Greening of Industry Networks Studies

Marcus Brandenburg
Gerd J. Hahn
Tobias Rebs *Editors*

Social and Environmental Dimensions of Organizations and Supply Chains

Tradeoffs and Synergies

Springer

Greening of Industry Networks Studies

Volume 5

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Foreword

Our world is filled with "wicked problems." The complexities and these relationships have resulted in extensive socially and environmentally wicked problems (Churchman 1967). Wicked problems are complex, intractable, conflicting, multidimensional problems many times with unforeseen and unintended consequences.

None is more wicked than trying to balance the triple bottom line of sustainability. Social, environmental, and economic dimensions along with the complex network of subdimensions make for a multifarious managerial, policy, and living environment. Add to this complexity the concept of multiple organizations and multiple functions within organizations seeking to manage the delivery of products and services, the wickedness increases.

To address these problems, simple unidimensional optimization tools, or single theories, from an academic perspective cannot work. Multiple perspectives, tools, and philosophical bents are needed to help, at a minimum, understand the problems. Even just understanding that there are issues and clarifying them is a complex task. Taking it to the next step to find solutions may still be tractable at some level, but its extreme difficulties remain. Implementing solutions then takes on a bevy of additional complexities.

Churchman establishes a moral principle for the research community when it comes to solving wicked problems. The moral principle states: "whoever attempts to tame a part of a wicked problem, but not the whole, is morally wrong" (Churchman 1967, p. B-142).

Sustainable supply chains are wicked problems. Trying to address them in just one stream of research, much less an individual research study, could be considered an immoral goal. Thus, it takes a whole book, and eventually multiple books, studies, and theories, with many differing perspectives to help uncover some potential solutions, and maybe implementations to solve these wicked problems.

This book represents the fifth book in the *Greening of Industry Networks Studies* book series. We believe the other books from this series can serve as valuable accompanying texts that help to more fully understand greening of industry wicked problems.

As can be seen in this book, there are a number of industries, supply chain, and sustainability perspectives taken. Economic, social, and environmental (greening) perspectives are replete in these papers. The "bottom-of-the-pyramid" and poverty alleviation viewpoints are especially prevalent in this unique book. The greening of industry cannot be completed without providing some social benefits. Sustainability also means the long-term adoption of practices and helping the environment and people simultaneously, which is a wicked problem.

Managing and balancing these issues is one of the running themes throughout the book. Disadvantaging one dimension does not necessarily derive from advantaging another metric or dimension. We believe that recognizing the win-win possibilities is critical, but we should not ignore the possibilities of trade-offs. Many times it is the lack of a more holistic perspective that opens the door to unintended consequences.

We urge readers to thoughtfully read, critically analyze, and comparatively evaluate each chapter separately, but more importantly as a compendium. Understanding the more complete picture, based on knowledge, theory, and research, is the first step to solving many of our world's most difficult problems. As with any single text or document, this is only one step of a continuing journey.

We hope that this series, and this book, help researchers, policy makers, teachers, students, and communities further understand the complex relationship man has with nature and themselves. Addressing these complex problems from a compassionate research perspective (Sarkis 2012), which this book attempts to do, is something all scientists and researchers should have as a goal.

Egham, Surrey, UK — Diego A. Vazquez-Brust
Worcester, MA, USA — Joseph Sarkis

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Contents

Chapter 1
Sustainable Supply Chains: Recent Developments and Future Trends

Marcus Brandenburg, Gerd J. Hahn, and Tobias Rebs

Abstract Sustainable supply chain management (SSCM) has become a highly relevant topic in scientific research as well as in managerial practice. This chapter summarizes the findings of several reviews of SSCM literature. In addition, propositions and guidelines for future SSCM research are given. Based on these insights, the structure of the book at hand and the coherence of the book chapters are outlined.

Keywords Sustainability • Supply chain management • Literature review

The rise of sustainability in corporate management increasingly leads enterprises to revisit the concepts of value and profitability that drive their operations. Actually there are mainly two critical factors by which industry networks are challenged: the compliance to social standards and the achievement of ecological targets. Together with economic criteria, these issues are synthesized to the triple bottom line (TBL) of sustainability (Elkington 1998). The interplay of these goals requires further investigation from both scientific research and managerial practice.

The practical relevance of sustainability persists since this topic has been put on the managerial agenda by international organizations such as the World Commission on Environment and Development (WCED 1987) or the United Nations (UN 2000, 2002). As a consequence, new or modified processes, practices, systems, techniques,

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and products are required to avoid or to reduce environmental and social harms and to promote benefits of sustainable management. These needs have resulted in green-growth strategies (see, e.g., papers in Vazquez-Brust and Sarkis 2012) or approaches to bridge the North-South divide by wealth transfers from richer to poorer countries (see, e.g., papers in Vazquez-Brust et al. 2014) as well as in new business models (see, e.g., papers in Azevedo et al. 2014) or innovative approaches for green logistics and transportation (see, e.g., papers in Fahimnia et al. 2015).

In parallel to the increasing practical relevance, the research on green, social, and sustainable supply chain management (SCM) has shown a strong and continuous growth over the last 10 years (see Fig. 1.1). The former area covers environmentally conscious logistics (Sarkis et al. 2011; Dekker et al. 2012), manufacturing (Ilgin and Gupta 2010), and sourcing (Bai and Sarkis 2010; Govindan et al. 2015a) as well as reverse logistics (Fleischmann et al. 1997; Govindan et al. 2015b) and closed-loop SCM (Souza 2013). In contrast, social aspects in SCM address corporate social responsibility (Mutti et al. 2012; Yakovleva and Vazquez-Brust 2012) and ethical behavior related to the environment, society, and the economy, as well as themes such as equity, health, education, or security (Hutchins and Sutherland 2008). Sustainable SCM provides an integrated perspective on economic, environmental, and social issues in a comprehensive profit-planet-people ecosystem (Tang and Zhou 2012). Scientific studies mainly focus on one of the two areas, green operations or social responsibility, but comprehensive studies that cover all three TBL dimensions are less often found. As illustrated in Fig. 1.1, the topic of green SCM

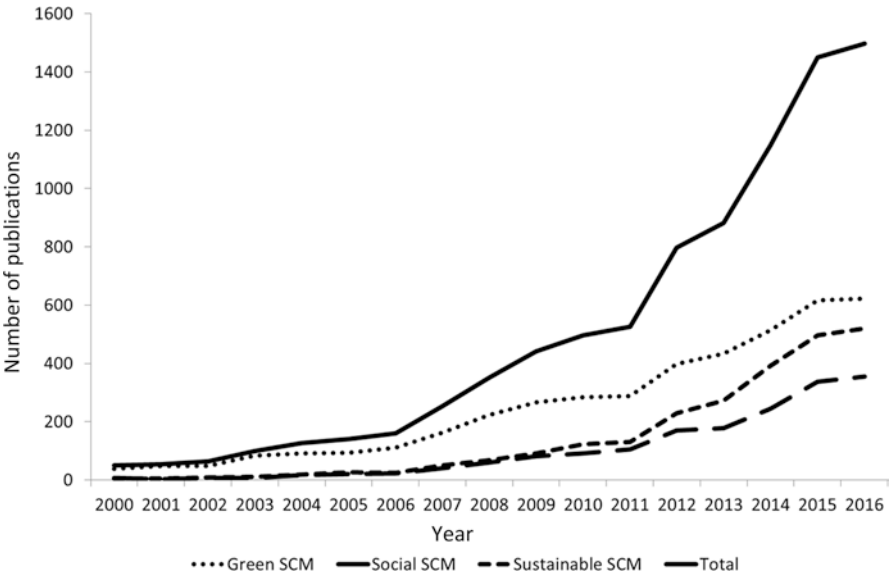

Fig. 1.1 Annual number of publications on green, social, and sustainable SCM over time (Note: Keyword-based search in Web of Science has been conducted to determine the annual number of publications. Each of the search strings (i) "green OR environmental OR ecological," (ii) "social OR societal," and (iii) "sustainab*" was combined with the search string "supply chain")

has been more prominent than social or sustainable SCM. However, in recent years, social aspects in particular and sustainability in general have also gained higher awareness in SCM research.

In order to explain sustainable SCM constructs and their relationships, numerous frameworks are developed based on reviews of related literature. Carter and Rogers (2008) conceptualize strategy, organizational culture, risk management, and transparency as facilitators and supporting facets of sustainable SCM. Moreover, the authors exemplify that environmental and social sustainability can create economic benefits for a firm and that a sustainable SCM strategy can increase the economic performance of a company. Based on a content analysis of 191 papers on sustainable SCM, Seuring and Müller (2008) design a conceptual framework that illustrates how government, customers, and other stakeholder groups trigger the sustainable management of focal firms which in turn propagate these influences to their suppliers and further upstream the supply chain. The authors observe a dominance of empirical studies, in particular, surveys and case studies, in comparison to theoretical papers that present conceptual frameworks and formal models. Furthermore, a clear focus on environmental factors is detected while social aspects and sustainable issues are less often addressed in sustainable SCM research. In addition, Seuring and Müller (2008) explain that sustainability objectives can create win-win(-win) opportunities between complementary targets but may also require trade-offs between conflictive ones or represent minimum performance levels which an organization needs to achieve. Yawar and Seuring (2017) review sustainable SCM literature with a focus on social aspects. The authors conceptualize communication, compliance, and supplier development strategies and their influences on social and economic as well as buyer and supplier performance.

Several reviews of case studies and meta-analyses summarize the empirical research on sustainable SCM. Gold et al. (2010a) analyze the content of 70 case study papers on sustainable SCM and observe strong increase of related empirical research after the millennium change. Food and textile industries are identified as main sectors of observation while automotive, chemical, and electronics industries are considered less often. The authors diagnose a high relevance of risk management for sustainability, mainly in context to environmental exposures, and a neglect of social factors in both scientific research and industrial practice. Besides, Gold et al. (2010a) advert to the high importance of communication, comprising information flows and coordination, for sustainable SCM. In another content analysis of 70 sustainable SCM case studies, Gold et al. (2010b) reveal the importance of environmental proactivity and green supply. The authors conclude that sustainable SCM has a catalytic effect on a firm's competitive advantage, which is seldom exploited on an intraorganizational or dyadic level. Furthermore, the relevance of external pressure for SSCM implementation and the dominance of environmental-economic factors compared to socio-ecological aspects were confirmed by this analysis. In a review of 80 empirical studies, Carter and Easton (2011) find that most prominent subjects of these studies include environmental issues, safety, diversity, and sustainability. In addition, a strong growth in the elaboration on holistic sustainability and its social facets corporate social responsibility (CSR) and safety is observed. Most

studies assess multiple industries or focus on the transportation sector or the consumer goods industry on a functional or firm level. The authors reveal that survey and case study are preferred methods and that a theoretical underpinning is lacking in a majority of studies. Golicic and Smith (2013) conduct a meta-analysis of 31 studies on green SCM and its performance implications. A positive and significant impact of environmental sustainability on market-based, operational-based, and accounting-based performance is detected.

Tang and Zhou (2012) evaluate developments and trends in model-based research on environmentally and socially sustainable operations based on a review of 56 related papers. The authors subdivide the environmental dimension of sustainable SCM into the consumption of natural resources and the disposal of emissions and wastes and split the social dimension to the people on customer and producers side. The authors observe lacks of operations research applications in transportation emission reduction and in product design issues that go beyond remanufacturability. Seuring (2013) analyzes the content of 36 modeling papers on sustainable SCM and finds that environmental factors, in particular the consumption of energy and natural resources and the emission of greenhouse gases and waste, dominate compared to social aspects such as employment rate, income distribution, or CSR. A majority of reviewed models aims at determining trade-offs between different sustainability parameters, while minimum performance solutions or win-win situations between the three sustainability dimensions are less often modeled. In a more comprehensive review, Brandenburg et al. (2014) reveal that sustainable SCM models most often analyze manufacturing companies while carriers, distributors, and retailers are less often focused. Technology-related sectors, consumer goods industries, or macroeconomic contexts represent preferred application areas. Descriptive models are by far more often applied than normative and preferred solution approaches include linear programming, analytic hierarchy process, and life cycle analyses. Brandenburg and Rebs (2015) detect that normative models are more often applied on the intra- and inter-organizational levels of SCM, while descriptive models are preferred for the macroscopic level of whole industries or economies.

Emerging research areas put sustainable SCM into relation to dynamic capabilities or the base of the pyramid (BoP). In a content analysis of 52 articles, Beske et al. (2014) elaborate on the coherence of sustainable SCM and dynamic capabilities in the food industry. Important dynamic capabilities include product and process development, transparency, and integration. The study illustrates that sustainability practices and dynamic capabilities improve traceability and tracking and help fulfilling customer demands. Land et al. (2015) conduct a similar analysis with a focus on the automotive industry and reveal how supply chain members adapt to changes in government regulations, customer demand trends, or competitors' behavior. Khalid et al. (2015) shed light on sustainable SCM practices in BoP context. The authors explain that the BoP should not be considered as a passive recipient of development policies. Instead, a sustainable development and win-win opportunities can be achieved by cooperation of all involved stakeholders and by co-creation of suitable solutions and approaches to overcome challenges faced by the poor. In this context, technological integration is a highly relevant success factor.

Numerous studies address opportunities for future research in sustainable SCM. These include the following propositions and guidelines:

- Sustainable SCM research needs to be broadened from a focused assessment of either green or social facets toward a comprehensive perspective that covers all three dimensions of the TBL.
- Taking comprehensive perspectives on and studying mutual interrelationships between sustainability and green SCM in sustainable and closed-loop SCM is recommended (Govindan et al. 2015b).
- Current measures for environmental and social sustainability need to be refined and new ones need to be developed (Golicic and Smith 2013).
- Models and approaches could consider uncertainties and support the management or mitigation of sustainability risks in supply chains (Brandenburg and Rebs 2015; Govindan et al. 2015b).
- Additional empirical research may employ methods such as econometric models that use actual data, behavioral research with lab experiments, longitudinal analyses, or multi-case studies to test and validate conceptual frameworks and formal models for sustainable and closed-loop SCM (Carter and Rogers 2008; Souza 2013; Brandenburg et al. 2014).
- More comprehensive studies are needed that reflect the environmental and social impacts on macroscopic levels of manufacturing sectors or whole industries as well as analyses that consider the political environment and regulatory frame conditions (Golicic and Smith 2013; Brandenburg and Rebs 2015).
- Promising research directions include in-depth analyses of social sustainability constructs as well as the role of power and information exchange or trust and commitment among supply chain stakeholders and the resulting performance impacts (Yawar and Seuring 2015).
- Theoretical and empirical research is needed to deepen the understanding of the coherence of sustainable SCM and BoP (Khalid et al. 2015).

The book at hand takes up these recommended research directions. It elaborates on the interplay of social and environmental factors in international supply chains and industry networks. The book intends to explore economic, ecological, and social performance and capabilities from various functional perspectives and different application contexts. One main question is to which extent socially responsible and environmentally conscious operations are complementary or conflictive. In total, 15 different book chapters give answers to this question. The chapters are clustered into three segments. Six chapters in Part I focus on aspects of performance management for sustainable supply chain management. Seven chapters in Part II take a closer view on sustainability in operational processes and specific applications. Two chapters in Part III particularly emphasize the social dimension of sustainability in hybrid business models and in supply chains at the BoP. In the following, a brief outline of each chapter is given that explains the approach and contribution of each study.

In Chap. 2, Campos and Rebs present the results of a review of SSCM practices based on a conceptual framework with generic practice categories. The opportunity

of combining several practices to further improve sustainability-related performance is central to this chapter. Using contingency analysis, significantly correlated categories of practice are identified. The combinations of practices are then exemplified with practices of five German automotive manufacturers. It is concluded that the integration of production and waste management with procurement and distribution practices yields opportunities for enhanced overall sustainability performance of supply chains.

Chapter 3 contains a study conducted by Zvezdov and Akhavan who elaborate on supply chain interactions that trigger the development of dynamic capabilities and, thus, result in competitive advantage through sustainable SCM. Interactions between supply chain actors are core elements of supply chain management and thereby contribute to supply chain performance. When environmental and social performance measures are taken into account in addition to conventional economic aspects, the role of collaboration between supply chain actors is amplified. Hence, the development of dynamic capabilities for sustainable SCM as a result of interactions will improve sustainability performance of supply chains.

In Chap. 4, Stohler, Rebs, and Brandenburg concentrate on the developments of the Green Supply Chain Operations Reference (SCOR) model, which extends the SCOR model by environmental besides economic performance criteria that are evaluated at a supply chain level. Since the scope of Green SCOR sustainability-related metrics is limited, the authors outline an approach to integrate further environmental metrics into the SCOR model. Besides, the integration of social sustainability metrics into and compatibility with the SCOR model is discussed.

A methodology for supply chain sustainability assessment based on qualitative and quantitative indicators is presented by Fritz, Schöggl, and Baumgartner in Chap. 5. The approach enables to select and calculate indicators related to the sustainability performance at the facility and company levels and finally aggregate indicators at the supply chain level. A comprehensive set of sustainability aspects and corresponding indicators is provided for the environmental, social, and governance dimensions of sustainability. Moreover, the authors emphasize that a software-based sustainability data exchange would support the practice applicability of this standardized approach to supply chain-wide sustainability assessment.

In Chap. 6, Fandl and Held present an approach to evaluate current and estimate future carbon emissions and costs in manufacturing. The approach is illustrated in a multi-case study from product development partnerships in German foundry supply chains. The approach is integrated into an IT tool which enables ex ante forecasts of changes in carbon emissions in cross-company casting development. Moreover, the study reveals four main factors that affect changes in carbon emissions in the iron foundry sector.

The work of Hartmann, Stehr and Struve in Chap. 7 discusses issues in sustainable supply chain management from the perspective of CSR. To this end, the authors put a special emphasis on companies in emerging markets and use interview data from consumer goods companies located in China. A checklist to support CSR implementations is developed and insights are derived with respect to the skills and

tools of CSR managers, the interface of CSR to compliance management, and global CSR implications for sustainable supply chains.

In Chap. 8, Rebs reviews 62 formal models that deal with the sustainability performance in inter-organizational supply chains. Cluster analysis is used to differentiate between groups of sustainable SCM models within the structural dimensions applied for content analysis. While environmental factors are frequently modeled, social sustainability criteria are still underrepresented. The author finds that governmental and customer pressures and incentives for sustainable SCM are operationalized by quantitative models. The representation of environmental and social risks is still scarce, thus calling for future research using stochastic models to account for uncertainties. Finally, the author suggests to move from the assessment of trade-offs to the determination of win-win(-win) situations for the interplay of the economic, environmental, and social dimensions of sustainability.

In Chap. 9, Sucky and Zitzmann examine issues in and approaches to risk management in sustainable supply chains with a specific focus on sourcing risks. The authors compare the intensity of different risk factors in conventional vs. sustainable supply chains and find that especially the quality and time dimension concerning risk differ. Investigating the applicability of classical strategies for supply chain risk management, the authors conclude that their effectiveness is limited in the context of sustainable sourcing. On the contrary, Sucky and Zitzmann see beneficial aspects of sustainable sourcing since quality and quantity risks are lower given the long-term supplier-buyer relationship. Moreover, customers are more willing to accept higher prices and longer lead times such that time and price/cost risks can be addressed more easily in sustainable supply chains.

A study on conflict minerals in the automotive industry is presented in Chap. 10. Based on a review scientific literature and company reports of five globally operating car manufacturers and on interviews conducted with three experts, Fritz and Tessmann identify major stakeholders in the area of conflict minerals in automotive supply chains. Moreover, the authors analyze current practices and challenges to build conflict-free supply chains. The study exemplifies the need to take a comprehensive perspective on the supply chain in order to manage conflict materials in the automotive industry. Moreover, the chapter points toward synergies and collaboration potentials between car manufacturers and firms from other sectors, e.g., the electronics industry.

A review of literature on the relationship between sustainable SCM and purchasing and supply management (PSM) conducted by Schulze and Bals is presented in Chap. 11. The review sheds light on the question if and how PSM knowledge and competences can promote the management of social and environmental targets in supply chains. The study emphasizes the influence of individuals on sustainable performance of firms in general and the PSM function in particular. Moreover, the authors suggest six avenues for future research.

In Chap. 12, Wensing studies the social and environmental impact of advances in economically driven transport optimization. For this purpose, the author uses a case study from automobile distribution and applies an optimization-based approach to short-term dispatch planning for car transporting companies. Comparing the results

of the optimization-based approach to a heuristic greedy algorithm, it can be found that economic, social, and environmental performance measures are improved simultaneously with the optimization-based approach even while focusing exclusively on economic objectives. The chapter also studies the implications of two different planning strategies: cost optimization given a fixed set of orders vs. profit optimization including the option to reject orders. The results indicate that a cost-based approach appears to be more beneficial from a TBL perspective since the cost drivers are more closely linked to social and environmental impacts.

In Chap. 13, Gmelin and Seuring elaborate on sustainability aspects in the development of new products. In a multi-case approach, the authors conducted 19 interviews in five car manufacturers. It is shown that success factors of product innovation are closely related to the TBL dimensions. The study reveals that, however, social factors are hardly reflected in new product development. The authors emphasize the need to closely align strategic management for sustainability with new product development processes.

A review and content analysis of 76 papers on sustainable SCM at the BoP is presented in Chap. 14. Monzer, Rebs, Khalid, and Brandenburg elaborate on economic, environmental, and social criteria of SCM in poor countries and reveal a clear dominance of social aspects and a deficit in environmental sustainability consideration in SCM. Moreover, the authors identify triggers and barriers of sustainability in supply chains at the BoP. In this context, the importance of customer and governmental influences is emphasized. The study contributes to research by analyzing the coherence of sustainability, in particular its social and societal aspects, and SCM at the BoP. Practitioners gain insights on social and societal aspects of SCM in context to poverty alleviation and making business with the poorest members of the world.

In Chap. 15, Bals and Tate elaborate on the questions how to design truly sustainable supply chains and what new practices and processes are required for such designs. The authors assess four social businesses from Haiti, a BoP country with a critical economic, environmental, and social situation, in a multi-case study. Moreover, the social resource-based view is conceptualized, and some of its key elements are identified as important capabilities that are needed to design a sustainable supply chain. In addition, the authors point toward three directions for future research on social and sustainable supply chain design.

To summarize, the book at hand comprehensively addresses economic, environmental, social, and societal dimensions of organizational and supply chain performance. It provides theoretical approaches for sustainable SCM and insights from business practices in different industrial and market contexts. Thus, scientific discourse on key developments in sustainable SCM is furthered and managerial implications as well as application opportunities are illustrated.

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Part I
Performance Management for Sustainable Supply Chain Management

Chapter 2
Opportunities of Combining Sustainable Supply Chain Management Practices for Performance Improvement

Juliana Kucht Campos and Tobias Rebs

Abstract Considerable efforts for research on sustainable supply chain management have become evident in the past years. Besides conceptual studies and quantitative models, empirical research on corporate practices has been contributing to promote reductions of impacts on the environment and society. The systematic combination of practices is, however, not yet approached in literature. Therefore, this chapter presents results derived from a systematic literature review based on a recently developed framework for managing sustainable supply chain practices. Through contingency analysis on the selected publications, correlations between the framework dimensions and categories enable the identification of dominating and underrepresented initiatives. Lastly, corporate reports published by five German automotive manufacturers are examined. Results show that both sustainable procurement and waste management practices are strongly correlated with a firm's production management practices. Moreover, general issues of waste management are most often discussed in concert with distributional and customer relationship practices. In contrast, corporate governance and supplier relationship practices are implemented isolated from other initiatives. The apparent lack of integration between these practices motivated a second round of analysis, which considers 21 more specific categories. The findings are further compared to sustainability leaders' examples to offer managerial insights and opportunities to enhance sustainable supply chain performance. This chapter focuses specifically on sustainable supply chain practices and introduces the concept of "initiative combination rent," contributing nonetheless to further the understanding of how companies can improve supply chain and sustainability performance.

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2.1 Introduction

In November 2016, the Paris Agreement entered into force highlighting the need for global response to climate changes and to "strengthen the ability of countries to deal with the impacts of climate change" (United Nations 2016). Aside from governmental efforts to improve sustainability, customers are increasingly demanding more responsibility and transparency in the way goods are sourced, produced, distributed, and sold (Mckinsey 2008) and willing to pay more for products and services provided by companies committed to sustainability. In 2011, these sustainability-oriented customers represented only 22%, while in 2014 they were 55% – more than 62% in Asia-Pacific and Latin America (Nielsen 2014). On the business side, Szekely and Knirsch (2005) point out that sustainability involves combining economic growth with "ethical business practices, sustainable jobs, value for all of the company's stakeholders, and attending to the needs of the underserved (p. 628)."

Businesses are, thus, changing the way strategies are planned including social and environmental aspects (Seuring and Müller 2008; Ageron et al. 2012) and struggling to reduce their impacts and risks, improve transparency, and comply with stakeholders' demands. The main barrier for general corporate sustainability is, however, located in supply chain management (SCM) (UN Global Compact 2013) which explains the gaps between what is desirable and what is implemented in practice (Bowen et al. 2006). According to Vachon and Mao (2008), "all industries will be challenged to reorganize their supply chains" (p. 1552) and incorporate sustainability values. Although companies worldwide have been implementing and reporting sustainable supply chain (SSC) practices, the systematic combination of practices is, nevertheless, not yet approached. This specific gap regarding SSC practices is also visible in the related literature, which is outlined in the following section.

2.2 Literature Review

2.2.1 Sustainable Supply Chain Management Practices

Sustainability is an increasing discussed topic among policy makers, academic researchers, and practitioners worldwide. A vastly adopted definition comes from the Brundtland Report of the World Commission on Environment and Development which stated that "development should meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987).

Some years later, Elkington coined the commonly used term "triple bottom line" (TBL) with the idea that "it is not possible to achieve a desired level of ecological or social or economic sustainability (separately), without achieving at least a basic level of all three forms of sustainability, simultaneously" (Elkington 1999). While most of the authors reinforce the need for balancing the three dimensions, Beske-Janssen et al. (2015) demonstrate that, in general, literature have been focusing on the traditional economic dimension, while in the last 20 years, the focus has been on the environmental dimension due to stricter regulations and larger public awareness. The social dimension is still underrepresented.

From a business perspective, the idea of sustainability as investments without returns (Walley and Whitehead 1994) is being changed by "keeping businesses alive and profitable so that they can continue to deliver the goods and services that society needs and wants" (Hardisty 2010, p.6). More than two-thirds of companies have placed sustainability permanently on their management agenda and consider it as being necessary to keep competitiveness nowadays (Kiron et al. 2012). Among the potential benefits, "reducing long-term risks associated with resource depletion, fluctuations in energy costs, product liabilities, and pollution and waste management" are central (Shrivastava 1995). Companies are, additionally, broadening their approach and visualizing opportunities for improving corporate performance with SSC practices. Businesses that depend on a resource that will be scarce in some decades are, for instance, not sustainable as well as other businesses that do not guarantee safe and healthy working conditions. In both examples, companies' behaviors are themselves responsible for the depletion of their needed resources. As reinforced by the resource dependence theory (Pfeffer and Salancik 1978), companies are resource insufficient and rely on external stakeholders to obtain the necessary resources to survive.

Shrivastava (1995) states that when long-term issues are systemically analyzed, companies can better manage risks that threaten business sustainability such as scarcity in natural resources. A holistic approach is, therefore, needed to build a system that encourages minimizing consumption and nothing is wasted or discarded into the environment, which promotes sharing and collaboration, and which balances human well-being, respect to the environment, and our truly needs (Jackson 2011), instead of mere competitive advantage. In other words, a system is where value creation to stakeholders is a requirement and firms are demanded to take responsibilities and commitments to them (Mathur and Kenyon 1997). One of the consequences of a systemic point of view is the crucial engagement of the logistics function in taking sustainability measures (Carbone and Moatti 2008). This is explained by the broader scope of logistics activities which include purchasing from suppliers, inbound logistics, production, distribution to final customers (outbound logistics), and reverse logistics (Sarkis 1999).

