspects related to distribution channels. Heinrichs and Grunenberg (2012) distinguish three types of shared consumption. These are professional product-service-systems (e.g. car-sharing), redistribution markets (e.g. platforms such as eBay) and collaborative lifestyles (e.g. sharing music files).

5.3 Raising Consumers' Awareness of Logistics Services

The participants also stated that a general consumer awareness not only for sustainable logistics issues, but also for logistics services in general as an integral part of a product should be raised as this is often barely noticeable for the consumer. In this context, an increased visibility and perceptibility of logistics services can lead to its higher recognition and esteem as well as a higher willingness to pay (Gruchmann et al., 2016). Therefore, the willingness to pay for sustainable products and services was defined as an important success factor, but simultaneously as a challenge (Melkonyan et al., 2017). In this vein, the workshop participants argued that consumers who are willing to pay more for sustainable products, might be willing to pay more for sustainable logistics services as well. On the other hand, willingness to pay was considered as a challenge by workshop participants, since a consumer has limited financial resources and once paying for the sustainable products, less income will be available to afford sustainable logistics services. In addition, the participants stated that communication and clear information about sustainability aspects concerning logistics services is considered to be a necessary condition for sustainable consumption behavior. Although it was mentioned that too much information could be a challenge as it might overburden the consumer, providing sufficient information about logistics services and its sustainability impact was considered to be predominantly positive (Melkonyan et al., 2017).

5.4 Causal Loop Diagram

Summarizing the results of all workshops, Fig. 12.2 presents the CLD using all parameters highlighted by the participants together with their logical feedback mechanisms. As shown in Fig. 12.2, there are six feedback mechanisms which influence the dynamics of the system (Melkonyan et al., 2017). The "Willingness to pay" feedback loop describes the stabilizing interconnection among the willingness to pay for the performance and the price of sustainable logistics services in dependence on the consumer income. The feedback loop "Investment in infrastructure" shows

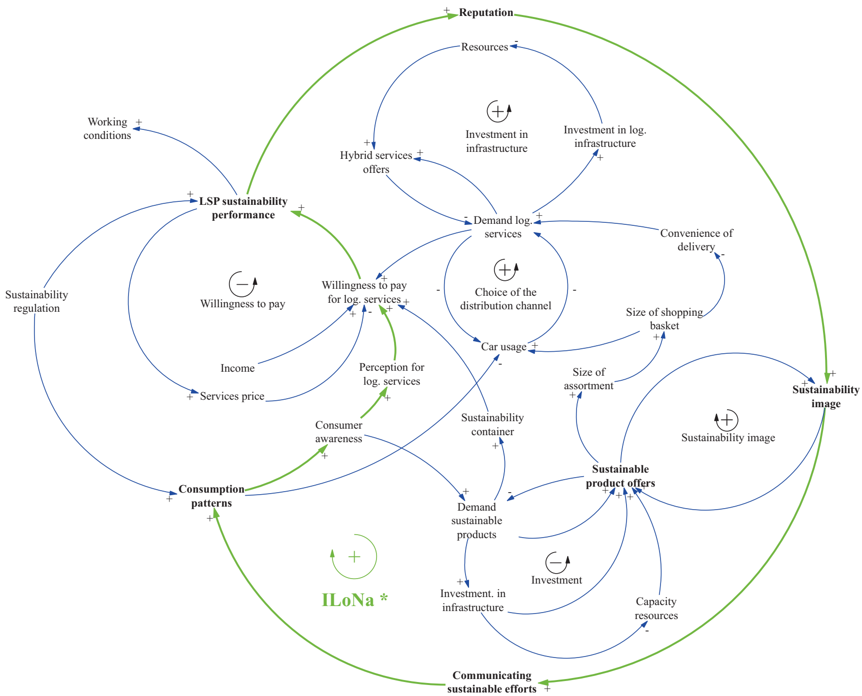

Fig. 12.2 Causal loop diagram (Melkonyan et al., 2017)

the positive impact of the demand for sustainable logistics services on investments in logistics infrastructure dependent on available resources. The option between the use of the private car and using logistics services representing the mobility preferences of consumers is clarified with the feedback mechanism "Choice of the distribution channel". "Sustainability image" shows that the image of the firm and its communication efforts positively influence the supply of sustainable products. All feedback mechanisms are summarized in the main feedback loop called "ILoNa" (according to the research project's name), which connects the awareness of sustainability aspects in logistics services (thus also the willingness to pay for them) with the image and reputation of the firm and, at the same time, supports sustainable consumption patterns.

6 Theoretical Lens

In the following, the classification scheme of SSCM functions proposed by Hassini, Surti, & Searcy (2012) is used to discuss the identified relevant causal relations in a broader SSCM context. The SSCM functions of *transformation*, *delivery* and *value proposition* were chosen as they imply linkages between logistic services and consumer decisions. The purpose of this section is to structure the findings of the PSM systematically and, at the same time, extend the SSCM functions pointed out by Hassini et al. (2012) by adding the LSP's causal relations and feedback mechanisms to the dynamic system. In this vein, the LSP's potential for building more sustainable production and consumption systems as well as necessary LSP's DCs in sustainable supply chains can be stressed. At the same time, insights into unfolding existing sustainability potentials through new business practices are derived.

6.1 Transformation

Following Hassini et al. (2012), the focal company in the supply chain may trigger an adaptation towards technologies and practices that result in engaging labor practices that are considered as fair and result in a lower impact on the environment. To achieve such a transformation, the members of a supply chain need to co-ordinate their cross-company activities in a network to share risks and rewards in a fair manner (Skjøett-Larsen, 2000). Relevant SSCM practices for achieving supply chain collaboration are the joint development of new technologies, processes and products (Vachon & Klassen, 2006), technical and logistical integration as well as an enhanced communication (Beske et al., 2014). When it comes to more sustainable product and service offers, the necessary infrastructure and resources have to be provided by the actors in the supply chain. Accordingly, the co-ordination of such resources which are distributed and shared across the supply chain (Halldorsson et al., 2007) must solve or avoid conflicts in the interests of all members to realize a supply chain reconceptualization. Here, technological innovations provide the opportunity to strengthen the position of LSPs and, at the same time, enable the creation of more sustainable and integrative production and supply systems. As technological innovations require knowledge management capabilities, routines for knowledge sharing as well as knowledge acquisition and evaluation need to be developed (Beske et al., 2014). In this context, Chapman et al. (2003) see particularly high transformation potentials by investing in advanced information technologies such as web-based ordering, electronic data interchange, barcoding, vehicle routing and scheduling, inventory replenishments and automated storage. Moreover, the development of new partnerships, also with partners who are not necessarily directly involved with the business, can ease the reconceptualization of the supply chain (Beske et al., 2014).

6.2 Delivery

Hassini et al. (2012) see the delivery process as a broad term to encompass multiple operational processes (like the choice of location, mode of transportation, etc.). Particularly with regard to sustainable logistics services and the possibilities of designing distribution channel options (stationary retailing, online retailing and hybrid configurations such as parcel stations or C&C), consumers' mobility preferences, especially their car usage, have to be considered to achieve more sustainable production and consumption systems. For instance, in regional settings with less stationary retailers, online retailing can be useful by bundling the flow of goods if additional private shopping trips can be avoided. Moreover, the convenience of the delivery is crucial for the consumers' choice of the distribution channel on the one hand and the sustainability performance of the system on the other hand hand. Thus, the offer of a large size of assortment has a negative impact on the convenience of the delivery, but, at the same time, is necessary to achieve less private shopping trips and demands for more sophisticated logistics services. Accordingly, distribution channels which simply bypass the LM responsibility to the consumer, such as C&C, need to be accompanied by additional activities to achieve more sustainable consumption patterns. Therefore, a co-evolution of supply chain partners, in a first step between LSPs and retailers, would lead to more sustainable distribution channel options. In a second step, a co-volution actively involving the consumer, for instance by organizing the LM with the help of sharing economy solutions, might tap further sustainability synergies.

6.3 Value Proposition

As consumer satisfaction is usually the primary goal of manufacturing or provided services, it is important that the product or the service is accepted by the consumer. Therefore, the performance measurement is not only defined and limited to financial and income-related indicators, but is also driven by performance indicators based on consumer wishes and judgements (Eisenhardt & Martin, 2000). Accordingly, willingness to pay is balanced by price and performance. However, consumer perception of logistics services as integral part of a product and its impact on sustainability (the so-called sustainability container) is still rather low (Gruchmann et al., 2016). Thus, costs related to environmentally friendly or sustainable products and services cannot be easily passed onto consumers. Consequently, the benefits of more sustainable products and services should be stressed to justify higher logistics service prices. Following Hassini et al. (2012), the key value proposition needs to be well communicated and understood by consumers in order to translate into alternative consumption patterns. Therefore, those consumers who are open-minded to social-ecological issues should be addressed first as they are more sensitive to a better sustainability performance (in the sense of "first movers" or "early innovators"). In this vein, establishing a reflexive control with regards to measuring the impact on sustainability increases the awareness directly among supply chain members and indirectly, through transparent and reliable communication, among certain consumer target groups. In addition, communication of a higher LSPs' sustainability performance has a positive impact on the reputation and sustainability image of the company. Nonetheless, the setup of key performance indicators reliably measuring social performance in particular is still a challenge in supply chains (Yawar & Seuring, 2017).

7 Conclusion and Outlook

On the way to identifying more sustainable alternatives with respect to environmental and social externalities of production and consumption systems, this study has shown the application of PSM that considers systems thinking (1) in terms of understanding a systems behavior and (2) the integration of available systems knowledge of experts in the field through a participatory process. This combined approach led to a system map based on perceptions and implicit knowledge stocks of the participating actors blending responsible consumership and SSCM into an integrated production and consumption system. The PSM approach explicitly incorporated the key issues for sustainable alternatives in the system, in particular the LM configuration, sharing economy solutions and consumer awareness of logistics services. Thereby, the interplay of logistics services from the sphere of SSCM and consumer behavior from the sphere of lifestyles was represented on an empirical basis. The derived CLD, which describes the relevant parameters and their logical feedback mechanisms, provides a reliable representation which serves as a starting point for several next steps of future research such as SD simulation.

To theoretically concretize DCs within sustainable supply chains and LSPs as supply chain facilitators, the initial anchor points of the PSM workshop series (LM configuration, sharing economy and awareness of logistics services) have been interpreted with the help of the theoretical frameworks proposed by Hassini et al. (2012), Beske (2012) and Beske et al. (2014). The SSCM functions of *transformation*, *delivery* and *value proposition* served to identify and structure DCs from an LSP's perspective with significant meaning for supply chain transitions towards sustainability. The findings indicate valuable elements for sustainable added-value services and respective business models in sustainable production and consumption systems. From a consumer's perspective, for instance, it is necessary to include ecological and social sustainability parameters into the price-performance ratio. Increased sustainability performance can only achieve a positive impetus if supply chain integrity is well communicated to the consumer and if the relevant effects and impacts of the system are made transparent. To conclude and highlight logistical DCs, the study reveals a high relevance of collaborative management skills in line with a coherent implementation of integrated supply chain information and communication technologies to achieve reflexive control. From the viewpoint of LSPs, supply chain reconceptualization with regard to shared financial and operational risks as well as interest conflict avoidance among supply chain members is seemingly a connected critical capability. A pre-requisite for the identification of such risks and conflicts, but also to spot opportunities, is appropriate knowledge management (for sharing, acquisition, evaluation, enrichment and preservation of knowledge) about interfaces between sub-systems in the vertical supply chain structure and in a horizontal order of main material and information flows with co-flows representing sustainability-related issues such as energy, water, waste, or emissions. These issues—such as enhanced consumer driven communication schemes in upstream information flows (sustainability demands) addressing vertical as much as horizontal structures and the internalization of external information through developing new partnerships, for example with mediate stakeholders (e.g. GOs, NGOs, independent expert groups)—represent promising potential for more sustainable operations and are important for companies to actively consider. In addition, the capability of LSPs to also channel rich product assortments, especially on the basis of decentralized production sites, is attractive to win competitive advantages against the backdrop of regional supply systems, while this combination is able to fulfill dominant consumer convenience aspects through the co-ordination and consolidating role of LSPs. This asks for a stronger co-evolution between LSPs and retailers, LSPs and producers, as well as LSPs and consumers. In this light, LSP/retailers' and LSP/consumers' co-evolution in particular shows sustainability potential through the integration of sharing economy solutions and collaborative consumption modes respectively.

Nonetheless, the specific LSPs' characteristics could not be fully addressed by the used frameworks due to the LSPs' fixed role within the supply chain as providers of services (Mentzer et al., 2001). In line with Beske et al. (2014), the majority of DCs are relationship-specific and aim to improve the relations among the different SC members in order to enable further transformation towards a more sustainable supply chain configuration. Considering the LSPs challenge to gain from developing new business practices stressing anti-competitive and performance enhancement purposes (Gruchmann et al., 2016), future research activities need to deduce LSP-specific DCs from the existing SSCM-related DCs. In particular, future research might conceptualize logistics social responsibility practices from a DC's perspective to enhance understanding of the logistics service providers' capability to shape alternative supply chain configurations and, therefore, to promote sustainability in supply chains. In this context, further research can also build on a stronger investigation of the resilience design based on the target levels of a sustainability transition. The theory of system resilience is not only offering concrete orientation for a sustainable economy discourse (Krumme, 2016), but, even more interesting in the context of this study, is naturally correlated to DCs (Christopher & Peck, 2004). Current literature on DCs for resilient supply chains shows a high concentration on the inherent dynamics of the supply chain structures, functions and actors with an emphasis still against an economically dominated background, but much less reflects on the wider system boundaries to explore the urgent relevance of sustainability-related factors of SSCM.

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13

Using the Green Performance Map: Towards Material Efficiency Measurement

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1 Introduction

A possible shortage of material resources in the long term, the total energy demand for extracting and processing of virgin raw materials and manufacturing products, and growth of industrial waste generation (Frostell, 2006; Song, Li, & Zeng, 2015) have caused concerns with respect to

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environmental sustainability and climate change (MacArthur, 2012). Improved material efficiency contributes to overcoming these issues by reducing the amount of material used for manufacturing a product and improving manufacturing practices using less material per product made and/or generating less waste per product (Peck & Chipman, 2007). However, the core business of manufacturing companies does not include material efficiency; as a result material efficiency improvement is mainly regarded as an independent system, rather than integrated into business strategies and core values (Shahbazi, 2015). Although manufacturing companies have been adopting environmental care into their production system and core values since the 1960s (Norén & Strömdahl, 2007), environmental performance is taken into consideration via a top-down perspective. Environmental data are collected and aggregated for the whole site and information is monitored and discussed on a yearly basis, mainly reactively for reporting purposes to authorities and external stakeholders. Aggravatingly, not all environmental aspects of manufacturing, such as total material efficiency, are regularly measured and evaluated. Therefore, there is an information gap for effective environmental management to regularly capture, communicate and react to environmental data (Kurdve & Wiktorsson, 2013). In addition, several studies, notably Smith and Ball (2012), pinpoint the lack of detailed methodologies for manufacturing improvement in terms of environmental sustainability and operational performance.

The lean and green concept has been established as an appropriate approach to solving this problem of integrating environmental strategies and goals into a production system (mainly based on lean philosophy (Netland, 2013)). The lean and green approach enables continuous improvement in both operations (lead time, defect rate, etc.) and environment (carbon footprint, energy usage, etc.), leading to enhanced competitiveness in manufacturing (EPA, 2003; King & Lenox, 2001) and increased environmental performance involving the whole organization's staff (Zokaei, Lovins, Wood, & Hines, 2013).

This chapter aims to reduce the functional gap between material efficiency management and operations management by presenting empirical data on the application of a novel lean and green tool that helps to measure material efficiency on different organizational levels by monitoring material consumption and waste generation.