In recent surveys, chief executive officers of global companies mentioned the management of supply chain (SC) as an area of specific importance in their sustainability strategy (Accenture 2012; Handfield et al. 2013) but also the top barrier for improving corporate sustainability (UN Global Compact 2013). Global sourcing causes an increase in SC complexity characterized by less transparency and control

over suppliers, more transport emissions (Flotzinger et al. 2008), and increasing reliability on suppliers and sub-suppliers (Welford 2002). Consequently, sustainable development involves not only corporations but also their networks (Carbone and Moatti 2008). The current challenge of making supply chains sustainable is, in fact, according to Pagell and Shevchenko (2014) the nature of SSC. As a result, a variety of benefits can be reaped, including enhanced firm competitiveness (Carter and Dresner 2001; Zhu et al. 2005), strengthened brand names or differentiated products (Klassen and McLaughlin 1996; Mahler 2007), supporting the management of reputational and environmental risk (Teuscher et al. 2006), cost savings from reduced waste (Mollenkopf and Closs 2005), and better working conditions (Carter et al. 2007).

2.2.2 Extra Benefits from the Combination of SSC Practices

In order to transform supply chain into a sustainable value chain, the involvement of all parts (Clarke and Roome 1999) for changing dominant mind-sets and single-company goals is fundamental (Harris and Crane 2002). The relational view pays special attention to the connection, tangible or intangible, between partners, individuals, departments, companies, or entire networks (Dyer and Singh 1998). According to these authors, this relationship allows companies to get a so-called relational rent, defined as "a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners" (Dyer and Singh 1998, p.662).

Furthermore, this extra gain is only possible to be created from shared resources among partners (Lavie 2006). Other theoretical backgrounds, e.g., network-related theories and extended resource-based view, also contribute to the analysis of inter-firm relationship structures, the impact of network-level cooperation on firm's performance (Eisenhardt and Schoonhoven 1996), and additional gains obtained from collaborative engagements.

Thus, we assume that a "combination rent" similarly to the "relational rent" applies to the combination of specific SSC practices, where extra benefits can be generated when two or more SSC practices are simultaneously implemented, generating overall higher performance than the sum of each isolated practice would yield. Companies may already realize this concept and apply it when planning their portfolio of practices; however, literature has not paid attention to the potential impact of SSC practice combinations. As a consequence, the main objective of this study is to introduce this concept through the identification of potentially beneficial SSC practice combinations and the outline of exemplary cases of SSC practice combinations by German automotive manufacturers.

2.3 Methodological Approach

2.3.1 Systematic Literature Review

To systematize existing SSC practices and examine the opportunities of their combination to improve corporate and supply chain performance, a systematic literature review was conducted following the recommended steps from Durach (2016). As detailed in Campos (2015), 2052 publications were scanned from two online databases, reference sections, and author's recommendations (Table 2.1), and specific selection criteria were applied. First, the selected literature should focus on activities directly related to SCM. It involves the management of activities that starts in sourcing and procurement and includes all logistics management activities such as warehousing and transport. It includes, additionally, coordination and collaboration with channel partners, such as suppliers, intermediaries, service providers, and customers (Council of Supply Chain Management Professionals 2015). Literature must also describe practices, projects, actions, and strategies as well as consider at least environmental or social aspects. Studies about one specific companies (case studies), industries, or countries were accepted, while literature reviews about the topic were excluded to avoid duplication of results. Finally, the text must be in English or Portuguese so both reviewers could analyze without the need of a translating service. No limitation on the type of publication was included; thus, reports from industries, governments and consultancy companies, project reports, books, articles published in journal of any kind or in conferences, working papers, technical/logistics magazine, among others, were considered.

The final sample of 99 publications also supported the development of an integrated framework for managing sustainable supply chain practices, displayed in Fig. 2.1, composed by 3 areas, 7 dimensions, 21 categories, and 96 different types of practices. The three areas and dimensions fit each other evidencing the integration and efficient flow of goods, services, and related information from the point of origin to the point of consumption in order to offer value to the customers. From a sustainability point of view, all activities and practices a company implements should somehow offer value to the customers through the balance of the three aspects of the TBL (Campos 2015). While more details about each dimension and categories are displayed in Appendix 1, it is visible from the figure the frequencies (in percentages) of the analytic categories in each structural dimension. The

Table 2.1 Summary of the results (Campos 2015)

Source	Initial list	After title/abstract reading	After full reading
Web of science	880	279	52
Business source complete	1055	150	27
References section	–	42	4
Author's recommendation	117	77	16
Total	2052	548	99

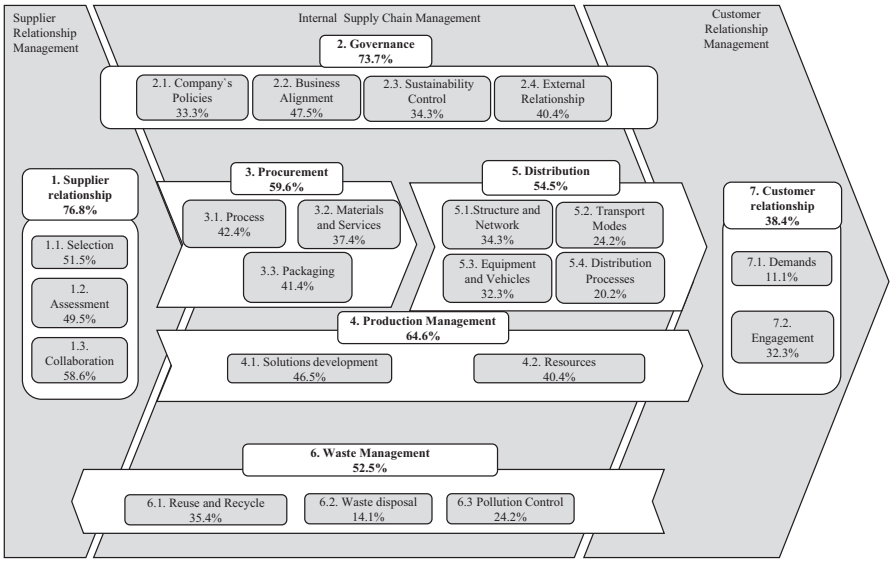

Fig. 2.1 Framework for managing SSC practices (Campos 2015)

conceptual framework is the basis of results from content analysis and, thus, underlies the results of contingency analysis presented in this chapter.

2.3.2 Contingency Analysis

Quantitative analysis from the literature review results involves counting the frequencies of occurrence for each category, i.e., SSC practices, and calculating relative frequencies to point out the relevance of each framework element. In this way, highly relevant SSC practices, but also underrepresented ones, can be identified. Furthermore, contingency analysis is employed to identify correlations of occurrence between pairs of analytic categories and thus reveal combinations of SSC practices that are more often linked than expected. Contingency analysis is carried out using SPSS® 22.0 where the phi (φ) coefficient is calculated (Backhaus et al. 2013). If the phi coefficient exceeds 0.300, a positive correlation between the occurrences of the analyzed pair of categories can be assumed, i.e., the two categories appear unexpectedly often together in the same reference. Contingency analysis is one possible method for quantitative assessment of findings gained during content analysis of large paper samples and has been used in similar research approaches (Wolf 2008; Gold et al. 2010).

2.3.3 *Content Analysis of Companies' Reports*

After identifying significant correlations between SSC practices using contingency analysis, corporate public reports from five German automotive manufacturers were examined in order to verify how companies have been improving their sustainability performance through practice combinations. This industry has been heavily investing in SSC initiatives and is considered as benchmarks for SSC practices (Perotti et al. 2012). Content analysis was used for interpreting subjectively the content of text data through the systematic classification of coding and identification of patterns (Neuendorf 2002). This approach has proved useful in related literature reviews in (sustainable) supply chain management (Tate et al. 2010; Colicchia et al. 2011; Wu et al. 2012; Piecyk and Björklund 2015). Secondary data were collected based on the scheme of the above-described framework by two independent reviewers, and doubts were discussed until consensus within a group of SC specialists, as suggested by Milne and Adler (1999) for increasing reliability.

As this section examines the realm of and relationships between SSC practices, the selection of ranked company leaders is supposed to contribute to comprehensive results. Thus, public documents from five automotive manufacturers listed in the Newsweek Green Ranking 2014 and 2015 were scanned. Besides corporate sustainability reports (CSR), which are vastly used for SSC researches (Tate et al. 2010; Wu et al. 2012; Comas Martí and Seifert 2013; Piecyk and Björklund 2015), websites and other publications, such as case studies and industry reports, were analyzed. The selected companies are Audi, BMW, Daimler, Porsche, and Volkswagen.

2.4 Contingency Analysis of the SSC Framework Dimensions

This section informs about the results from applying contingency analysis to identify highly correlated SSC practices. Before looking at the detailed analytic categories in the next section, the aggregate framework dimensions are briefly analyzed in the following. Figure 2.2 gives an overview of the pairs of structural dimensions with a phi coefficient of 0.3 or above and can thus be considered as significantly correlated dimensions. Even though, it is important to note that those relationships that do not exceed the threshold of being regarded as significant contingency are equally important for SSC. This is reflected in the cross-functional perspective of SCM, which necessitates the integration of all the framework dimensions.

Results show that with regard to SSC practices, two of the seven framework dimensions are dominant: supplier relationship (76.8% of the selected references) and governance (73.7% of the selected references). In the first one, no relationship was found with other dimensions which might be a sign that, in general, practices in this group are not necessarily implemented together with practices from other specific groups. Exceptions were found in supplier collaboration category, which is described in the next section. On the other hand, corporate governance, located on a

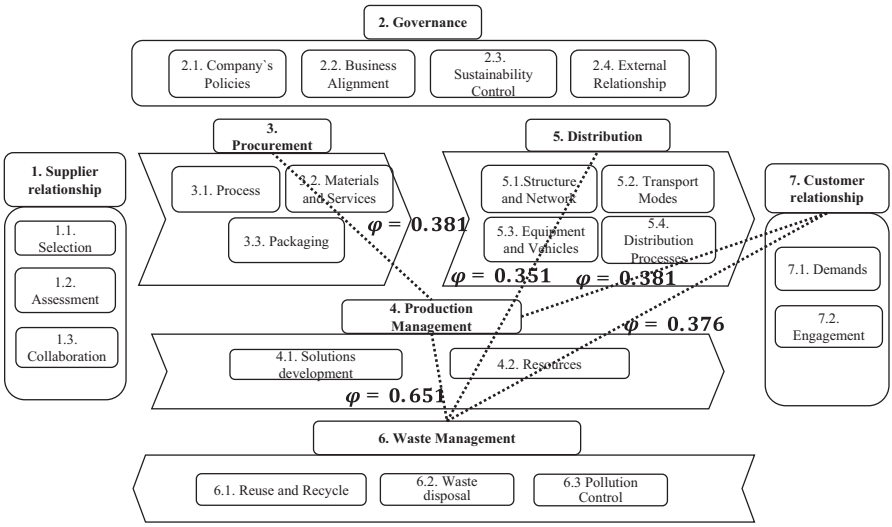

Fig. 2.2 Correlation between structural dimensions

strategic level, seems to be decoupled from the other (often tactical and operational) dimensions. It refers to the foundation for building corporate sustainability such as policies and guidelines, human resources management, sustainability control, and external stakeholders' relationships. These are commonly applied to support other specific initiatives, similarly to the concept of Porter's secondary processes (Porter 1985). The customer relationship dimension, although vital for business, was cited in only 38.4% of the sample papers.

Furthermore, it is concluded that production management and waste management are central dimensions of SSC with strong correlations with each other (phi = 0.651) and with customers (phi = 0.381). From a life cycle perspective, SSC practices that support managing products at the end of their lives are particularly relevant in connection with sustainable production management practices (phi = 0.651). To support reverse supply chains, distributional SSC practices are relevant in the context of waste management (phi = 0.351), especially for products to be reused or remanufactured. Moreover, production-related SSC practices are significantly correlated with sustainable procurement practices (phi = 0.381). After checking inter-dimensional correlations, detailed contingency analysis was conducted with categories of each dimension in order to identify significantly correlated pairs of SSC practices. As a result, 17 category combinations are identified and displayed in Appendix 2. In the following section, the results from contingency analysis are further analyzed and discussed based on data from sustainability leaders in Germany (Fig. 2.3).

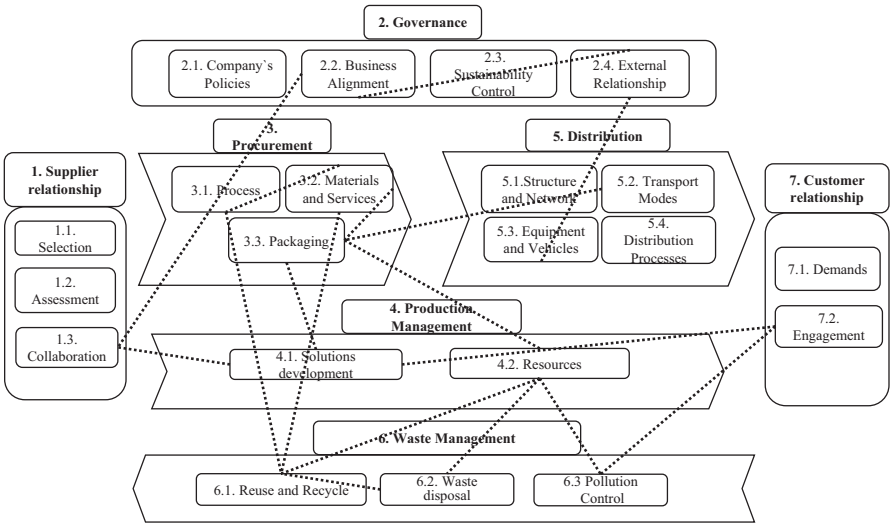

Fig. 2.3 Correlations between categories of SSC practices

2.5 Contingency Analysis of Framework Categories and Discussion of SSC Practice Combinations

The results from contingency analysis are displayed in details in Appendix 2, while the discussion regarding SSC practice combinations is further presented.

2.5.1 Supplier Collaboration Combined with Business Alignment (phi = 0.329) and Solutions Development (phi = 0.354)

The relationship between these categories is identified in corporate reports and available information published by German automotive manufacturers and can be explained when analyzing some of the reasons why companies collaborate with suppliers:

- Ensure compliance with sustainability standards

The set of quality, environmental, and social standards for the purchased products is a common initiative by companies worldwide. For BMW, the sustainability and environmental protection department takes responsibility for monitoring water, waste, energy, and emissions from internal operations and also from suppliers. An environmental management system filled with these data supports decision-making such as subject of training programs. Porsche highlights the importance of building

a cross-functional team with internal professionals from different departments and with suppliers, while VW reinforces the need for its link directly with the management board. Daimler reports that suppliers who are unable to meet environmental and social requirements should not be immediately delisted from the supplier pool. It is more efficient to support supplier development, which improves collaboration and enhances mutual trust between the two parties. Supplier development programs in VW and Porsche consist of digital learning module (e-learning) and for Audi involve internal departments such as human resource, health and safety, procurement, and quality. By the end of 2014 in VW, for instance, 14,457 suppliers had completed the e-learning module, which equates to 71% of procurement expenditures. The tool is made available to the supplier's workforce as well as to employees of Volkswagen AG procurement for qualification purposes. Integrating suppliers when discussing sustainability standards that influence business is a strategy of SC alignment and for extending company's values to its partners.

- Improve transparency

Transparency is very critical and one of the reasons for collaborating with suppliers. Since VW considers the environmental impacts of their products, particularly carbon dioxide (CO_2) emissions, at every stage of their life cycle, SC collaboration is fundamental for achieving target reductions in products' carbon footprint. International initiatives such as Supply Chain Program of the Carbon Disclosure Project are used by BMW to improve supply chain transparency. Though a common and standardized platform, suppliers record their resource consumption and identify business and cost-saving opportunities. The vehicle manufacturer also makes use of this platform to evaluate supplier potential for improvement and discuss further collaborations in supplier performance review meetings. VW also promotes meetings where more than 900 suppliers and manufacturers discuss challenges and joint solutions to improve sustainability along the supply chain.

- Development of new solutions

Another benefit from SC collaboration is the possibility of developing more sustainable solutions considering a broader perspective. The BMW Group Research and Innovation Centre in Munich encourages suppliers to present best-practice case studies on innovative and sustainable products, materials, and production processes during specific monthly forums. A closer relationship also allows the settlement of new standards together with business partners and the promotion of process innovation. VW participates in the "Innovation Alliance Green Carbody Technologies" together with suppliers such as Siemens to develop a simulation model to improve energy efficiency in the trajectories of production robots.

2.5.2 Business Alignment Combined with External Relationship (phi = 0.371)

The cross-functional groups responsible for managing sustainability act as promoters of stakeholder dialogues, not only in an SC scope but also with stakeholders such as governments, other companies, universities, and nongovernmental organizations (NGOs). A closer relationship with governments supports the compliance with current and future laws and development of industry standards and collaborative platforms which promotes better use of resources, cost reductions, and joint training programs. BMW, for instance, organizes stakeholder forums with representatives from all groups of interest and cooperate with universities to support employees and suppliers' development.

On the one hand, companies may achieve competitive advantage as a first mover when supporting governments in planning future regulations. On the other hand, continuous relationships with stakeholders keep the company informed about customers' demands, laws that influence its operations, and environmental and social issues raised by NGOs. The ability to manage these aspects and provide quick answers differentiates companies' sustainability in a global competitive market.

2.5.3 External Relationships Combined with Equipment and Vehicles (phi = 0.311)

Relationships with stakeholders such as governments, universities, and industry associations regarding SSC issues are clearly focused on two types of improvements in equipment and vehicle's performance: electric mobility and alternative fuels. Sustainable Mobility 2.0 is a project from the World Business Council for Sustainable Development of which most of the automotive companies, e.g., VW, are members. They collaborate with other companies from different industries to develop solutions for sustainable future urban mobility. BMW Group is also part of the National Platform for Electric Mobility, a German government advisory committee on electromobility. The company launched a roundtable with students in Berlin to discuss topics such as greenwashing vs. credibility, electromobility, and transformation of the German energy industry. Daimler designed a LivingLab BWe, where business, science, and public authorities cooperate to study different approaches to electric mobility and the technologies they involve.

Discussions regarding alternative fuels are conducted by Daimler in the "Automotive Fuel Cell Cooperation," a joint venture by this company (50.1%), Ford (30%), and Ballard (19.9%) founded in 2008. Another example is Audi that in early 2014 entered into a strategic partnership with the French biotech company Global Bioenergies.

2.5.4 Procurement Process Combined with Materials/Services (phi = 0.900) and Reuse and Recycle (phi = 0.306)

The sustainable procurement process starts with the reduction of the demanded materials which is directly linked with reusing and recycling initiatives (Min and Galle 1997). An example is the Original Parts Center of VW, the largest of its kind in Europe, which remanufactures used engines and gearboxes. Since 1994, it has saved more than 351,000 tons of steel and 49,000 tons of aluminum. Audi has been researching new concepts and techniques for reusing carbon fibers and reconditioning components such as starters and alternators from used vehicles. Their Ingolstadt plant saved roughly 500 metric tons of steel, 48 tons of copper, and 76 tons of aluminum in 1 year of operation.

The procurement process also involves the demand for more sustainable materials, components, products, or services, with lower impact in the environment and society. Audi is active in the Aluminum Stewardship Initiative, which aims to develop a global standard for sustainable aluminum, with environmental and social criteria for all stages of raw material extraction, production, and processing. The movement to acquire more sustainable inputs influences waste elimination strategies during and in the end of the product life cycle. According to Min and Galle (1997), the potential liability and costs of disposal of hazardous materials are the most important factors when choosing suppliers. An example is the use of renewable materials in new models from VW (Polo 5, Sharan N F, Golf 6, Golf 7, Passat 8) and Daimler. One of the main drivers for improving material use is the directive 2000/53/EC of the European Parliament and of the Council that, since 2015, requires automotive producers to ensure that new vehicles are reusable and/or recyclable to a minimum of 85% by weight per vehicle and reusable and/or recoverable to a minimum of 95% by weight per vehicle (European Parliament).

Besides how much and what is procured, for implementing a sustainable procurement process, it is essential to understand how they are purchased. Aspects such as building the contract with clear clauses and requirements, as well as shared responsibility principles, are currently being discussed among automotive manufacturers. Consequently, long-term collaborative relationships and joint efforts are promoted in order to reduce the impacts of their business in the environment and on society. VW, for instance, supports the European Commission in suppressing the funding of armed conflicts through the raw material trade. Another initiative presented in the literature but not reported by the selected companies is encouraging the use of e-procurement, which saves paper and time and increases transparency between buyers and suppliers.

2.5.5 Materials and Services Combined with Reuse and Recycle (phi = 0.302)

As explained in the previous section, the procurement of more sustainable materials, components, products, and services is directly related to waste management. The increase in the purchase of this kind of materials offers more opportunities for reusing the parts, remanufacturing, refurbishing, or facilitating the recycling process. One example comes from BMW that uses the "Design for Recycling" principle since the design phase, when materials and components are defined. The objective is to use components that can largely be reused or recycled. Audi's "MAI recycling" research project involves industrial partners in an attempt to find new concepts and techniques for reusing carbon fibers in volume production, therefore, reducing the need for raw ones. The company aims to develop the "Munich–Augsburg–Ingolstadt region" into a European center of excellence for carbon fiber-reinforced polymer lightweight construction.

2.5.6 Packaging Combined with Materials/Services (phi = 0.368), Solutions Development (phi = 0.368), Resources (phi = 0.352), and Transport Modes (phi = 0.338)

When companies decide to invest in procuring more sustainable materials and services, they include in this strategy the avoidance of using disposable packaging (including containers) or nonrecyclable packaging materials. In order to minimize any negative impact on the environment as well as additional financial charges caused by disposable packaging, VW invests in reusable packaging and containers in a larger extent. BMW established a packaging manual, which is integrated into the purchasing terms and conditions. This document makes clear their requirements, focused on the avoidance of packaging, on encouraging the use of reusable packaging and materials that can be recycled after its life cycle ends.

Besides reducing the product footprint, packaging innovations enable complementary efficiency gains that benefit the environment and society. BMW and Porsche use packaging design as opportunity for identifying the ideal density for protecting the product as well as the optimal use of space during transport loading. In an attempt to reduce overall material consumption, Daimler dispenses the paint-protection film used in their vehicles resulting in saving approximately 40,000 m^2 (430,000 ft^2) of the material in a year. Moreover, the use of bumper pads was discontinued for the entire fleet of exported passenger cars, a total annual volume that could fill ten large shipping containers. BMW also reduces transport volume and, thus, resource consumption, by optimizing packaging on inbound distributions.

According to the findings from contingency analysis based on the results from the initial literature review, additional initiatives to improve packaging in transport management are correlated with the employed transport mode; however, no clear explanation could be found based on the researched documents. All automotive manufacturers preferably use rail transport, e.g., Audi has 60% of their vehicles distributed using this mode and some through the Eco Plus, the CO_2-neutral rail transport by DB Schenker. The packaging redesign, use of less or lighter materials, as well as reusable ones might depend on each mode's specific restrictions.

2.5.7 Solutions Development Combined with Customer Engagement (phi = 0.309)

The design of more sustainable products, processes, and services is an excellent opportunity for encouraging changes in customer behaviors. Several examples are available to emphasize the improvements by the automotive industry in order to increase eco-efficiency and reduce the amount of emissions, including noise, which affects directly the society. Companies have set targets to reduce CO_2 emissions in the European new vehicle fleet, aligned with the European Union requirements, which generates large investments in new technologies. Beyond the development of hybrid and electric vehicles, other considerable improvements in vehicle's performance are visible. More efficient engines, optimized aerodynamics, intelligent energy management, lightweight design with carbon fiber-reinforced plastic, downsizing, forward-looking drive control, the "Auto Start Stop" function, brake energy regeneration, tires with reduced rolling resistance or air flap control (Johnson and Turner 2015) are some of the innovations that automotive manufacturers are implementing to improve sustainability of their cars. VW offers, for both commercial and personal vehicles, an additional driver assistance system that enhances road safety by reducing driver errors. The company centralizes the development of fuel-saving and low-carbon technologies in the "Complete Vehicle Architecture" unit. Initiatives to improve overall traffic flow, which are combined with reductions in energy consumption, are also being tested by companies and customers. Audi highlights the active lane assist, which warns drivers if they leave their lane; adaptive cruise control (ACC) with "Stop & Go," which automatically maintains the distance from other cars; and the night vision assistant that detects people and animals in the dark.

Solutions that provide economic gains (e.g., less fuel consumption) combined with environmental (e.g., less emissions) and social benefits (e.g., more safety) show to be accepted by the customers. Moreover, local governments have also been investing in more sustainable solutions, e.g., Stuttgart testing the Citaro G BlueTec Hybrid buses (manufactured by Daimler) for public transport. In addition, engaging customers in purchasing more sustainable products includes informing them about technical issues such as fuel or electricity con-

sumption, annual fuel costs, CO_2 emissions, and the amount of tax payable based on the amount of pollutants emitted. Since December 2011 in Germany, it is mandatory that new cars present a label with these information and a summary range from A+ (very efficient) to G (inefficient).

2.5.8 Resources Combined with Reuse and Recycle (phi = 0.338), Waste Disposal (phi = 0.375), and Pollution Control (phi = 0.447)

One of the strategies used to optimize overall consumption of materials is to reuse them. It can be incorporated in remanufactured and refurbished products or even into new products after being reprocessed. Automotive companies employ reused, recycled, and renewable materials in order to improve the product carbon footprint. New models from VW showed that such content accounts for approximately one-third of their weight. Furthermore, Daimler invests in more recycled materials and less weight ones which provide gains in energy consumption and overall emissions.

Product development considering environmental and social aspects is central, for instance, regarding the amount of non-useful waste, which is finally disposed. When the attention to sustainability aspects is taken since the design phase, the amount of this kind of waste in the end of the life cycle can be minimized. An example is VW and Audi that follow the ISO 22628 standards for recyclability and recoverability of road vehicles and whose vehicles are at least 85% recyclable and 95% overall recoverable. At the same time, the BMW Group Recycling and Dismantling Centre has been researching new solutions for increasing the vehicle recycling rate, reducing consequently the amount of waste disposed, e.g., regarding batteries from hybrid and electric models, which can be used to produce photovoltaic systems.

Finally, by managing resources more efficiently, overall emissions and the amount of energy, materials, and waste disposed are further reduced. According to VW, the efficient use of resources reduces not only the environmental impacts but also manufacturing costs. Savings in energy consumption affect directly energy-related emissions. Porsche switches off the machines and lighting during the morning brakes, resulting in less energy, costs, and waste, including noise. The use of renewable energy, e.g., solar panels by the plant in Leipzig, allowed an annual reduction of 11,637 t of CO_2 emissions. Audi factory in Győr (Hungary) is building a geothermal heat plant which is expected to meet approximately 60% of the plant's total heat requirements and to reduce the company's CO_2 emissions by a further 23,000 t. The usage of waste heat offers great sustainability impacts for companies. Porsche reports that a nearby woodchip-fired heating plant provides almost 80% carbon-neutral heating resulting in cost savings of approximately €360,000 per year.