The remainder of the chapter is structured as follows: first a theoretical background on sustainable manufacturing, material efficiency methods, and in particular the green performance map (GPM) is given. Next, the deployed methodology for data collection and analysis is outlined, followed by empirical findings. Afterwards, analysis and discussion on material efficiency via GPM are presented. The chapter ends with the conclusions.

2 Theoretical Background

2.1 Sustainable Manufacturing

An awareness and understanding of the risks related to limited resources and waste generation (as part of the total environmental impact) have been achieved since the introduction of the "sustainable development" concept (Brundtland, 1987). By relating to the general aspects of sustainability in manufacturing (see, e.g., Dubey, Gunasekaran, & Chakrabarty, 2015; Rahimifard & Clegg, 2007; Wiktorsson, Bellgran, & Jackson, 2008), many companies have taken environmental steps to reduce their carbon footprint. Garetti and Taisch (2012, p. 85) address the environmental dimension of sustainable development in the manufacturing context, defining sustainable manufacturing as "the ability to smartly use natural resources for manufacturing, by creating products and solutions that, thanks to new technology, regulatory measures and coherent social behaviours, are able to satisfy economic, environmental and social objectives, thus preserving the environment while continuing to improve the quality of human life". Nevertheless, manufacturing still contributes to key environmental issues, including raw material consumption, the greenhouse effect, climate change, energy, biodiversity, toxics, waste generation and water and air pollution (Esty & Winston, 2009). The main reason might lie in the fact that business understanding still focuses on the particular industry in which the company competes, while the broader business environment surrounding the major operation receives less attention (Porter & Kramer, 2011). Although manufacturing companies accept environmental excellence as a benefit, the cost of complying with environmental legislation and best practice targets is found to be high, at least in the short term (Smith & Ball, 2012). On the contrary, recent literature reports the relation between environmental performance and positive financial and market performance of firms in the long term. Companies are able to gain economic value through creating societal value (Porter & Kramer, 2011), which for the sake of this chapter implies creating economic value (not only lowering costs but also gaining revenue through selling properly segregated waste) by creating environmental value (less material input and less waste generated). For manufacturing to start creating shared value is to recognize the societal needs and benefits that are closely associated with production and product such as health, safety, working conditions and natural resources. Material efficiency directly contributes to both economic and societal (environmental) performance and value creation, where less input material is consumed and less waste outputs are generated, which are costly to segregate, collect, transport and dispose of.

2.2 Material Efficiency Methods

A number of researchers in environmental sustainability have drawn attention to material efficiency (see, e.g., Abdul Rashid & Evans, 2010; Allwood, Ashby, Gutowski, & Worrell, 2013; Lilja, 2009a). However, these researchers mainly concentrate on and explain the whole industrial waste management system. For example, Lilja (2009b) discusses promotion of waste prevention and material efficiency in the whole Finnish industrial sector, and Allwood, Ashby, Gutowski, and Worrell (2011) attempt to stimulate interest in material efficiency in the broad perspective by presenting opportunities and barriers. The majority of strategies developed for material efficiency are also generic (Smith & Ball, 2012) and related to the whole supply chain. For instance, eco-efficiency (Ehrenfeld, 2005), product stewardship (Rogers, Rogers, & Lembke, 2010) and industrial ecology (Roberts, 2004) correspond to a broad area of influence, suiting macro-economic management for optimization of the whole industrial system (a top-down approach), rather than focusing on the improvement of a process or operation by tools and methods to map waste streams and material consumption (a bottom-up approach). One of the most common tools mainly associated with products is life cycle assessment (LCA), but it has proven to be cumbersome, expensive and time-consuming with a great level of resources (cost and man/hours) required for data gathering, modeling, and analyzing (Hallstedt, Bertoni, & Isaksson, 2015). Other criticisms against LCA have been on the expected results (uncertainty) and reproducibility of them (Finnveden, 2000). Therefore, methods and tools that are more goal-oriented with simpler measurement and implementation and a limited area of influence on manufacturing operations or products or services are required. These tools should be relatively easier to implement for assessment and understanding and specify an action plan to achieve a specific sustainability goal.

Mapping and analysis of material and waste flows should address quantity of material consumption and waste generation as well as quality of generated waste (i.e. homogeneity of waste) (Shahbazi, Kurdve, Bjelkemyr, Jönsson, & Wiktorsson, 2013). The homogeneity of waste is vital for further recycling and reuse of wasted material. A lower level of waste disposal is linked to the mixed waste fractions in comparison to the homogeneous segregated waste that retains a large portion of the material's original value. An analysis of generated waste and material consumption can be carried out using a top-down or bottom-up approach. To achieve an operational perspective and understand the impacts of each operation, a bottom-up approach can be applied, whereas for breaking down the overall impact of the entire plant in a given period of time, a top-down approach can be used. Moreover, mapping and analysis of waste and material flows requires highlighting the input and output of processes (Smith & Ball, 2012), in order to be able to fit a process output to the input of another process, to reduce total material consumption and waste generation.

2.3 Green Performance Map

The GPM (Bellgran, Höckerdal, Kurdve, & Wiktorsson, 2012) is a structured lean and green tool based on the input-output model for identifying and visualizing the different environmental aspects of a manufacturing process, operation or factory. The green performance map is reported to be a fruitful tool to identify, prioritize, measure and follow the complementary actions of environmental aspects of different levels of operation by any team member with any functional position (Romvall, Kurdve, Bellgran, & Wictorsson, 2011).

The tool divides the input materials into productive (i.e. primary product material) and auxiliary materials (i.e. process materials, non-value adding material, non-productive material) and the outputs into products and residual materials (i.e. by-products, intermediate products, sub-products, rest material). In addition, energy and water consumption (as inputs) together with generated emissions to air (like heat or noise), soil or water (as outputs) is taken into consideration. This inclusion of input and output is in line with material flow cost accounting (Kokubu & Kitada, 2015) and a framework suggested by international environmental standards ISO 14001 and ISO 14051. Afterwards, the environmental aspects are identified through the go-to-gemba concept of bringing them to the workplace and engaging them in continuous improvement. The identified environmental aspects are then prioritized by red, yellow or green colors based on improvement cost and environmental effect. Red-tagged environmental aspects have the highest priority for the operation/company for improvement, while green ones have the lowest.

3 Methodology

3.1 Circular Economy and Material Efficiency

Since the development of the GPM, there have been few studies (e.g. Kurdve & Wiktorsson, 2013) investigating the testing and implementation of GPM to identify and visualize different environmental aspects. This chapter is mainly focused on (1) reporting the application of GPM in manufacturing companies and (2) concentrating on material efficiency via GPM. Considering the circular economy as an open production system in which products and waste are reused and recycled in a new system to conserve energy and resources (Preston, 2012), Fig. 13.1 illustrates different phases of product life cycles and their associated material efficiency solutions. The *manufacturing* phase is depicted via GPM to indicate material and waste flows.

The *design* phase and *end-of-life* scenarios to be material-efficient subsequent to the *use* phase are visualized by red arrows in Fig. 13.1. Reverse

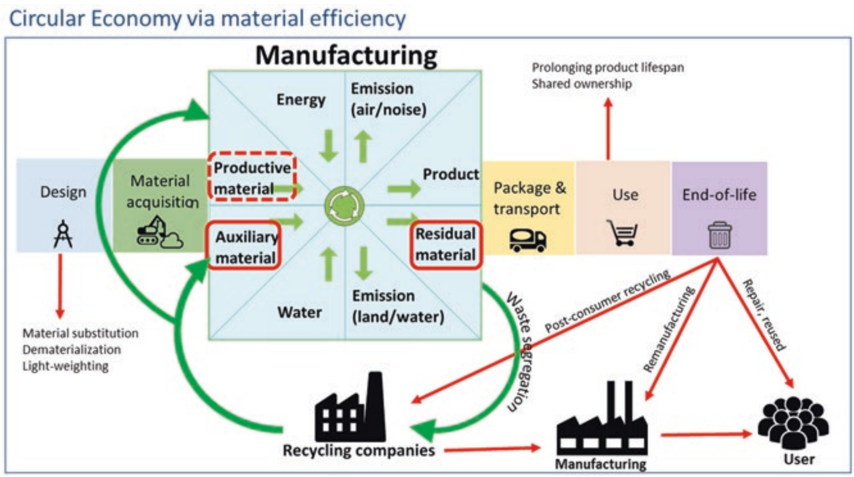

Fig. 13.1 Circular economy via material efficiency, adapted green performance map from Romvall et al. (2011)

logistics and product recovery approaches such as post-consumer recycling, repair or reuse of products with different purposes, product upgrades or remanufacturing and prolonging product lifespan or shared ownership are essential to preserve resources and achieve a circular economy; however, these approaches have been excluded in this study as their area of influence is beyond the borders of an operation site. This chapter focuses on the *manufacturing* phase only, which is indicated by green arrows. In the *manufacturing* phase (1) waste is correctly segregated into pure fractions and sold to a recycling entrepreneur, and (2) incoming materials are purchases from recycled materials. Both these actions need to be carried out simultaneously to move towards sustainable manufacturing and a circular economy. Ideally, the pure waste fractions without any contamination are sent back to the original manufacturer/supplier through reverse logistics to avoid any downgrade recycling, ensure material quality and supply, as well as increase mutual relations between industrial supplier and the industrial user/manufacturer. A current example of this bilateral relation is found in aerospace manufacturing where returning of swarf and metal chips from expensive materials and alloys is included in contracts. This can also be imitated when bulk metals in the automotive industry are used to manufacture the products, but tons of scraps made of pure steel are wasted and mixed with other metals, when they could be sent back to the supplier instead of being sold to an external recycling entrepreneur for mixed-metal recycling.

3.2 Research Design

A literature study on material efficiency and industrial waste management has been carried out. The literature selection incorporated different keywords and combinations of them. The literature search focused on papers addressing material efficiency in the manufacturing industry. The empirical base for this chapter relies on case studies during the period 2012–2015 as part of three Swedish research projects, here named LG, ME and SPM. The research area of each project directly contributes to different aspects of this research. The LG (lean and green) project correlated with integration of environmental aspects in development and improvement of production systems; the ME (material efficiency) project assessed current industrial barriers to increased material recycling and efficient waste management for the manufacturing industry; the ongoing SPM (sustainable performance measurement) project focuses on developing a performance measurement system to support companies in the development and redesign of performance measurement systems taking sustainability into consideration. Manufacturing companies studied are mainly large global automotive companies but vary in terms of plant size, product type, volume and complexity, and waste handling system; see the overview of companies in Table 13.1.

Data collection was performed through multiple sources of evidence as suggested by Yin (2003), including observations and site visits (both operations and waste management handling systems), meetings and discussions with academics and industrial practitioners during the projects, and document reviews (mainly environmental and previous environmental project reports). On an overall level, the analysis of the empirical data from the case studies followed the process suggested by Miles and Huberman (1994), involving data reduction, data display, and conclusion drawing and verification. Hence, the collected data were simplified, organized and interpreted.

Table 13.1 Companies studied

Manufacturing companies	Company description	Operation where GPM was used	Project
Company A	Developer and manufacturer of brake and air suspension for heavy trucks, buses and trailers	The whole operation in the factory (aggregated level)	SPM
Company B	Manufacturer of heat transfer, separation and fluid handling	Heat transfer production	ME
Company C1	Automobile manufacturer	Body component manufacturing	LG
Company C2		Engine manufacturing	
Company D	Manufacturer and assembler of gearboxes for trucks, construction equipment and marine industry	Development of a new production line	LG

4 Empirical Findings

Company A has four main strategic goals including zero accidents, zero customer complaints, 100% delivery on time and 95% overall equipment efficiency. The main environmental visions for coming years however include CO_2 reduction related to electricity and material efficiency improvement, without any explicit goal in number or percentage terms. The green performance map in this company has been used mainly for environmental reporting and to set environmental goals and sustainable key performance indicators (KPIs). The global environmental manager collects the results from different sites around the world and visualizes them on an aggregated GPM to obtain an overall environmental picture in order to be able to set next year's environmental targets. The aggregated GPM is also used to calculate annual total material efficiency. There was a consensus about the application of GPM that creates a performance management culture within the company, with a focus on the importance of communication and increased environmental commitment to set goals and identify environmental problems. However, during the project it was perceived that the GPM application was not completely understood at all production sites and different types of data were included in the GPMs. For instance, there has been disagreement about the definition of productive material (value-adding material) and auxiliary material (non-value-adding or non-productive material) in the GPM and their contribution to adding value, and whether customers are willing to pay for non-value-adding materials. It was also problematic to define the categories in which to include incoming packaging material as productive material. As a result, GPM was concluded to be fruitful but complicated with eight categories and definitions. Company A therefore initiated the idea of restructuring GPM into an easier version by combining value-adding and non-value-adding material on the map, although this turns the focus away from better material flow management.

Company B's main environmental strategy relates to the reduction of environmental or health risks associated with the use of chemicals, reducing greenhouse gas emissions from manufacturing and goods transportation. Its environmental vision related to material efficiency concerns optimizing the use of natural resources, although no explicit target has been defined. Other strategic measurements include an employee satisfaction index, number of customer complaints, a cost flex gap (cost base on volume), an operational factory and engineering result, inventory days of supply, an employee satisfaction index, lost time injury, delivery on time packed, a correction action hit rate, defects per million opportunities, suppliers' delivery on time, suppliers' quality, price variation from standard, delivery on time invoiced, and order fulfillment lead-time. The GPM in this company is used as a pilot to train not only operators in production and assembly in the company but also university students who take an environmental engineering program and do student projects in the company. Green performance map workshops at this company aim at addressing environmental aspects of a specific operation for operators and engineers as well as students. These workshops were in line with the company's environmental management goal to move towards a green operation. Therefore, a total number of 17 people mapped two different processes in a heat transfer operation in a bottom-up approach to identify relevant environmental aspects, jointly develop shop-floor level environmental goals, develop action plans for continuous improvement, and prioritize the environmental aspects and link identified environmental aspects on the process level to environmental management goals on the overall factory level. There was agreement among participants that GPM involves staff in the environmental work, visualizes information and provides a better understanding of the environmental aspects of the business; it also helps integrate environmental improvement into ordinary continuous improvement via a lean approach.

Company C's strategic objectives include safety, standard and quality, stability and security (through overall equipment effectiveness, OEE), responsibility and methodology to reduce stress, customer respect, flow of production, competitive price, inventory turnover and smart investments. The environmental focus of the company is on zero environmental accidents, soil and ground control, climate-neutral operations and energy efficiency, water footprint, total waste management, sustainable transportation, emission to air and the product environmental impact. The total waste management theme does not include any explicit goal like reduction of waste volumes, increase of recycling, reduction of waste to landfill or reduction of quality scrap (as opposed to design or set-up scrap). Company C mainly uses GPM as a continuous improvement tool in its current operations. The green performance map in this company was implemented in two different plants, where the participant groups were machine operators, assemblers and manufacturing engineers aiming to improve their own work station/process in an environmental sense. At factory C1 identification of environmental impacts through GPM was made on both the shop floor (fabrication and assembly of engines) and strategic corporate levels (including all C's factories). At factory C2, the GPM was used on the shop floor (fabrication and logistics) and factory levels; findings were then used to define operational environmental targets for the main issues and develop team actions to improve performance towards the targets. The general conclusions from GPM were that it engages people in environmental work to identify and reflect on environmental issues and find solutions in a continuous and iterative process. There was a consensus on growth of environmental awareness in the organization as well.

Company D's strategic objectives include turning volume into profit, strengthening the customer-business partnership, capturing profitable growth opportunities, having innovative energy-efficient transport and infrastructure solutions, and building high-performing global teams. The main environmental focus of this company is on energy efficiency, electricity consumption, process fluid consumption and recycling rate of conventional waste. This company used GPM as a tool in the development of a new production line. The GPM was carried out by environmental experts and operators who were supposed to work on the new production line. However, the performed GPM was based on a similar existing production line to indicate the environmental aspects of the planned production line. The overall goal was (1) to have an initial environmental analysis of the existing line to find environmental improvement potentials for a future production line, (2) develop a pre-understanding of environmental improvements at a low cost (which was mainly left out owing to other production indicators like cost, time and quality), (3) propose an environmental navigator for production preparation as well as an action plan on environmental work by operators and technicians on the new line and (4) test GPM as a method or training tool for the production development process including a dynamic checklist for the concept phase and purchasing specifications. The overall conclusion of implementing GPM was that it is an easy tool to use in preliminary process evaluations, to go beyond system boundaries, and to collect different environmental aspects of the new equipment by visualization. It was also concluded that in an iterative process of using GPM, details of each aspect need to be included as a checklist (for instance, inclusion of an Excel file suggested) to better monitor environmental aspects over time. However, a major difficulty was to apply the GPM to unknown parts of the process; it was easier to assess the existing process and extrapolate it towards the new one. Different levels of environmental aspects were also problematic, such as processing chemicals and energy consumption (i.e. it was difficult to quantify and evaluate the environmental impact). The suggested solution was to have predefined environmental KPIs and measurements and a life-cycle cost perspective.

Figure 13.2 illustrates two GPMs performed at companies C and A. On the left-hand side, Company C used a conventional GPM to identify and visualize environmental aspects of limited operations. The environmental aspects were written in boxes and located on a GPM based on their area of impact including productive material, energy, water and pro-

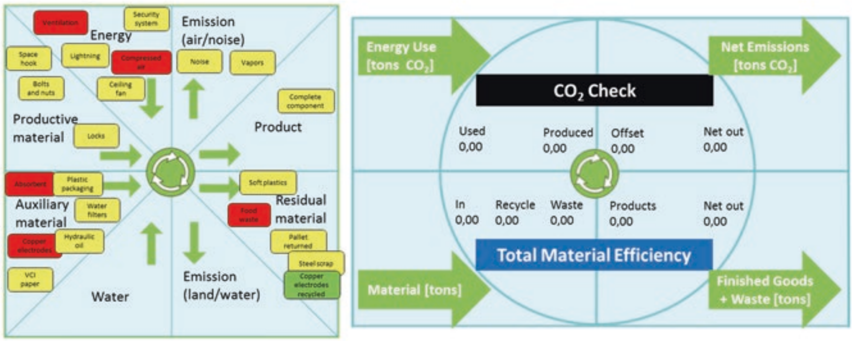

Fig. 13.2 GPM examples (normal GPM on the left and modified GPM on the right)

cess material as the input flow, and product rest material/waste and emissions as the output flow. The environmental aspects were color-coded based on their importance in terms of cost and environmental burden (also depending on the manufacturing company's priorities), red for high priority, yellow for medium and green for low priority. On the right-hand side, Company A used a modified version of GPM based on its environmental strategies and goals which were higher material efficiency and CO_2 reduction. Therefore, the two flows of energy/emission consumption and material/waste consumption were measured in a generic way. As is shown, water consumption and product have been removed from the GPM, and process and productive material streams have been combined for the purpose of simplification.

Table 13.2 summarizes the empirical results, where an overview of the application of GPM is presented.

5 Analysis and Discussion

Even though the companies studied consider material efficiency as an independent system and do not integrate it in their core business strategies (which mainly include cost, delivery, quality, safety and environment but in terms of energy efficiency or energy consumption and CO_2 neutralization), still the majority of them have material efficiency, resource efficiency

Table 13.2 Summary of empirical results

Companies	Primary goal of using GPM	Secondary goal of using GPM	Main approach
Company A	Reporting and setting environmental goals for next year	Finding environmental improvement opportunities of current operations	Top-down
Company B	Training of staff and students	Finding environmental improvement opportunities of current operations	Bottom-up
Company C	Finding environmental improvement opportunities of current operations	Training of staff	Bottom-up
Company D	Developing a new line and finding environmental improvement potential for the future production line	Training of staff	Bottom-up and top-down

or waste management on their environmental agenda. However, efficient use of material and waste reduction in operations should be further investigated. Relevant material efficiency KPIs are challenging due to different types of materials and units to measure, in contrast with energy that has a single unit (kWh) or is converted to CO_2 or global warming potential.

Previous environmental studies indicate several barriers to sustainability, including lack of a suitable tool for environmental initiatives (Bey, Hauschild, & McAloone, 2013), unclear/weak strategies and goals (Koho, Torvinen, & Romiguer, 2011), limited environmental motivation and engagement (Murillo-Luna, Garcés-Ayerbe, & Rivera-Torres, 2011), lack of effective measures to evaluate sustainability (Seidel, Recker, Pimmer, & Brocke, 2010), and poor visualization and limited intraorganizational interaction (Simpson, 2010). Studies on the manufacturing industry indicate the same barriers to improved material efficiency, but in a limited scope and direction (e.g. Abdul Rashid, 2008; Shahbazi, Wiktorsson, Kurdve, Jönsson, & Bjelkemyr, 2016). Although the application of GPM in the companies studied was not specifically for material efficiency purposes, it is regarded as an effective tool for different environmental initiatives to overcome the above-mentioned barriers. Empirical findings showed that GPM is a goal-oriented tool to measure and visualize basic material efficiency measurements such as the amount of waste generation and material consumption; it engages different organizational functions (via go-to-gemba) in a continuous improvement process to identify the right environmental aspects (here material and waste-related aspects), prioritize them and plan the right improvement focus. In addition, GPM might be used as a stepping stone for more comprehensive sustainability measurement methods or be integrated with them. For instance, GPM can be integrated with LCA to provide relevant information including: (1) identifying environmental improvement opportunities of products in different life-cycle phases, in particular in the manufacturing phase (e.g. at Company C); (2) inform decision makers and top management regarding strategic planning (e.g. at Company A); prioritization, and product or process design (e.g, at Company D): (3) selection of sustainability KPIs (e.g. at Companies A and D). In an LCA and GPM combination, integration has a complementary role, as GPM does not include final product transportation to the customer or use phase. In addition, GPM measures different environmental impacts with various units, while this issue can be addressed with LCA, which quantifies the environmental impacts into a single unit like global warming.

For improved material efficiency, productive material (value-adding material) and auxiliary material (non-value-adding material) need to be distinguished. Distinguishing between different input materials is not only in line with the ISO 14051 framework and LCA perspective (Zackrisson, Jönsson, & Olsson, 2014), but also in accordance with lean and green thinking (Zokaei et al., 2013). Although Company A encountered complexity in doing so, the main reason lay with a management team perspective that only considered a single material flow including both productive and non-productive materials to make the products. Therefore, Company A only reports the total material efficiency and cost associated with waste disposal on a yearly basis (see the right part of Fig. 13.2).

There was also uncertainty regarding the definition of total material efficiency in all of the case studies. Equations (13.1a) or (13.1b) can be derived based on the definition of material efficiency (the ratio of output to input). However, Company A uses Eq. (13.2) to calculate and report total material efficiency, primarily because incoming materials data are not always collected, and if they are, the data are not always precise. In contrast, the total product weight and the total waste weight are more of a valid approximation, principally indexed per units produced (ton/#).

$$\text{Total material efficiency} = \text{Product output} / \text{Material input} \tag{13.1a}$$

$$\text{or} = \text{Product weight} / \text{Incoming material weight} = \mathrm{A} / (\mathrm{C} + \mathrm{D}) \tag{13.1b}$$

$$\text{Total material efficiency} = \text{Product output} / \begin{pmatrix} \text{Generated waste} \\ +\text{Manufactured product} \end{pmatrix} \tag{13.2a}$$

$$\text{or} = \text{Product weight} / \begin{pmatrix} \text{Waste weight} \\ +\text{Product weight} \end{pmatrix} = \mathrm{A} / (\mathrm{A} + \mathrm{B}) \tag{13.2b}$$

Looking at Fig. 13.3, in an ideal circumstance with precise data, the sum of product output (A) and residual material (B) should be equal to the sum of productive material (C) and auxiliary material (D), in other words A + B = C + D. Therefore, the denominator in Eq. (13.1) (material input or C + D) should be equal to the denominator in Eq. (13.2) (generated waste and produced products or B + A), in other words Eq. (13.1) equals Eq. (13.2). However, this was not the case in the studies performed owing to lack of data on input material and output waste. Residual material (Sect. B) can also be divided into B1: recycling/reusing material (which retains a large amount of value) and B2: material that is landfilled or incinerated. This is in accordance with redefining value chain productivity via resource use (Porter & Kramer, 2011). This division was also discussed at the case companies, regarding who might be willing to calculate total material efficiency according to Eq. (13.3).

$$\text{Total material efficiency} = \begin{pmatrix} \text{Product output} \\ +\text{Recycling material} \end{pmatrix} / \text{Material input} = (\mathrm{A} + \mathrm{B1}) / (\mathrm{C} + \mathrm{D}) \tag{13.3}$$

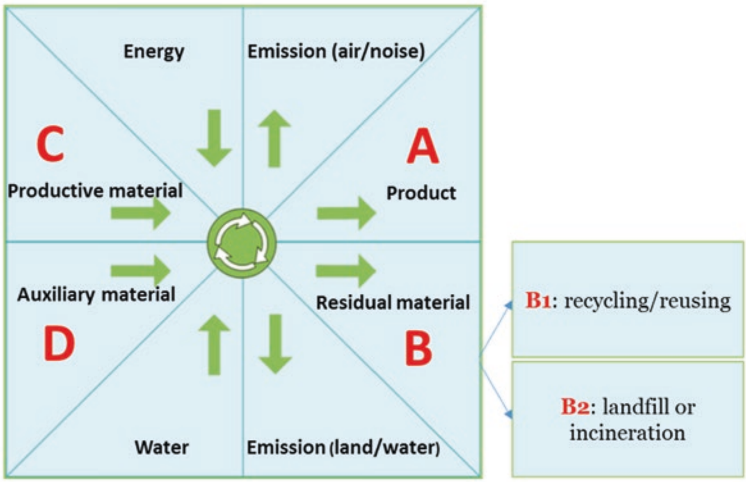

Fig. 13.3 Material efficiency via GPM

Further discussion on value-adding material efficiency was carried out at the companies studied regarding only taking value-adding materials into consideration (A and C). The discussion led to Eq. (13.4), although the correctness of the equations remained a relatively unexamined issue due to lack of precise data from companies. The same logic on recycling/reusing materials and materials to landfill and incinerators can be applied here in Eq. (13.5).

$$\text{Value-adding material efficiency} = \text{Product output} \,/\, \text{Value-adding material input} = A / C \quad (13.4)$$

$$\text{Value adding material efficiency} = \left(\text{Product output} + \text{Recycling material}\right) / \text{Value adding material input} = \left(A + B1\right) / C \quad (13.5)$$

In addition to total material efficiency, relevant KPIs should also be set, such as waste sorting rate, average segment treatment cost, material segment weight per produced unit as well as cost efficiency and service efficiency for each waste management process (Kurdve, Shahbazi, Wendin, Bengtsson, & Wiktorsson, 2015), waste productivity (Rahdari & Rostamy, 2015), or waste intensity (Krajnc & Glavič, 2003). The limitation of only measuring total material efficiency can be linked to a lack of environmental enforcement. The current environmental enforcement scheme addresses only chemicals and hazardous waste; the results also show that residual material derived from primary product materials (metal scraps in the companies studied) and hazardous materials are correctly managed, but residual materials derived from auxiliary materials such as packaging are not optimally handled. This perceived sufficiency of compliance with current environmental regulations is a barrier that needs to be overcome by governmental incentives and tax reductions as well as regulatory pressure (the carrot and stick approach).

Except for Company A, GPM is being used as a bottom-up approach to train shop floor employees and improve operations, which helped companies to have a realistic picture of the current state and set focused environmental targets (Romvall et al., 2011). The difficulty of collecting relevant data that Company A faced can be linked to this fact as well, in other words, GPM had not been practiced in a bottom-up approach at that company and sufficient information had not been communicated. Although GPM suits both top-down and bottom-up approaches, the main application remains bottom-up for continuous improvement and training to create shared value mainly through redefining productivity in the value chain (Porter & Kramer, 2011).

6 Conclusion

The overview indicates that GPM is effectively being used in manufacturing companies for different purposes including environmental training, environmental and operational improvement, identification of environmental aspects for developing a production line, and reporting and setting yearly environmental targets. The lean and green characteristics of GPM including visualization, involvement of different functions through go-to-gemba, goal orientation for improvement, simplicity and coverage of top-down and bottom-up approaches fill the gap between operations management and material efficiency management and remove some of the barriers to material efficiency. The quantified GPM can be used to regularly measure and monitor the material efficiency measurements for a process, on an aggregate level for the plant and even at the corporate level. This works as a stepping stone for more comprehensive sustainability measurement methods like LCA. In addition, the homogeneity of the generated waste can be calculated by GPM if specified data are collected. For instance, the segment waste sorting rate for metals (which is the sum of sorted metals divided by the sum of sorted and mixed metals) is obtainable from the GPM. However, further material efficiency KPIs ought to be set and measured regularly to achieve improved material efficiency. Improving material efficiency not only provides environmental benefits but also yields short- and long-term economic advantages by improving the recyclability, reusability, reduction and prevention of industrial waste, which in turn reduces the total environmental effect of the manufacturing industry. All in all, although GPM had different applications, all helped in moving towards a circular economy and creating shared value.

This research contributes to the literature on the circular economy, resource efficiency as well as green and lean via reporting on the application of GPM in helping to identify and improve environmental effects, particularly those related to material and waste flows, and also presenting a better understanding of regular total material efficiency measurement via GPM. The green performance map also suppresses some barriers towards sustainability and material efficiency that were previously identified in the literature. This research also contributes to capture value in industry by using GPM for different environmental improvement initiatives at companies including environmental improvement, training, reporting and development. There is significant potential in industry to segregate more and better, and retain high-quality residual material to further recycle and move on up the waste hierarchy. The green performance map proved to be a fruitful tool to enable companies to increase their contributions to reducing industrial waste volumes, the demand for virgin raw material, carbon emissions and total energy consumption.

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Part IV

SOM Capability Development

In this final part of the book, we shall focus on fulfilling the fourth necessary condition for effective control of an operation with a view to making it more sustainable, namely creating a sufficiently rich set of steering options. In other words, the organisation needs to possess and develop thecapability to identify enough appropriate alternative actions in order to achieve the goals it has set.

Each of the two chapters in this part provides a specific perspective on fulfilling this condition.

The first (Chap. 14), written by Raitasuo, Kuula, Ruiz-Torres and Finne, investigates the link between green capabilities and performance outcomes in the logistics sector. In particular, their study examines relationships between green capabilities and two performance outcomes, namely environmental performance and innovation performance. Data were gathered from different parts of the world: Finland, Russia, Puerto Rico and Panama. Green capabilities and environmental performance are positively linked in all four countries, whereas the link between green capabilities and innovation performance was found only in Caribbean countries.

Next, in Chap. 15, Mieko Igarashi considers the topic of green public procurement (GPP), which involves environment-related information exchange and knowledge transfer between buyers and suppliers. Her study sheds new light on how environment-related information is processed and used in buyers and suppliers. The results suggest that the success of GPP may depend on both the buyer's and supplier's ability to value, understand and utilize the information they exchange in the procurement process.

14

Linking Green Supply Chain Management Skills and Environmental Performance

Pinja Raitasuo, Markku Kuula, Alex J. Ruiz-Torres, and Max Finne

1 Introduction

Companies face pressure from various sources to develop environmentally friendly business practices, such as reducing energy consumption (Glover, Champion, Daniels, & Dainty, 2014). A wide variety of actors, including consumers, legislators and non-governmental organizations (NGOs), are calling for companies to adopt environmental practices that protect nature.