2.5.9 *Reuse and Recycle Combined with Waste Disposal (phi = 0.306)*

The more a company reuses and recycles, the less disposed waste is generated. Solutions for separating and recycling the waste in an effective way support reductions in disposal expenses and allow capturing its value. VW launched a project I 2014 in two locations in China to increase the recycling ratio to 80%. In Germany, BMW operates a mandatory closed system for waste disposal. All dealers and dealerships are responsible for returning the listed materials to the BMW system for recycling and raw material recovery. Waste from service, maintenance, and repair (e.g., bumpers, batteries, trim) is equally part of this reverse logistics flow. Daimler, Audi, and VW have been investing in projects for developing innovative solutions for recycling waste from electric vehicles (Lithium Battery Recycling Initiative). Besides, Audi is involved in the Aluminum End-of-Life (Aleol) project, which aims at developing a recycling process chain, for testing the effectiveness of the latest sorting technologies, among others. Moreover, Daimler searches for alternatives for reusing wastewater from the production plant. All initiatives intend, thus, to reduce waste disposal to the environment.

2.5.10 *Pollution Control Combined with Customer Engagement (phi = 0.315)*

Discussions about how to minimize emissions to the environment (air, water, visual, noise, or odor) consider the product life cycle, starting in the design phase until how customers use and dispose their products after the end of the use phase. This concept needs, therefore, to increase customer responsibility in reducing the overall impact of a product and encourage them to set a more sustainable behavior. Additional services can also support this change, such as Daimler's tool to support decision-making between each available alternatives for urban mobility and car-sharing services, e.g., car2go.

2.6 Conclusions

Despite the increased efforts by research on sustainable supply chains and companies to implement SSC practices, new approaches that support corporations in balancing supply chain and sustainability performance are still necessary. This chapter concentrates on the combination of SSC practices by identifying significant

relationships in related literature and by exemplifying the observed practice combinations based on corporate reports. The results from contingency analysis among the 7 structural dimensions and 21 categories of the framework for managing SSC practices (Campos 2015) provide insights into the correlation of SSC practices discussed in literature. Subsequently, based on the public reports of five German automotive manufacturers, the combination of SSC practices is described to substantiate the findings from contingency analysis and to outline SSC practices that are suitable to be implemented in combination with others. First, the governance dimension as a compound of initiatives for building corporate sustainability is positioned at a strategic level and plays a fundamental role in supporting the implementation of other practices. Secondly, in contrast, the supplier relationship dimension showed to be decoupled from the other dimensions. While this points supplier management as a specialized function, in the scope of SSC management, this evidences a lack of integration between companies and its suppliers and logistics service providers and customers' points as well as reinforces the challenges of SC collaboration. Thirdly, the strong correlations among categories of procurement, waste, and production management confirmed the central role of corporate alignment and closed-loop principles toward a sustainable supply chain. Examples of combination of initiatives from German leaders showed how practices are being implemented in combination with others in order to enhance company performance. From a conceptual point of view, the concept of a relational rent (Dyer and Singh 1998) can be transferred to rents resulting from the combination of SSC practices. These combination rents are assumed to result in considerably enhanced sustainability performance compared to SSC practices being implemented separately and without integrating relevant functions.

The analysis of relevant literature is guided by a fixed coding framework that groups practices according to the stages of firm's supply chain. Even though contingency analysis of joint occurrences of SSC practices reveals significant correlations that are interpreted as opportunities for practice combination to improve SSC performance, the causal directions are not identified. Hence, the chronological order of practice implementation and mutual influences of practices have to be evaluated. Moreover, appropriate ways to measure combination rents are needed to evaluate the benefits of SSC practice combinations in various industry contexts. Action research may contribute to the exploration of ways to quantify the combination rents derived from implementing pairs or groups of SSC initiatives simultaneously.

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Appendices

Appendix 1: Descriptions of Dimensions and Categories of SSC Practices

Dimensions/categories	Description
1. Supplier development	Implement practices related to suppliers' selection, assessment, and collaboration to improve company's and suppliers' performance on environmental and social outcomes
1.1. Selection	Include sustainability criteria during the supplier selection process (certifications, management systems, compliance with guidelines, code of conduct), prefer using specific group of suppliers that are more social-environmental responsible
1.2. Assessment	Communicate expectations, monitor suppliers' performance, and ensure they meet the required objectives, using questionnaires/ inspections. Evaluate indirect suppliers and penalize them in case of lack of compliance
1.3. Supplier collaboration	Collaborate with suppliers to increase SC sustainability, promote integration and information sharing, financial support for sustainability
2. Governance	Implement sustainability policies and management systems, align business operations with sustainability matters, and establish a good relationship with stakeholders
2.1. Company's policies	Implement policies to motivate quality improvements combined with reduction of the impact on the environment and people. May include supply chain-specific policies and compliance with current regulations
2.2. Business alignment	Promote alignment between company's strategies and sustainability issues, create formal departments/functions to manage this topic, stimulate internal communication and education
2.3. Sustainability control	Implement management systems and internal KPIs related to sustainability, manage company's certifications and risk-safety-related issues
2.4. External relationship	Manage relationship with external stakeholders and publicize sustainability efforts
3. Procurement	Improve sustainability through changes in the procurement process, materials, and services (including packaging) that are purchased
3.1. Process	Implement improvements on the procurement process, including on contracts, in order to make it more social-environmental responsible
3.2. Materials and services	Purchase sustainable materials, components, products, and services, including those that are certified (e.g., eco-label)
3.3. Packaging	Use or design innovations on packaging in order to make them more sustainable

(continued)

Dimensions/categories	Description
4. Production management	Implement practices related to the development of new solutions and management of resources
4.1. Solutions development	Design more sustainable products, processes, and services, considering the product life cycle and resource consumption
4.2. Resources	Manage resources (materials, energy, water) and invest in renewable sources
5. Distribution	Improve sustainability through adjustments in structure, network, modes of transport, new vehicles and equipment's technologies and distribution processes
5.1. Structure and network	Implement adjustments during construction phase, facilities management, network structure, and specific distribution strategies
5.2. Modes of transport	Improve sustainability through switches on modes of transport
5.3. Equipment and vehicles	Improve sustainability through adjustments on logistics equipment and vehicles (fuel, rolling resistance, body type, maintenance, others)
5.4. Distribution processes	Implement changes in the distribution process such as inventory management (particular attention to hazardous materials) and transport optimization, improve driving skills, and use low speed driving
6. Waste management	Manage waste and pollution in order to decrease environmental, economic, and social impact
6.1. Reuse and recycle	Encourage reuse practices, including remanufacture and recycling
6.2. Waste disposal	Implement practices for disposing (not selling) waste in a correct way
6.3. Pollution control	Control, minimize, and compensate pollution
7. Customer relationship	Manage customer relationship identifying their demands and engaging them on sustainability issues
7.1. Demands	Collect information about customer demands/habits and react according to their necessities
7.2. Engagement	Engage customers actively on sustainability issues and encourage behavior changes

Appendix 2: Significant Correlations Between SSC Practices

Acronyms	Category combination	Phi coeff.
Supplier relationship		
SC*GBA	Supplier Collaboration (1.3)*Business alignment (2.2)	0.329***
SC*PmS	Supplier collaboration (1.3)*Solutions development (4.1)	0.354***
Governance		
GBA*GE	Business alignment (2.2)*External relationship (2.4)	0.371***
GE*DE	External relationship (2.4)*Equipment and vehicles (5.3)	0.311***
Procurement		
PP*PMC	Procurement process (3.1)*Materials/services (3.2)	0.900***

(continued)

Acronyms	Category combination	Phi coeff.
PP*WPR	Procurement process (3.1)*Reuse and recycle (6.1)	0.306***
PMC*WPR	Materials/services (3.2)*Reuse and recycle (6.1)	0.302***
PPL*PMC	Packaging (3.3)*Materials/services (3.2)	0.368***
PPL*PMS	Packaging (3.3)*Solutions development (4.1)	0.368***
PPL*PME	Packaging (3.3)*Resources (4.2)	0.352***
PPL*DM	Packaging (3.3)*Transport modes (5.2)	0.338***
Production management		
PmS*CE	Solutions development (4.1)*Customer engagement (7.2)	0.309***
PmE*WPR	Resources (4.2)*Reuse and recycle (6.1)	0.338***
PmE*WPW	Resources (4.2)*Waste disposal (6.2)	0.375***
PmE*WPP	Resources (4.2)* Pollution control (6.3)	0.447*
Distribution (subcategories included under "Supplier Relationship" and "Governance")		
Waste management		
WPR*WPW	Reuse and recycle (6.1)*Waste disposal (6.2)	0.306***
WPP*CE	Pollution control (6.3)*Customer engagement (7.2)	0.315***
Customer relationship (subcategories included under "Production Management" and "Waste Management")		

* $p <= 0.050$, ** $p <= 0.015$, and *** $p <= 0.005$

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Chapter 3
Interactions Along the Supply Chain for Building Dynamic Capabilities for Sustainable Supply Chain Management

Dimitar Zvezdov and Roya Manuela Akhavan

Abstract Today's dynamic business environments require that company expand their focus beyond the gates of their premises. The growing number and relevance of social and environmental issues, in particular, attracts companies' efforts along the entire supply chain. Yet, doing so requires capabilities companies need to develop in order to cope with a dynamic set of challenges with various business effects. Using a key constituent in supply chains – interactions – as a starting point, this conceptual contribution conducts an initial investigation of how interactions can help develop dynamic capabilities for an effective sustainable supply chain management.

The analysis arrives at the conclusion that interactions can be used in a variety of situations to promote the development of dynamic capabilities. These results identify a number of interaction properties that can play an important role in developing a certain dynamic capability. The findings present a first approach of these issues. As such, it serves to shed light on the research direction that could potentially reveal a promising aspect of interactions, which has been neglected to date.

Keywords Sustainable supply chain management • Dynamic capabilities • Interactions

3.1 Introduction

Supply chain management (SCM) – from a cross-functional perspective – is considered one of the key resources for gaining and securing a competitive advantage in tomorrow's global race (Schoenherr et al. 2012). Whereas managing complex

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supply chains (SCs) is related to a number of advantages that measurably enhance company competitiveness (Cousins 2005), numerous uncertainties and risks arise – being either intended (e.g., due to opportunistic behavior) or unintended (such as poor working conditions and negative environmental impact) in origin. Many of these uncertainties and risks are related to social and environmental effects of business on society and vice versa. Therefore, integrating such social and environmental aspects has become an embedded prerequisite for focal companies and their SCs in the pursuit of gaining and maintaining long-term competitiveness (Bai et al. 2012; Zimmer et al. 2015).

Managing the thus increased SC complexity is related to developing and adopting various approaches – such as implementing costly monitoring mechanisms – that may inflict additional transaction and opportunity costs (Carter and Rogers 2008). The challenge pertains to moving from unsustainable SCs to more "sustainable supply chains with an emphasis on the reduction of harm and trade-offs between all aspects of sustainable performance [i.e., society, environment, and economy]" (Schaltegger and Burritt 2014, p. 233).

As a consequence, sustainable supply chain management (SSCM) has become an important approach in management practice (Beske and Seuring 2014). From a practical perspective, the goal of SSCM can thereby be summarized as designing, organizing, coordinating, and controlling SCs in an attempt to maintain economic viability while minimizing harm to social or environmental systems.

The application of SSCM practices and strategies requires rethinking and adapting decision-making processes and practices, processes which in turn require organizational capabilities to do so, both in terms of internal routines and external relationships (Parmigiani et al. 2011). Therefore, companies need organizational capabilities that alter the way of deploying existing capabilities and resources. Such higher-order capabilities are labeled as dynamic capabilities (DC).

The DC concept offers a theoretical view on how companies achieve new resource configurations as dynamic markets and environmental conditions change (Eisenhardt and Martin 2000; Teece et al. 1997; Winter 2003; Zahra et al. 2006; Zollo and Winter 2002). Such capabilities are particularly relevant in high-velocity markets, where DCs shape opportunities and threats and can help to gain and maintain competitiveness through enhancing, combining, and protecting the enterprise's intangible and tangible assets that assist corporate evolutionary fitness (Teece 2007; Teece et al. 1997).

However, only little effort has been invested into providing tangible outputs on management approaches such as structures, practices, and processes that companies use to develop DCs (Ambrosini and Bowman 2009). SSCM research has, in particular, largely neglected DCs and their role in dealing with established cross-firm relationships as part of today's dynamic SCs (Rauer and Kaufmann 2015). Such cross-firm relationships can be observed based on the interactions between the focal company and the actors in its direct and indirect environment.

This research gap roughly sketched above, therefore, boils down to the question: How do SC interactions help companies to develop DCs to enhance their SC sustainability performance? The purpose of this contribution is focused on discussing

(a) the DCs companies need for implementing SSCM and (b) the processes to build these DCs in a first step. In linking the DC perspective to SSCM, we directly respond to calls from prior studies to enhance theory and empirical research on DCs in (sustainable) SCs (Beske 2012; Beske et al. 2014).

In order to support the transition toward sustainable supply chains (SSCs), this chapter first identifies the outcomes of the different interactions before it sketches what DCs are advantageous in SSCM. Subsequently, the two – interactions and DCs – are drawn together in an attempt to connect the two categories and highlight potential bridges between the two. Finally, the key learnings are summarized, and future research is mapped in order to extend this first conceptual analysis.

3.2 SSCM, Interactions, and DCs

In order to approach the issue adequately, we first seek to gain a better understanding of SSCM and of the challenges it poses on the organization. This enables us to subsequently construct an approach that addresses the SSCM challenges identified in extant literature. For this, we start with a brief discussion of what SSCM is and why it matters.

3.2.1 SSCM

3.2.1.1 What Is SSCM?

Businesses demonstrate a growing recognition of (a) the relevance of sustainability aspects for corporate success and (b) the company's limited ability to manage these sustainability aspects along the entire SC – from the raw material to the product end-of-life (Schaltegger et al. 2013). In order to embrace and manage this challenge as to minimize potential risks and create and pursue related chances, a multitude of businesses have started expanding their understanding of the conventional SCM to encompass social and environmental aspects.

In view of the rising importance of managing social and ecological aspects along the SC, SSCM has become an important phenomenon in management practice (Beske and Seuring 2014; Walker et al. 2012). Whereas a number of authors (Seuring and Müller 2008) have defined SSCM from various (partially diverging) perspectives, a SSCM understanding that has been largely agreed upon or served as the basis for further deliberations was coined merely a decade ago. SSCM is thereby defined 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" (Carter and Rogers 2008, p. 368). It is, nevertheless, important to note that at least a dozen further

definitions of SSCM and nearly twice as much green SCM definitions have been identified in literature (Ahi and Searcy 2013). Their common denominator appears to be (i) the extension of the purely economic view to include the social and environmental dimensions, (ii) the multidirectional resource flows along the SC and (iii) the company's activities related to the challenge.

Having broadly defined the subject of investigation, we now look into related literature to highlight key SSCM strategies.

3.2.1.2 Basic Strategies in SSCM

In implementing SSCM, companies adopt a broad spectrum of instruments, practices, and strategies. Within this spectrum, we find practices such as screening and development (Seuring and Müller 2008) or decommodization (Pagell and Wu 2009) as well as instruments such as codes of conduct (Mamic 2005; Preuss 2009) or sustainability standards, (Beske et al. 2008) to name a few.

Extant literature (Akhavan and Beckmann 2017) identifies and observes two norm SSCM strategies referring, on the one hand, to risk orientation and, on the other hand, to opportunity orientation. The risk-oriented strategy inhibits practices to reduce sustainability risks and challenges by applying established norms and standards to screen, select, and monitor suppliers against a set of defined minimum requirements (Harms et al. 2013). In contrast, an opportunity-oriented strategy emphasizes supplier development (Seuring and Müller 2008). Such a strategy requires qualification of suppliers and can also intend joint development and the sharing of resources and risks (cf. Seuring and Müller 2008).

Whereas the above two basic strategies provide a robust framework for companies to engage with SSCM, a multitude of issues have been identified as critical for solving related organizational challenges (Carter and Easton 2011; Sarkis et al. 2011). These are sketched briefly below in order to highlight the potential interface between the challenges and their potential solutions described in the subsequent sections.

3.2.1.3 Challenges in Implementing SSCM

First, only limited understanding exists on the structures, management practices (i.e., instruments, systems), and processes companies use to build DCs (Ambrosini and Bowman 2009) in the alignment of SSCM strategies.

Second, building upon the presumption that the challenge of corporate sustainability and the development of SSCs is a cross-functional challenge, mechanisms of knowledge transfer need to be shed light on (Gorovaia and Windsperger 2010).

The above list only covers a fraction of the challenges identified in extant literature, and it can therefore be expanded. For the sake of brevity, this is not carried out. However, to summarize, it can be said that the challenges vary in nature and approach (e.g., organizational, interorganizational, regulatory, social, etc.).

The more important insight is, however, that SSCM is a complex task regardless of which of the numerous understandings scholars and practitioners in the area adopt. As such, it challenges companies in several ways. In order to develop solutions for these challenges, the following section investigates interactions as a link to make supply chains more sustainable. Again, we start with a brief outline of our contemporary understanding of interactions in the context of SCM.

3.2.2 Interactions in Supply Chains

3.2.2.1 What Are Interactions?

In the context of management science, the term interaction refers to the activity when two or more actors affect each other's behavior. Interactions can be, among others, implicit or explicit, direct or indirect, desired or undesired, regular or one-off, and planned or accidental.

More specifically, interactions have been defined as "a way through which mutual behavior are modified via the medium of scarce resource availability upon which both struggling entities depend" (Antai and Olson 2013, p. 511). For the purposes of this chapter, interactions can be described as the relationship between two or more points in SCs for the purpose of securing and exploiting critical resources.

In order to avoid ambiguity, it is important to distinguish between interactions and related terms. The discussion around SSCM seems to implicitly put an equal sign between interaction on the one hand and cooperation (Seuring and Müller 2008; Guoyou et al. 2012) or collaboration (e.g., Bowen et al. 2001; Pagell and Wu 2009) on the other. It needs to be emphasized that whereas cooperation and collaborations can be treated as interactions at all times, the opposite does not necessarily hold true. This is particularly relevant whenever the intended outcomes of the one (i.e., interaction) or the other (i.e., cooperation or collaboration) are discussed. The following section, therefore, investigates the purpose of interactions in the context of SSCM.

3.2.2.2 The Purpose of Interactions in the Context of SSCM

As previously discussed, interactions may be of unintended or deliberate nature. Similar reasoning applies to their purpose: whether intended or not, interactions may have outcomes that were initially intended or such that were not originally intended or intended at all (and are thus often undesirable).

Several models (e.g., Medlin 2004; Ford et al. 2008) describe the ex ante purpose of interactions. In the context of SCM, Ford et al. (2008) adopt an industrial network perspective that directly upgrades the model, originally developed a decade earlier (Hakansson and Johanson 1992).

The original model conceptualizes the process and outcomes of interaction in terms of three interconnected factors: actors, resources, and activity; hence its designation, A-R-A model, whereby:

- *Actors* in an SC are characterized by their organization form, company mission, and profit orientation. Interactions may include actors different than typical SC participants (Pagell and Wu 2009).
- *Resources* are controlled and exploited by organizations in the pursuit of fulfilling their mission. In accordance with the SC perspective adopted in this chapter, resources can be categorized as either tangible or intangible.
- *Activities* describe the actions that the actors in an SC undertake to fulfill their mission.

Bringing the discussion back to the purpose of interactions, the above model provides several key implications we pursue in this chapter. Actors (i) engage in interactions to (ii) attain their organizational objectives and pursue their strategy. In achieving this, (iii) resources play a key role; therefore, (iv) actors seek to gain control of resources that support them in (v) implementing a strategy to fulfilling their mission.

Before matching interactions to obtaining SSCM objectives, we first need to shed light on SSCM interactions and their attributes.

3.2.2.3 Interaction Attributes in the Context of SSCM

Extant literature on interactions in the context of SSCM seems to be limited, yet well consolidated, i.e., extant knowledge is comprised in a few publications. We draw the following typology of interactions based on this literature and structured in accordance with the A-R-A model.

First, in terms of the actors, Pagell and Wu (2009) differentiate between internal and external (related to the SC) actors. Whereas adjacent internal actors are forced to interact with one another, further interaction is normally not the case. External actors can, however, also play an important role in an SC – they can facilitate interactions between members of the SC.

Second, the theme of resources has been central to the SCM and thus to the SSCM discussion (Alfonso et al. 2010; Seuring and Müller 2008). In this discussion, three basic types of resources have been of key significance: material, capital, and information.

Essential to the resource discussion in the context of SSCM is the fact that resources can be exchanged among the different actors. Second, resources can be optimized (Halldórsson et al. 2009). An example for the latter is the establishment of product recycling as a closed-loop SC that includes a new product design.

Third, in the context of SCM, activities have been discussed both as a central theme and as a supporting element, often with synonymous expressions such as routines. In either case, both their objectives (e.g., Antonacopoulou and Pesqueux

2010) and factors that shape them have been discussed. This section discusses those aspects that propagate the understanding of activities in view of SSCM.

Activities can be structured in a hierarchy of practiced routines that are coherent (Nelson 1991). The latter – routines – refer broadly to the way things are done in and around (i.e., among others in its SC) an organization and may thereby include not only clear-cut routines but also "the relatively constant dispositions and strategic heuristics that shape the approach of a firm to the non-routine problems it faces" (Nelson and Winter 1982, p. 15).

The discussion becomes even more encompassing once it is recognized that activities are carried out collectively rather than on an individual level (e.g., Pentland 2011). While studying such activities, therefore, the emphasis is placed on the interactions between the actors rather than on the individual actors (Feldman and Pentland 2003; Felin and Hesterly 2007). The latter conclusion deduces key implications in the context of SC interactions, whereby resources are distributed among different parts of the organization (Sako 2004). Therefore, managing interactions and channeling them to develop DCs is a matter of coordination between individuals.

Another differentiation can be made with regard to the purpose of activities. The extent and nature of a company's interaction with various SC actors not only is marked by the exchange of resources (as discussed above), but it also affects their capacity to manage innovation and risks.

Having discussed the key aspects of SSCM and interactions, we now focus our attention to DCs and how these could benefit from interaction in order to enable effective SSCM.

3.2.3 Dynamic Capabilities

3.2.3.1 The Nature of Dynamic Capabilities

This section starts with a brief deconstruction of the DC concept to its key components. This is done to better grasp their nature and to clearly delineate them from closely related concepts such as abilities or first-order capabilities.

A DC can be seen as "the capacity of an organization to purposefully create, extend, or modify its resource base" (Helfat et al. 2007, p. 4). The idea of DCs is based on the understanding that routines – learned, repetitious, and standardized processes – are used to modify operational activities or other resources, forming the resource base (Winter 2003; Zollo and Winter 2002). As such, DCs reconfigure and modify a firm's resources and operational capabilities, i.e., it raises the question of how operational routines are changed (Collis 1994; Winter 2003). In contrast, zero-order capabilities reflect the ability to perform the basic functional activities of the firm, i.e., it looks at how "living is earnt." Thus, the fundamental difference of DCs and operational capabilities lies in the embedded process character to continuously alter resource configurations addressing the changing environment (Eisenhardt and

Martin 2000). Teece (2007) and colleagues (Teece et al. 1997) underline the relevancy of such capabilities in high-velocity markets, where DCs shape opportunities and threats and maintain competitiveness through enhancing, combining, and protecting the enterprise's intangible and tangible assets that assist corporate evolutionary fitness.

To illustrate, examples for such stable patterns of renewing the resource base are product development, acquisition routines, or research and development (R&D) processes where managers integrate, reconfigure, or gain and release resources (Zollo and Winter 2002). What these examples share is the necessity to implement processes creating a new bundle of resources and capabilities to sustain a competitive advantage. DCs, thereby, cover main processes such as leveraging, reconfiguration, sensing, seizing, and integrating assets and resources (Ambrosini and Bowman 2009; Teece 2007). In that sense, DCs have an indirect effect on competitive advantage as DCs per se seek to modify the resource base to stay competitive in dynamic environments (Ambrosini and Bowman 2009).

In the context of SCM, DCs play an important role to improve the coordination and integration of good and information flows up- and downstream the SC (Chen et al. 2009). For example, supply management alignment refers to the capacity of the procurement department to engage in knowledge acquisition processes with different stakeholders to interact with suppliers consistent with those needs and strategy goals (Handfield et al. 2015).

Having sketched the basic features of DCs, we now draw the attention to the question, in what way SSCM strategies can substantially benefit from the development and of higher-order capabilities.

3.2.3.2 In What Way Can DCs Affect SSCM Outcome

Taking sustainability issues into consideration, different DCs are required to improve the sustainability performance of SC partners and to implement SSCM (Paulraj 2011). The specific challenge lies in sustainability's nature of an interdisciplinary concept that not only modifies selection criteria for suppliers and materials – from monetary and lead indicators to environmental and social aspects – but also changes internal routines, structures, and management processes. These characteristics change SCM in several ways.

First, as distances along the SC increase, it becomes more difficult to incorporate environmental and social aspects and to develop trust between SC partners (Carter and Rogers 2008). Second, in managing SCs sustainably, a firm usually orientates itself at what competitors do and what other stakeholders expect. Third, companies have to create and demonstrate transparency and ensure traceability of their products along the upstream SC requiring above described activities (Grimm et al. 2012). Furthermore, sustainability involves more actors around the typical SC raising requirements but also interact in risk mitigation processes (Harms et al. 2013). As a consequence, sustainability expands the depth and width of the SC.

Thus, from a capability perspective, firms need to develop capabilities and skills to handle outside constituencies (Parmigiani et al. 2011). As SCs are prone to unpredictable changes and challenging stakeholder requirements (Beske 2012), companies need different DCs to respond to such dynamic environments (Eisenhardt and Martin 2000; Teece 2007).

Having identified how DCs can affect SC activities, a number of DCs can be induced and conceptualized. The following section briefly reviews a few such DCs. The review focuses explicitly on those mechanisms that rely and/or can be influenced by interactions significantly.

3.2.3.3 Interactions' Influence on DCs Needed for Improved SSCM Performance

In complex SCs, the competitive advantages are not gained only within firms but also between multiple SC members showing also high interaction in deploying DCs (Defee and Fugate 2010).

In contrast to conventional SCM, SSCM looks at an extended SC and evaluates impacts on actors and system elements outside the value chain (Carter and Rogers 2008). This issue requires the consideration of external stakeholders and, in particular, their expectations regarding how companies manage their SCs in a sustainable way (Parmigiani et al. 2011).

In this context, companies apply different DC processes to integrate necessary partners and capabilities, to leverage knowledge and experience from others, or to recombine internal and external resources and skills in order to deal with sustainability dynamics. These routines and DC processes can be deployed on different levels of the SC, as sustainability requires both internal and external interaction forms.

In the SSCM context, global sourcing companies often use external resources (such as nongovernmental organizations) in order to be responsive and to integrate knowledge and capabilities for effective SSCM practices (Reuter et al. 2010). Doing this, firms need to sense the stakeholder expectations regarding sustainability in advance and seize the opportunity for external cooperation (Reuter et al. 2010; Teece 2007).

More concretely, to overcome SSCM implementation barriers, companies need to build and deploy alignment capabilities (Rauer and Kaufmann 2015). Against this backdrop, companies should possess routines to develop and align objectives and shared solutions overcoming structure-related barriers in the vertical SC. With regard to standard-related barriers, firms require industry-alignment capabilities to form a common understanding of sustainability definition and standards between SC partners. On a political level, legislation-focused sensing capabilities help to generate knowledge about the institutional environment in time and alignment capabilities to influence political decisions (Rauer and Kaufmann 2015).

Related to the requirement to adopt constantly upcoming sustainability issues and ideally before competitors doing it, crucial DCs represent the capacity to coevolve and to purposefully develop SC partners (Beske 2012; Beske et al. 2014). Coevolving means that SCs change together and develop capabilities to jointly develop products and other partner-based synergies (Beske et al. 2014; Defee and Fugate 2010). Partner development typically refers to knowledge sharing and trainings across the SC to improve the performance regarding the basic SSCM strategy (Beske 2012).

The above examples of DCs in the SSCM field show that a bundle of different practices, routines, and operational capabilities form a DC process. However, we have to remark that these processes and routines are not dynamic per se but relate to the purpose to deal with constantly changing sustainability issues (Beske et al. 2014).