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Environmental practices include all of the various activities, initiatives and processes designed to improve firms' environmental performance. Growing environmental awareness has led to the emergence of green criteria and evaluation of green supply chain management skills in supplier selection processes (Kumar, Datta, & Sankar Mahapatra, 2014). Thus, environmental pressures have begun to influence not only retail businesses, but also business-to-business (B2B) companies. Companies increasingly need to think about what their business partners and business customers expect from them with respect to the environment. Furthermore, since some B2B companies (e.g. logistics and transportation companies) have a greater impact on the environment than others (e.g. information technology companies), companies in different industries may experience different kinds of pressures in relation to their environmental protection efforts.

In recent years, environmental sustainability has become a popular research area in operations management (OM). However, research on environmental sustainability in the logistics sector is still scarce (see Lieb & Lieb, 2010; Rossi, Colicchia, Cozzolino, & Christopher, 2013), although it is clear that logistics operations, especially transportation, have a significant impact on the environment. In addition, since the logistics sector is highly competitive, logistics service providers (LSPs) have to be sensitive to their customers' needs. Environmentally friendly logistics services may be one way to provide more value to customers who demand more than low-cost basic services. It has been found that pure differentiation companies outperform pure cost companies, perhaps partially due to the changing requirements of logistics users (Yeung, Selen, Sum, & Huo, 2006). This means that focusing on cost cutting and competing solely on cost is not necessarily the best option for LSPs. Instead, forward-looking LSPs may need to develop their green supply chain management skills in order to offer differentiated value-added services and achieve enhanced performance. However, previous research on LSPs' green supply chain management skills and the environmental pressures they experience is still scarce, and more research on this issue is needed.

Previous research has established that green supply chain management practices contribute to environmental performance (Zhu & Sarkis, 2004), but we do not know whether green supply chain management skills and adoption of green practices can lead to better performance in other outcome measures. In other words, can becoming "green" bring other benefits to a company? Green companies are often considered forward-looking and innovative. Thus, could there be a positive link between being green and being innovative?

What, then, is needed for companies to achieve greater environmental performance? Drawing on the resource-based view (RBV) (Barney, 1991), one could argue that it is necessary for companies to first possess green supply chain management skills in order to adopt environmental business practices and achieve enhanced performance. Green supply chain management skills refer to firms' abilities to implement green practices beyond environmental laws in order to reduce or minimize environmental impacts (Benitez-Amado, Perez-Arostegui, & Tamayo-Torres, 2010). Whereas prior research has investigated the drivers of green supply chain management skills development (see e.g. Benitez-Amado et al., 2010; Lee & Klassen, 2008; Rugman & Verbeke, 2000), this chapter seeks to contribute to the RBV literature by examining the relationships between green supply chain management skills and two performance outcomes: environmental performance and innovation performance. Accordingly, the research question examined in this study is: *do green supply chain management skills lead to greater environmental and innovative performance?*

We begin by explaining the study's theoretical background. This is followed by a literature review and hypotheses development. We then continue with a description of the modeling framework and an explanation of the structural equation modeling (SEM) method used in this study. Next, we discuss the study's theoretical and managerial implications. In the final section, we draw conclusions for the study, discuss its limitations and provide suggestions for future research.

2 Theoretical Background

According to the RBV, not all firms have similar competencies. Instead, firms differ in their sets of available resources and organizational skills. Thus, the key to achieving competitive advantage comes from accumulating resources and organizational skills that are rare, valuable, non-substitutable and difficult to imitate (Barney, 1991). In other words, an organization attains competitive advantage through a particular and unique set of resources and capabilities (Barney, 1991; Rumelt, 1991; Wernerfelt, 1984). Resources are inputs to organizational processes (Grant, 1991), while capabilities refer to firms' abilities to combine and use their resources to create value (Amit & Schoemaker, 1993). In recent years, the RBV has been used to evaluate firms' organizational skills and performance in the area of environmental business practices. There is some initial evidence that specific supply chain management skills are needed to implement green supply initiatives (Bowen, Cousins, Lamming, & Faruk, 2001) and that a proactive environmental approach can foster firms' environmental management skills (Bowen et al., 2001).

2.1 Literature Review

This section presents a representative literature review by discussing relevant research on green supply chain management skills and their relationships to firms' performance. In this discussion, since the literature concerning green supply chain management skills is very limited (see e.g. Bowen et al., 2001), the terms "supply chain management skills" and "practices" are considered equivalent.

Research by Zhu and Sarkis (2004) examined the relationship between green supply chain management (GSCM) practices in Chinese manufacturing enterprises and environmental performance. They established, among other findings, that there is a positive relationship between GSCM practices and environmental performance. The results also indicated that other practices, such as quality management and just-in-time (JIT) manufacturing, moderate the effect of GSCM practices on performance. Zhu, Sarkis, and Geng (2005), who also studied Chinese manufacturing enterprises, drew similar conclusions pointing to a positive relationship between GSCM practices and performance: in this case, environmental and operational performance. A similar study by Zhu, Sarkis, and Lai (2007) showed that Chinese automobile manufacturing enterprises have significant external and internal drivers for the adoption of GSCM practices, but that, due to low implementation, these produce only slightly improved environmental and operational performance.

While they did not consider firm performance, Zhu, Sarkis, Cordeiro, and Lai (2008) did explore such diverse factors as regulations, marketing, suppliers, cost pressures and industry levels of relevant practices, with a focus on the relationships among organizational learning mechanisms, organizational support and the adoption of GSCM practices. Their results support the hypothesis that organizational learning is strongly related to the extent of use of GSCM practices—and, therefore, that learning and continuous improvement programs are valuable complementary activities for GSCM practice. Furthermore, their results emphasize the importance of pressure from regulators, suppliers and customers in the implementation of GSCM practices.

Azevedo, Carvalho, and Machado (2011) investigate the relationships between GSCM practices and supply chain performance in the context of the Portuguese automotive industry. Their results indicate that some green practices have positive effects on quality, customer satisfaction and efficiency, while others have negative effects on other supply chain performance measures. Hoejmose, Brammer, and Millington (2012) address engagement and implementation issues related to GSCM practices in the UK. Their results show that GSCM practices and engagement are more limited among firms in B2B markets than among firms in business-to-consumer (B2C) markets. They also show that developing trust with supply chain partners is a more relevant driver of engagement with GSCM among firms in the B2B sector, affirming that engagement and performance are strongly related. Chan, He, Chan, and Wang (2012) study foreign-invested enterprises operating in China and demonstrate a relationship between some types of green pressures and the implementation of certain GSCM practices. Furthermore, Diabat and Govindan (2011) find that government regulation drives product designers and suppliers to collaborate in order to reduce environmental burdens. In their study of Taiwan's textile and apparel manufacturing sector, Wu, Ding, and Chen (2012) investigate the relationship between GSCM drivers and practices by moderating a sub-set of driver and practice relationships. Their results indicate that most GSCM practices are positively affected by GSCM drivers and that several factors have moderating effects, including market pressure, regulatory pressure and competitive pressure.

Yang, Lu, Haider, and Marlow (2013) address the relationships among internal green practices, external green integration, green performance and firm competitiveness within Taiwan's container shipping industry. Their results indicate that internal and external GSCM practices have positive impacts on environmental performance, which, in turn, can enhance a firm's competitiveness. Hajmohammad, Vachon, Klassen, and Gavronski (2013) sought to understand the roles of lean and supply management practices in improving firms' environmental performance, using Canadian manufacturing firms as a basis. Their results indicate that, though supply management and lean activities are agents by which resources are invested in environmental practices, these practices themselves are not significantly related to environmental performance. Further, their findings suggest that environmental practices are the most significant indicator of environmental performance. Liao and Kuo (2014) investigate the relationships among supply chain value innovations, other types of supply chain capabilities and firm performance in Taiwan's manufacturing sector, and their results indicate that these supply chain management skills are positively related to firm performance. Innovation and sustainability are often discussed together, since companies moving towards sustainability frequently need to develop greener products or business models (Nidumolu, Prahalad, & Rangaswami, 2009). Such studies also tend to use concepts like "sustainability innovation", "eco-innovation" and "green innovation" (Schiederig, Tietze, & Herstatt, 2012). Collaboration and commitment are also concepts related to companies' environmental performance. Luzzini, Brandon-Jones, Brandon-Jones, and Spina (2015) study the linkages between sustainability commitment and collaboration capabilities and two dimensions of a firm's performance: environmental and cost. Their results, which are based on procurement managers from 10 countries (in North America and Europe), supports a positive relationship between sustainability commitment and collaboration capabilities; however, it does not support a relationship between collaboration and performance.

The body of literature indicates three key points. First, past research suggests that companies frequently face pressure to implement green practices (Chan et al., 2012; Diabat & Govindan, 2011). Second, sustainable practices positively influence companies' environmental (Zhu & Sarkis, 2004) performance, although not all supply chain performance outcomes are positive (Azevedo et al., 2011). Finally, sustainability and innovation are often discussed together, and companies need to be innovative in order to develop sustainable business models and new products (Nidumolu et al., 2009).

3 Hypothesis Development

As presented in the previous section, numerous studies have analyzed the relationships among environmental drivers, environmental supply chain management skills and firm performance. Most of these studies have focused on manufacturing firms (Azevedo et al., 2011; Chan et al., 2012; Wu et al., 2012; Zhu & Sarkis, 2004; Zhu et al., 2005, 2007), though Yang et al. (2013) examined logistics enterprises. In addition, most of the studies are based on companies located in a single country (e.g. China, Taiwan or the UK). While the literature has shown that there are typically significant relationships between GSCM drivers and practices and between GSCM practices and firm performance, the extant research is very limited with respect to purely logistic enterprises. Furthermore, studies seldom consider the relationships based on respondents from multiple countries. Next we discuss our primary hypothesis.

3.1 GSCM Skills and Environmental Performance

Several previous studies, including the works of Zhu and Sarkis (2004), Hajmohammad et al. (2013), and Huang, Hu, Liu, Yu, and Yu (2016), have demonstrated the significant relationship between GSCM practices/skills and environmental performance. However, these studies have not examined whether this relationship is valid for logistics service providers. Thus, our first hypothesis is as follows:

H1 GSCM skills positively affect the environmental performance of logistics service providers.

3.2 GSCM Skills and Innovation Performance

Innovation, in terms of new products, new services and new ways of doing things, has been recognized as a leading indicator of firm performance (Lii & Kuo, 2016). In order to be innovative, firms must be able to recognize the value of new information and assimilate it into their operations to achieve commercial ends. This capability can be referred to as a company's absorptive capacity (Cohen & Levinthal, 1990). Innovation can play a major role in reducing the environmental burden of the logistics sector, particularly in terms of pollution and CO_2 emissions. However, historical trends have shown that the logistics sector is not particularly innovative; instead, it is a mature sector in which changes tend to be evolutionary rather than revolutionary (Mena, Christopher, Johnson, & Jia, 2007). The relationship between operations/supply chain capabilities and innovation performance in the case of logistics services has been considered by Liao and Kuo (2014). Since previous studies have positively linked supply chain skills with environmental skills, it is hypothesized that GSCM skills will have a positive relationship with innovation performance, in that they may force firms to develop new products and services that meet green requirements. Thus, our second hypothesis is as follows:

H2 GSCM skills positively affect the innovation performance of logistic service providers.

4 Research Method

A survey methodology was used to analyze the links between green supply chain management skills and performance outcomes. Survey data were collected from LSPs operating in four countries: Puerto Rico, Panama, Finland and Russia. In total 173 companies participated in the survey, and SEM was used to test the proposed model (Gefen, Straub, & Boudreau, 2000) (Fig. 14.1).

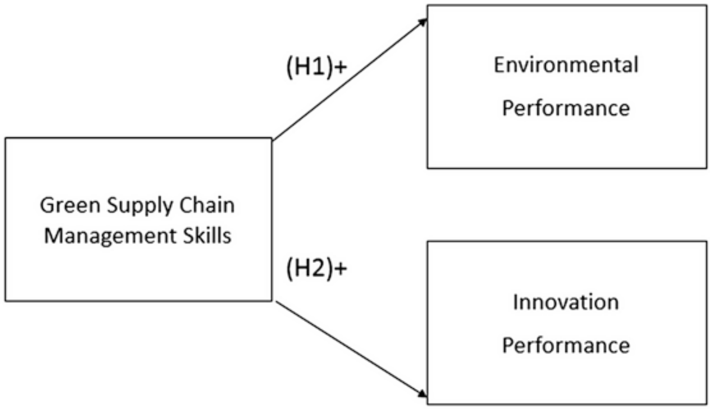

Fig. 14.1 Research framework including the hypotheses

4.1 Sample

This study sought to answer the presented research questions by testing the two hypotheses. In order to make results generalizable across different countries and operating environments, the study used a sample of LSPs from four countries: Finland, Russia, Panama and Puerto Rico (a commonwealth of the United States). These countries differ from one another in many different ways, such as regulations, geographic size, culture and GDP (gross domestic product). Thus, the countries also foster very different business settings. Most existing OM sustainability studies focus on only one country; therefore, there is a need for multinational studies exploring LSPs' green supply chain management skills and performance outcomes across different geographic locations. The results of previous studies indicate that a country's context, regulatory environment and GDP might influence companies' environmental practices. For example, in the UK, Hoejmose et al. (2012) found that regulation and a firm's broader institutional environment could promote co-operation and sustainability along the supply chain; however, in China, Zhu et al. (2007) found that coercive pressures had no impact on buyers' environmental practices. This example illustrates the differences that exist across countries and contexts.

A questionnaire was designed with various sections, each related to a single construct or group of constructs. Questions were designed using a seven-point Likert scale. LSP executives were contacted by phone and asked for their participation. The total usable number of responses was 173. The theoretical model was subjected to analysis using SEM (Gefen et al., 2000), a very general linear statistical modeling technique that covers factor analysis, regression and many other estimation methods as special cases. SEM was suitable for the purposes of this study because it is a primarily confirmatory (rather than exploratory) technique.

5 Results

The data were collected from the four studied countries using carefully defined joint instructions. Measurement equivalence across the different countries was verified to ensure that the various data collection methods did not result in differences in data quality and that the combined data could be used for the analysis. In each country, the same questionnaire translated into the local language was used. This questionnaire and its standardized Likert scales ensured calibration equivalence (Wiengarten, Humphreys, Gimenez, & McIvor, 2016). The questionnaire was initially created in the English language and then translated by the team members into their mother tongues: Spanish, Finnish and Russian. The translations were then examined by third persons in local universities. This ensured translation equivalence. Finally, the surveys were pre-tested in each language by local logistics professionals.

The team members also verified that the measured values of the constructs were comparable across the different countries (metric equivalence). This was done by calculating Cronbach's alphas for all constructs. As Hair, Black, Babin, Anderson, and Tatham (2006) have recommended, discriminant validity was tested by calculating separately for each factor the average variance-extracted estimates and the squared inter-factor correlations and then comparing these values. Finally, a confirmatory factor analysis (Harman single test) was conducted for the five constructs to assess the unidimensionality, validity and reliability of the proposed model (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). The results of the reliability check are presented in Table 14.1.

Table 14.1 Reliability check results

	Green supply chain management skills	Innovation performance	Environmental performance
Green supply chain management skills	1.000	0.165	0.713
Innovation performance	0.164	1.000	0.258
Environmental performance	0.718	0.257	1.000
Mean	0.000	0.000	0.000
Min	−1.929	−2.907	−2.681
Max	1.951	1.717	1.553
STD	1.000	1.000	1.000
Cronbach's alpha	0.92	0.87	0.96
Composite reliability	0.75	0.68	0.97
Average variance extracted	0.92	0.86	0.97

Cronbach's alpha was measured to confirm the scale reliability. The corresponding measures were: for green supply chain management skills 0.92 (four items), for environmental performance 0.96 (10 items) and for innovation performance 0.87 (three items). These are all above a minimum benchmark value of 0.7 (Garver & Mentzer, 1999) (Figs. 14.2 and 14.3).

The model's fit was assessed using AMOS and found to have an acceptable fit with the data (RMSEA = 0.07, TLI = 0.905). Furthermore, CMIN/DF = 1.733 was below the threshold value of 5. To compare the findings across the two studied geographic areas, the data were divided into two groups: group 1 (EURUS), comprising Finland and Russia, and group 2 (CARIBBEAN), comprising Panama and Puerto Rico. The rationale for this division was the assumption that neighboring countries are likely to share several characteristics. The results suggest a significant positive relationship between green supply chain management skills and environmental performance outcomes. Regression weights were: in Caribbean countries 0.722 ($p < 0.001$) and in Eurus companies 0.794 ($p < 0.001$). However, the relationship between green supply chain management skills and innovation performance was significant only in Caribbean countries 0.290 ($p < 0.05$), whereas the link between green supply chain management skills and innovation performance was not significant in Eurus countries (Table 14.2).

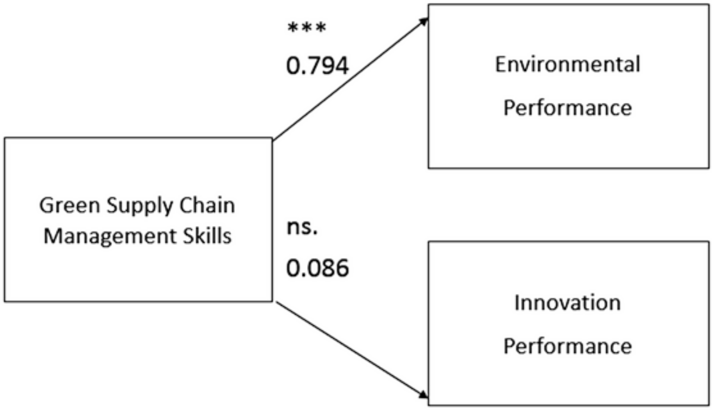

Fig. 14.2 Results for Eurus companies

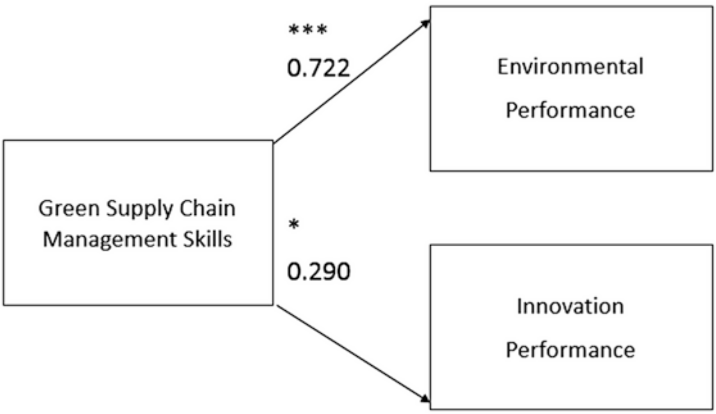

Fig. 14.3 Results for Caribbean companies

Table 14.2 Summary of the results

Hypothesis	Supported	Not supported
H1	X	
H2		X

6 Discussion

This section concludes the results by discussing how the research question was addressed in this study. Furthermore, this study offers some important contributions for theory and practice. Thus, the theoretical and managerial contributions are discussed. The results of the study are compared with previous studies. In addition, research limitations and future research directions are presented.

6.1 Theoretical Contribution

In the contemporary market economy, firms seek to create wealth for their shareholders. Therefore, in order to make firms greener, we must consider how green supply chain management skills influence companies' performance. All countries exhibited a significant positive relationship between green supply chain management skills and environmental performance. This result is in line with previous studies and confirms the importance of these supply chain management skills for LSPs that must meet regulations and customer requirements for green partners.

Our results regarding innovation performance were mixed. In the Caribbean countries, we found a positive link between green supply chain management skills and innovation performance; however, no such link existed in the cases of Finland and Russia. In Finland, in particular, this absence of a link may be due to the country's highly developed economy. This finding is in line with Mena et al. (2007), who suggested that the logistics sector is not one of the most innovative sectors primarily because it is mature. An alternative explanation could be that, since Finland already has cleaner supply chain management practices than Panama and Puerto Rico, the marginal benefit of an effort to support greener logistics may be higher for Panama and Puerto Rico than for Finland. In Russia, the lack of innovativeness among LSPs could be explained by the country's past as part of the Soviet Union, which prevented the development of competition and efficiency for several decades. Finally, in the Caribbean countries, there was a positive link between green supply chain management skills and innovation, perhaps due to these countries' higher levels of competition and greater exposure to multinational corporations.

Across all countries, there is still room for innovativeness in the logistics sector. For example, the recent growth in online shopping is already prompting changes in retail businesses, where traditional retailers are supplementing their brick-and-mortar shops with online storefronts. Technology is increasingly blurring the distinctions between physical and online retailing, forcing all supply chain members to rethink their competitive strategies (Brynjolfsson, Hu, & Rahman, 2013). Additive manufacturing (3D printing) is also changing existing supply chains, making it possible for companies to use less material in their production processes. These changes have implications for inventory management, transportation, warehousing and purchasing (Waller & Fawcett, 2014). They may also provide new opportunities for innovative logistics companies. Essentially, in order to remain competitive, logistics companies need to focus more on innovativeness.

6.2 Managerial Implications

Although our research is theory-driven, it has important implications for practice. The role of the logistics sector in terms of global pollution is pivotal. Thus, increasing the understanding of the value of environmental supply chain management skills in the sector is essential. We found that the skills contribute to green performance, which is an important finding for policy makers. It seems that the investment in greener operations can contribute to more environmental operations, implying that the regulators should drive the development of green skills among domestic companies in order to reduce the negative effects on the environment.

LSPs should also benefit from our results showing that green actions lead to better environmental performance. The strong link found could serve as an impetus for logistics organizations to "green" their processes even further. The results of this study help to clarify the situation by indicating that the development of green supply chain management skills makes sense for companies. This is because it demonstrates that investment in environmental systems and management is not wasted but does indeed bring better performance. Further, the results indicate that investment may bring better innovation performance at least to companies from less-developed economies. As they lag somewhat behind the wealthy nations, LSPs in these countries can also enhance their innovativeness through improving their green skills. This may provide a pathway to both better economic development and more sustainable operations.

7 Conclusions

This study investigated the link between green supply chain management skills and performance outcomes. The results show a positive link between green supply chain management skills and environmental performance in all four of the studied countries; however, a link between green supply chain management skills and innovation performance was found only in the Caribbean countries. The present study complements the existing RBV and sustainable OM literature by demonstrating how developing green supply chain management skills can be beneficial for logistics companies. Previous RBV-based studies in the field of sustainable OM have investigated green practices without considering companies' green supply chain management skills.

This study has some limitations, which could offer interesting opportunities for future research. First, in this study we did not investigate the link between green supply chain management skills and financial performance. Yeung et al. (2006) suggested that future research may also address the perceptions of competitors in order to give a more holistic picture of performance within the industry.

Another interesting research direction may involve a closer look at the impact of global politics on LSPs' green supply chain management skills and performance outcomes. In 2016, the G20 economies made their standard promise to avoid protectionism in order to keep markets open (G20 Finance Ministerial and Deputies Meetings, 2016). However, in the current 2017 post-Brexit world, there is again a fear of growing protectionism and trade barriers. This raises questions concerning what is going to happen to the international transportation sector and LSP performance outcomes in coming years. A reduction in global trade will negatively impact the international transportation sector. Similarly, fears of trade barriers may reduce transport companies' willingness to invest in greener transport solutions and develop green supply chain management skills. Thus, it may be useful to conduct a longitudinal study of LSPs' green supply chain management skills and performance outcomes to study how world politics influences the transport sector.

Finally, this study has investigated the link between green supply chain management skills and performance supply chain management skills across four countries. Future research including even more countries would make the results more generalizable.

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15

Information Exchange and Processing in Buyers and Suppliers in Green Public Procurement: An Absorptive Capacity Perspective

Mieko Igarashi

1 Introduction

Green public procurement (GPP) involves environment-related information exchange and knowledge transfer between buyers and suppliers. It has been said that laws and regulations put considerable restrictions on public procurement process and the interaction between buyers and potential suppliers. But how much (or how little) interaction do these actors have and how do they process information from the other actor? GPP is often described as a demand-driven policy aiming for sustainable consumption (OECD, 2003). But are suppliers only passive? Can suppliers drive or positively influence GPP as well?

GPP is defined as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (Commission

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L. de Boer, P. Houman Andersen (eds.), *Operations Management and Sustainability*,
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of the European Communities, 2008). While this definition clearly states that public authorities, meaning buyers, are the main actors in GPP, suppliers, or the market, should also be critical actors because, in the implementation of GPP, both buyers and suppliers must exchange information on relevant environmental issues and process it. However, we have limited knowledge on the interaction between public buyers and suppliers (McKevitt, Flynn, & Davis, 2014), and much less on information exchange and processing in interaction. While regulations impose constraints on how and when public buyers interact with suppliers, informal buyer–supplier interaction in public procurement can take place in the pre-tender phase (McKevitt & Davis, 2013). An enormous amount of research has been conducted on buyer–supplier interaction in the private purchasing setting, but little attention has been paid to buyer–supplier interaction in the public procurement setting (Erridge & McIlroy, 2002). Furthermore, the existing literature on green purchasing typically describes suppliers as barriers from the buyers' perspective, because of their lack of awareness of environmental issues (Min & Galle, 1997), lack of resources required for green initiatives (Giunipero, Hooker, & Denslow, 2012) and unwillingness to share environmental information (Walker, Di Sisto, & McBain, 2008). Only a few studies are based on both sides' perspectives and they reveal perceptual differences regarding the frequency and importance of the environmental requirements formulated by buyers (Michelsen & De Boer, 2009) and the rejection of bids for environmental reasons (Holt, 2004). These findings suggest the need for more insights on how information is handled by both actors.

This study aims to investigate the exchange of environment-related information between buyers and suppliers and the processing of such information on both sides to seek a more effective interaction between buyers and suppliers. More specifically, the research questions in this paper are formulated as follows: how do buyers and suppliers exchange information in GPP? How is the environment-related information exchange between buyers and suppliers and its use on both sides understood? In GPP both buyers and suppliers play the essential roles of transmitters (senders) and recipients, depending on the stages of procurement.

How knowledge is sent and received has typically been analyzed in terms of absorptive capacity (AC) (Grant, 1996). Knowledge includes two types; information (explicit knowledge) and know-how (tacit knowledge) (Dyer & Singh, 1998). AC enables us to look at both information exchanged through interfacing with the external party and information processed internally. GPP embraces both information and know-how. An example of the latter would be how to define the most significant environmental criteria for a product being procured. Thus this study seeks to examine information exchange and processing in GPP through AC.

This study first provides a deeper understanding of GPP in buyer–supplier interactions. Most purchasing and supply management (PSM) research has placed the dominant focus on the buyer's perspective as earlier studies pointed out (Igarashi, De Boer, & Fet, 2013; Revilla, Sáenz, & Knoppen, 2013). This study includes both buyers' and suppliers' perspectives. Also, public procurement literature has discussed very little about the buyer–supplier interaction. The second contribution of this study is to extend the application of AC to the procurement domain. Many scholars have applied AC in research and development and the technical learning context in business-to-business (B2B) relationships: however, little research has extended the application beyond this domain (Lane, Koka, & Pathak, 2006; Zahra & George, 2002).

The structure of the chapter is as follows. First, the relevant literature and basic theoretical foundations are presented. The next section describes the case study method and how the empirical data were gathered. Then, the qualitative data analysis is presented, followed by a discussion and interpretation of the results. The chapter ends with conclusions, implications for policy makers and researchers, and a discussion of the study's limitations.

It should be noted that throughout the chapter the term "buyer" refers to "a buyer organization" and "supplier" refers to "a supplier organization". If an employee of a buyer organization is addressed, "buying officer" or the job title is used. If an employee of a supplier organization is addressed, the job title is used.

2 Theoretical Foundation for the Study

In this section, existing discussions of buyer–supplier interaction in public procurement are outlined. The focus of this study is not the interaction itself but information exchange and processing in relation to the interaction. Still, buyer–supplier interaction is fundamental in this study, thus existing literature focusing on buyer–supplier interaction is reviewed. Next, AC, the underlying theoretical concept applied in this study is explained. The key literature applying AC in the PSM domain is then reviewed.

2.1 Interaction Between Buyers and Suppliers in Public Procurement

The public procurement process consists of three stages: pre-tender, tender and post contract award. Potential buyer–supplier interaction can be found at all stages but varies among stages (McKevitt & Davis, 2015). Buyer–supplier interaction also depends on procurement procedures taken. There is a group of existing studies (e.g. Uttam & Le Lann Roos, 2015) that focuses on competitive dialogue procedures allowing authorities to hold discussions with selected candidates regarding all aspects of the contract before they invite final tenders (European Commission, 2004). However, this chapter examines interactions between buyers and suppliers in the most typical public procurement procedure, that is, the open competitive procedure. The pre-tender stage includes possible engagement with the market:

> To get a more detailed picture from the market you can also engage in dialogue with potential suppliers prior to tendering. This may be of particular use if you wish to apply ambitious environmental requirements. (European Commission, 2011)

McKevitt and Davis's (2013) study shows that informal mentoring is acceptable and desirable at the pre-tender phase when the opportunity for buyer–supplier interaction is greatest in cases of small firm engagement. At the tender stage, public procurement regulations shape the buyer–supplier interaction. The regulations, aiming at transparency and non-discrimination (New, Green, & Morton, 2002), make the buyer–supplier interaction formal. Public buying officers are not allowed to use environmental criteria that could be regarded as favoring (or excluding) specific suppliers (European Commission, 2011). Queries by suppliers regarding clarification of the tender document before bids are submitted are allowed. When decisions are made to award a contract and select preferred bidder(s), the buyer must provide all bidders with details of the scores of the preferred bidder(s). If a tenderer is not satisfied that the award has been made properly and in accordance with the rules, it may seek court action (Cousins, Lamming, Lawson, & Squire, 2008). The last stage, the post-contract award, includes the negotiation of a contract between the buyer and awarded supplier(s) and monitoring during the contract execution.

In spite of these various possibilities of buyer–supplier interaction in the procurement process, there is only limited research on buyer–supplier interaction in public procurement. As mentioned above, McKevitt and Davis have done multiple studies (2013, 2015) on public buyers' and SMEs' interaction. Erridge and McIlroy (2002) found that buyers more often use collaborative methods in procurement projects with environmental or social goals than in those with commercial and regulatory goals. Rizzi, Frey, Testa, and Appolloni (2014) emphasize the importance of the supply side of the market for actively attracting public demand. These studies imply that understanding public procurement from both actors' perspectives and with more focus on suppliers is needed. In general, interactions between two organizations always involve information exchange. As described earlier, handling of environmental related information is perceived differently by buyers and suppliers (Holt, 2004; Michelsen & De Boer, 2009). Thus, we need to understand how environmental criteria and related information are sent and received and further perceived in GPP.

To conceptualize such information exchange, AC, which looks at an organization's ability and process of absorbing information as knowledge transfer and organization learning, seems to provide a useful framework. The next section will provide an explanation of concepts and discussions over time regarding AC.