In order to be capable of modifying, creating, and extending the resource base for SSCM, it is, thus, crucially relevant to design management practices, structures, and mechanisms to alter these capabilities and resources in a purposeful way (Helfat et al. 2007).

Last but not least, the question arises, what mechanisms govern the development of DCs. This is discussed in the following section.

3.2.3.4 Mechanisms of Developing DCs

If DCs are now related to organizational change, how are DCs developed and built? Extant research (Schilke 2014) conceptualizes these routines as second-order DCs which reconfigure first-order DCs referring to the above described processes (i.e., routines altering the resource base). Such meta-capabilities are understood as learning-to-learn capabilities to build new first-order DCs (Collis 1994; Danneels 2012). Exemplarily, creating and managing strategic alliances are seen as first-order DCs, whereas alliance learning capabilities form second-order DCs increasing this alliance management capability (Schilke 2014).

In general, this suggests that processes and routines, which function as such meta-capabilities, are grounded in learning processes, knowledge, and experience accumulation (Sirmon et al. 2007; Zollo and Winter 2002). Accumulating this knowledge and experience can be grouped around the sources of origin. In order to obtain capabilities from external sources, DC literature suggests that mechanisms such as acquisitions or alliances integrate new capabilities (Vassolo and Anand 2008). Acquisitions can provide an infusion of required capabilities which cannot be developed internally or obtained from markets. Alliances and joint ventures with other firms can provide a forum to exchange capabilities through organizational boundaries (Vassolo and Anand 2008). As the integration of sustainability issues is often related to knowledge expansion – for example, learning and defining SSCM practices – companies accumulate experiences and articulate and subsequently codify knowledge to develop DCs (Zollo and Winter 2002). Thus, DCs are often built by internal learning processes involving necessary steps such as bundling or

mobilizing capabilities to unfold the full potential of a firm's resource portfolio (Sirmon et al. 2007).

Having charted the territory that lies at the intersection of the three domains, SSCM, DCs, and interactions, a concluding discussion summarizes the key aspects that can help explore and exploit interactions in order to develop DCs.

3.3 Conclusion and Outlook

In summary, this chapter focuses on the significance of SSCM for today's business and highlights a number of challenges that arise due to the additional complexity introduced by the explicit consideration of social and environmental issues along economic ones. In order to deal with such issues successfully, companies need higher-order, i.e., dynamic capabilities that enable companies to improve the overall performance of their SCs and thus gain and retain competitive advantage.

Driven by the reasoning that a solution to the problem often lies in the problem itself, we magnify the aforementioned SC complexity to observe that this complexity largely arises due to the interactions between the different actors involved. Therefore, it seems intuitive to analyze how these interactions can be harnessed in developing DCs.

The analysis in the above sections makes a first attempt at highlighting how interactions – as a principal constituent of SCs – can be used in approaching the challenge of improving the sustainability performance of SCs.

The key findings of the above analysis boil down to pinpointing general and specific mechanisms of how interactions can be used to successfully develop DCs that can in turn be applied to enhance the sustainable SC performance. The underlying reasoning shows that interactions, broken down to actors, resources, and activities, provide numerous starting points for developing DCs.

The above key learnings present several implications to consider. First of all, while several interaction properties appear to have a role on developing DCs, the spectrum of possibilities within this property rarely allows a clear distinction. This aligns with previous research which has, e.g., identified that capabilities developed in-house blur with such that have been developed through relationship with external actors (Gadde and Håkansson 2001). Nevertheless, it can be argued that it is precisely the interaction with other parties that activates a company's resource base.

This initial conceptual exploration has revealed unchartered territory and can be expanded in several directions. First off, qualitative research could seek anecdotal evidence that supports the statements made. Of particular interest are various contingencies – such as SC length or proximity between the different nodes – that might strengthen (or weaken) the effect of interaction on building DCs. This would enable making more definite statements regarding the applicability of the theory while avoiding the uncertainty that arises due to contingencies that negate the effect.

Last but not least, interaction typology for building DCs would help structure and match key DCs to those interaction properties that play a key role in developing DCs.

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Chapter 4
Toward the Integration of Sustainability Metrics into the Supply Chain Operations Reference (SCOR) Model

Margarita Stohler, Tobias Rebs, and Marcus Brandenburg

Abstract The consideration of ecological and social impacts of supply chains is becoming a pressing issue and a competitive advantage for companies. Therefore, sustainability-related aspects have to be identified and integrated into supply chain management to allow for sustainable performance measurement. However, the widely recognized Supply Chain Operations Reference (SCOR) model and its extensional Green SCOR model do not comprehensively address the triple bottom line (TBL) of sustainability, i.e., the interplay of the economic, environmental, and social dimensions, especially because social aspects are neglected so far. Furthermore, the ecological metrics are mainly output oriented, thereby omitting input factors that are crucial to environmental performance. Against this background, this chapter (1) elaborates on literature concerned with the integration of the TBL of sustainability into supply chain management processes and (2) develops a conceptual framework to match sustainability metrics to the SCOR processes. On the one hand, the resulting conceptualization contributes to closing the current research gap on the integration of sustainability metrics into supply chain process models, and on the other hand, it alleviates practice application through compatibility with the standardized SCOR model. It is found that environmental metrics can be directly related to existing SCOR process elements, while social metrics are more difficult to integrate. Nevertheless, the research presented should subsequently be subject to empirical validation and formal mathematical modeling to shed light on holistic sustainability performance measurement of supply chains.

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4.1 Introduction

Increasingly complex economic structures and global competition imply the need for continuous managerial efforts to optimize a firm's supply chain processes and thereby achieve and secure competitive advantage. Besides, interwoven international supply chains tend to bring about issues related to environmentally sound and socially responsible procurement, production, and distribution. The triple bottom line (TBL) of sustainability (Elkington 1997), i.e., the consideration of the interplay of economic, environmental, and social aspects, is a core element in the framework of sustainable supply chain management (SSCM) (see Seuring and Müller 2008; Carter and Rogers 2008). However, there are considerable goal conflicts between these three dimensions, even though in a few cases win-win(-win) situations are achievable (Seuring and Müller 2008). Managing the stakeholders is another crucial task in this regard because their pressures and incentives are of growing importance (Seuring and Müller 2008; Carter and Easton 2011). For supply chain managers, the evaluation of these aspects might unveil optimization potential.

Supply chain management and the controlling of related processes have been focused by the Supply Chain Council and resulted in a continuous development of a Supply Chain Operations Reference (SCOR) model (Supply Chain Council 2008). It integrates all stages of an organization's supply chain including sourcing, production, and distribution activities and links them to the supplying organizations and the customers, respectively. Moreover, there have been first attempts to construct a Green SCOR model (Supply Chain Council 2008) that aims at integrating environmental impacts into supply chain process management. However, the scope and applicability of the Green SCOR model is still limited, and, besides, there is no holistic TBL approach observable.

Against this background and due to its standardized structure and applicability across various industries, the SCOR model is considered as potential starting point for the integration of metrics that equally measure environmental as well as social aspects besides existing economic performance indicators. Thus, the central research question of this study is: To what extent can the processes of the SCOR model be complemented by environmental and social metrics for SSCM?

In the following, current literature related to metrics for SSCM and developments of the SCOR and Green SCOR models is briefly reviewed to assess the state of research. Subsequently, the logic of the presented conceptual framework is outlined. Deduced categories of metrics are then focused with regard to the elaboration of distinct metrics and their connections to SCOR processes. Finally, this chapter concludes by discussing the presented approach and pointing to limitations as well as to future research directions.

4.2 Literature Review

The management of supply chains has become an essential function for corporate performance. Supply chains principally consist of all actors that are involved in receiving and fulfilling a customer request (Chopra and Meindl 2007). To this end, appropriate management systems have to be put in place to control activities and outcomes. A study of the German-based supply chain controlling literature (i.e., management accounting in supply chains) has identified rationality, integration, and information as central issues for supply chain control (Seuring 2006). Already in 1996, the Supply Chain Council released a first version of a cross industry process reference model to enhance evaluation, monitoring, and benchmarking of a company's performance in view of targeted competitive advantage (Stewart 1997). One significant advantage of the SCOR model lies in its standardized performance measures (Weber and Wallenburg 2010) that can be applied by organizations in various industrial sectors.

Besides the economic goals for efficient supply chain processes and resulting performance, the requirements for the sustainable management of supply chains are increasingly relevant (Seuring and Müller 2008). SSCM comprises the integration of goals from the TBL and the coordination of business processes to secure long-term performance (Carter and Rogers 2008), which means to maximize supply chain profitability while environmental impacts are minimized and social well-being is maximized (Hassini et al. 2012). In this context, the assessment of quantitative models for SSCM has recently gained increased attention (see, e.g., Seuring 2013; Brandenburg et al. 2014).

A Green SCOR model, containing additional processes, metrics, and best practices, was added to the SCOR model to address environmental issues (Supply Chain Council 2008). However, this part of the SCOR model is still in its first stages of development. This can be concluded from the literature review showing that the number of publications pertaining to the development of a green or even holistic (i.e., environmentally and socially) sustainable SCOR model is limited and that many sources are contributions at conferences (e.g., Qianhan et al. 2010; Schrödl and Simkin 2013a, b; Yongan and Menghan 2011), which indicates the early stage of research with regard to the application of a Green SCOR model. In face of the scant literature and SCOR documentation that is available and due to the fact that social aspects are not reflected, the remainder of this chapter describes a procedure to match existing SCOR processes with metrics that measure the sustainability performance.

4.3 Methodology

This section describes the steps taken to deduce a conceptual approach for the integration of sustainability metrics into the SCOR model version 9.0 (Supply Chain Council 2008). Subsequently, the framework is summarized and graphically illustrated.

Metrics, as quantitative performance indicators that are used throughout different departments of an organization, play an essential role for effective supply chain performance management. As outlined in the introductory section, the management of environmental and social parameters is gaining importance for organizations that operate on international supply chain levels. The SCOR model already provides plenty of economic performance metrics that facilitate the controlling of supply chain performance by a standardized process model, while environmental metrics are not thoroughly developed and social metrics are neglected.

Sustainability metrics, as proposed by Hassini et al. (2012), comprise aspects from all three dimensions of the TBL, i.e., economic, environmental, and social performance criteria. In their framework for SSCM, Hassini et al. (2012) define sustainable supply chain functions that correspond to the stages of a supply chain, i.e., sourcing, transformation, delivery, value proposition, and product use as forward processes and reuse, recycle, and return as reverse processes. Additionally, they point out several core issues for each of these supply chain functions and provide an extended list of sustainable performance measures that are derived from key publications in this field to build a composite indicator for supply chain sustainability. Their conceptualization structure strongly resembles the SCOR model structure which equally features forward and reverse supply chain processes and addresses key aspects by metrics and practical solution approaches by best practices. As a consequence, the framework by Hassini et al. (2012) is considered as suitable conceptual element for a Green SCOR model.

The Green SCOR model (Supply Chain Council 2008) contains five output-related environmental footprint metrics, namely, "Carbon Emissions," "Air Pollutant Emissions," "Liquid Waste Generated," "Solid Waste Generated," and "% Recycled Waste." The first two metrics "Carbon Emissions" and "Air Pollutant Emissions" relate to greenhouse gases (GHG) and other gaseous pollutants that contribute to different environmental impacts like global warming, eutrophication, or acidification potential. The remaining three metrics "Liquid Waste Generated," "Solid Waste Generated," and "% Recycled Waste" refer to liquid and solid waste management. Thus, GHG and gaseous pollutants and nongaseous waste management metrics are particularly connected with output that originates from various SCOR processes.

As mentioned before, a Green or even sustainable SCOR model is still in its early stage of development. Besides, a clear allocation of the sustainability metrics to the relevant SCOR processes and existing SCOR metrics is necessary but not evident from the SCOR model documentation. Therefore, the following steps are followed to integrate additional metrics into the SCOR model:

Sustainability Metric	SCOR Level 1 Processes					SCOR Level 2 processes
	Plan	Source	Make	Deliver	Return	
Metric 1		…	…	…		Make-to-Stock M1
		…	…	…		Make-to-Order M2
		…	…	…		Engineer-to-Order M3
		…	…	…	…	Plan (P2-P5)
		…		…		Return (SR1-3, DR1-3)
	…	…	…	…	…	Enable (EP, …, ER)

Legend: No process exists
Level 3 processes

Fig. 4.1 Conceptual framework for the integration of sustainability metrics into the SCOR model

- Step 1: Selection of an environmental/social metric through deduction from existing conceptual frameworks
- Step 2: Allocation of the selected metric to SCOR processes
- Step 3: Compilation of an overview that links the selected metric with the processes

These steps for the selection of a metric and the allocation to the relevant SCOR processes are described in the following. First, step 1 means to select a metric that has to be integrated into the SCOR model. Therefore, a suitable and recognized framework should be chosen from the literature. Subsequently, existing SCOR process elements are matched with the proposed metrics. To this end, the search for relevant processes within the comprehensive SCOR model documentation can be facilitated by keyword search. Finally, as a third step, the findings are summarized and illustrated using the template conceptual framework shown in Fig. 4.1.

4.4 Aligning Sustainability Metrics with the SCOR Model

4.4.1 Integration of Environmental Metrics

Exemplarily, the integration procedure outlined in the previous section is illustrated for two input-related environmental metrics for measuring “source reduction” and “energy usage.”

The metric “source reduction” is derived from a conceptual framework on green SCM performance (Hervani et al. 2005). This aspect comprises organization’s efforts to reduce the consumption of resources, especially those that are not renewable or those that are toxic. Simultaneously, the production of minimum shares of waste is a central objective in this context. For instance, excessive packaging is a source for optimization potential and thereby exerts positive effects on required transport capacity, which again results in lower emissions or fewer land use. Source reduction is closely linked with product development and production technologies so that comprehensive coordination is necessary. In concert with environmental management standards like ISO 14001, continuous source reduction programs

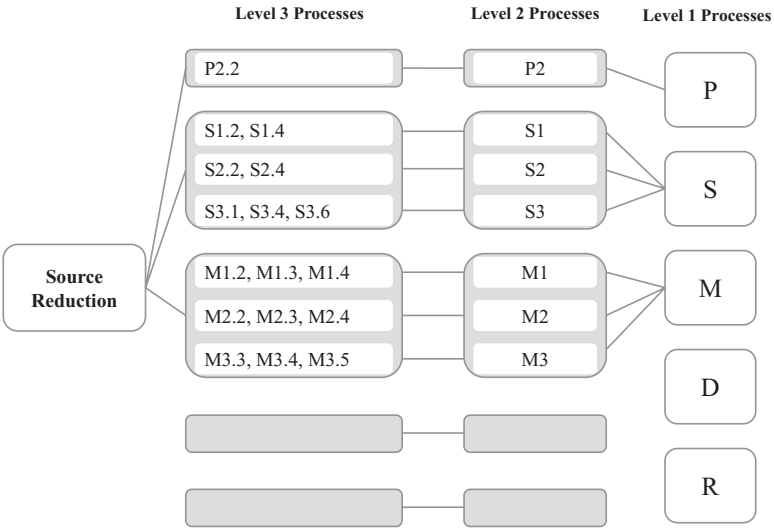

Fig. 4.2 Source reduction metric and related SCOR processes

(Kitazawa and Sarkis 2000) can become an integral part of an organization's efforts to produce both efficient and environmentally sound. Based on the conceptual framework presented in the methodology section, Fig. 4.2 illustrates the single view on the selected metric and allocated SCOR process elements.

The integration of the metric "source reduction" into the "plan" process can be controlled by the process element P2.2 (Identify, Assess, and Aggregate Product Resources). P2.2 integrates planning activities like identifying and procuring recyclable and reusable materials and green products and minimizing packaging or reusable packaging. The "source" and "make" process types are obviously most relevant in the context of source reduction. To achieve an improvement of this metric, the SCOR model already lists several relevant best practices in process S1.4 (Transfer Product, in S2.4 and S3.6, respectively), e.g., to utilize high fuel efficiency vehicles and to utilize alternative fuel vehicles, and in S3.1 (Identify Sources of Supply) to purchase products from recyclers or remanufactures (Supply Chain Council 2008). The latter might be formulated as a sub-metric "share of renewable and recycled resources input." In the end, source reduction is supposed to have a positive effect on waste management metrics and GHG or gaseous pollutant metrics that are already implemented in the SCOR model as outlined in Sect. 4.3. Moreover, the "make" process type is relevant in connection with the sourcing of goods, e.g., the process elements M1.2 (Schedule Production Activities, in M2.2 and M3.3, respectively), M1.3 (Produce and Test, in M2.3 and M3.4, respectively), and M1.4 (Package, in M2.4 and M3.5, respectively), because the type of sourced raw materials, goods, and packaging materials – if recycled or not – has an effect on the transformation process.

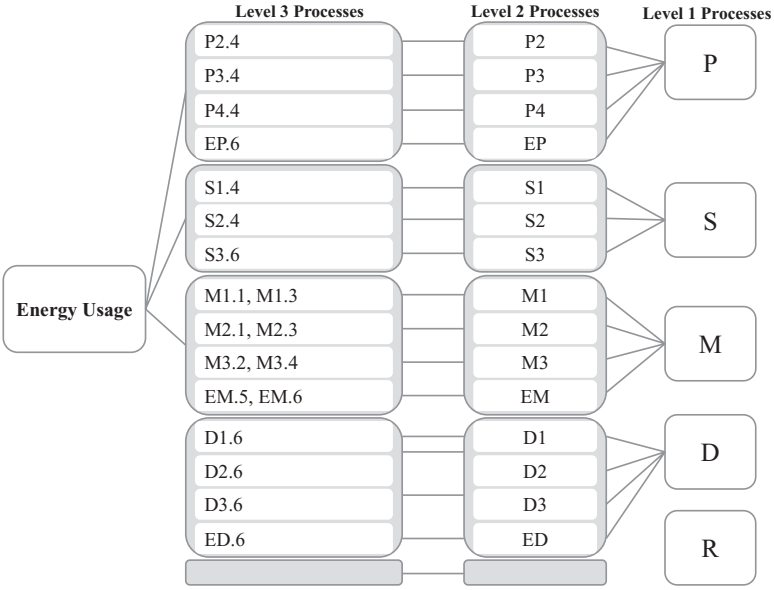

Fig. 4.3 Energy usage metric and related SCOR processes

A second exemplary metric "energy usage" is derived from Sarkis' (2006) study on the environmental performance of organizations. This metric embodies the objective to reduce energy consumption. The more energy is used, the more resources are depleted, and the more pollutant emissions are generated. Consequently, this metric is associated with the carbon emissions metric proposed in the Green SCOR model. The cost metrics category of the SCOR model already includes metrics that measure the energy cost per unit (CO.3.144) for the make process, energy costs as a percent of total product transfer and storage costs (CO.3.145), energy-efficient upgrades (CO.3.146), peak time energy use (CO.3.167), and equipment energy efficiency (AM.3.13). Possible allocations of the metric "energy usage" to SCOR processes are displayed in Fig. 4.3.

Basically, each single SCOR process element might be included for the metric energy usage because electric energy is needed across the entire supply chain. However, the example presented here only takes into account those process elements that are related to energy-intensive activities, e.g., transformation and transport. As can be seen from Fig. 4.3, the processes plan, source, make, and deliver are equally represented, which means that energy usage can be optimized by appropriate planning of sourcing, production, and delivery. The findings with regard to the two presented environmental metrics are summarized by Fig. 4.4. It gives an overview of the process elements that are related to the selected metrics.

Sustainability Metric	SCOR Level 1 Processes					SCOR Level 2 processes
	Plan	Source	Make	Deliver	Return	
Source Reduction (economic & environmental sustainability)		S1.2, S1.4	M1.2, M1.3, M1.4	-		Make-to-Stock M1
		S2.2, S2.4	M2.2, M2.3, M2.4	-		Make-to-Order M2
		S3.1, S3.4, S3.6	M3.3, M3.4, M3.5	-		Engineer-to-Order M3
		P2.2	-	-	-	Plan (P2-P5)
		-		-		Return (SR1-3, DR1-3)
	-	-	-	-	-	Enable (EP, …, ER)
Energy Usage (economic & environmental sustainability)		S1.4	M1.1, M1.3	D1.6		Make-to-Stock M1
		S2.4	M2.1, M2.3	D2.6		Make-to-Order M2
		S3.6	M3.2, M3.4	D3.6		Engineer-to-Order M3
		P2.4	P3.4	P4.4	-	Plan (P2-P5)
		-		-		Return (SR1-3, DR1-3)
	EP.6	-	EM.5, EM.6	ED.6	-	Enable (EP, …, ER)

Legend: No process exists / Level 3 processes

Fig. 4.4 Allocation of environmental sustainability to SCOR level 3 processes

4.4.2 Integration of Social Metrics

For the case of social sustainability, the two metrics "job satisfaction ratio" and "effectiveness of staff training programs" are focused in terms of their integration into the SCOR model.

The metric "job satisfaction ratio" is taken from a study by Searcy et al. (2007) who analyzed sustainable performance measures. Job satisfaction is a crucial factor not only for the well-being of workers but also for corporate performance which depends on employee performance. Principally, this metric could be applied in all processes where people work. However, there are no process elements that could be directly related to the metric. This can be explained by the nature of the SCOR model, which actually sets a framework for organizing the sourcing, production, and delivery of physical goods. One approach to resolve this complicated integration of social metrics could start from a distinct objective, e.g., "the reduction of hard physical work" like working with both arms over head, and then to define a sub-metric for measuring the relevant impact factor(s), e.g., the "amount of time worked with both arms over head." In this way, the metric "job satisfaction ratio" can be indirectly matched with the SCOR processes. The general idea of this approach is illustrated in Fig. 4.5 using the example just given.

The metric "effectiveness of staff training programs" was also deduced from Searcy et al. (2007) and equally has economic relevance for an organization, since well-trained personnel works more efficiently and effectively. Similar to the job satisfaction metric, the effectiveness of staff training programs appears to be less tangible than environmental metrics. Moreover, specific objectives or measures that contribute to these metric have to be defined and allocated to relevant process elements. However, the relevance of specific employee skills is envisaged by the new developments of to the current SCOR version 11.0 (Supply Chain Council 2012).

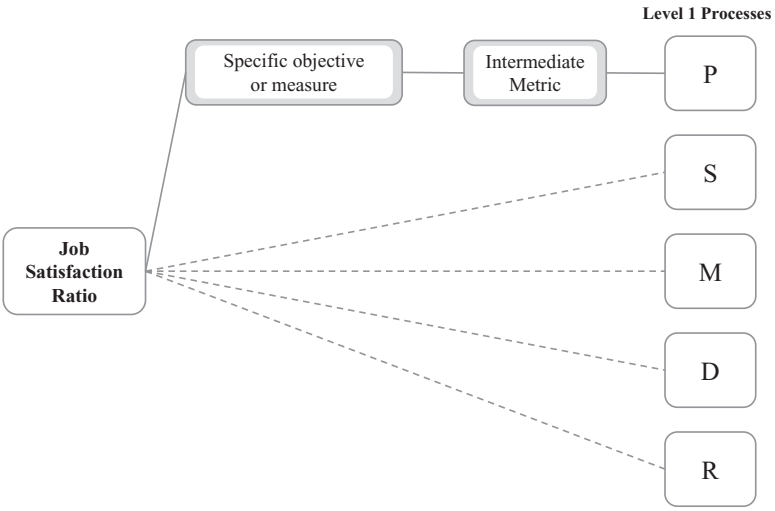

Fig. 4.5 Job satisfaction ratio metric in relation to SCOR processes

4.5 Discussion

From the illustration of allocating two exemplary environmental metrics in Sect. 4.4, the top level SCOR processes "plan" and "make" seem to be most relevant, while "source," "deliver," and "return" are also concerned albeit less process elements have been identified for these latter ones. However, it is found that input-related environmental metrics have to be focused, since the existing elements within the Green SCOR model are mainly output related. Further important input-related environmental metrics could be water usage and land usage or degradation. Actually, a "water use reduction" metric (CO.3.199) exists within the SCOR model, but it is only allocated to the process ES.4 (Manage Product Inventory). Since water usage is not only relevant for inventory management, it needs to be matched with other relevant processes as well. For a more comprehensive consideration of environmental impacts, further output-related environmental metrics could be derived from the set of impact categories in life cycle assessment.

Both social metrics that are exemplarily illustrated in the previous section could only be indirectly matched with the SCOR processes. Principally, social metrics are relevant for all processes where people work, but there are no individual processes elements that are compatible with those selected metrics. It is rather necessary to identify specific aspects that contribute to performance of the aggregate metrics and then determine intermediate level 2 or 3 metrics. Considering the employee-related metric "job satisfaction ratio," which was presented in Sect. 4.4, the allocation to SCOR processes might be achieved by adding specific measures like suitable equipment and tools, applicability and development of knowledge and skills, or a participative leadership style by leaving room for employees to foster self-confidence and

personal initiatives (Olfert 2009) as well as human relations (Clark 1998). These objectives can then be operationalized by establishing an intermediary variable that measures related performance. Furthermore, social metrics should include health and safety, which is also relevant for a job satisfaction metric. One existing SCOR metric is the "number of worker absences due to poor indoor air quality," which is connected with the processes ES.4 (Manage Product) and EM.5 (Manage Make Equipment and Facilities). Nevertheless, a more comprehensive set of health and safety metrics could be integrated.

The attempt to integrate the "effectiveness of staff training programs" metric shows that the existing SCOR model has to be extended to account for such social metrics related with staff development. This might be done by coupling a Balanced Scorecard perspective (Kaplan and Norton 1996), particularly the learning and growth dimension, so that vision and strategy of an organization are aligned, and additional sustainability-related metrics are integrated for supply chain performance management. Even though, as mentioned before, the SCOR model version 10.0 has set a starting point for the integration of human resource-related aspects. Hence, it becomes obvious that new social processes and metrics have to be defined if a holistically sustainable SCOR model is aimed at. Apart from these supply chain internal social aspects, the integration of metrics that quantify the impact on external stakeholders and the wider society appears to be even more complicated, since the theoretical conceptualization of supply chain external social metrics for SSCM is fragmentary and still underdeveloped.

While environmental and economic metrics are integrated into the SCOR model, it can be concluded that social metrics are not easily compatible with an economically oriented supply chain process model that focuses on objects (i.e., products) rather than on subjects (i.e., people). The contemplation and integration of supply chain external social metrics appears to be more complicated and probably not feasible because it would exceed the intentions of the SCOR model. To answer the research question, it can be summarized that due to the lack of social metrics, the existing Green SCOR model cannot be called sustainable in line with the TBL of sustainability (Elkington 1997). Thus, further research directions are uncovered to depart from the standardized SCOR model in an effort to holistically integrate sustainability in order to manage profitable as well as environmentally and socially responsible supply chains.

4.6 Conclusion

The aim of this chapter is to scrutinize the feasibility of matching sustainability metrics for SSCM with the SCOR model processes. A review of relevant literature revealed that the integration of environmental and social metrics into the SCOR model is still in its infancy. Only little documentation on Green SCOR developments was issued by the Supply Chain Council, and the majority of directly relevant research contributions stems from conference papers and presentations. Furthermore,

the five metrics proposed for a Green SCOR model are only output related and environmentally oriented. These metrics are not yet fully approved as the Supply Chain Council emphasizes that this approach is currently not in use and that feedback on applicability is asked for (Supply Chain Council 2008). Besides, the SCOR model version 9.0 (Supply Chain Council 2008), which is the basis for the study at hand, and the latest revision 11.0 (Supply Chain Council 2012) do not explain which SCOR process elements are concerned by the proposed five metrics.