2.2 Absorptive Capacity (AC)

The first and original definition of AC was provided by Cohen and Levinthal (1990): “an ability to recognize the value of new external information, assimilate it, and apply it to commercial ends” (p. 128). They developed an explanation based on individuals’ cognitive structures and problem solving (Lane et al., 2006), emphasizing the importance of prior knowledge for a firm’s ability to assimilate and utilize new knowledge. They also argue that an organization’s AC is not simply the sum of its members’ AC; it is largely determined by communication that transfers knowledge across and within sub-units. Cohen and Levinthal’s concept is also useful in thinking about how the actors in inter-organizational relationships systematically engage in inter-organizational learning (Dyer & Singh, 1998). Lane and Lubatkin (1998) expand the concept based on a relational perspective and suggest a relative AC (partner-specific AC). Their main argument is that a firm’s AC is determined by the similarity between its characteristics and those of another firm; its knowledge base, dominant logic and organizational structure and compensation policies. The influence of organizational factors is a new addition by Lane and Lubatkin (1998). Zahra and George (2002) incorporate dynamic capability into their definition. In their view, AC is “a dynamic capacity embedded in a firm’s routines and processes” (p. 186) and involves four dimensions: acquisition, assimilation, transformation and exploitation. “Acquisition” is a replacement for “recognizing the value” in Cohen and Levinthal’s model. Zahra and George call the former two dimensions potential AC and the latter two realized AC. Their argument is that potential AC provides firms with the strategic flexibility and the degrees of freedom to adapt and evolve in high-velocity environments. Todorova and Durisin (2007) take a critical view of Zahra and George’s reconceptualization of AC and extend the model by returning to the original AC definition by Cohen and Levinthal (1990). Major changes they made are to reintroduce a component of “value recognition”, redefine “transformation”, add “power relationship” in contingency factors and include feedback loops. Table 15.1 presents evolution in the definition of AC.

Table 15.1 Evolution of the AC concept

Definition	AC concepts' component and contingent factors		
	Capabilities	Contingent factor	Outcome
Cohen and Levinthal (1990): an ability to recognize the value of new information, assimilate it and apply it to commercial ends (p. 128).	Recognizing the value Assimilate – Apply	Regimes of appropriability	Innovation Performance
Lane and Lubatkin (1998): relative AC is jointly determined by three characteristics of the student and teacher firm. Knowledge base, organizational structure and compensation policies, and dominant logics (p. 461 and p. 473).	Recognizing the value – Assimilate – Apply	Other firm's organizational structure Other firm's dominant logics	
Zahra and George (2002): a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability (p. 186).	Acquisition – Assimilation (potential AC) – Transformation – Exploitation (realized AC)	Activation triggers Regimes of appropriability Social integration mechanisms	Innovation Flexibility Performance
Todorova and Durisin (2007): the components of AC include recognizing the value, acquiring, transforming or assimilating, and exploiting knowledge (p. 777).	Recognize the value – Acquire – Assimilate Transform – Exploit	Activation triggers Power relationships Regimes of appropriability Social integration mechanisms	Innovation Flexibility Performance

The basic concept of GPP relies on having clear and ambitious environmental criteria for products and services in procurement projects (Commission of the European Communities, 2008). Thus, it is critical in GPP for a buyer to refer to the correct information sources, both internal and external, and to acquire the necessary knowledge to identify relevant environmental criteria. Cohen and Levinthal (1990) point out that knowledge includes not only substantive, technical understanding, but also awareness of where useful complementary expertise resides both inside and outside the organization. AC considers not only internal knowledge management but also external knowledge learning; therefore an AC perspective seems to fit to the focus of this study.

This study applies the AC model developed by Todorova and Durisin (2007) to analyze information exchange and processing in buyer–supplier interaction. Their model is founded on Cohen and Levinthal's model and further develops Zahra and George's model. It presents a more comprehensive model than the others. Further, it presents better GPP relevance in the AC concept. The relevance of GPP for the AC model will be explained after the constructs in Todorova and Durisin's model are described. The model (Todorova & Durisin, 2007) has five components of AC and contingent factors. The model furthermore considers the feedback loop, which other models do not explicitly address. *Recognizing the value* depends on prior knowledge (Cohen & Levinthal, 1990). The valuation is not automatic, and it needs to be fostered to allow absorption to begin (Todorova & Durisin, 2007). *Acquisition* refers to gathering external knowledge that is critical to a firm's operations. The intensity, speed and direction of a firm's efforts can determine the quality of its acquisition capability (Zahra & George, 2002). The new knowledge is *assimilated* when the new idea or knowledge fits the existing cognitive schemas and the new idea is only slightly altered and incorporated into existing cognitive structures (Todorova & Durisin, 2007). *Transformation* occurs when the new idea cannot be altered to fit the existing knowledge structure. That is, organizations need to transform their knowledge structures because the knowledge cannot be assimilated (Todorova & Durisin, 2007). Thus, *transformation* represents an alternative process to *assimilation*. *Exploitation* refers to refining, extending and leveraging existing competences or creating new competences by incorporating acquired and transformed knowledge into a firm's operations (Zahra & George, 2002).

Other components of the model, that is, contingency factors and a feedback loop, are addressed briefly. *Social integration* mechanisms build connectedness and shared meanings through social networks, co-ordinators and so on (Zahra & George, 2002). A social integration mechanism can affect all components of AC and has either a positive or negative effect (Todorova & Durisin, 2007). *Power relationships* include both those inside an organization and those with customers and other external stakeholders (Todorova & Durisin, 2007). Power relationships influence the valuation and exploitation of new knowledge. *Activation triggers* are events that encourage or compel a firm to respond to specific internal or external stimuli (Zahra & George, 2002). Internal triggers could be performance failure or redefinition of a firm's strategy, and external triggers include radical innovations, technological shifts and changes in government policy (Zahra & George, 2002). Activation triggers moderate the impact of knowledge sources and the experience of AC development. *Regimes of appropriability* refer to the institutional and industry dynamics that affect an organization's ability to protect its advantage and benefit from new products or processes (Zahra & George, 2002). They can be a moderator of the antecedent of AC (Cohen & Levinthal, 1990) and can also influence sustaining a competitive advantage (Zahra & George, 2002). Lastly, it should be recognized that *feedback* relationships exist between the current absorption of new knowledge and future AC (Todorova & Durisin, 2007). Cohen and Levinthal's (1990) and Zahra and George's (2002) idea of the path dependency of AC could imply this feedback mechanism.

Some GPP aspects seem to be quite relevant and significant in Todorova and Durisin's AC model. First, the model has prior knowledge as an antecedent, similar to other models. GPP studies identify lack of knowledge of buying officers on green issues as one of the GPP obstacles (Varnäs, Balfors, & Faith-Ell, 2009; Zhu, Geng, & Sarkis, 2013), which implies a possible influence of prior knowledge on GPP. Second, the model reacknowledges the value recognition capability as the first step. Existing studies found that valuing on green issues in general, or green procurement at the level of individuals and organizations, enhances GPP implementation (Grandia, Steijn, & Kuipers, 2015; Igarashi, Boer, & Pfuhl, 2017; Walker et al., 2008). Thus having *value recognition* as the first capability in the AC model makes good sense in the GPP context.

Third, the model proposes the moderating effect of power relationships on the valuing and exploitation of new knowledge. In green public procurement setting, policy makers put pressure on buyers to include environmental demands in tender documents. In turn, environmental demands from buyers put pressure on suppliers. Suppliers are expected to adopt the signals of buyers' demands and respond by submitting required information about product or service performance, otherwise they cannot bid. Suppliers might choose not to participate in the bid, that is, suppliers do not value the buyer's environmental demands. In this case, suppliers most likely see that the cost of bid participation would exceed the expected benefit of winning the bid (Amann, Roehrich, Eßig, & Harland, 2014). Thus, having power relationships as one of the contingent factors is another good reason to make the AC model relevant to GPP.

2.3 Application of AC in the Existing PSM Literature

According to the AC literature review by Lane et al. (2006), AC was originally applied in B2B relationships in research and development and technical learning settings.

Recently, several studies have investigated the application of AC in PSM or buyer and supplier relationships. Schiele (2007) found a significant relationship between a purchasing organization's maturity and its performance. He associated a higher maturity level with a higher AC, but did not examine AC itself. Revilla et al.'s (2013) study revealed a significant relationship between a supplier's AC and its performance in a buyer and supplier relationship. The higher the level of the supplier's AC, the more likely it was that the supplier could leverage buyer knowledge to build internal competences and capabilities. Another study regarding AC in buyer and supplier relationships (Sáenz, Revilla, & Knoppen, 2014) found that a supplier can show greater innovation and efficiency when organizational compatibility is translated into the supplier's AC. Similarly, it has been found that social capital between buyers and suppliers, such as trust and shared norms, facilitate building potential AC in suppliers, and suppliers can achieve greater cost efficiency and innovation if they possess realized AC (Preston, Chen, Swink, & Meade, 2017). Arroyo-López, Holmen, and De Boer (2012) suggested that suppliers' AC can have a moderating effect on the development of capabilities, that is, suppliers' performance in the supplier development program.

When it comes to green or sustainable purchasing and supply management, only a few studies have applied AC. Gluch, Gustafsson, and Thuvander (2009) showed the potential of the AC model for understanding mechanisms behind green innovation and performance in the construction industry. Meinlschmidt, Foerstl, and Kirchoff (2016) applied AC in analyzing their findings from empirical observation. One of their important findings was that firms utilize the same mechanisms as knowledge identification and assimilation to increase knowledge diffusion among their suppliers. AC, especially in public procurement, has received only limited attention until now, with the exception of Zheng and Caldwell (2008), who looked at learning activities through AC in public clients and private contractors in complex infrastructure projects.

This study will explain information exchange and processing in the interaction between buyers and suppliers by drawing on the AC model components, including contingency factors and the feedback loop.

3 Methods

This study employs an embedded multiple-case design (Yin, 2009), using three different product categories as cases in the overall context of the Norwegian public sector. Figure 15.1 presents the case design. The reasons for having a product category as a case are as follows. First, in public procurement, especially in GPP, the product category is a key classification for both policy makers and public buying authorities. Manuals and guidelines discussing the environmental aspects to be considered in procurement are typically developed based on product (or service) categories because potential environmental concerns are attributable to the characteristics of products or services. Second, it is quite natural for buyers to see their expertise based on product type and to categorize suppliers by product types.

In this study, three product groups were selected because they are expected to exemplify typical situations and issues in GPP (Bryman, 2016). The three product groups are: information and communication

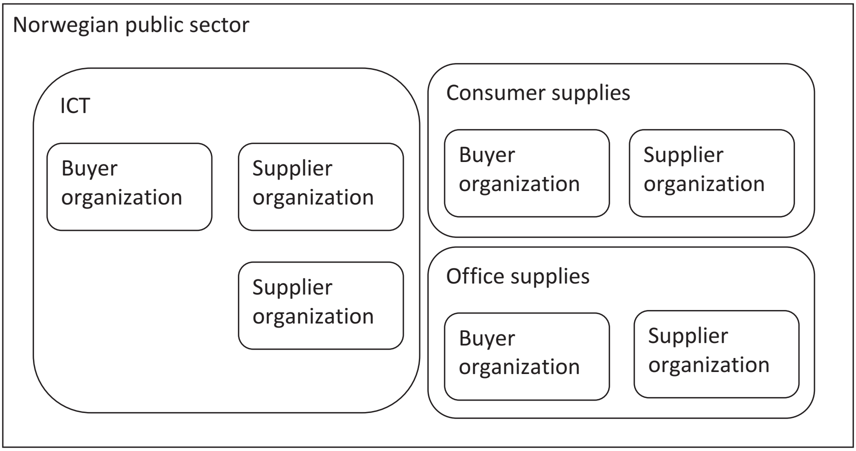

Fig. 15.1 Case design

technology (ICT), consumer supplies and office supplies. These are goods that are typically procured by public authorities. Furthermore, the product groups are covered by GPP criteria guidelines issued by the European Union (EU) and individual countries, such as Norway, Sweden and Denmark. This implies that the market for these product groups is, to a certain extent, under pressure from concrete environmental issues, and providers and customers are likely to be aware of environmental issues. Hence, it is intriguing to examine environment-related information use in these product groups' procurement.

3.1 Data Collection

In each of the three selected product categories, at least one buyer organization and one supplier organization were invited to be interviewed from May through November 2015. All organizations are located in Norway. Ten informants attended the interviews. The interviews normally lasted 45–60 minutes. Follow-up meetings were conducted if necessary. One interview was conducted by telephone and one by written

Table 15.2 Interview respondents

	Buyer organizations	Supplier organizations
1. Office supplies	Buyer A • Purchasing advisor	Supplier H • Tendering leader
2. Consumer supplies	Buyer B • Purchasing leader • Purchasing advisor	Supplier I • CSR and quality manager
3. ICT	Buyer C • Purchasing advisor • IT department leader • IT department advisor • Environmental advisor	Supplier J • Sales director Supplier K • Tendering manager

questionnaire due to accessibility issues (in both cases the informants were from suppliers). A list of organizations and informants (anonymous) is presented in Table 15.2. The informants had three to 16 years' experience working in their current capacities, except one who was new to his current company but had long experience in the same industry.

Prior to the interviews, informants from buyer organizations were asked to focus on their latest contract(s) through an open procedure so they could provide specific and detailed answers to the questions. During the interviews with supplier organizations, informants were asked to focus on a designated product group. Questions to the suppliers were not exclusively meant to state the buyer in the given product category, thus the suppliers could also address issues between their buyers and themselves in general. Questions asked in the interviews were mainly concerned with communication between buyers and suppliers, the organizational structure, the environmental criteria usually specified, and the use of environmental information. The interviews were conducted in an in-depth semi-structured manner and the interview guide is presented in the Appendix to this chapter (see Table 15.3).

All interviews were digitally recorded and transcribed. A summary of the interview was sent to each informant for verification. Relevant tender documents and other internal documents were obtained for the purpose of supplementary data.

3.2 Data Analysis

First, the procurement process was chosen as the time-frame within which to identify when interactions between buyers and suppliers include environment-related information exchanges. For each procurement process stage, statements or phrases indicating any of the dimensions of AC, including contingent factors, were coded using constructs in Todorova and Durisin's AC model (for deductive coding, see Miles, Huberman, & Saldana, 2014). To aid coding, a list of descriptions of the AC concept component was made beforehand, based on the four seminal papers in Table 15.1. This helped the researcher objectively identify related statements or phrases in each case. Then themes that cut across cases were sought to highlight points in common or draw distinctions between the cases.

4 Results

In this section, each case is first described, including a brief explanation of the buyer and supplier organizations, the informant(s), and their practices of exchanging environment-related information between the supplier and the buyer organization. Then, within-case analysis is provided by looking at the case through AC.

4.1 Case Description of Office Supplies

Buyer A is an academic agency located in the Sør-Trondelag region of Norway. The central purchasing department conducts purchases above 500,000 NOK (approximately US$60,000). Purchases below this amount are executed by local purchasers in 50 different departments. The central purchasing department has a management function with local purchasers and provides courses on environmental and ethical issues. The informant is a purchaser from the central purchasing department and has five years of experience in her current position. She is particularly responsible for ethical issues in purchasing. Office supplies were the focus of the interview.

The purchasing department conducts dialogue conferences during the preparation of tender documents if they are needed to identify the market level or to become familiar with products. In the conferences, procurement officers listen to suppliers' feedback and learn which demands are the most realistic and logical, and at the same time, they educate suppliers. When embarking on purchases in unfamiliar areas, talking to users is an informative method for learning about potential requirements. Looking at other authorities' tender documents is another way to obtain useful information. When preparing tender documents, Buyer A gives serious consideration to how requirement questions should be formulated in order to obtain the necessary answers from suppliers. Buyer A would like suppliers to perceive its requirements as serious, giving them sustainable consideration, as well. In cases of framework agreements, which establish the terms governing contracts to be awarded during a given period, the purchasing department always meets with contracted suppliers to follow up on issues addressed in contract clauses. In such meetings, they can also discuss possible future directions for environmental considerations. In the focus area, the informant thinks that suppliers are not very concerned with environmental (or, more broadly, sustainable) issues. Suppliers provide environmental information only because they are asked to do so by buyers. Nevertheless, one supplier had actively advocated for its new products made from a new biodegradable material.

Supplier H is one of the nation's largest wholesalers and has a long history of delivering goods to industry and the public sector. It has various supply goods, ranging from medical, office and computer supplies to hardware, facility equipment (such as chemicals, hand towels and plastic bags) and school products. The informant from this company is the leader of the tender section in the sales department and has more than 10 years of experience within the industry. The tender section is responsible for preparing bid documents and can seek advice from a product expert in another department when necessary. The company is almost always asked about qualified environmental management systems. Ecolabels are most often requested, but not always. Sometimes, the requirement descriptions in tender documents are not sufficiently specific, and the tender section must ask buyers for clarification. The informant doubts that all public purchasers fully understand what they are asking for in the tender documents. The informant stated that communication is not always convincing. He also acknowledged that some public procurement officers are extremely good at making use of environmental information. They use Nordic Ecolabel criteria at the evaluation stage. On the other hand, in general, environmental criteria often make no difference. He has often seen cases in which all bids received the same score on environmental criteria, in spite of the weight given to the criteria, which in some cases was 20%. The informant thinks that it would be useful to have meetings with buyers to discuss difficulties and possibilities and to analyze markets unrelated to specific tenders.

4.2 Within-Case Analysis of Office Supplies

Next, related dimensions in AC will be considered, and comparison between the buyers' and suppliers' perceptions of each other will be made. It turns out that the *recognizing value* dimension is not easily discernible in actual operation, and *acquiring* external knowledge often happens while *valuing*. Hence those two dimensions are addressed together. Also *assimilation* and *transformation* are alternative processes, according to Todorova and Durisin's (2007) description, and it is usually impossible to tell if new information/knowledge is slightly altered to fit the existing knowledge structure or an organization needs to transform the knowledge structure for new information. Hence, *assimilation* and *transformation* are often addressed together.

Buyer A obtains external information that can be relevant to a coming procurement project through different channels, such as suppliers, users and other authorities (i.e. *identifying the value/acquisition*). Then Buyer A tries to determine the appropriate environmental requirements and their appropriate levels by understanding and interpreting the relevant information. That is, *assimilating/transforming* capability. It is usually easy for Supplier H to understand buyers' requirements. However, Supplier H doubts buyers' understanding of what they include in tender documents. Sometimes Supplier H needs to question a buyer when the descriptions in a tender document are not specific enough, which is relevant to buyers' *assimilation/transformation* capability. Buyer A sometimes has difficulty understanding the technical terms in suppliers' answers and needs to research such terms. Here Buyer A acquires external information, looks for related information (*acquisition*), and understands the answers (*assimilation/transformation*). Then Buyer A evaluates suppliers based on his company's own scoring system, which implies that information from suppliers is internalized for use in Buyer A (*exploitation*). Buyer A follows up on issues addressed in contract clauses so that environmental information exchanged in the bidding process continues to be monitored. This matches *exploitation* because the follow-up can ensure the fulfillment of the environmental requirements in the buyers' and suppliers' operation. Finally, Buyer A mentioned learning feedback. Buyer A thinks that dialogue between buyer and supplier educates both, and that framework agreements let buyers and suppliers grow together.

4.3 Case Description of Consumer Supplies

Buyer B is located in a mid-sized municipality in Norway with 45,000 inhabitants. There are two informants from Buyer B, a purchasing department manager and a purchasing advisor. Buyer B conducts market investigations when preparing upcoming procurement projects. Procurement officers visit suppliers, talk with them by telephone and/or search for information through several channels, for example, a public procurement database. Buyer B had many discussions with suppliers, procurement officers and the relevant ministry on the amount of time available to suppliers to make offers to the public sector when it started to include the environmental criteria of the Nordic Ecolabel in its tender documents in 2004. The procurement policy of Buyer B addresses good use of the Ecolabel in procurement projects. Buyer B is interested in hearing suppliers' voices, and it realizes that some suppliers have been complaining that they sometimes have to spend money and time to meet certain criteria.

Regarding environmental qualifications, Buyer B has a template that it previously developed with a consultancy firm and uses it in almost every procurement project. When deciding environmental demands, in either specifications or award criteria, or evaluations of suppliers' environmental performance, it seeks help from Nordic Ecolabel. Buyer B is the head of procurement co-operation with 18 neighboring municipalities. Buyer B procures in the same way when conducting procurements for the procurement co-operative it leads as it does on its own behalf.

Supplier I is a large, international, Fortune 500 wholesaler. Supplier I has a clear, sustainable vision, which states, "[W]e offer only sustainable choices to our customer." The informant from Supplier I is a corporate social responsibility (CSR) and quality manager. A tender manager, a product expert and the CSR manager work together when preparing bids. The informant thinks that only minimum communication is allowed in public procurement. Suppliers can ask buyers questions about tender documents in a certain period, but after submitting a bid, there is no chance to communicate until bidding suppliers have received an award notice. The informant describes a case in which the same tender requirements were used in similar procurement projects by the same buyer organization. This observation makes the supplier wonder whether the buyer learns anything. As a member of the same purchasers' club as Buyer B (naturally, Supplier I is a buyer and a provider) and also a member of another network on CSR, Supplier I thinks that it has good communication with large purchasing organizations and is frequently updated about new regulations, public procurement frameworks, and so on.

4.4 Within-Case Analysis of Consumer Supplies

Both Buyer B and Supplier I make efforts to get up-to-date environmental-related information by joining networks. They regard being members of such networks to be worthwhile because they can easily and promptly collect externally generated information and knowledge through the network (*acquisition*). Buyer B works hard to understand the market through several channels and seeks effective and realistic requirements. *Acquisition* and *assimilation/transformation capabilities* work here because Buyer B identifies critical external information to gauge the appropriate market level. When it comes to answering environmental criteria, Supplier I realizes that it is not easy to formulate answers to buyers' requests. *Acquisition and assimilation/transformation* can be related here because Supplier I sometimes needs to collect relevant information from sub-contractors or other external organizations to assess what answers can be given to environmental questions. The informant in Supplier I suspects that buyers in general do not understand the information that suppliers submit, which often includes a huge amount of data from the supply chain. This, in turn, touches on buyers' *assimilation/transformation* capabilities. In contrast, Buyer B described cases in which suppliers sent many documents that did not include direct answers. This corresponds to suppliers' *assimilation/transformation* capabilities, in that it addresses the ability to combine relevant information and formulate answers.

Another emerging issue is that, while Buyer B claims that a weight of 20% for environmental criteria at the award stage makes a difference, Supplier I doubts whether buyers in general evaluate data from suppliers. Supplier I thinks that the bid with the lowest price (and lower environmental performance) usually wins. It should be noted that these discrepancies are observed not in the specific Buyer B–Supplier I relationship, but in general buyer and supplier relationships in consumer supplies. This last issue is associated with buyers' *exploitation* capabilities, in that evaluation of environmental performance involves scoring a product's performance on the buyer's own accounting. Last but not least, Supplier I's observation that a certain buying organization used the same requirements and wording in a tender document for a similar project may indicate a dysfunctional learning loop in the buyer.

4.5 Case Description of ICT

Buyer C is an administrative agency that is subordinate to a Norwegian ministry. The agency's headquarters is located in Oslo, and it has eight units. There are multiple informants from Buyer C, as shown in Table 15.2. The purchasing department collaborates with the IT department when it purchases IT equipment. The former is responsible for the procurement process and tender documents, and the latter for technical specifications and evaluation. Buyer C includes fewer environmental criteria in its current tender documents than it did in the past because all its suppliers now meet the previous criteria, and Byer C did not think that these environmental criteria differentiated bidding suppliers. An informant from the IT department believes that the market is doing well in environmental issues, having working on the issues for decades. In addition, several informants expressed that they had deliberated when including environmental requirements in tender documents. They feel that the regulations are too strict on the formulation of requirements. Buyer C has meetings with suppliers during the framework agreement period but is cautious about contacting suppliers during the tender document preparation stage due to the public procurement principle of equal treatment of all suppliers. Buyer C states that environmental aspects worked on by each department are determined by the results of an internal audit of the environmental management system.

Supplier J provides IT infrastructure to Nordic countries. The informant from Supplier J is a sales director. The company does not face particular challenges in understanding and answering environmental demands during the tendering process. The informant does not recall any discussions related to environmental aspects between customers and the company. Usually, environmental demands concern standardized programs or documentation; thus, it is not difficult to prepare answers to buyers' questions. The informant has the impression that public authorities ask about environmental requirements because they are obliged to do so by regulations. Providing environmental-related information is necessary for suppliers seeking to do business with public authorities.

Supplier K is one of the largest IT providers in the Nordic countries and Europe. Supplier K recently bought Supplier J. The informant from Supplier K, a bid manager, works in a different section from Supplier J. Supplier K states that only a few types of customers seem to be very concerned about environmental aspects, and most are not concerned about those issues at all. The bid manger points out that there is usually no follow-up of environmental aspects in meetings during framework agreements. He thinks that environmental aspects are generally not a focus for buyers and there are other issues that buyers value much more. He doubts whether buyers make use of the environmental information that suppliers provide. Supplier K would like to see more emphasis on environmental aspects from their customers, because they focus on it as a company. Supplier K experienced a case in which a question was raised about the suitability of an environmental criterion in a tender document. Supplier K expressed great concern that the criterion could exclude most of the ICT products delivered by subcontractors. It ended with the buyer changing the criterion level.

4.6 Within-Case Analysis of ICT

For Buyer C, public procurement regulations seem to act as an influential, contingent factor in considering environmental criteria. Even with its deliberation of environmental requirements, the buyer believes that the agency does well in terms of environmental criteria. In contrast, the two suppliers' biggest concern was whether buyers in general treat environmental issues as an important theme among other criteria. Supplier K feels that bidders are often evaluated equally no matter what their environmental performance (as described earlier, this concerns buyers' *exploitation* capability) is. Having no follow-up on compliance with environmental requirements makes the supplier doubt the buyer's seriousness regarding environmental issues (as described earlier, this relates to buyers' *exploitation capability*). Another point to be noted is that Buyer C exhibited negative feedback. When Buyer C learned that the environmental requirements of a previous project were no longer screening criteria, it simply removed the requirement without adding other criteria or upgrading the criteria in successive, similar procurements.

5 Discussions

This section provides cross-case analyses and highlights three issues that appeared in several cases. The three issues are described from the viewpoint of both buyers and suppliers. The last part of the section proposes a GPP model based on AC perspectives.

5.1 Formulation of Environmental Criteria for Tender Documents

Formulating environmental criteria that are compliant with legal guidelines and have appropriate levels according to the market seems a demanding job. Buyers need to properly interpret regulations, know the up-to-date market situation and find the right words to describe their requirements. Thus *acquisition*, *assimilation* and *transformation capabilities* matter here. Buyer C is especially concerned about compliance with public procurement regulations. This concern seems to dissuade Buyer C from actively considering and collecting information potentially related to environmental criteria, which hinders *acquisition* capability. Van den Bosch, Volberda, and De Boer (1999) suggest that rules, procedures and manuals (formal systems) could have a negative impact on the level of AC, while recognizing their positive impact in some situations. Buyer C's deliberation on new environmental requirements seems to exhibit the negative proposition addressed in their study.

To different degrees, the buyers use various means to collect relevant information and knowledge, such as meeting with suppliers, referring to authorized agencies' websites and reviewing other procurement projects. Buyer A pays special attention not to set high-level criteria and to interact with suppliers and users. Criteria should not include requirements which are too high-level in order to be effective when screening suppliers. Supplier K has experienced a procurement case in which the environmental requirements were at a very high level and the buyer had to revise them.

To cope with these difficulties, Buyer B makes use of the resources of an expert organization when deciding how to state environmental criteria in tender documents. While Lane et al. (2006) argue that sourcing expertise may increase opportunities for acquiring novel knowledge it remains unclear whether organizations are able not only to acquire the knowledge but also to assimilate and exploit it. Meinlschmidt et al.'s (2016) case studies present actual examples of an external knowledge provider and a sustainability alliance working to identify, assimilate and exploit new knowledge. Our study provides another case supporting their observation.

To summarize, this issue highlights the significance of the buyers' *assimilation/transformation* and *exploitation* capabilities when preparing tender documents. Activities illustrating *acquisition* capability seem to vary among the buyers.

5.2 Examination of Environmental Performance

Understanding suppliers' answers to environmental questions (*assimilation/transformation*) and "recoding" their performance (*exploitation*) requires a great deal of expertise in chemical substances and local environmental management systems (Buyer A's case), as well as the competence to fairly judge a supplier's descriptive answers that do not follow the certification standards of ecolabels or environmental management systems (Buyer C's case). Given that the procedure for assessing suppliers' answers is key to understanding how green procurement leads to actual results (Alberg Mosgaard, 2015), this issue seems quite critical in the GPP outcome. To increase its competence, Buyer B makes use of resources from an expert organization.

Buyer B alleges that environmental award criteria with a weight of 20% can influence the final results of supplier selection, and further observes that most suppliers seem to be unaware of that fact. An existing study argues that even 5% can have an influence because it signals to suppliers that the environmental soundness of a product contributes to decision making (Parikka-Alhola, Nissinen, & Ekroos, 2006). In contrast, the suppliers interviewed in this study uniformly note that they do not believe environmental performance makes any difference in bid evaluation. They observe that all bidders are often given the same scores in the environmental category. They even think that whoever submits the lowest bid wins. Some suppliers questioned whether buyers in general actually evaluate information from suppliers. This observation is in line with Michelsen and De Boer's (2009) finding that there is a discrepancy between buyers' and suppliers' perceptions of the significance of environmental criteria. There are also doubts whether buyers understand the documentation submitted by suppliers. The suppliers have a critical eye on buyers' *assimilation* and *transformation* capabilities. It was further pointed out by one supplier that there were no environment-related discussions in follow-up meetings during the contract period. Follow-up can ensure actual fulfillment of environmental requirements in tender documents in the contract period, thus the use of environmental techniques or knowledge (*exploitation*).

Suppliers H and I hope for more interactive communication before submitting answers related to environmental performance. Suppliers H, I and K wished that there was more fairness in the evaluation of environmental performance in the awarding process. If suppliers feel that their performance is not evaluated as it "should be", they might lose motivation to faithfully respond to questions in tender documents. Here, a negative feedback loop can be expected. Amann et al. (2014) argue that the level of inducement is measured by the supplier's (subjective) perceived value of the tender. A supplier's decision about an offer is made in favor of the expected benefit if the costs of the opportunity exceed the costs of bid participation. Further, the possibly related concept of "buyer attractiveness" (Schiele, Veldman, & Huttinger, 2011), meaning that a supplier's technical capability more efficiently influences supplier innovation if the supplier positions the buyer as a preferred customer, could lead to the argument that a reward from buyers for suppliers' environmental performance (i.e. a higher score for better performance) would be necessary in a positive feedback loop, that is, to enhance GPP.

In summary, there appear to be large perception gaps between the buyers and suppliers interviewed concerning the evaluation of environmental performance, and such gaps can have a negative feedback on their procurement or bidding operations. Buyers need to further develop *assimilation*, *transformation* and *exploitation* capabilities to motivate suppliers.

The two issues above identify AC in two different procurement processes: AC at the stage of preparing tender documents, and at the stage of evaluating tender documents and executing contracts.