Against this background, this chapter elaborates a procedure that departs from the deduction of sustainability metrics from existing conceptual literature and matches the selected metrics with SCOR process elements. The application of this conceptual framework is illustrated by selecting two input-related environmental metrics "source reduction" and "energy usage" and two supply chain internal social metrics "job satisfaction ratio" and "effectiveness of staff training programs". These indicators are exemplarily linked to SCOR process elements. Integrating environmental metrics and allocating them to existing SCOR process elements is feasible and also supported by the first developments of a Green SCOR, while for the integration of social metrics, it is concluded that they are hard to match with specific processes. This is one limitation which is encountered in the course of the presented study. The two social metrics examples address supply chain internal issues of human resource management and show that direct allocations to SCOR process elements are complicated. Besides, the nature, relevance, and operationalization of supply chain external social aspects for sustainable supply chain performance management should be further investigated.

Finally, the chapter shows how the SCOR model can be extended by metrics that measure the environmental and social dimension of sustainability and how they can be allocated to existing SCOR process elements. In addition to the existing output-related environmental Green SCOR metrics, this study evaluates two input-related environmental metrics. It is concluded that sustainability metrics for SSCM can partially be integrated into the SCOR model processes. Particularly environmental metrics are most apt to be implemented in the SCOR model and connected with existing processes and metrics, while the integration of social metrics into SCM and in particular into the SCOR model has to be assessed and conceptualized in advance. Future research and practice applications should also concentrate on using existing SCOR metrics and imbedding new sustainability-related metrics within the model structures. Once a sustainable SCOR framework is conceptualized, quantitative modeling of the metrics and subsequent empirical validation are needed to assess the applicability of and benefits from this approach.

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Chapter 5
Enabling a Supply Chain-Wide Sustainability Assessment: A Focus on the Electronics and Automotive Industries

Morgane M.C. Fritz, Josef-Peter Schöggl, and Rupert J. Baumgartner

Abstract This chapter presents research results on the topic of supply chain sustainability assessment. It is based on interactions with multiple stakeholders from the automotive and electronics industry to determine on which sustainability aspects data exchange could take place all along the supply chain. A focus is then set on company representatives in these sectors to define which indicators make sense to assess these sustainability aspects and what the company requirements are to implement a supply chain-wide assessment. Findings suggest a set of 36 sustainability aspects to exchange sustainability data along the supply chain with 69 corresponding qualitative and quantitative indicators. A framework and methods to calculate the sustainability performance of supply chains are also provided and assessed according to seven industry requirements. The standardized approach enables practitioners to save time in sustainability data exchange and improve the assessment and traceability of their products, individual companies and supply chains. This work provides to our knowledge the most complete tool for a supply chain-wide sustainability assessment on the environmental, social and governance dimensions of sustainability.

Keywords Sustainability aspects • Sustainability performance • Sustainability assessment • Supply chain-wide • Aggregation methods

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5.1 Introduction

The recent Sustainable Development Goals reinforce the need to take actions to reach sustainability targets. However, their applications in companies lack of guidance and case studies, and applications along companies' supply chains are all the more complicated. In this context, we are presenting here the outcome of a 3-year research program financed by the European Commission on the topic of sustainable data exchange and assessment along the supply chain of the electronics and automotive industries.[1]

Both industries are interrelated since cars contain several electronics appliances and hence reflect the difficulty to exchange sustainability data along supply chains for various reasons. For instance, both industries are subject to increasing European regulations that have an impact on their supply chain partners, even though they are not located in Europe. Also, both industries' supply chains are constructed with global partners from different sizes (e.g., SMEs, multinationals) and different knowledge about sustainability. Moreover, several leading supply chain companies called focal companies have their own sustainability data exchange tools that are not necessarily compatible with each other and imply a high effort for supply chain partners to provide the desired data in the desired format.

Consequently, we observed the need to develop tools and methods that ease the process of sustainability data exchange in both sectors. Easing the data exchange process first means defining sustainability aspects and indicators that are standardized and can be easily converted into the desired format of the focal company via an online sustainability data exchange platform. Easing the data exchange process secondly means developing indicators that can be understood by all supply chain partners, whatever their experience with sustainability indicators is as well as their maturity level regarding sustainability (Baumgartner and Ebner 2010). Finally, easing the data exchange process means reducing the workload efforts of employees in charge of reporting, especially in SMEs with limited resources and other companies that are more or less mature with sustainability reporting. The originality of the approach lays in the fact that sustainability is considered from a multi-stakeholder perspective where the sustainability aspects on which companies are supposed to report on are defined with nongovernmental organizations (NGOs), researchers, and companies.

A mixed-method approach was followed to address the challenge of easing the data exchange process relying on explorative and structured literature reviews on sustainability aspects and indicators, interviews with experts and qualitative content analysis of the transcripts, the analysis of sustainability reports, and an online survey.

[1] See http://www.sustainhub-research.eu/.

5.2 Conceptual Framework and Industry Requirements

The sustainability aspects presented in Table 5.1 and corresponding indicators were developed according to the framework presented in Fig. 5.1. Each of the three steps presented in this framework are explained in the following sections.

This framework encompasses seven requirements to assess sustainability performance supply chain-wide that were defined by the companies that participated in this research. These requirements are (Schöggl et al. 2016a):

1. Accessibility for companies inexperienced in sustainability assessment
2. Applicability with respect to different types of sustainability data
3. Applicability in supply chain-wide assessment
4. Adaptability to supply chain dynamics
5. Adaptability to regional and cultural characteristics
6. Comparability of results
7. Robustness in the face of insufficient information

5.3 Information Collection

Information collection for an assessment typically consists in four stages: measurement, collection, calculation, and entry. In order to assess sustainability supply chain-wide, we defined sustainability aspects and corresponding indicators that shall undergo this data collection process.

The information collection is based on a set of 36 sustainability aspects comprising the social (S), environmental (E), and governance (G) dimension of sustainability. The economic dimension is included indirectly in these aspects since each activity a company undertakes to fulfil a specific sustainability aspect is necessarily linked to monetary resources. We have assessed with multiple stakeholders that the 36 sustainability aspects presented in Table 5.1 are relevant for the electronics and automotive industries. Ideally, the data collection process shall be supported by an online platform where a wizard would assure that the data entered is delivered in the appropriate format to avoid errors.

In order to assess the sustainability performance of supply chains while considering the heterogeneous characteristics of the data collected in terms of quality and availability, qualitative and quantitative indicators were developed. Qualitative indicators are indicators that any company in the supply chain shall be able to report on since they consist in yes/no questions and require little collection effort.

Quantitative indicators are indicators expressed in monetary values, percentages, or else that companies with more information and experience in sustainability reporting shall be able to report on. We have developed a set of 69 indicators corresponding to each sustainability aspects on the basis of current standards, guideline, and scientific literature on sustainability assessment along the supply chain. All indicators are available in Schöggl et al. (2016b).

Table 5.1 Thirty six aspects to exchange sustainability data supply chain-wide

Sustainability dimension	Sustainability categories	Sustainability aspects
E	Materials	Avoidance of hazardous substances in products and production
S	Product and services responsibility	Product quality and safety (including customer health)
E	Wastes	Prevention, reuse, collection, separation, recovery, and safe disposal
E	Emissions	Reduction and prevention of greenhouse gas emissions (GHG)/carbon footprint
E	Energy	Production of energy-efficient products and services, initiatives to reduce indirect energy consumption
E	Energy	Energy-efficient production
S	Business Ethics	Corruption and bribery
G	Compliance	With environmental regulations
S	Human Rights	Prohibition of child labor
G	Management Systems	Environmental management system (e.g., EMAS, ISO 14001)
S	Occupational Health and Safety	Accidents/lost days/fatalities
S	Product and services responsibility	Communication with customers, consumer satisfaction, and after sales services (includes take back operations)
S	Occupational Health and Safety (OH&S)	OH&S trainings (e.g., safety equipment, first aid training, chemical management, machinery safety, maintenance and workers training, transport risks, and rules)
S	Training and Education	Employee training
G	Compliance	With social standards, regulations, and laws
S	Human Rights	Discrimination
S	Materials	Use of conflict minerals
G	Management Systems	Quality management system (e.g., ISO 9001)
G	Stakeholder Inclusiveness	Stakeholder inclusiveness
G	Compliance	With human rights standards and regulations
S	Employment Conditions	Securing minimum and living wages
E	Materials	Sustainable production and use of renewable materials (e.g., from sustainable forestry)
E	Water	Water consumption/reuse of water/water footprint
G	Designation of responsibility and authority to achieve SD objectives	Top-management involvement
S	Business Ethics	Confidentiality of data

(continued)

Table 5.1 (continued)

Sustainability dimension	Sustainability categories	Sustainability aspects
G	Compliance	With product-related standards and regulations
G	Sustainability Strategies	Life cycle approach (i.e., consideration of the whole product life cycle in decisions)
S	Occupational Health and Safety	Emergency preparedness and response
E	Energy	Use of renewable energy
S	Human Rights	Freedom of association and collective bargaining/ protection of worker's representatives
G	Sustainability Strategies	Long-term strategies (e.g., scenario analysis)
S	Community engagement	Local communities (e.g., engagement, public hearing, respect for cultures, and traditions of local communities)
G	Research & Development (R&D)	R&D
E	Biodiversity	Reduction of impacts of activities/products/services
G	Sustainable supply chain management	Evaluation of suppliers' social performance
G	Management Systems	Corporate social responsibility (CSR) management system (e.g., ONR 192500)

Based on Fritz et al. (2017)
E environment, *S* social, *G* governance

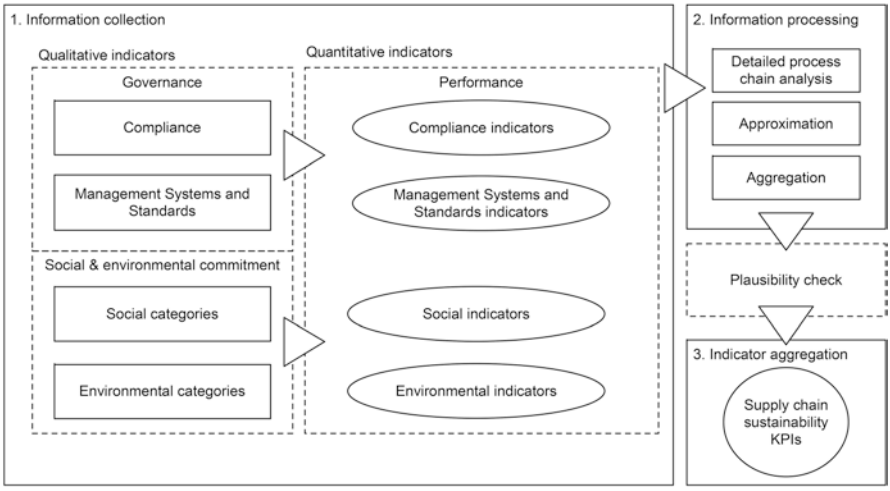

Fig. 5.1 Assessment of supply chain sustainability (ASSC) framework (Adapted from Schöggl et al. 2016a)

5.4 Sustainability Data Processing, Aggregation Methods, and Application Examples

As presented by Schöggl et al. (2016a), once data has been collected, it can be processed in different ways depending on the requirement of the focal company who is still nowadays leading and pushing for sustainability data exchange along the supply chain. As shown in Fig. 5.2, data can be subject to a detailed process chain analysis, approximation, or aggregation implying different levels of work effort and accuracy. A detailed process chain analysis is the *compilation of various approaches used in environmental impact assessments such as life cycle assessment*, *carbon footprint*, *cumulative energy demand*, *and water footprint* that make use of real data from the production process. Approximation refers to *approaches that use generic data instead of the actual process information*, where data may already be aggregated. Processing sustainability data is hence often a trade-off between accuracy and work effort, and the aggregation method proposed here is meant to deliver the highest accuracy with a relatively low work effort.

The aggregation method we developed follows our conceptual framework (Fig. 5.1) and consists in the aggregation of qualitative and quantitative indicators.

In order to provide the highest possible accuracy, the data used to calculate the proposed 69 indicators shall be real company data (versus generic data). The following application examples are not based on real company data but were devel-

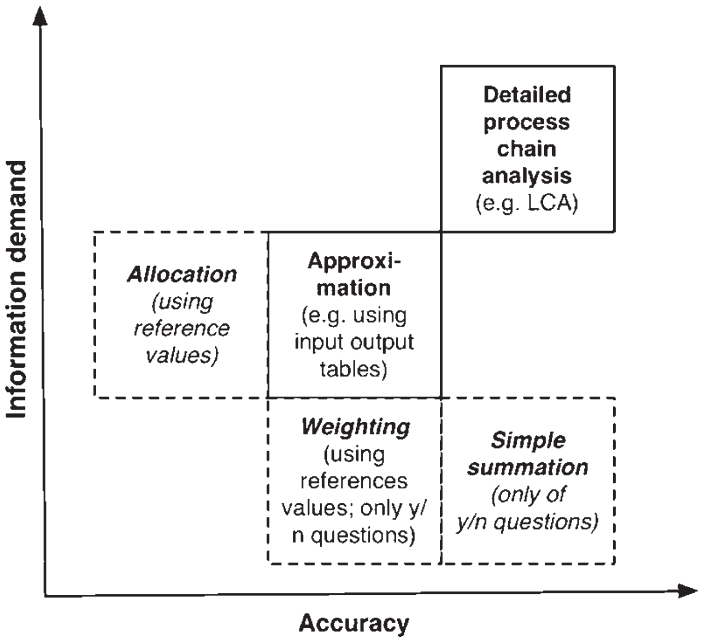

Fig. 5.2 Three approaches for information processing (Source: Schöggl et al. 2016a)

oped and validated with industry experts in the course of focus group workshops as described in Schöggl et al. (2016b). They illustrate how the aggregation methods can be applied to the different types of indicators proposed, namely, qualitative and quantitative indicators, and how the aggregation methods can be applied depending on the level of information exchange the focal company defines (i.e., product, facility, or company level).

5.4.1 Qualitative Indicators

Qualitative indicators correspond to indicators that consist in questions on the general engagement of a company for sustainability and that have to be answered by yes or no, according to the left-hand side of the ASSC framework presented in Fig. 5.1.

The aggregation of yes/no questions is exemplified with the indicator on conflict minerals. In accordance to the conflict minerals reporting template (CMRT) of the conflict free sourcing initiative, this indicator requires suppliers to state whether or not tantalum, tin, gold, or tungsten are used in their product. Since this is an assessment on product level, the materials and parts used in the final product define the supply chain under consideration. Hence, a focal company can send an information request to all the suppliers in this particular supply chain. By stating whether or not conflict minerals are used in their product, the company values (CV) entered (i.e., yes or no) are used to calculate the supply chain key performance indicators (KPI) (SV) on conflict minerals, which is the sum of all yes and no answers per conflict mineral.

If a sustainability data exchange hub is used, the effort for the requesting company is limited to sending the predefined request to their direct supplier. The suppliers, requested to provide sustainability information, have to enter the information once and have to pass the request on to their suppliers. This also holds true for requesting and providing information on the quantitative indicators, for which examples are provided in the following.

5.4.2 Quantitative Indicators

Quantitative indicators correspond to sustainability performance indicators as shown in the center of the ASSC framework presented in Fig. 5.1. They are expressed in form of ratios and amounts. In order to integrate these quantitative indicators in the assessment of a supply chain-wide sustainability assessment (e.g., the calculation of a cumulative energy demand), equations for the aggregation of ratios or amounts were developed.

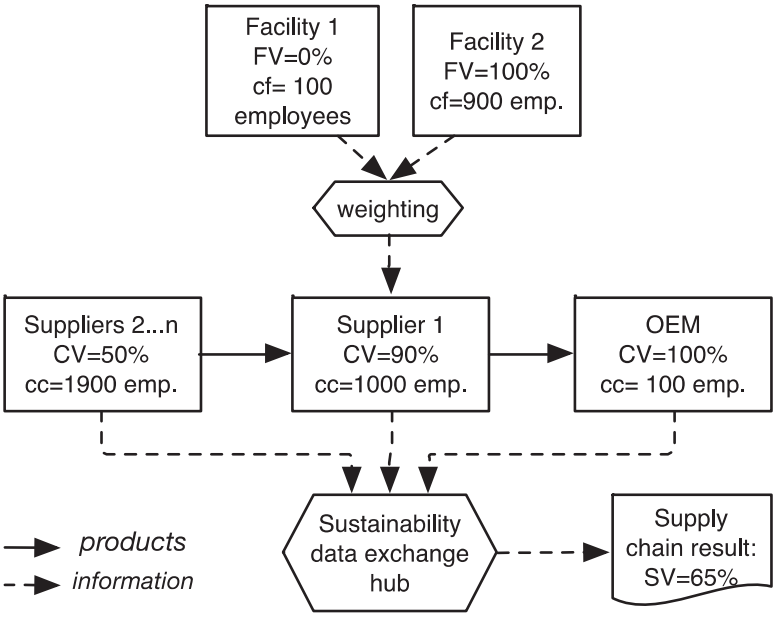

Fig. 5.3 Example of the aggregation of ratios for the indicator "Employees covered by collective bargaining agreements." *FV* facility indicator value, *CV* company indicator value, *cf.* contribution factor facility, *cc* contribution factor company, *SV* supply chain indicator value, cc_i contribution factors per company, *SV* supply chain indicator value, *emp.* employees

5.4.2.1 Aggregation of Ratios

Compared to the aggregation of qualitative indicators, the aggregation of ratios allows weighting the results of different suppliers according to their contribution to the supply chain. For this weighting, in addition to the sustainability indicator value per facility (FV), the suppliers are required to enter a value that is representative of their contribution to the supply chain under consideration (cc). For the indicator "Employees covered by collective bargaining agreements," this value could, for instance, be the number of employees contributing to the product and supply chain under consideration.

Figure 5.3 illustrates an example in which Supplier 1 provides the required information for its two facilities (FV). These values are used to calculate Supplier 1's company value (CV), which is furthermore used to calculate the supply chain (SV) value for the indicator.

Equation 5.1 below shows the calculation of the company internal value (CV) based on the information provided by Facilities 1 and 2 of Supplier 1. This calculation weights the results according to the number of employees which results in a CV of 90%. This means that 90% of Supplier 1's employees contributing to the supply chain under consideration are covered by collective bargaining agreements:

$$CV = \frac{\sum_{i=1}^{n} cf_i^* FV_i}{\sum_{i=1}^{n} cf_i} = \frac{100^*0 + 900^*1}{100 + 900} = 0.9 = 90\% \tag{5.1}$$

Equation 5.2 furthermore shows the calculation of the supply chain value (SV), which is a weighted average of the company values of the supply chain partners. In the example illustrated in Fig. 5.3, the company value (CV) of Supplier 1 (90%) is used in the calculation with the already aggregated CVs of suppliers 2-n of 50% and the CV of the OEM of 100%. Weighting these company values along the supply chain according to the number of employees results in a supply chain value (SV) of 65%. Analogous to Eq. 5.1 the supply chain result reflects that 65% of the employees in the supply chain under consideration are covered by collective bargaining agreements:

$$SV = \frac{\sum_{i=1}^{n} cc_i^* CV_i}{\sum_{i=1}^{n} cc_i} = \frac{0.5^*1900 + 0.9^*1000 + 100^*1}{1900 + 1000 + 100} = 0.65 = 65\% \tag{5.2}$$

With regard to the aggregation of ratios, it is important to note that "*…the change in a weighted average can be as much a result of changes in the weights as it is of changes in the values being averaged* (Peters 2012)". The so-called Simpson's paradox denotes extreme cases in which the weighted average can change into a direction that is opposite to the change of all values being averaged, i.e., increase while all values decrease, due to a change in weights (Simpson 1951). When using a sustainability data exchange hub, this problem can be solved by providing the requesting company not only with the weighted average but also with non-weighted results of the information providing suppliers. This would allow identifying cases of a Simpson's paradox.

5.4.2.2 Aggregation of Amounts

Figure 5.4 provides an example of applying the equations for an "aggregation of amounts" to the indicator "Total amount of solid waste generated" for the production of a fictive car. The term aggregation of amounts refers to assigning of a certain indicator value (e.g., total amount of solid waste generated) to a reference object, i.e., a product or an organization.

The first value that has to be calculated by Supplier 1 is the aggregation factor (ap). This aggregation factor supports the estimation of Supplier 1's contribution to the product under consideration. Equation 5.3 shows the calculation of ap for Facility 1 of Supplier 1:

$$ap = \frac{fsp}{tfv} = \frac{1 \text{ part}}{100{,}000 \text{ parts}} = 1^*10^{-5} \tag{5.3}$$

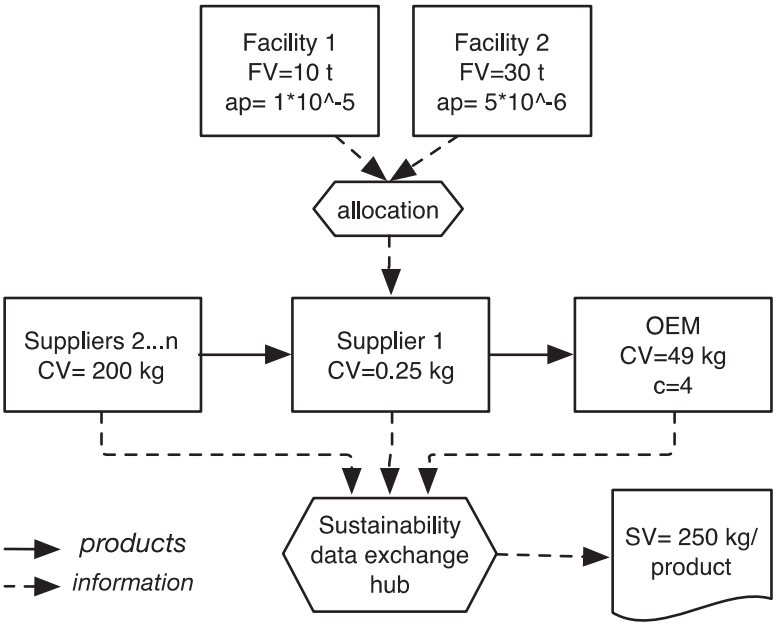

Fig. 5.4 Example of an aggregation of amounts on product level for the indictor "Total amount of solid waste generated." *FV* facility indicator value, *ap* aggregation factor per product, *CV* company indicator value, *c* defines how many parts are used in the final product

Equation 5.4 shows how these aggregation factors per facility are furthermore used to allocate the sustainability indicator value to the product the company contributes to the supply chain (e.g., a brake system produced in Facilities 1 and 2 of Supplier 1). This results in a company value (CV) of 0.25 kg per product:

$$CV = \sum_{i=1}^{n} ap_i^* FV_i = 1^*10^{-5*}10 + 5^*10^{-6*}30 = 2.5^*10^{-4}\, t = 0.25\, kg \tag{5.4}$$

Equation 5.5 shows the calculation of SV. In order to allocate the CVs correctly to the final product, the additional value c_i has to be provided by the customers using the product/part/substance of their suppliers. In the example the OEM provides a c_i of 4 for the four brake systems used in the final product. The remaining CVs are already correctly allocated. Integrating the bill of materials into the calculation process of the sustainability data exchange hub could ease the task of correctly allocating values. The resulting supply chain value (SV) is 250 kg waste per product. This reflects the supply chain KPI for the indicator "Total amount of solid waste generated" per product:

$$SV = \sum_{i=1}^{n} CV_i^* c_i = 200 + 0.25^*4 + 49 = 250 kg \tag{5.5}$$

For the same indicator "Total amount of solid waste generated," the requesting company could also ask their supply chain partners to provide detailed information on the production process for a certain part that is used in their final product. They could also ask their direct suppliers to only report their total indicator values, without an allocation to a certain part/product. The suggested set of indicators and the ASSC framework could stay the same. The same allocation factors per company could also be used for assigning other sustainability indicator values to a reference product.

In this flexibility lies the strength of the approach. First, the set of supply chain sustainability indicators provided by Fritz et al. (2017) comprises simple qualitative as well as quantitative performance indicators. This allows for adapting the information demand to supply chain specifications. Second, the quantitative performance indicators can be assessed on different levels of detail according to the aggregation method. Thus, generally complex sustainability assessments, such as the calculation of a product's carbon or energy footprint, can be conducted with a lower information demand via the aggregation of amounts and ratios, as shown in Figs. 5.3 and 5.4. Third, the indicators and the underlying rationale of supply chain sustainability assessment are compatible with a software-based data exchange hub as argued in the next section. On the one hand, this increases the practical relevance of the approach, since assessments can be conducted more efficiently. On the other hand, an implementation into a software solution would help to overcome organizational and technical challenges that any supply chain-wide sustainability assessment is facing.

5.5 A Software-Based Solution to Measure the Sustainability of a Supply Chain

Since the collection and processing of sustainability data implies an important workload, a software-based solution would facilitate data exchange and enable to reduce errors in data entry and implausible or false data exchange by automatically detecting missing, incorrect, or implausible data via the use of plausibility checks. These are major challenges in supply chain-wide sustainability assessment and are addressed by the plausibility checks for supply chain sustainability information (Schöggl et al. 2016a). The development of this concept is based on the interdisciplinary work of IT experts, sustainability researchers, and practitioners in the electronics and automotive industries that were part of the SustainHub project.

5.5.1 Plausibility Checks

Since one main issue in data exchange is the reliability and correctness of the data, plausibility checks are necessary to support the development of reliable supply chain sustainability indicators. Plausibility checks are a common instrument used in information and telecommunications systems. Within the SustainHub project, concepts and concrete plausibility checks were developed for this purpose. Like for the data entry, these plausibility checks are ideally implemented via a software to lower the related work effort of data exchange. Indeed, when using Excel documents, a high workload is implied for the company/person in charge of compiling and checking the data received. For this, we suggest the use of general, indicator-specific, and consistency checks as presented in Fig. 5.5 below.

General checks are meant to detect errors in the unit used to enter an indicator and missing data. They can also block the entry of implausible data. These are standards in software development. For instance, on the topic of employee training, companies are asked to answer the question "Are you committed to continuous skills improvement of your employees?" and to specify the total training hours divided by the total number of employees. Checks shall be used to ensure that only a yes or a no is entered in the field of the first question and numbers for the second question. Hence general checks play a role to detect errors regarding data type, data format, and missing data.

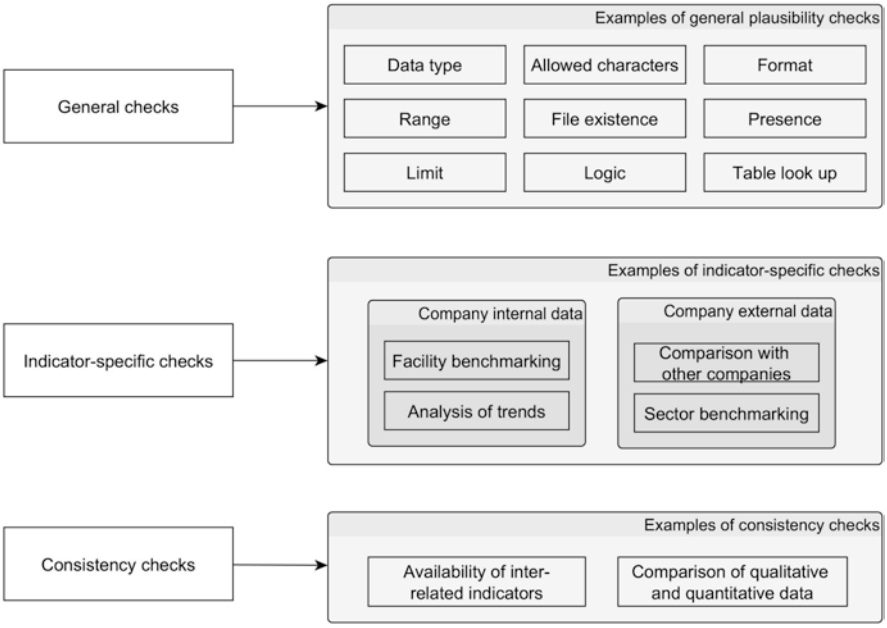

Fig. 5.5 Overview of plausibility checks

Indicator-specific checks are meant to compare the data entered for one specific indicator with the indicator-related context (e.g., geographical location, production processes used, number of employees). Indicator-related context can be, for instance, the data entered by other companies in the same field with similar performances or data already entered by a company in the past. Dramatic discrepancies with other companies or changes compared to the past-indicator values may be a sign of mistake (e.g., due to an additional 0 to a number, a comma or point missing). Such checks requires an online platform to dedicate a place for the collection of background information (e.g., company location, size, number of employees, type of production processes) that will be related and compared with indicators making use of this information that may be internal (e.g., comparison of GHG emissions of several facilities from the same company with similar production processes) or external (e.g., comparison of GHG emissions of several companies with similar production processes).