As mentioned above, one buyer sourced external expertise to increase its own AC. Cohen and Levinthal (1990) raise the question of whether AC needs to be internally developed or a firm may simply buy it by hiring new personnel, contracting consulting services or even acquiring other corporations. The public organizations examined in this study, and public organizations in general, do not have any production processes, so they have less need to integrate AC into their production activities (Cohen & Levinthal, 1990). Following this argument, making good use of external expertise seems to be a feasible solution for public buyers.

5.3 Interaction Between Buyers' and Suppliers' AC

This chapter does not analyze the interaction of AC in a specific buyer and supplier relationship because the data from suppliers include general views on their buyers and little about a specific buyer. Still, the cases reveal interaction issues between buyers' and suppliers' AC, and these should be addressed.

First, the above-mentioned issue of formulating environmental criteria affects recipients' acquisition of related information. If suppliers do not properly understand what kind of environmental information buyers would like to have, they fail to collect and identify relevant information. The end result is that buyers cannot acquire products or services with the expected environmental performance.

Second, suppliers' capability to prepare bids, which requires understanding the information from the supply chain and compiling the information needed to answer buyers' questions, can affect the procurement outcome. Buyer B addresses the problem that suppliers sometimes send many documents that upon inspection turn out not to state anything directly related to environmental requirements. Again, without suppliers' ability to prepare a bid, buyers cannot obtain a product with the expected environmental performance.

Third, in cases where suppliers do not think that their information is given worthy consideration during the bid evaluation, naturally they think that it is not worth spending resources on faithfully replying to buyers' environmental demands. Most likely, suppliers will lose their motivation or not see any incentives to be a green or sustainable provider. Buyers need to show how faithfully they treat the information that suppliers submit. When buyers' capability of evaluating bidders is weak, it is likely to affect suppliers' future responses to environmental demands, that is, the way they recognize environmental value. It was also observed that, when buyers do not follow up on environmental demands during a contract execution period, suppliers start to doubt whether buyers actually place a value on environmental issues. This will further lead suppliers to, again, diminish the value of environmental aspects in public procurement. Thus, there are interactions between buyers' and suppliers' AC in different ways.

5.4 Development of AC-Based GPP Model

Following these issues and Todorova and Durisin's (2007) argument about the importance of a balanced development of all component capabilities, this study proposes that effective GPP outcomes would be obtained when the actors in public procurement possess sufficient subsets of AC and interact positively. Figure 15.2 presents this argument. More specifically, if any of a buyer's AC in preparing tender documents, supplier's AC in formulating bids, or buyer's AC in evaluating and executing, is missing, one cannot expect the procurement project to be green. This argument could further explain why some organizations are

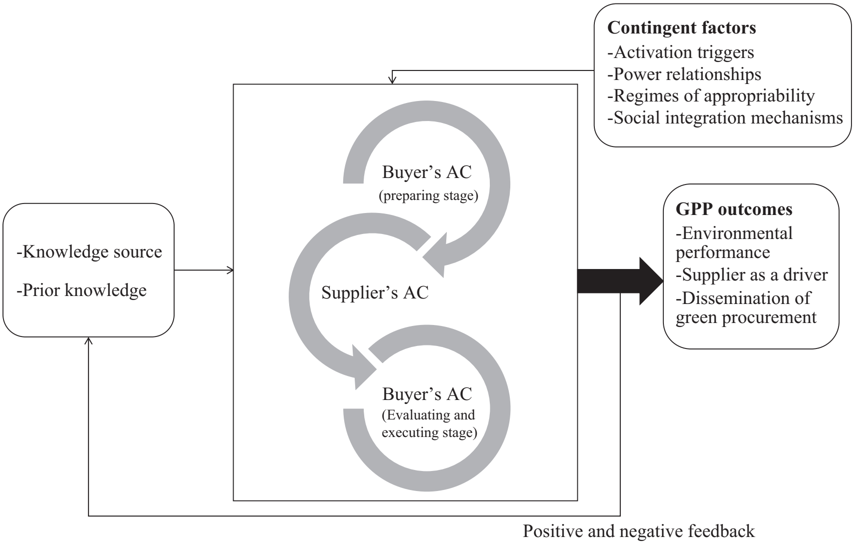

Fig. 15.2 AC-based GPP model

better in implementing GPP. The GPP outcome is partner specific, which means how green a public procurement project is depends on the buyer's and supplier's AC. Accordingly, a supplier who actually has a better green solution, is not always a winner, if a buyer does not have the AC to make use of the information.

Here we ask a question, "When does one see a procurement project as green?" In other words, "How are effective GPP outcomes defined?" GPP outcomes can include: (1) environmental performance (i.e. lower environmental impact) of procured goods or services; (2) tapping the latent strength of suppliers in green performance/technology; and (3) the dissemination of green procurement examples in both the public and private sectors. A lower environmental impact will be associated with products or services procured if environmental requirements are properly communicated from buyers to suppliers and environmental performance is appropriately evaluated in the awarding stage. The environmental performance should also be confirmed in a follow-up during contract execution.

While the first one, a lower environmental impact, is a direct outcome, the other indirect outcomes (i.e. the second and third ones) are worth elaborating. The second one, tapping suppliers' latent power, contrasts the usual view that suppliers are seen as a barrier. This is probably because the core of the GPP policy is in the buyers' action of demanding suppliers' environmental criteria. Buyers have the power to make a request of suppliers and suppliers take a passive role. This study suggests that we do not need to insist on such a view. The cases indicate that suppliers could positively influence GPP. If suppliers' readiness or willingness in green issues is sufficiently recognized by buyers, and suppliers' environmental performance is fairly evaluated at the award stage, this would make use of the suppliers' potential in the environmental contribution and further motivate them to work further on environmental issues.

The third outcome, dissemination of illustrative GPP examples, includes both tangible knowledge and process knowledge and could be shared in inter-organizational networks through buyers' AC. Tangible knowledge concerns a set of advanced environmental criteria in a procurement project. Buyers, either in the public or private sector, learn from illustrative projects and adopt similar criteria in their procurement projects. The latter concerns sharing successful interaction processes between buyers and supplier, for example, know-how on dialogue with stakeholders in the form of conferences at the pre-tendering stage. Process knowledge can be of great importance to an organization over the long run, while AC tends to overemphasize tangible outcomes (Lane et al., 2006). So, it is important to explicitly address here know-how dissemination as well.

Importantly, the argument in this section advances our existing understanding of GPP. According to the EU, "the basic concept of GPP relies on having clear and ambitious environmental criteria for products and services" (Commission of the European Communities, 2008). Similarly, Amann et al. (2014) argue that the inclusion of environmental criteria in the tender should favor more environmentally sound products and hence promote the integration of environmental considerations in the procurement process. This study emphasizes that, when obtaining outcomes that could contribute to green consumption, it is not enough to include environmental criteria in tender documents. It does matter that buyers' and suppliers' capabilities that determine how information on environmental criteria is utilized work together to produce effective green outcomes.

6 Conclusion and Recommendations

This study explains how buyers' and suppliers' AC plays a role in their exchange of environmental-related information. The first research question concerns the interface of environmental information exchanges. The study identified several interfaces in different stages of procurement. At the tender document preparation stage, buyers and suppliers have meetings to share state-of-the-art green products and technique. Through tender documents, buyers formulate their messages as environmental requirements and convey these messages to potential suppliers. Suppliers provide bidding documents that answer buyers' requirements by collecting information from supply chains. The award stage is another opportunity to communicate; buyers send their evaluation results to the bidders. During the contract period, follow-up meetings can confirm the environmental performance addressed in contract clauses. In addition to these various interfaces, buyers and suppliers (also playing a role as buyers in the upper supply chain) meet in a formal setting orchestrated by an expert organization and may have a meeting unrelated to a specific contract for the purpose of informally discussing challenges and updating each other on market and customer trends. This study provides evidence of buyer–supplier interactions which include more than transactional ones in public procurement practices.

The second question is addressed by describing what kind of actual operational processes could be related to the AC components: *valuation*, *acquisition*, *assimilation*, *transformation* and *exploitation*. *Valuation* and *acquisition* of the knowledge capabilities of buyers in GPP are identified as a dialogue with stakeholders, market investigations, benchmarking practices of other procurement authorities and contacts with expert environmental organizations. For suppliers, processes or routines related to *acquisition* are contact with buyers, sub-suppliers and expert organizations. The *assimilation*/*transformation* capability of buyers includes efforts to understand unfamiliar terms and information, and internal environmental audits. The *assimilation*/*transformation* capability of suppliers is the process of asking buyers questions to clarify the content of a requirement and understanding information collected from the supply chain.

The *exploitation* capability of buyers includes formulating environmental questions in their own words and evaluating suppliers' information through their own scoring. *Exploitation* also concerns a follow-up on environmental performance and information provided by suppliers during the contract period, as well as applying performance information to future projects. Finally, delivering answers to buyers' question after assembling information from the supply chain depends on the *exploitation* capability of suppliers. The study showed that buyer's *assimilation*, *transformation*, and *exploitation* capabilities are especially in need of being strengthened, as is the supplier's *exploitation* capability. The study also identified factors which can influence these processes. Public procurement regulations can hinder an active attitude of including environmental criteria, thus may restrict the search of related information. The knowledge source is enriched by experience from previous projects, both in terms of tangible knowledge related to environmental criteria and intangible knowledge related to processes (i.e. know-how in AC components). On the other hand, experience from previous projects can also act as a depressant on the inclusion of environmental criteria.

The final GPP outcome is determined by interactions between the buyers' and suppliers' AC. When buyers and suppliers develop and possess the components of AC, interaction between buyers' and suppliers' AC can contribute to produce effective GPP outcomes: better environmental performance of procured products or services, the latent strength of suppliers' in green performance/technology, and dissemination of green procurement examples among both private and public buyers. The significance of buyers' and suppliers' AC interaction indicates that to achieve effective GPP it is not enough just to state environmental criteria in tender documents. Subsequent processes on both suppliers' and buyers' sides should be carried out with their AC. By looking at the interaction between buyers and suppliers and their perception of each other, this study reveals the possibility of better utilizing suppliers' competence in the environmental area, unlike existing studies pointing out suppliers as one of the barriers to green procurement (Giunipero et al., 2012; Walker et al., 2008).

6.1 Implications/Recommendations

It is important for both buyers and suppliers to identify their active and inactive capabilities and make an effort to further develop the latter. Green outcomes cannot be realized if any capabilities are substantially missing on either the buyer's or supplier's side.

Buyers should put effort into developing AC to enable suppliers to get motivated, and thus enhance their environmental contribution. This study indicates that suppliers feel unrewarded in environmental performance. The study revealed that suppliers judge a buyer's seriousness from its environmental criteria on tender documents and its utilization of environmental information. Buyers need to have stronger *acquisition* capability to catch up to the market's environmental level and stronger *exploitation* capability to differentiate when scoring suppliers' environmental performances, which could be an incentive to suppliers to become greener providers.

Importantly, suppliers to public buyers play a role as buyers in the upper supply chain. Thus, they in turn should be aware of the capabilities mentioned above that are significant for buyers implementing green purchasing.

Policy makers should facilitate buyer–supplier interactions by providing more detailed instructions than the current description in the regulations and guidelines about what is allowed in public procurement. There are still fears of breaking laws and regulations when interacting with or putting requirements to suppliers. Additionally, providing opportunities for public buyers and suppliers to meet in general and exchange environmental information could help both actors to learn from each other. Furthermore, policy makers should seek more interventions that focus on contract management, which in this study turned out to be rarely utilized. There has already been much focus on the tender process, especially regarding the inclusion of environmental criteria, but in contrast there was little follow-up during the contract execution period. Lastly, policy makers can support buyers in continuously improving their practice in green public procurement. If public buyers keep requiring the same environmental level and do not ask for more advanced environmental criteria to be met, the supplier market will not see any advantage in improving its environmental performance. Hence the development of green products and techniques could stagnate. Policy should stimulate continuous effort in GPP by both buyers and suppliers; and suppliers should receive more attention regarding GPP policy.

The current study contributes to GPP literature in that it presents a positive effect on GPP by suppliers as opposed to the typical view in existing studies that suppliers are a barrier to GPP. In addition, this study draws attention to the fact that environmental criteria in tender documents are not enough for more effective GPP, which has been the typical focus in policy making and existing research.

Finally, this study illustrates the potential use of AC in areas other than research and development, the conventionally used areas. The GPP model is presented based on the interaction of buyers' and suppliers' AC. This is a novel modification of the AC model. At the same time, this study adds theoretical rigor to public procurement literature, which has been pointed out to be lacking (Flynn & Davis, 2014; McCue & Prier, 2008).

6.2 Limitations and Future Research

This study has research limitations resulting from the research method. The cases cover a limited number of interviewees in three product categories. Future research should expand this study by looking at other product categories including services. Such studies would highlight similarities or differences in other categories.

The data were collected in 2015 at a specific point at each organization and do not include longitudinal data. This data collection was conducted before the reform of public procurement, that is, transposition of the new EU Public Procurement Directives (2014/23/EU and 2014/24/EU) into national law. In Norway, the new Public Procurement Act was established in 2016 and a new public procurement regulation came into force on January 1, 2017. It would be intriguing to see how the reform of public procurement influences buyer–supplier interactions and information exchange in future research.

Contingent factors of the AC model had less focus compared to the five capabilities despite the identification of some activation triggers and feedback loops. Researchers could further investigate those contingent factors, for example by longitudinal case studies, and look at the dynamics of buyers' and suppliers' AC. Such studies would offer a more comprehensive insight on GPP through AC, highlighting activation triggers and feedback loops.

In this study, little is addressed about the intra-organizational processes of AC, that is, communication within organizations and organizational sub-units. This could be relevant to one of the contingent factors: social integration. Cohen and Levinthal (1990) suggest that, to understand the sources of organizational AC, transfer of knowledge across and within sub-units matters. Lane et al. (2006) point out that researchers should not overlook the role of individuals in developing, deploying and maintaining AC. Future research should thus seek to understand interactions among individuals, organizational units' levels and organizational AC.

The study contributes to the AC theoretical stream by showing its application to green public procurement cases. It is among the first to investigate the components of the AC model postulated by Todorova and Durisin (2007) in the buyer and supplier information exchange and explain how the two actors' AC can interact and produce outcomes. The study shows that AC is valid not only in the research and development setting but also in procurement administration. Given that it is not unusual to see a statement that GPP stimulates eco-innovation (Rainville, 2017), future research on innovation in GPP would add to the strength of AC application in the procurement setting.

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Appendix

Table 15.3 Interview guide

General questions to buyers regarding	• Organizational structure and purchasing function • Main goods purchased • Informant's responsibility and experience as a procurer
Specific questions to buyers	• What are the environmental requirements/criteria in a focused procurement project? What are the most critical environmental aspects? • How do you identify/choose environmental criteria? • Do you have any experience that your suppliers ask questions about, or do they show interest in environmental requirements/criteria? • What do you think of your suppliers' understanding of environmental requirements/criteria that you state in the tender document? • Do you obtain correct and sufficient information from suppliers? • Do you have any experiences of misunderstandings? • How do you make use of the information that suppliers provide? • Are there any strategies or actions to improve or enhance communication between your suppliers and your organization?
General questions to suppliers regarding	• Organizational structure and sales/marketing function • Main supply goods, main customers • Informant's responsibility and working experience
Specific questions to suppliers	• What is the most common environmental requirement/criterion you receive? • Are requirements different among your buyers? • Is it easy to understand buyers' wording in tender documents? Are buyers easy to meet? • How do you think buyers make use of the information that you provide? • Are there any strategic changes regarding environmental issues on your buyers' side? If yes, how do buyers inform you of that? • Are there any changes in your industry regarding environmental issues? • Do you want more dialogue with buyers (dialogue conference, meeting during a framework agreement)? If so why?

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