Consistency checks are meant to compare indicator-specific data with other related indicators. For instance, the indicator compliance with Human Rights Regulations is related to the indicator prohibition of child labor. If a company answers the first indicator positively (Are you compliant with the human rights regulations of your country? Fines due to noncompliance with human rights regulation = €0, total number of incidents due to noncompliance with human rights = 0), then the answers to the second indicator (Are you committed to the abolition of child labor? Sum of child labor incidents) shall fit together. Hence indicator-specific checks enable to compare indicators related to the same thematic or the same context (e.g., company location, production process, number of employees). Consistency checks enable to identify gaps and inconsistencies in data entries that the platform automatically notifies to the user.

Plausibility checks hence support the identification of "implausible" information in the data entry process by comparing qualitative and quantitative information provided for each indicator and for the background information (e.g., company location, size). Plausibility checks support the need for valid and reliable information exchange. When errors occur or when some data is missing, the online platform can support the user (both the provider and receiver) with notifications tracing back the problem to one of the four data collection stages mentioned in the section Information Collection (i.e., measurement, collection calculation, or entry). These automatic checks also contribute to the reduction of the work effort in data processing that are still today an issue for companies that do not have an information system in place for supply chain data exchange.

5.5.2 *Additional Benefits of a Software-Based Solution*

When data collection and entry are finished and correct, the software-based solution developed as a prototype in the SustainHub project may have additional benefits. It could, for instance, provide an overview to the user and the company on its present and past sustainability performance. This would facilitate data monitoring and sharing with stakeholders as well as decision-making among managers for future sustainability goals. The ability to distinguish between a mother company and its facilities also gives the possibility to identify easily sustainability issues and remediate to it more easily. For companies among the same industry, an exchange of best practices from companies or other stakeholders (e.g., consultants) may also be implemented to remediate to sustainability issues.

By anonymizing data, one could see a software-based platform as a tool for benchmarking the sustainability performance and activities of companies among one sector, country, or product-specific manufacturing processes. Such a benchmarking tool may be relevant not only to companies but also to other stakeholders such as NGOs or governments. The platform may also be a place for companies to stay informed on current and upcoming regulations that may impact their reporting practices. The platform is hence aimed at being flexible for the exchange of new sustainability indicators. This is necessary, for instance, for conflict minerals where the upcoming EU regulations will consider not only conflict minerals from the Democratic Republic of Congo but all conflict mineral sources worldwide.

5.6 Discussion

The suggested list of 36 aspects, the corresponding 69 indicators, and the aggregation methods proposed are aimed at supporting sustainability data exchange and assessment along the supply chain of the electronics and automotive industries. They address key sustainability issues such as compliance, efficiency improvement, or cost reduction that are sustainability challenges for both industries (Fritz et al. 2017). Assessing their supply chains and providing transparent information to their stakeholders based on this research may provide focal companies a competitive advantage that could benefit their whole supply chain (Markley and Davis 2007).

The set of indicators developed shall support companies in comparing their performance with their supply chain partners as well as their own sustainability performance over time, to set priorities and monitor their performance in a standardized manner (Schöggl et al. 2016a; Fritz et al. 2017). A standardized data collection system is indeed a key facilitator for data exchange along the supply chain (Beske-Janssen et al. 2015). The online platform here plays an additional crucial role since it shall be able to make use of already existing reporting tools and data companies

provide for regulations (e.g., the European Directives REACH[2] and RoHs[3]) or voluntary reporting standards (e.g., the Electronic Industry Citizenship Coalition (EICC)[4]) to reduce the workload efforts of employees in charge of reporting and to avoid duplication of work (Fritz et al. 2017). This is particularly important for small- and medium-sized enterprises (SMEs), companies from developing countries, and the variety of companies that compose a supply chain and have a different maturity level on sustainability (Baumgartner and Ebner 2010) to support their decision-making in the sustainability field.

Due to the need of companies and other stakeholders for multilevel assessments (at a product, facility, company, or supply chain level), the aggregation methods proposed can be used for a supply chain-wide but also an internal or bilateral sustainability assessment. This is useful since such information is needed to identify hotspots and monitor the performance of a company internally. This is also useful to collect data and communicate about it to other stakeholders via, for instance, sustainability reports. Combining the suggested indicators and methods for assessment with an online platform is particularly important to assure that data is delivered in the proper format and checked for consistency with the whole reporting of a company and for plausibility with regard to each entity reporting context (e.g., focal company, supply chain partner, facility in different geographical areas). When information is missing, specific tools in an online platform could also enable to approximate them (e.g., reference to databases, performance of similar companies with similar production processes in the sector). Furthermore, the sustainability information obtained by a focal company could support risk management activities by identifying suppliers on the platform that comply with the focal company's sustainability policies.

Although 36 aspects were defined as relevant by a multi-stakeholder engagement research with industries, NGOs, and researchers, companies shall of course have the freedom to choose on which sustainability aspects to report and at which level. The findings presented in this chapter have indeed been developed with industry partners that underlined their need to exchange sustainability data on a bilateral or multilateral basis mainly. According to these practitioners, sustainability data exchange takes place along the supply chain for a limited number of topics (e.g., related to compliance). Still, supply chain partners and focal companies shall select the aspects they want to report on carefully and take into consideration stakeholders' transparency expectations rather than selecting aspects that are convenient to them for reputation reasons, for instance (Fritz et al. 2017). One may conceive that third-party audits could certify the correctness and quality of the reported information. If noncorporate stakeholders (e.g., governments, intergovernmental organizations) would have a role to play, one may imagine that they could select on which aspects

[2] REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals (see: http://ec.europa.eu/growth/sectors/chemicals/reach_en)

[3] RoHS: Restriction of Hazardous Substances (see: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32002L0095)

[4] See: http://www.eiccoalition.org/.

data shall be exchanged along the supply chain to reduce the risk of reporting only on good performance indicators (Fritz et al. 2017). This is already the case for certain indicators like conflict minerals (Dodd Frank Act, USA), having an indirect impact on companies along the supply chain that need to report to their American partners where they source minerals.

A sustainability assessment supply chain-wide is however limited when data is considered confidential and if trust among supply chain partners is limited (Fritz et al. 2017). The indicators and methods developed would also be applicable without an online platform, but the workload effort would then be an important issue. The output of this research would also require a full testing with a variety of companies which took place so far with a limited number of companies within the SustainHub project and on three indicators only. There may indeed be trade-offs to consider when it comes to country and sector-specific regulations, standards, or guidelines that are valid for some companies due to their geographical location but not for companies outside this geographical location (e.g., EU regulations like REACH). These challenges may however also be seen as positive since they imply the need for dialog between companies and other stakeholders to find win-win situations and support sustainability data exchange.

5.7 Conclusion

A set of 36 sustainability aspects is suggested to exchange sustainability data along the supply chain with 69 corresponding qualitative and quantitative indicators. A framework and methods to calculate the sustainability performance of supply chains are also provided and assessed according to seven industry requirements. The methods developed for sustainability data exchange show that a supply chain-wide and meaningful assessment of sustainability performance along the supply chain is possible with the example of the electronics and automotive industries. This is particularly true when an online platform can support users with data collection, data entry, and plausibility checks that would assure the quality of the data delivered by supply chain partners. The standardized approach enables practitioners to save time in sustainability data exchange and improve the assessment and traceability of their products, individual companies, and supply chains. This work provides to our knowledge the most complete tool for a supply chain-wide sustainability assessment, including on the social dimension.

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Chapter 6
Sustainable Development Partnerships: Development of an Estimation Model of CO_2 and Cost-Saving Potentials in German Foundry Value Chains

Robert Christian Fandl and Tobias Held

Abstract This paper presents an evaluation model of CO_2 and cost-saving potentials, which could be realised by early supplier integration. By analysing serval factors, this paper explores how CO_2 emissions and cost effects are realised by cast development partnerships. Based on the results of the analysis presented, an estimation model to forecast the CO_2 emissions and cost effects of early supplier involvement is shown. Finally, the paper presents a multiple case study analysis, covering 41 cast product development projects of one German iron foundry which were realised together with 27 different customers.

Keywords Sustainable development partnerships • Early supplier integration • CO_2 and cost-saving potentials • Foundry value chain

6.1 Introduction

In the context of ecology and environmental friendliness, there is a growing focus on emissions of carbon dioxide (CO_2), which is by far the most important of the greenhouse gases. This trend can also be seen in the foundry industry. There is growing customer demand for "ecological castings", or at least for products whose CO_2 footprints have been measured and published and are therefore comparable. Foundries are, among other things, known for their high rates of recycling (e.g. 90% of cast parts are produced from melting down scrap metal) (Sturm 2011). However, the melting process requires a considerable energy input. Hence, the foundry industry has the highest energy costs by percentage of total costs of all metal-processing

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sectors. That is why energy efficiency in the foundry industry (in the casting process) has for decades been a subject of debate and discussion (see, e.g. Lownie 1978; Herfurth 1991; Ketscher and Herfurth 1997; Huppertz 2000; Wagner and Enzler 2006). For cast products, the focus has been on achieving energy savings by assessing and optimising casting processes rather than on potential improvements centred on the casting itself (Huppertz 2000; Kuchenbuch 2006; Institute of Foundry Technology 2013).

A number of methods have been developed over the years for assessing, selecting and involving suppliers in the product development process (e.g. Ellram 1987; Kamath and Liker 1994; Peter 1996; Petersen et al. 2005; Kirst 2008; John 2010). These methods consider factors such as project timeline, product quality and project costs. However, there has not been a sufficiently robust theory-based investigation of energy efficiency aspects (in particular reductions in CO_2 emissions) either in cross-company casting development partnerships or within the foundry sector itself.

6.2 Theory and Case Study for Calculating Potential CO_2 Emissions and Production Cost Savings

6.2.1 Ecological Casting Development

Many publications address product development (Pahl et al. 2007; Ehrlenspiel 2009; Schäppi 2005), and many focus specifically on casting development (Richter 1984; Hasse 2007; Roller et al. 2013). There is, however, relatively little material available on cross-company cast product development; there are only brief reports from industrial practice (Hespers 2000; Vollrath 2004; duMaire 2003; Becker 2002). The projects run in this area over recent years such as the BMBF project "Wachstumskern Precision Cast – Verbundprojekt: Entwicklung einer virtuellen, integrierten Technologieplattform für Guss-Konstruktion und –Fertigung (viTeG)" ["Deployment of a virtual and integrated technology platform for construction and manufacturing of castings (viTeG), subproject: precision cast – development process for foundry network"] have addressed the development of computer-aided design guidelines and explored casting simulation (Getzlaff 2010). They have not focused on integrated business processes and the specific ecological implications of casting development.

A wide range of terms and methodological approaches are used in the field of ecological product development, for example, design for sustainability (Jaafar et al. 2007), design for the environment (Ashley 1993), life-cycle design (Kölscheid 1999), eco-design (Fuad-Lake 2002), environmentally conscious design (Myer 2007), design for environmentability (Navinchandra 1991), eco-effectiveness in product development [öko-effektive Produktentwicklung] (Frei 1999), sustainable value engineering (Stahlmann 2006) and green design (Mackenzie 1991). These terms and approaches are all closely related and offer many potential starting points

for optimisation, in particular if they are employed at an early stage in the product development process across roles and companies (Clarke and Gershenson 2007, pp. 70; McDonough and Braungart 2006, pp. 39; Giudice et al. 2006). Around 80% of a product's environmental impact depends on decisions taken at the start of the product creation phase (Jaafar et al. 2007, pp. 33; Clarke and Gershenson 2007, pp. 88; Caduff 1999, pp. 55; Atik 2001). The particular environmental significance of the early product development phases and their increasingly scientific analysis has been explored by authors including Zhou and Schoenung (2009), Kölscheid (1999), Alting et al. (2007), and Baumann et al. (2002). One aspect of particular relevance to cast parts is the attempt to produce less mass-intensive products ("lightweight components") (on "demassification", compare e.g. Fiskel 2009; Hitchcock and Willard 2009). Less mass-intensive products mean, for example, less energy for preparing the smaller amounts of raw materials, less energy for melting, more environmentally friendly transport and a lower environmental impact after the (initial) use phase, i.e. reducing mass and weight generally offers benefits at all stages of the life cycle (Fiskel 2009). Reducing energy consumption also reduces emissions, in particular CO_2 emissions.

6.2.2 The Increasing Importance of Energy Consumption and CO_2 Emissions in the Foundry Industry

Increasing attention has been paid over recent decades to the serious effects to be expected from global warming (WMO 2014). Investigations have focused on global changes in greenhouse gas emissions, and in particular emissions of carbon dioxide (CO_2). Growing concerns not least in the fact of a rise in natural disasters (storm tides, droughts, etc.) are increasing pressure on companies to reduce their environmental impact, and that not just for a specific sector, but along the entire value chain (UNEP 2012). Companies are increasingly also taking responsibility for the environmental problems of their suppliers (Koplin et al. 2007). A number of studies and company surveys, for example, "Nachhaltigkeitsmanagement in Unternehmen" ["Sustainability management in businesses"], conducted by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, have shown that companies are increasingly recognising the economic benefits of sustainable processes (German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety 2007). A study by the German Engineering Federation states that the German mechanical engineering sector alone could achieve a reduction in CO_2 emissions of 198 million tonnes over 10 years through the increased use of innovative processes and methods (VDMA 2009).

According to the World Energy Council, energy costs currently account for a global average of 10% of production costs; this percentage is forecast to rise to over 25% over the next 10–15 years (Robison 2011). In Germany, industry is responsible for more than 40% of total energy consumption (Neugebauer 2008), and the foundry

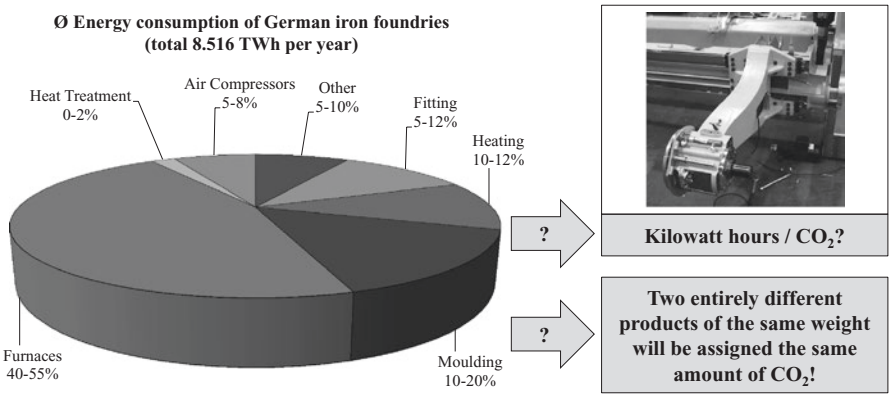


Fig. 6.1 Energy consumption of German foundries for cast iron materials (Fandl et al. 2014a; Picture: Heidenreich & Harbeck GmbH)

industry is particularly energy intensive. Energy savings are therefore an important factor in profitability and sustainability for German foundries (Trauzeddel 2009). Energy consumption in foundries varies significantly depending on the material cast, the process and the measuring methods and specifically also on the defined areas for measurement (cf. Figure 6.1).

Significant differences in consumption strongly indicate that considerable potential remains (Coss et al. 2015). On average, e.g. 60–70% of a foundry's total energy consumption is in the melting process (Bührig-Polaczek et al. 2014). German iron foundries use an average of 40–55% of total energy on melting (Bosse 2012). An assessment of the energy consumption of an iron foundry should not be limited to the melting process, as around half of the total energy is used in upstream and downstream processes in a foundry (Spall 1997). A standard, consistent and quality-assured tool is needed for measuring and evaluating energy and cost effects in casting development.

6.2.3 Case Study of an IT Tool for Early Assessment of CO_2 Emissions and Production Costs

A review of the available literature offered a number of aspects to explore in terms of how foundries could address environmental issues (e.g. Spall 1997; Huppertz 2000; Kuchenbuch 2006). None of the studies, however, directly addressed the CO_2 emissions in the casting process that are directly connected to the cast parts themselves. Building on the previous work in the field, a detailed process analysis was conducted for a German iron foundry (Fandl et al. 2014a, b). In line with the defined areas of measurement, detailed material and energy flow data were collected as inputs and outputs of the various steps in the production process and clearly

distinguished from nonintegrated material and energy flows. Data were collected in part on the basis of ISO 14040 (life cycle assessment) and VDI 4600 (cumulated energy demand), with additional data where required. Information on the energy consumption of all machines and technical equipment in the case study foundry was collected (a total of 282 items of equipment) (Fandl et al. 2014a, b).

A more in-depth process cost analysis was required in certain areas for an analysis of production costs (Kuchenbuch 2006). The IT tool developed on the basis of this analysis allows the development and design department of the iron foundry in question to assess both CO_2 emissions and production costs systematically. The difference in emissions between customer specifications and finalised development can be established by calculating the CO_2 emissions and production costs for a casting both on the basis of specifications from the customer (e.g. using customer 2D/3D models) and after conclusion of the joint, cross-company development process. As far as the authors are aware, the tool is the first to allow CO_2 emissions to be calculated specifically for castings without using an extremely simplified breakdown of total company emissions. It was found that castings of a similar mass can produce very different levels of CO_2 emissions and that previous breakdowns, for example, of energy consumption on the basis of component weight, are an oversimplification. Using a sample casting (support arm for a paper rolling machine), Fig. 6.2 shows how the IT tool offers considerable potential for reducing CO_2 emissions by drawing on casting development expertise. Production costs were also reduced by around 24% in this development project.

In the course of development of the IT tool, it became clear that there are many potentially important factors effecting cross-company product development part-

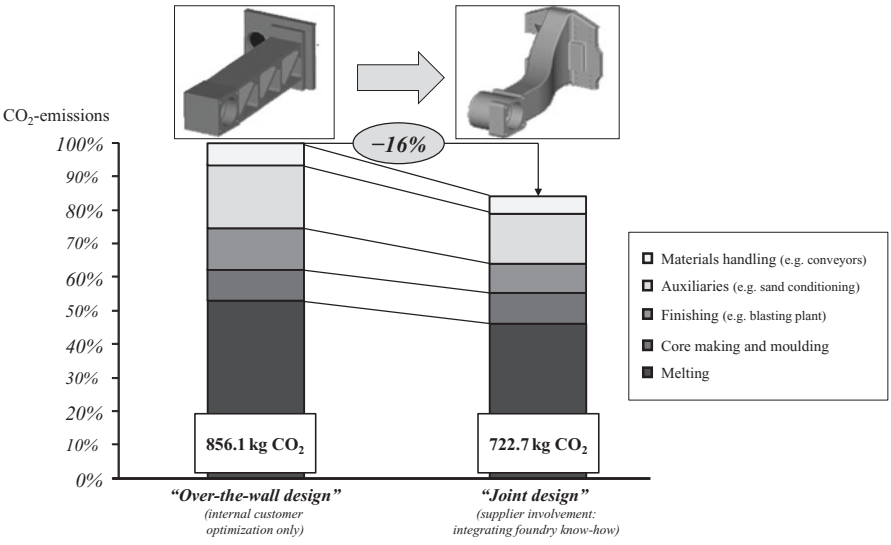


Fig. 6.2 Functionally identical castings: product development by the customer only (on the *left*) and with collaborative optimization (on the *right*) (Pictures: Heidenreich & Harbeck GmbH)

nerships. Further analysis was then required to identify what factors significantly affect a product development partnership and their impact on potential for CO_2 emissions and production cost reductions (Fandl and Held 2015a).

6.3 Design of the Study

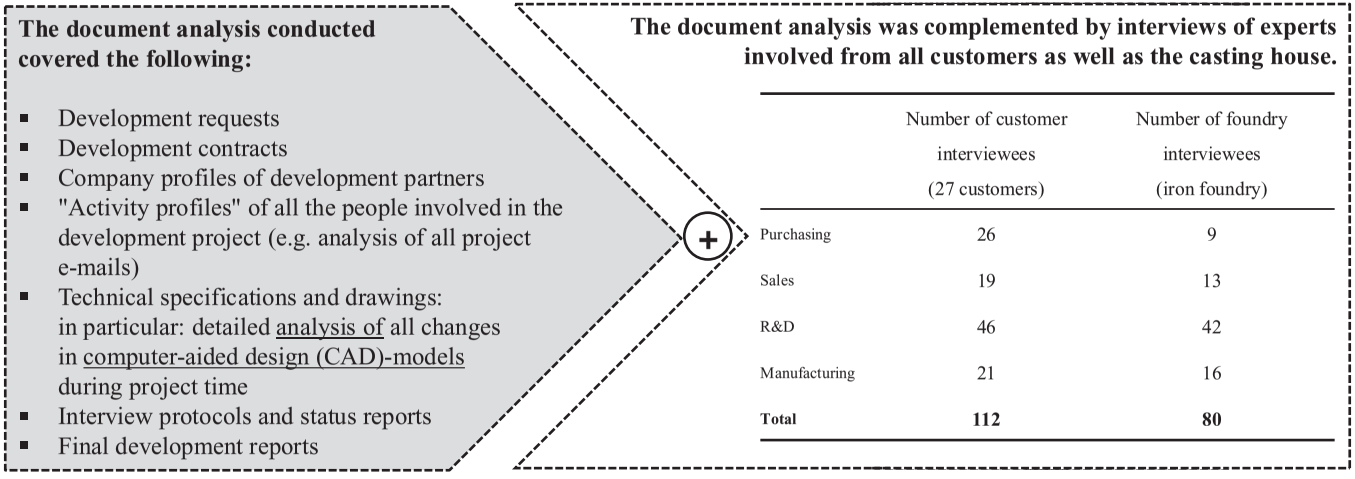
6.3.1 Scope of the Study

A case study is a useful way to analyse cross-company development partnerships in the context in question here (Yin 2003). The case study discussed below allowed in-depth analysis and theoretical replication (Eisenhardt 1989; McDonough 2000; Lamnek 2005; Miles and Huberman 2014). As shown in Fig. 6.3, the present study used guided expert interviews (on the right) with staff at the iron foundry in question and its customers, as well as document analysis (on the left) as data collection methods (e.g. Mayer 2013; Prior 2003). Cross-company casting development was defined as follows for the analysis: it starts when a customer first informs the foundry of a new development project and ends when the foundry hands over the development report with the final technical drawings and specifications to the customer.

The documents analysed (all e-mail communication, all CAD models in various stages of development, specifications, etc.) were supplemented with semi-structured interviews with experts involved in the relevant development projects at the customer end. One hundred ninety-two customers and foundry workers from purchasing, sales, research and development and production were interviewed face to face, and the interviews were then transcribed (Rubin et al. 1995).

The iron foundry in question is a medium-sized company in northern Germany. Its core business is the production of cast components for the mechanical engineering industry. The foundry currently supplies cast components developed and casts to high-quality standards, which are in some cases provided ready for installation. Materials are cast in weights of, e.g. 50–8000 kg in small-scale and medium-scale series production in accordance with DIN EN 1561 and DIN EN 1563. The iron foundry is certified in accordance with DIN EN ISO 9001 and DIN EN ISO 50001. The research and development (R&D) department uses 3D CAD software, finite element method (FEM) calculation tools and development tools for topology optimisation and casting simulation.

All development projects in the iron foundry in question for the period from 2006 up to and including July 2014 were recorded. There were a total of 78 development projects in this period. Restrictions, for example, on the basic material (the iron foundry casts materials in accordance with DIN EN 1561 and DIN EN 1563), production processes (only sand cast products) and project type (this study only covers new development projects), meant however that 39 development projects were excluded from further analysis. An analysis was conducted to determine the



	Number of customer interviewees (27 customers)	Number of foundry interviewees (iron foundry)
Purchasing	26	9
Sales	19	13
R&D	46	42
Manufacturing	21	16
Total	**112**	**80**

Fig. 6.3 Data collection methods

change in CO_2 emissions and production costs for cross-company casting development for the remaining 39 new development projects at the iron foundry.

The 39 case studies cover a total of 27 large- and medium-sized customer companies in the mechanical engineering industry that all operate German R&D departments.

6.3.2 Analysis of Data

In the light of the challenges outlined at the beginning, the aim of the study was to establish which factors could improve sustainability in cooperation between casting suppliers and buyers (primarily CO_2 and cost savings). This article therefore aims to answer the following two research questions (RQ):

- RQ A: What factors influence casting development partnerships?
- RQ B: How could an evaluation method for casting development partnerships be designed?

A combination of qualitative and quantitative methods (mixed method research design; see, e.g. Schreier and Odag 2010 pp. 271) particularly suited to exploratory questions was used to answer these research questions (Foscht et al. 2009 pp. 256).

First, the qualitative data (from the expert interviews, document analysis and literature research) was coded and converted to quantitative data. Thereby, the data collected were collected in figures and mapped using statistics software SPSS 22 (Schendera 2014; Field 2005). For a better understanding of the available data on cross-company casting development, the absolute frequency and percentage for each factor in the 39 development projects were then mapped with univariate statistics (Mayer 2013; Rasch et al. 2014). Factors were categorised as either customer or project factors; the project factors were then broken down further (e.g. characterisation of castings developed in partnership, communication and information).

The relationships between factors and changes in CO_2 emissions/production costs were then examined using bivariate analysis. A particular focus was on the strength of the relationship, for example, to changes in CO_2 emissions. On the basis of the information obtained from the univariate and bivariate analyses, an explanatory model was then developed for predicting future CO_2 savings [and production costs] in cross-company casting development, using, among other things, multiple analytical methods (e.g. univariate and multiple regression).

6.4 Development of a Method for Early Assessment of Potential CO_2 and Cost Savings in Cross-Company Casting Development

6.4.1 Findings of the First Statistical Analyses

The IT tool (see Sect. 2.3) was used to calculate both changes in CO_2 emissions and changes in production costs for all development projects analysed (cf. Fig. 6.4). Cross-company development partnerships had overall a significant positive effect on CO_2 emissions. The average change in CO_2 emissions for all development projects analysed was −14.39% (median −11.61% CO_2 emissions); the standard deviation was s = 14.81. The changes in production costs amounted on average to −23.18% (median of −20.94% production costs); the standard deviation was s = 21.78. The IT tool developed was used to calculate the changes in CO_2 emissions and production costs in the development projects analysed, which were implemented in a development partnership involving the iron foundry. A number of other measurements were also made, including the change in weight for the castings evaluated. It was found that this figure was not identical to the CO_2 savings or cost savings; a more detailed examination of individual design drivers and factors was therefore essential.

First, factors potentially affecting cross-company casting development and CO_2 emissions [and production costs] were identified and derived. A total of 48 such factors were identified (using, among other things, four case studies and a comprehensive

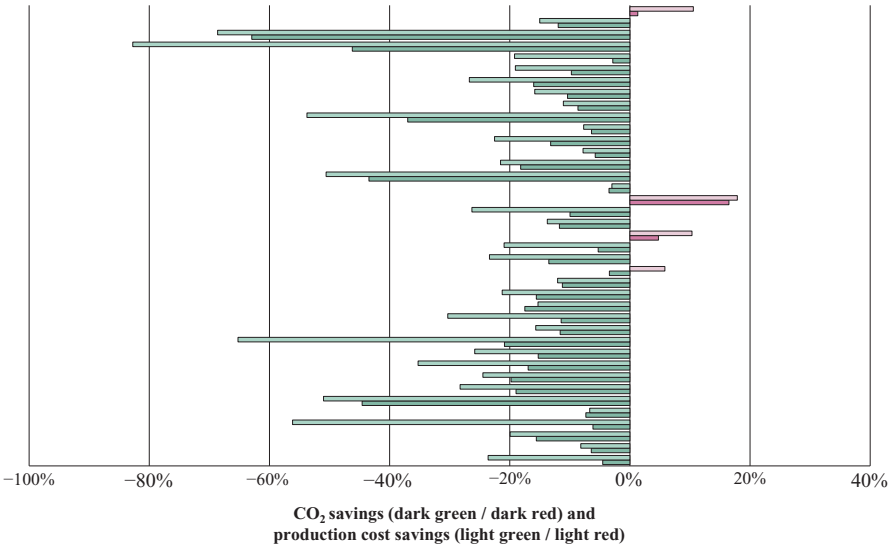


Fig. 6.4 Changes in CO_2 emissions and production costs in the cross-company development projects analysed

and more in-depth study of the literature). A top-down approach was used to narrow down these factors, for example, through interviews with over 100 experts from industry and research (Fandl and Held 2015b). In this way, 34 factors affecting cross-company casting development were identified for further analysis. Univariate analysis of the individual factors was then conducted, in part to better understand the available sample and to restrict further factors.

For the subsequent bivariate analysis of relevant factors, hypotheses were developed on the basis of the expert interviews and a comprehensive document analysis. For example, the following hypotheses (H) were formed: "The higher the number of full-time staff at the customer, the lower the potential CO_2 savings in cross-company casting development (H_3)"; "The earlier casting supplier is involved in the casting development process, the higher the potential CO_2 savings in cross-company casting development (H_{20})". Figure 6.5 below gives an overview of the hypotheses formed on the factors affecting the change in CO_2 emissions.

The next step was in-depth analysis of the relationships between influencing factors and CO_2 reductions. An initial, "simple" binary analysis showed that the CO_2 reductions achieved with customer companies "with fewer than 250 full-time staff" were on average −16.63%, in other words greater than customer companies "with more than 250 full-time staff" (average of −12.09% reduction in CO_2). Table 6.1 below gives examples of four more of the 27 factors investigated for cross-company casting development.

Building on the results above, boxplot and scatter diagrams were used to visualise more detailed bivariate relationships between the relevant factors and the change

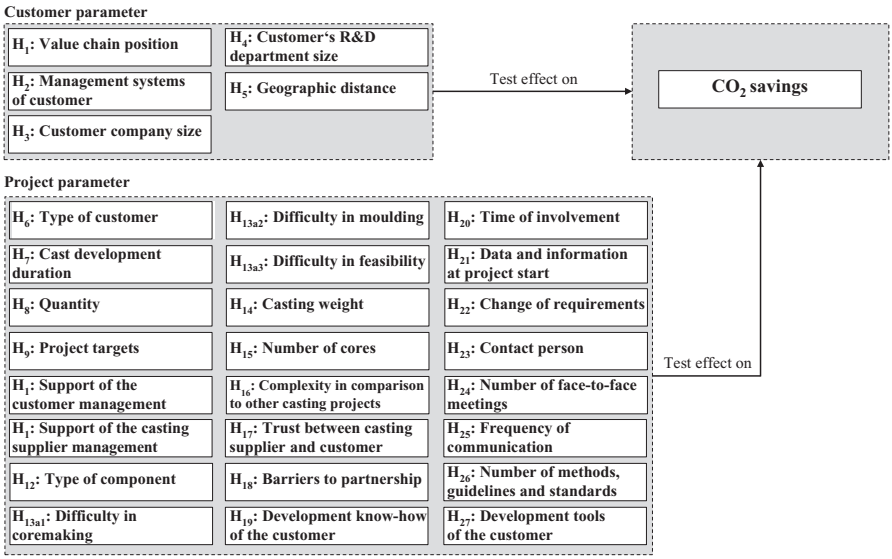


Fig. 6.5 Cross-company parameters with a potential impact on CO_2 savings when foundries are involved in cross-company casting development

Table 6.1 Simplified presentation of CO_2 emissions reductions with selected factors

H_{14}: **Casting weight**		
Average of CO_2 savings	Castings with "low mass" (<2000 kg)	Castings with "high mass" (≥2000 kg)
	−11,25%	**−17,09%**
H_{20}: **Time of involvement**		
Average of CO_2 savings	Idea phase	Design phase
	−21,52%	**−8,23%**
H_{24}: **Number of face-to-face meetings**		
Average ofCO_2 savings	"Without" face-to-face meetings during cross-company casting development	"Starring" face-to-face meetings during cross-company casting development
	−9,39%	**−23,59%**
H_{25}: Frequency of communication		
Average of CO_2 savings	"Scarce" project communication between the customer and the foundry (<15 interactions)	"Frequent" project communication between the customer and the foundry (≥15 interactions)
	−8,75%	**−16,06%**

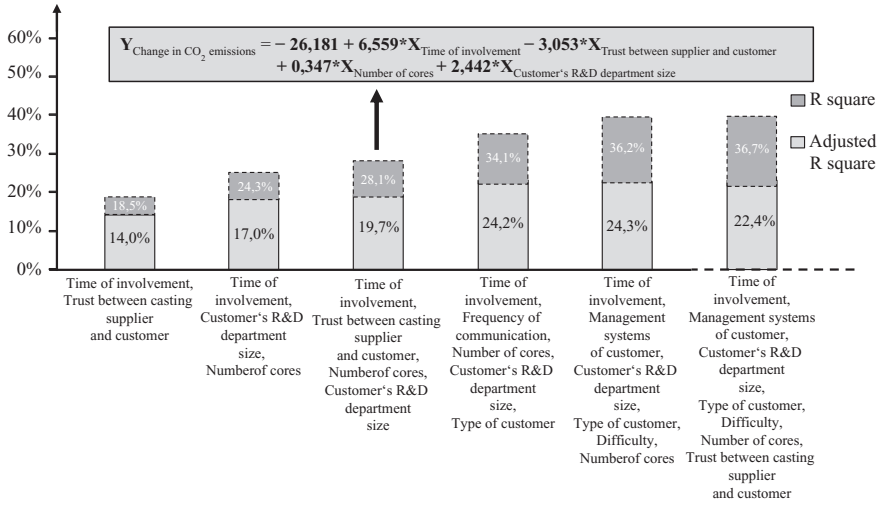


Fig. 6.6 "Combinatorics" of factors affecting cross-company casting development with the best degree of explanation

in CO_2 emissions. The hypotheses formed were tested (see above); and, e.g. hypothesis 3 was confirmed by comprehensive binary analysis. A subsequent analysis of the relationships between all influencing factors found largely (in 92.3% of cases) "very low" to "low" correlations between the individual factors. Only in 5.9% of cases there were "moderate" correlations, and in only 1.7% of cases, the correlation coefficients were greater than 0.6.

To summarise, many factors affected cross-company casting development, but only 27 were suitable for in-depth analysis of their impact on changes in CO_2 and cost savings (response to research question A). The change in CO_2 emissions found in the bivariate analysis gave a clear initial indication of potential factors impacting on sustainable cross-company casting development.

6.4.2 Full-Model Regression

A number of different models were then developed to explain the change in CO_2 emissions overall. The factors with the highest adjusted R squared were mapped starting with the first model (cf. Fig. 6.6).

The influencing factors examined in the univariate regression analyses were first correlated using "all-subset selection" (Albers et al. 2009, pp. 225; Field 2005, pp. 169ff.). Following the best model in each case with the highest adjusted R squared, further models were then also calculated.

On the basis of the requirements for regression analyses (see, e.g. Albers and Skiera 2000; Jann 2005), the fourth model was selected as the most suitable (cf. Fig. 6.6). This significant ($p < 0.05$) model covers four factors and shows that earlier involvement, a high level of mutual trust, the number of cores and a smaller customer R&D department in particular can have a positive effect on cross-company casting development. However, only the relationship for the time of involvement was individually significant at the 5% level. The relationships for the size of the R&D department and the number of cores had a tendency to significance at the 10% level. The model explained over 28% of total variance in CO_2 reductions through cross-company casting development (cf. Fig. 6.6, equation above).

The explanatory model then underwent another correlation analysis, and multicollinearity was examined. The relationship between the factors was examined first; no increased positive or negative correlation was found. A number of methods were used to test for multicollinearity; there was no multicollinearity.

6.4.3 Limitations of the Model for Predicting Future CO_2 Reductions

This section reflects critically on a number of aspects, such as the method applied, the factors affecting the empirical study and the robustness of the findings. The definition of the evaluation period and evaluation method was examined. The evaluation period ran from 2006 to 2014. Both shortening the evaluation period and extending the evaluation period by several years could have led to different results. The study considered all development projects at the case study foundry: complete data were not available for development projects prior to 2006.

There were various aspects to be considered in terms of the number of factors. The study started by addressing a wide range of possible factors affecting cross-company casting development. The large number of factors was due in part to the many expert interviews conducted. Other interesting potential factors were ruled out of the study in subsequent qualitative and quantitative analysis. There were many factors other than those discussed here which could be investigated in research in this field.

A comprehensive inductive statistical analysis was conducted to analyse the robustness of the results of the empirical study. Studies on heteroscedasticity and on special cases were also carried out as part of this process with outlier analyses. The findings of the regression analyses were found to be extremely useful and, in line with the scope of the sample, reliable.

6.5 Practical Implementation and Summary

On the basis of the method developed (see Sect. 4.2), an IT tool was created for the evaluation model. This tool was designed to assess the scope of possible ecological potential – i.e. changes in CO_2 emissions – offered by changing cross-company casting development. Design was followed by operational implementation of the IT tool using MS Excel.

The IT tool was then used by the head of the development and design department at the iron foundry on the basis of the data from two verification development projects. Table 6.2 shows the results of the ex ante forecast of changes in CO_2 emissions in cross-company casting development at the start of the verification development projects. The findings of the forecast with the evaluation model were then compared with those from an evaluation of the actual castings (cf. Table 6.2).

Table 6.2 above shows a −1.26% deviation between the forecast and the actual change in CO_2 emissions at a "base frame development project". The CO_2 savings of just under −11.29% mean that a total reduction of 2.3 tonnes of CO_2 emissions could be achieved with the number of castings planned. The verification development project "machine base unit" showed a +1.45% deviation in the difference. In the light of total output, this means savings of nearly 1 tonne of CO_2 emissions.

Testing the IT tool developed allowed an ex ante forecast of the CO_2 emissions saved by cross-company casting development (response to research question B). Collecting comprehensive data on material and energy flows in the various steps in

Table 6.2 Forecast quality assessment for verification development projects

Verification development project	Forecast of changes in CO_2 in cross-company casting development [%]	Actual saving [%]	Difference in [%]
Base frame	−8,98	−10,24	−1,26
Machine base unit	−11,29	−9,87	+1,45

the production process at a German iron foundry provided the basis for the development and implementation of an IT tool to assess energy consumption/CO_2 emissions and production costs (see Sect. 2.3). This IT tool was then used to assess the changes in CO_2 emissions [and production costs] in 39 cross-company development projects using the expertise of the foundry. The first step towards evaluation was a qualitative study of influencing factors in case studies and a preliminary bivariate quantitative analysis at a German foundry (see Sect. 4.1). The multivariate analyses presented (see Sect. 4.2), supported by the statistical analysis conducted and based on a large number of expert interviews and extensive document analysis, found that the main factors affecting changes in CO_2 emissions at the iron foundry investigated were as follows:

- The time at which a foundry's customers involve it in cast part development
- The level of trust between cast part customer and foundry
- The number of cores at the start of development
- The size of the cast part customers' R&D department

This set of factors is both customer related and project related and interacts with other factors. A final decision on long-term collaboration or on the scale of and resources provided for a cross-company product development partnership should always be taken on a situational basis for each individual development project; the assessment model developed can be used as a supporting tool. In the future, we can expect the German foundry industry to seek to investigate and evaluate the entire life cycle of its cast parts in the light of continuing competitive pressures and the growing importance of material and resource efficiency. The assessment of large-scale series production, for example, for the automotive industry, is not the only focus here. Another important area is single and large cast parts, in which the requirements are becoming ever more complex.

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Part II
Sustainability in Operational Processes and Specific Applications

Chapter 7
Sustainable Supply Chain Management: How to Integrate Sustainability in a Global Supply Chain

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Abstract This chapter aims to analyze the fundamental issues related to a sustainable supply chain. Based on a case study conducted recently at suppliers for retail business in China, it evaluates why Corporate Social Responsibility (CSR) has to be discussed using a holistic approach alongside the whole supply chain and how CSR in a sustainable supply chain can improve its competitiveness and the quality of products. Furthermore, it provides a state-of-the-art compilation of the most frequently applied definitions of Corporate Social Responsibility and Sustainable Supply Chain Management (SSCM).

China has been selected as focus area, since more than 80 % of the goods in retail are manufactured in China. Beside the objective to prove the significance of CSR in global supply chains impacting product competitiveness, this chapter also summarizes the measures initiated by the companies interviewed and compiles commonalities into a CSR checklist for further application and amendment by CSR managers to improve their company's financial performance while using CSR measurements.

Keywords Corporate social responsibility • Sustainable supply chain management • Retail • China • Global sustainable supply chain • CSR management • Compliance management

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7.1 Motivation: Moral Responsibility: Ethical Dilemmas

We can find manifold examples and further evidence of ethical failures in all aspects of our daily lives. Complex technological integration within supply chains has created ever more complex systems out of previously isolated systems. This makes single organizations more vulnerable to ethical failure and thus a business ethics imperative is even more important to be considered within a business context (Westover 2015). But also economic imbalances between developed and developing countries will force global and local companies to undertake the mission to strengthen their potential customers with low buying power, economically and socially, integrating CSR aspects, and to apply personalized customer acquisition and retention methods which have not been used so far (Naci 2015).

7.1.1 Companies Between CSR and High Performance Pressure

Companies are increasingly recognized as the bearers of moral responsibility in both the manufacturing and the retail industry, calling for sustainable management of the environment, resources and human capital. Retail companies act in the context of sustained responsibility and permanently high performance pressure to increase efficiency since they are at the interface between the producer and the consumer and in continuous focus of society. At the same time, it is difficult to distinguish CSR from corporate governance and corporate citizenship, due to their proximity in content and partly identical objectives. Companies can develop various categories of responsibility and bundle their corporate sustainability activities (e.g. through corporate culture, or commitment to the community). This implies a legally binding obligation for CSR and the creation of win-win-win situations for all stakeholders of a sustainable supply chain (Beck 2016).

Moreover, in this context, current negotiations in court also underline this new focus on global responsibility of transnational companies for their supply chain concerning compliance with and the implementation of human rights, socially acceptable working conditions as well as environmental protection at their supplier base (Jungkamp 2016).

7.1.2 Corporate Social Responsibility as "Social License to Operate"

CSR must be understood as an essential prerequisite for the survival of companies rather than a pure luxury activity in economically prosperous times (Müller 2008). The motivation for companies to engage in CSR ranges from ethical consciousness

to voluntary service in order to ensure the legitimacy of company activity and to get a so-called "social license to operate" from all stakeholders and society in general.

The European Commission defines CSR, on a voluntary basis, the approach of companies to integrate social concerns into company activities and to interchange with stakeholders. CSR can also be described as the triangle of responsibility (in the result), attitudes (to assume responsibility) and fundamental business practices (to show responsibility in action, e.g. CSR integrated in the international/global supply chain), which can and should be implemented with sustainability management systems (systematic approach and set of methods) (Weber 2008).

7.1.3 Ethical Culture: From Conformism to a Culture of Integrity

Ethical culture, impeccable reputation, and promoting integrity are key ingredients of moral leadership, and are interconnected with morality, integrity, and compliance concepts which any company has to target at least in some way. To translate the company's values, principles, and beliefs into practice, any company has to move from conformism to a culture of integrity. Risk management can be seen as one approach to pursue this. It needs to cover possible ecological and social impacts and risks along the supply chain. Moreover, a company's risk management system has to add value to the company, i.e., it needs to be part of the organizational and the decision-making processes. It should especially point out the uncertainties and presumptions, and should be organized in a systematic and structured way (Vaduva et al. 2016).

7.2 Definitions of CSR: Different Perspectives

Although there are a high number of CSR and business ethics studies in research available, no universal definition for CSR can be found.

7.2.1 The CSR Definition of the European Commission

In March 2000, the European Council made a special appeal to companies' sense of social responsibility regarding best practices for lifelong learning, work organization, equal opportunities, social inclusion and sustainable development. This initiative resulted in the first green paper of the European commission titled "Promoting a European framework for Corporate Social Responsibility" (European Commission 2001). The green paper defines CSR as follows: "Most definitions of corporate

social responsibility describe it as a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis." (European Commission 2001).

In 2011, the European commission puts forward a new definition of CSR as "the responsibility of enterprises for their impacts on society" (European Commission 2011). The European Commission more specifically states "to fully meet their corporate social responsibility, enterprises should have in place a process to integrate social, environmental, ethical, human rights and consumer concerns into their business operations and core strategy in close collaboration with their stakeholders" (European Commission 2011).

7.2.2 CSR Defined by the International Organization of Standardization

The International Organization of Standardization (ISO) published its standard ISO26000:2010 in 2010 which was prepared by the ISO/TMB (technical management board) working group on social responsibility (International Organization of Standardization 2010) and was further reviewed and confirmed in 2014. It defines CSR as the "[r]esponsibility of an organization for the impacts of its decisions and activities [including products, services and processes] on society and the environment, through transparent and ethical behavior that contributes to sustainable development, including health and the welfare of society, takes into account the expectations of stakeholders, is in compliance with applicable law and consistent with international norms of behavior, and is integrated throughout the organization and practiced in its relationships [that refer to an organization's activities within its sphere of influence]" (International Organization of Standardization 2010).

7.2.3 CSR Defined by Experts

In early an work, Luetkenhorst (2004) describes CSR as an approach whereby "companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis […] not only fulfilling legal expectations, but also going beyond compliance.", what most authors agree to.

Loew and Rhode published a slightly different definition compared to the European Commission in 2013 (Loew and Rohde 2013): "CSR is a company's responsibility for the impact of its activities on society and the environment, and its CSR management, so that the use of appropriate procedures, and the implementation of projects that allow the company and its activities to avoid or minimize the negative impact on individuals, society and the environment, respect applicable law, adequately consider the interests of stakeholders, and contribute to a sustainable development".

7.3 Reasons for CSR in the Supply Chain: Push and Pull Factors

The aspect of CSR in the supply and value chain is directly addressed in the European Union Non-Financial Reporting Directive (EU NFRD) which was derived in 2014 based on the CSR definition of the European Commission and has to be transformed in national law until the end of 2016 by all EU member states.

Besides this future legally binding obligation for CSR (push factor) especially consumers increasingly require (pull factor) esp. retailers to offer CSR compliant products in order to meet their expectations (Sievers and Gerling 2012), and as a means of bearing their personal responsibility (Schoenheit n.d.). The demand for organic and fair trade products is growing as steadily as the group of consumers who want to combine healthy food with enjoyable food (Schaltegger et al. 2010).

7.3.1 LOHAS as Pull Factor for Sustainable Supply Chains

The so-called LOHAS consumers maintain a "lifestyle of health and sustainability" (Helmke et al. 2016) and want to know in detail the social and ecological conditions along the whole supply chain under which the products they consume are manufactured. They are also willing to pay a markup for CSR as an add-on feature, in particular for food items (Stehr and Struve 2015). Consequently, CSR is becoming a critical factor in the competitive environment especially but not only in the retail industry (Schaltegger et al. 2010; Stehr 2015).

However, retailers have to bear their responsibility on behalf of the whole value chain by integrating the supply chain (Heur 2014a). A study conducted by Stehr and Struve (2015) shows that consumers who believe they shop sustainably and responsibly are highly divergent in their actual buying decisions (2015). But still, the question remains: does CSR add value to the products?

Numerous companies have recognized the importance of CSR for the purchase decisions of consumers in the meantime. But the strategies taken by the affected companies are quite different (Jones 2016; Knoppe 2015). Companies in the textile industry are in a leading position, possibly due to the shattering events in Bangladesh in 2013 (International Labour Organization n.d.). The efforts of the parties affected are at most with regard to their own progress (Keck 2015a), but also with regard to the implementation and monitoring of the supply chain (Chi 2011).

Companies such as Puma (2016a) go even further beyond. They have committed themselves, not only to align their own actions according to the CSR standards, but to involve and monitor all suppliers within the supply chain as part of their responsibility to increase quality and improve financial performance (McGill n.d.). Puma has published its sustainability reports since 2007, describing all undertakings related to sustainability for the whole supply chain with increasing success (Puma 2016b).

7.3.2 From Global Supply Chains to Sustainable Global Supply Chains

But how are todays supply chains structured? Supply chains consist of many individual company members such as suppliers of raw materials, producers, distributors, logistics service providers, commercial enterprises and end customers, and are highly specialized and disaggregated. While, in particular, producers of high-quality market goods are strongly dependent on the cost, quality and delivery performance of their direct and indirect suppliers, Non-Governmental Organizations (NGOs) such as Greenpeace, Oxfam, Global Witness or China Labor Watch, but also enlightened and sustainable consumers like the so-called LOHAS, have placed the focal companies in the duty to ensure good social and environmental standards along the (global) supply chain (Werther and Chandler 2011). This development also plays an important role for international supply chains as they frequently face tensions between supply chain actors.

7.3.3 Key Ethical Issues for Different Stakeholders

Key ethical issues in global supply chains arise for producers, intermediators, retailers, and consumers, some issues, such as fair prices and production according to environmental and social standards concern all stages (Schlegelmilch and Öberseder 2007). Negative examples such as lead poisoned toys from Mattel in 2007 or the collapse of the Rana Plaza textile factory in Bangladesh raise a fundamental question for supply chain managers: ***do the suppliers of a company's network produce according to internationally recognized environmental and social standards?***

Sustainability activities along all relevant areas of supply chain management, which are directly involved in the value-adding process, such as purchasing, product development and design, internal processes and production, logistics and recycling, require a functional categorization. Any money that is invested in sustainability will pay interest in the short to medium term through higher sales, better corporate visibility and higher profitability. The closer the company comes to the end customer, the more it benefits from sustainability activities.

However, the success effect decreases with increasing customer proximity. The most potentially economic profiteers are those who invest least in sustainability: end-to-end raw material and component suppliers. Unfortunately, end-to-end suppliers have not yet discovered the full economic potential of their sustainability commitment (Förstl and Schleper 2015).

7.3.4 Reasons and Barriers for Sustainable Global Supply Chains

Whilst SCM can be viewed as part of operations management, logistics, and purchasing, it can also be viewed as multidisciplinary breaking from the dominance of single disciplines (Burgess et al. 2006). Issues for SSCM and evaluation are sourcing, transformation, delivery, value proposition, customers and product use, and reuse/ recycle/ return of the products (Hassini et al. 2012). Reasons for SSCM are top management vision, government regulatory requirements, type of business sector, customer demand, competitor actions, and external stakeholders (e.g. NGO's). To measure the performance of SSCM, quality, price, reliability, service rate, delivery, and flexibility come into effect (Ageron et al. 2012).

Potential barriers for SSCM are financial costs, green investments, and return on investment, whilst benefits and motivation are customer satisfaction, supplier's capabilities to innovate, and quality (Contractor et al. 2010). Moreover, a green supply chain concept should be applied across the entire value chain sharing managerial approaches such as intended strategy or external collaboration.

7.3.5 Sustainable Supply Chains in Emerging Countries

The divergence in the interpretation of CSR can affect the strategy and performance of CSR-engaged businesses in emerging markets as well. In case of Apple, 331 of 600 manufacturing sites in Asia are located in China. Hence, the performance of Foxconn and Wintek as Apple suppliers is also of great interest. The development of CSR in China is in early stage today, whilst state-owned enterprises (SOE) are taking a leading role in CSR practices, and private or foreign enterprises are lagging behind. But still the question remains for the supply chain manager: ***how to facilitate Chinese firms as part of the global supply chain to proactively adopt CSR practices in order to gain international competitiveness and to fulfil customer and legal requirements?***

So far, investigations on CSR focused mainly on western countries. However, only little attention was drawn to CSR activities in so-called developing and emerging countries (Schmidpeter et al. 2015). The ASEAN market with an annual growth rate of 4.5 % is currently one of the strongest economic regions in the world. The ASEAN market represents huge opportunities for consumer products with potential consumers of approx. 620 million (Verhezen et al. 2016). Due to recent trade agreements, the ASEAN region will most likely enter into a new dynamic period. China, on the other hand, offers enormous business opportunities in the China-ASEAN relationships (Crosby 2016).

7.4 Case Study: Chinese Suppliers: CSR in the Retail Supply Chain

The following case study was conducted as an empirical survey using expert interviews. These interviews themselves were carried out during two 14-day stays in China in autumn 2016. China was chosen as target country as a main "global supplier": the majority of electrical appliances and consumer electronics are made in China (Heidemann and Weber 2015). The selection of the surveyed companies was based on multiple criteria: firstly on their relevance due to their business segments, and secondly on the ability to compare multiple suppliers of the same business segments in peer reviews. The questionnaire contained quantitative, multiple-choice, as well as open questions to support the widest data collection possible in quantitative terms (Baur and Blasius 2014) as well as in qualitative terms (Mayring 2008, 2010; Mayring and Frenzl 2014).

Even though the discussions in research on mixed-method studies are controversial, the approach allows to cluster the companies investigated, and to discover individual solutions at the same time. From the viewpoints discussed above, the question arises whether CSR-compliant products can be more competitive in the market than non-compliant products and what the consequences for the supply chain are.

At the same time, consumers are obviously not willing to pay additional costs that may arise as a result of conforming to CSR production conditions. In this respect, retail has to seek other approaches to introduce CSR. A decisive factor is that CSR is no longer seen as an external product feature; rather it is understood as an internal, product-determining property as shown in Fig. 7.1.

7.4.1 CSR and Its Impact on Product Competitiveness

The characteristic as an internal, product-determining property is a basic prerequisite for CSR products to gain competitive advantage compared to standard products (Knoppe 2015). In the context of competitiveness, the products of the market participants mutually compete in terms of price, quality, service or design (Tolksdorf 1994; Whish and Bailey 2015).

As already mentioned above, China is a major hub in global supply chains. For instance, two companies located in China manufacture 80 % of the global microwave production. About 60 % of the round and coin cell three companies in China

Fig. 7.1 CSR impact on product competitiveness

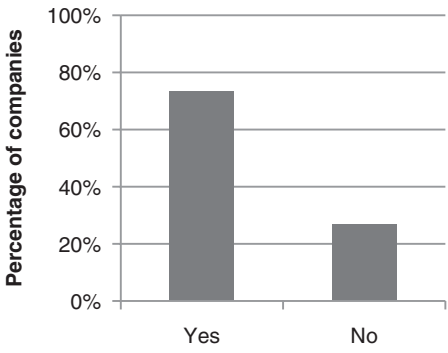

Fig. 7.2 Has your product quality increased?

manufacture batteries worldwide; the same is true for the top 5 manufacturers of electric kitchen appliances.

Hence, it is essential to evaluate the understanding of the impact of CSR on product competitiveness and pricing for those key members of global supply chains. In a first step, the companies were asked about their understanding concerning the impact of CSR on product competitiveness and the supply chain in general. Five out of 15 respondents (33 %) provided answers that can be clustered with "better product quality". The second most common clusters are "training of the employees", "lower manufacturing costs", and "employees are more motivated" with 3 of 15 respondents (20 %). The respondents being asked to quantify the impact on the products can further confirm this understanding. Five of 15 respondents (33 %) reconfirmed "higher product quality", 4 respondents "higher production yield", and 2 respondents "better product performance". Product quality as non-price competitive advantage (Gersmeyer 2004; Li and Liu 2014) was stated as key factor to increase product competitiveness through CSR. The initial assessment of product quality could be re-confirmed by 11 of 15 respondents (73 %) when asking if CSR has improved product quality (Fig. 7.2).

When being asked to what extent has your product quality increased, most of the respondents (55 %) stated "higher product quality". Furthermore, 46 % of the respondents indicated "less failures in the field" which proves the non-price competitive advantage for the consumers using the items. This advantage was further confirmed by 18 % of the responses stating a "better product performance". But also the manufacturing costs are improved for 36 % of the respondents by indicating a "higher yield" in production through CSR as shown in Fig. 7.3 (11 respondents, minimum 2 responses).

Moreover, the companies are able to specify the reason for the increase of product quality. The majority of 55 % indicated "higher skilled employees" as reason: the second most common response with 36 % stated a "higher loyalty of employees" as reasons for the increase of product quality.

But also "higher motivated employees" by 27 % of the responses, and "greater automation" with 27 % of the responses are stated as key factors as well. Further reasoning provided "working conditions", "safety at the workplace", "automation",

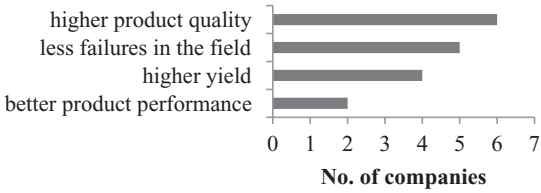

Fig. 7.3 To what extent has your product quality increased?

"less manual work", or "lean production" as factors impacting product quality in a positive way. Some companies were even able to quantify the impact of CSR on product quality. The majority (55 %) of respondents indicated a higher yield with up to 20 % to quantify the impact of CSR on product quality. The second largest cluster with 45 % of the responses indicates less failure in the field stating an improvement of up to 10 %.

7.4.2 The Positive Impact of a CSR Report

But the 15 companies can be further grouped whether they prepare a CSR report or not. Eleven respondents (73 %) stated that their company is already preparing a CSR report. Four respondents (27 %) replied that they do not prepare a CSR report. This distinctive feature can be used to cluster the answers provided, since the preparation of a CSR report indicates that the companies has already been exposed to CSR related issues, whilst the other group may not have reflected about CSR so far. While 82 % of the respondents preparing a CSR report stated an increase of product quality due to CSR, only 50 % of the respondents without CSR report shared this assessment as shown in Fig. 7.2.

In contrast to the most common perception, CSR is not necessarily related to additional costs. Furthermore, the investigation revealed that CSR has the largest impact through "weak" factors such as employee recognition, identification with the company, and opportunities for personal development. However, this underlines that CSR helps these companies to consider its employees not only as its most valuable resource, but moreover, to integrate them as stakeholders into the decision-making of the company.

Secondly, CSR improves product competitiveness to a great extent. However, this approach can only work efficiently, if all stakeholders of the supply chain are involved and engaged. Even though the own company may be a good starting point to introduce the concept of CSR, sustainable and reliable advantage for all parties can only be achieved if all stakeholders are involved as described for the introduction of CSR top down due to the international/global customer requests.

The analysis and interpretation of the findings proceeded on several levels. Firstly, the surveyed companies are able to increase employee motivation, loyalty, skill level, and safety by means of most simple activities such as recognition, training, participation, personal development, and protection of the employees. The

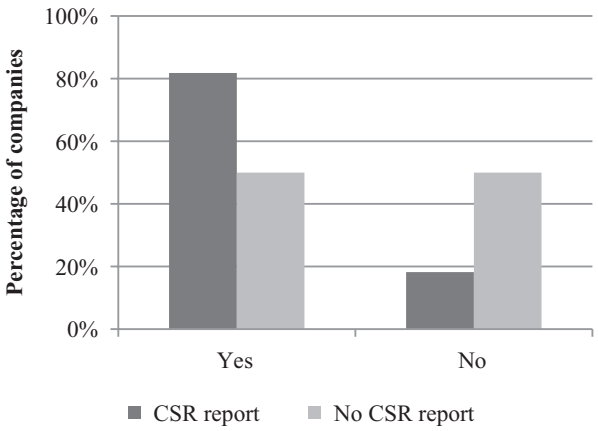

Fig. 7.4 Has your product quality increased?

companies are further able to increase product and company competitiveness through the improvement of product quality. This is a win-win situation for all stakeholders: the Chinese company, the employees, the suppliers, the customers, the environment, and the society (Heur 2014b; Lehmacher 2016). But also the international consumers will benefit from higher product competitiveness through higher quality products at a lower cost (Hackl 2015) (Fig. 7.4).

7.5 CSR Management Checklist for Sustainable Supply Chains

All findings discussed above can be translated into a CSR checklist for supply chains combining internal and external perspectives. This list of questions allows pursuing a gap analysis and comparing different companies on a peer level. The checklist is structured in different segments (employees, work environment, company, and society) depending on the level of impact.

7.5.1 Suppliers

- Do you monitor the status of CSR implementation at your suppliers' end? Do you know their CSR strategy?
- Do you know your first-tier, second-tier, third-tier suppliers and their CSR management approaches and systems?
- How and how often does your company monitor the status of CSR implementation?

- Which Key Performance Indicators (KPIs) and other measurements of your company could help to monitor the CSR development of the different levels of tier supplier?
- Which KPIs are required in order to fulfil social and legal requirements (e.g. due to the European Union Non-Financial Reporting Directive)?
- How could you integrate the development, the mentoring and teaching of the supplier regarding the social, environmental and legal issues in the company's strategy and operations?

7.5.2 Employees

- How do you evaluate the employees' feedback in relation to CSR and in terms of the supplier?
- What measures can help to improve employee working conditions on the supplier side?
- How can your company improve employee training either at home or at the suppliers' side in relation to the CSR approach and the CSR strategy?
- How can your company increase employee motivation? What measure can you improve further?
- Would you consider the payment to be fair and competitive? Are you referring to the right benchmark?

7.5.3 Work Environment

- How can your company improve the working conditions for the employees (local/national/international)?
- How can you enhance the safety of the work environment at all stages of the supply chain?
- How about your risk management and compliance management systems? When do you plan to implement those systems? Who is in charge of?
- What measures can help to enrich the employees' jobs?
- What measures can reduce labor intensity at your company?

7.5.4 Company Level

- Do you have to fulfil the legal requirements of the European Union Non-Financial Reporting Directive?
- Do you have a CSR responsible person? What is the organizational level (e.g. department level) (s)he is located at?

- Are you intrinsically/externally motivated to publish a CSR report? When are you going to publish a CSR report?
- What financial benefits can you generate while implementing CSR on all levels of the value and supply chain?
- How can your company establish the exchange between employees and management level?

7.5.5 Society/Environment

- What is your impact on environmental/social developments on a local, national, global level from your entrepreneurial activities?
- How do you measure these impacts along the value chain and your supply chain?
- How can your company reduce energy consumption?
- How can your company reduce waste generation?
- In what educational programs can your company engage?
- In which way does your company engage in public welfare?
- Which CSR projects do fit into the corporate strategy and thereby do create an internal and external benefit?
- Which CSR projects could increase your "social license to operate" under the global CSR perspective?

7.6 CSR in the Supply Chain as Future Proof of the Company

In the scope of global SSCM and to understand differences in CSR interpretation, it is also important to understand the nature of intercultural competence, and the process by which intercultural competence develops. This can help to evaluate how individuals can be taught, trained, and/or mentored regarding the development of intercultural competence (Vande Berg and Paige 2009).

Sustainability and in broader understanding CSR can be seen as a future proof of the company and not primarily as a marketing tool or philanthropy. As an integral part of the corporate strategy, it can guide on the way to a 100 % sustainable business including sustainable supply chains, environmental and social responsibility in the production, social commitments and social responsibility to the employees, consumer protection and consumer responsibility, and promoting sustainable consumption. In addition to strategic alliances, a program to enforce social standards for suppliers should cover social and environmental code of conducts, monitoring, qualification, stakeholder dialogues, and verification (Schiebel 2015).

7.7 The Role of Management in Implementing SSCM

Due to their strong authority, top management members possess a great influence on the value structure and ethical culture of their company. To successfully implement CSR measures within the company, ethical actions have to be embodied and actually lived by the company's management (Stehr 2015). To do so, trust is a necessary basis for collaboration and organizational commitment. Unfortunately, up to board level, managers are described as being dishonest in the future development of the company, and how the internal competition issues were played (Bachmann 2017). Hence, the way how the company operates can only be influenced by changing leadership realities. In effect, this would mean that more than 90 % of the existing research in CSR is analyzing false transformational drivers.

But CSR cannot be always explained in terms of a strategic commercial interest. Also, each individual manager can exercise influence by initiating or changing specific projects to address personal moral concerns (Hemingway and Maclagan 2004).

Not only have the companies taken benefit from their CSR activities, but also the society. Different integrative CSR management approaches such as CSR strategies, non-profit management, shared value chain management, sustainable supply chain, or ISO26000 provide short-term, mid-term, and long-term benefits (Schneider and Schmidpeter 2015). To implement those strategies, top management has to act as anchor of the company's concept of responsibility as they possess great influence on the value structure and ethical culture of the company (Keck 2015b). The implementation of CSR as a management tool enables the companies to be better manageable and competitive since the simplicity of methods and tools leads to systematization (Schneider 2015).

7.7.1 Skills and Tools of CSR Managers

In order to successfully implement the requirements of CSR, a CSR manager should own a leading role acting as relationship manager with social skills, engage as motivator with high flexibility, and persistently strive for an innovative CSR management. In order to monitor the progress of CSR management, Lotter and Braun (2010) proposes the introduction of a CSR scorecard with four perspectives: finance, internal processes, learning and development and customers/stakeholders. This scorecard can be further developed to a strategy map to visualize the cause-effect-relations.

The CSR report primarily addresses information requirements of stakeholders external to the company and thus complements the merely internal focus of a CSR scorecard to provide a comprehensive managerial view on CSR activities. The structure of a CSR report should have the following characteristics: key figures, preface of the management, short profile of the company, vision and strategy, company policy, organization and company performance. Moreover, to ensure sustained

success of CSR management, the CSR goals, performance indicators, movement, as well as definition of new goals should be included as well (Lotter and Braun 2010).

7.7.2 Sustainable Supply Chains: Integrating a Global CSR Perspective

A differentiated consideration of the concept of CSR has a direct effect on a company's CSR strategy evaluating sustainability competence vs. relevance in the industry, and defensive (compliance, risk limitation) vs. offensive (pro-active use, competitive advantage) approaches. In this context, CSR 4.0 manifests as the new future of CSR, with the approach "think global, act local" for either the management and or the employees. It follows the understanding that even an international company must be aware of its local context abroad and needs to promote it in the sense of a mutual dependency between companies and society. It leads to a new global Corporate Citizenship, since sustainability and compliance can no longer be separated and restricted to the limits of one's own company but must holistically cover the entire value chain. This makes efficiency and effectiveness the two biggest and most important advantages of a common approach (Stehr and Struve 2015).

7.7.3 Compliance Management in Sustainable Supply Chains

In addition to the relevance of CSR to the product, the supply chain and a company's competitiveness, further aspects are equally important to the company's success. The significance of compliance and compliance management, as well as legal requirements (e.g. European Union Non-Financial Reporting Directive) and risks of liability, possible allegation of the lack or insufficient organization of rules of conduct have steadily increased. The compliance officer plays a key role as a responsible manager for the control of legal opportunities and risks. Key roles are protection and risk management, consulting and information, monitoring and supervising, quality assurance and innovation, as well as marketing. Core elements of effective compliance management are identification, compliance risks, promoting a culture of compliance (code-of-conduct), information and training, checking, detecting and sanctioning of infringements. The compliance officer has to report to the top management and compile a compliance report in written form for documentation and evidence purposes. The frequency should be at least annually. The extent of the reporting depends on the risk structure and the compliance status of the company (Schulz and Galster 2015).

7.8 Conclusion

This chapter intended to show the benefit to all stakeholders of applying CSR not only within the horizontal level of the global sustainable supply chain. The highest impact of CSR to a value chain can be achieved at the far-end of the suppliers. The case study showed that CSR will lead to a higher competitiveness of all stakeholders involved in the value chain underlining that a global sustainable supply chain can only be discussed in a holistic approach involving all stakeholders affected. Furthermore, the results showed that a higher focus has to be drawn to the countries of origin in order to understand the specifics of local CSR applications. The CSR implementation checklist can support CSR managers in evaluating successful best practices for further application in their individual company. However, aligned CSR activities among all parties involved will increase the customer benefit through a higher competitiveness in a global perspective.

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Chapter 8
Quantitative Modeling of Sustainability in Interorganizational Supply Chains

Tobias Rebs

Abstract The consideration of environmental and social aspects has become essential for the management of supply chains where decision-making is particularly supported by formal models. This chapter reviews interorganizational quantitative models for sustainable supply chain management (SSCM) by employing content and cluster analyses. The paper sample consists of 62 formal models that meet the selection criteria for this literature review. The selected articles are analyzed with regard to sustainability and supply chain management constructs derived from related conceptual literature. In pursuit of greater insight into model types in conjunction with stakeholder triggers for SSCM and sustainable risk management, this review confirms the preponderance of deterministic approaches focusing on the interplay of economic and environmental aspects while social indicators are broadly omitted. It is detected that stochastic approaches to model all factors of the triple bottom line of sustainability are missing so far. Moreover, the operationalization of stakeholder pressures and incentives as well as sustainability-related risks is underrepresented, which calls for further research in this respect.

Keywords Supply chain • Sustainability • Interorganizational • Formal modeling • Literature review • Cluster analysis

8.1 Introduction

The management of supply chains has evolved from the mere strive for economic targets related to efficiency, customer satisfaction, and competitive advantage (Cooper et al. 1997; Mentzer et al. 2001; Chopra and Meindl 2007) to the comprehensive concept of sustainable supply chain management (SSCM) that includes social and environmental aspects of the triple bottom line of sustainability (Elkington 1998). SSCM focuses on downstream material flows from suppliers to customers

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(Seuring and Müller 2008) and is distinguished from reverse logistics or remanufacturing which deal with upstream material flows (Fleischmann et al. 1997) or closed-loop supply chain management (CLSCM) that includes forward and reverse material flows (Guide and van Wassenhove 2009).

A large majority of SSCM studies is based on conceptual or empirical research (Carter and Rogers 2008; Carter and Easton 2011), and thus quantitative models are needed to operationalize the conceptualized constructs (Golicic et al. 2005). In contrast to numerous quantitative approaches for reverse logistics, remanufacturing, and CLSCM (see reviews of Fleischmann et al. 1997; Guide and van Wassenhove 2009; Ilgin and Gupta 2010; Govindan et al. 2015), formal SSCM models are found less often (Min and Kim 2012). Although the company-internal supply chain needs to be distinguished from supply chains and networks of externally linked firms (Chen and Paulraj 2003), related reviews on formal SSCM modeling take a broad perspective on firm-specific, interorganizational, and macroeconomic approaches (see reviews of Seuring 2013; Brandenburg et al. 2014; Brandenburg and Rebs 2015).

As a result, more clarity is needed about how formal models can support decision-making for the sustainable management of forward supply chains on the interorganizational level. This chapter elaborates on this research gap and presents a systematic review of related papers. A particular focus is put on sustainability risks, on sustainable supplier management, and on stakeholder pressures and incentives for SSCM. The remainder of this chapter is structured as follows. The next section gives a brief review of related literature and is followed by the employed research methodology. Subsequently, the results of analysis are presented. The chapter concludes by summarizing and discussing the major findings.

8.2 Literature Background

Within the last couple of years, numerous reviews of SSCM and CLSCM papers were published. Apart from reviews that exclusively focus on empirical studies (e.g., Gold et al. 2010a, b; Carter and Easton 2011), 12 reviews include formal models in the paper sample. As illustrated in Table 8.1, these reviews can be categorized with regard to the research focus, the supply chain management (SCM) perspective, and the underlying sustainability perception as well as with regard to the research methods that are employed in the reviews.

Only two of these reviews are limited to environmental aspects, while all other reviews include social factors. For most reviews, the sampling process is based on structured keyword search, and content analysis is the method of choice. A large majority of reviews do not limit their focus on sustainability in forward supply chains but takes into account reverse flows or CLSCM. A clear focus on SSCM is taken by Seuring and Müller (2008), Seuring (2013), Brandenburg et al. (2014), and Brandenburg and Rebs (2015).

Table 8.1 Overview of related literature reviews

Author(s) and year	Sample size	Focus		SCM perspective		TBL aspect		Research method	
		General	Models	Direction	Focused level	Environmental	Social	Keyword search	Content analysis
Carter and Rogers (2008)	n/a	X		Undisclosed	Undisclosed	x	x		
Seuring and Müller (2008)	191	X		Forward	Undisclosed	x	x	x	x
Min and Kim (2012)	519	X		Closed loop	Undisclosed	x	x	x	x
Ilgin and Gupta (2010)	540		X	Closed loop	Undisclosed	x			x
Dekker et al. (2012)	60		X	Closed loop	Undisclosed	x			
Tang and Zhou (2012)	56		X	Closed loop	Undisclosed	x	x		
Hassini et al. (2012)	87		X	Closed loop	Undisclosed	x	x	x	x
Seuring (2013)	36		X	Forward	Undisclosed	x	x	x	x
Winter and Knemeyer (2013)	456	X		Closed loop	Undisclosed	x	x		x
Brandenburg et al. (2014)	134		X	Forward	All levels	x	x	x	x
Govindan et al. (2015)	382	X		Closed loop	Undisclosed	x	x	x	x
Brandenburg and Rebs (2015)	185		X	Forward	All levels	x	x	x	x

Brandenburg et al. (2014) inform about formal modeling approaches for different supply chain levels, where company-specific or macroeconomic models are not excluded. Seuring (2013) takes into account the model purpose, i.e., the different relationships of sustainability goals, and distinguishes between (i) win-win(-win) approaches that simultaneously improve social, environmental, and economic factors, (ii) trade-offs between these three factors, and (iii) models that aim at achieving a minimum performance with regard to socio-ecological aspects.

In their seminal review on SSCM, Seuring and Müller (2008) develop a framework that identifies *pressures and incentives for SSCM* caused by legal authorities and customers as key stakeholders. Moreover, they point out the strong relevance of *sustainable risk management* and *sustainable supplier management*. Risk management for SSCM was further conceptualized by identifying distinct practices (Beske and Seuring 2014). These dimensions of analysis have been applied to review quantitative models for SSCM on different supply chain levels (Brandenburg and Rebs 2015). However, approaches to model these constructs on the interorganizational level are not focused so far.

This brief overview summarizes trends and shortfalls of literature reviews on SSCM models:

- Structured keyword search and content analysis are adequate elements of a rigorous literature review process.
- Literature reviews that focus on forward SSCM models are found comparably seldom.
- Structured analyses of related literature should take into account how the relationships of the different sustainability goals are reflected in formal SSCM models.
- There is limited knowledge about how formal models can support decision-making for SSCM on the interorganizational level.
- Assessments of quantitative SSCM research approaches have neglected the question on how to include sustainability risks, sustainable supplier management, or pressures and incentives for SSCM into formal SSCM models on the interorganizational level.

The observed shortfalls result in two research questions of the study presented in this chapter:

1. How do formal SSCM models support decision-making on the interorganizational level?
2. How are sustainability risks, sustainability aspects in supplier management and stakeholder pressures, and incentives for SSCM integrated into formal SSCM models?

8.3 Methodology

In accordance with previous reviews, a content analysis of model-based SSCM research papers sampled by keyword search is conducted to answer these research questions. As suggested by Seuring and Gold (2012), the process of content analysis comprises four steps: (1) material collection, i.e., creating the paper sample, (2) descriptive analysis of the paper sample, (3) selection of structural dimensions and analytic categories for content analysis, and (4) evaluation of the paper sample according to the structural dimensions and analytic categories.

Methodological rigor is ensured by executing a systematic sampling process in a replicable and reliable way. Selecting the structural dimensions and analytic categories deductively contributes to construct validity. Furthermore, two researchers are involved in the paper coding process in order to achieve inter-coder reliability and internal validity. To strengthen external validity, the review results were presented and discussed at international scientific conferences and workshops.

The paper sample is based on a comprehensive review of 134 quantitative models for SSCM by Brandenburg et al. (2014). All 38 papers that propose interorganizational models were chosen for the study at hand and have been complemented by another 9 papers from a more recent paper sample of a related literature review by Brandenburg and Rebs (2015). Additionally, 14 relevant publications from a review of green logistics models (Dekker et al. 2012) as well as one additional paper obtained by journal-specific search are considered. In total, the sample of reviewed manuscripts comprises 62 papers. The sample papers have to focus on the forward supply chain and sustainability aspects in a formal model. Moreover, papers have to be published in English peer-reviewed scientific journals within the last 20 years (i.e., 1994–2013).

Descriptive analysis informs about the distribution of papers over time and over journals as well as about the geographical regions in which the authors' institutions are located. Results of descriptive analysis help in identifying temporal developments, relevant journals, and geographical foci.

The framework for content analysis, which is displayed in Table 8.2, comprises the structural dimensions and analytic categories that are defined deductively from related scientific publications and inductively in the course of analysis of the paper sample (Mayring 2008). The structural dimensions can be divided into four sections. Deductively defined modeling dimensions include the *model type* (Shapiro 2007) and *model purpose*, i.e., goal relationships between the three sustainability criteria (Seuring and Müller 2008; Seuring 2013). Supply chain management dimensions are defined deductively to elaborate on the SCOR *process of analysis* (Supply Chain Council 2008), the *level of analysis*, and the *primary actor of analysis* (Halldórsson and Arlbjørn 2005) and inductively with regard to *function of analysis* and the *industry focus*. The sustainability dimension is analyzed based on

Table 8.2 Structural dimensions and analytic categories selected for content analysis

Structural dimension	Analytic categories
Modeling dimensions	
Model type[a]	Descriptive-deterministic, descriptive-stochastic, normative-deterministic, normative-stochastic
Model purpose[a]	Win-win(-win), trade-off, minimum performance, not applicable
SCM dimensions	
Level of analysis[a]	Dyad, chain, network
Actor of analysis[a]	Manufacturer, carrier, wholesaler, retailer, warehousing, other, various, not applicable
Process of analysis[a]	Plan, source, make, deliver, return, not applicable
Function of analysis[a]	Logistics, network design, pricing, production, sourcing, SCM, technology and IT, various, not applicable
Industry focus[a]	Agriculture, apparel, automotive, chemicals and pharmaceuticals, electronics, energy, food and beverages, metal, pulp/paper, retail, transportation, various, not applicable
Sustainability dimension	
TBL dimensions[a]	Economic, environmental, social, economic-environmental, socioeconomic, socio-environmental, holistic
SSCM dimensions	
Pressures and incentives[b]	Government, customers, other stakeholders
Risk management[b]	Economic risks, environmental risks, social risks
Supplier management[b]	Supplier selection, environmental standards, social standards

[a]Single classification only
[b]Multiple classification possible

the *triple bottom line* (*TBL*) of sustainability (Elkington 1998). The sustainable supply chain dimensions are deduced from a conceptual framework for SSCM by Seuring and Müller (2008) that comprises stakeholder *pressures and incentives* for SSCM, sustainability *risk management*, and sustainable *supplier management*.

The paper sample is evaluated by counting the frequencies of occurrence of the analytic categories outlined above. As a result, the numbers allow to understand which constructs are particularly relevant for research and which ones are underrepresented. Furthermore, multivariate statistical analyses have been conducted to unveil correlations between analytic categories, since this approach has proven useful in related studies that employ content analysis (see, e.g., Wolf 2008; Gold et al. 2010a, b). Cluster analysis (Backhaus et al. 2008) is executed as TwoStep Cluster (TSC) analysis in SPSS® 22.0 to identify groupings of sample papers that feature the same combinations of analytic categories. In addition, contingency analysis (Backhaus et al. 2008) was tested for selected combinations of categories, but it did not lead to statistically significant results due to the sample size.

8.4 Results

8.4.1 Descriptive Analysis

The *distribution of publications* per year and journal is depicted in Table 8.3. It shows that model-based SSCM research evolved after 2000 and more strongly since 2008. The recent strong growth of publications was fostered by several reviews and conceptualizations on SSCM at that time (e.g., Srivastava 2007; Svensson 2007; Carter and Rogers 2008; Seuring and Müller 2008) which triggered intense scientific discourse on the operationalization of environmental and social criteria in SCM by formal models.

The *geographical analysis of the author's institutional affiliations* reveals that contributions from North America (29 counts) and Europe (28 counts) are prevailing and followed by Asian research institutions (16 counts) and articles authored by researchers with Latin American and Australian institutional affiliation (2 counts each). Fourteen of these papers result from intercontinental research cooperation. Papers written at African research institutes were not detected.

8.4.2 Content Analysis

Content analysis is structured into the *modeling dimensions*, the *sustainability dimension*, the *SCM dimensions*, and the *SSCM dimensions.*

8.4.2.1 Modeling Dimensions

The analysis of the *model type* (see Table 8.4) shows that deterministic models (54 papers) are prevailing in contrast to only eight stochastic models. Furthermore, the majority of sample papers suggests normative models (39 papers) in distinction from descriptive models (23 papers). These findings point to the objective of optimizing SSCM performance rather than only descriptively exploring the

Table 8.3 Distribution of articles per year and journals

Year	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	Total
IJPE	–	–	–	–	–	–	–	–	1	–	–	–	1	1	1	–	1	1	5	5	16
JCLP	–	–	–	–	–	–	–	–	–	1	1	1	1	–	2	1	1	–	–	3	11
IJPR	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	2	2	–	1	1	8
EJOR	–	–	–	–	1	–	–	–	1	–	1	–	–	–	2	–	–	–	2	–	7
Other	–	–	–	1	–	–	–	2	–	1	–	2	–	1	1	2	3	5	1	1	20
Total	–	–	–	1	1	–	–	2	2	2	2	3	2	3	7	5	7	6	9	10	62

Table 8.4 Results from content analysis of the model type

	Deterministic	Stochastic	Total
Descriptive	17	6	23
Normative	37	2	39
Total	54	8	62

Table 8.5 Results from content analysis of the model purpose

Model purpose	Number of papers
Win-win	6
Trade-off	45
Minimum performance	1
Not applicable	10
Total	62

complexities of supply chains. On the other hand, the paucity of stochastic models suggests that adding uncertainties to these complexities is still underrepresented.

The frequencies of *model purposes*, i.e., goal relationships between TBL dimensions, are displayed in Table 8.5 and indicate the dominance of balancing economic and environmental (or social) aspects by trade-offs (45 papers). Win-win situations are modeled in six papers, while only one paper accounts for minimum performance standards. The structural dimension is not applicable for ten papers, which include purely environmental models that do not integrate economic or social factors.

Modeling trade-offs most often involves a balance between costs and emissions. Win-win situations can be reached, for instance, by the reduction of both cost and material input (e.g., Corbett and DeCroix 2001). Minimum standards are modeled by pollution limits (Maider 2008).

8.4.2.2 Supply Chain Management Dimensions

The results for each of the five structural dimensions are shown in Table 8.6. Most models consider a manufacturing company (15 papers) as *primary actor* or various actors (23 papers) without primarily focusing on one of them. Eight papers focus on carriers, but retailers and distributors are addressed by only one model each. Strikingly, warehousing and wholesalers are not modeled by any of the sample papers.

The prevalent *level of analysis* is a network (41 papers), followed by dyads (12 papers) and chains (9 papers). The observed focus on networks mirrors the interwoven supply structures that exist in industrial practice and illustrates the attempts to develop decision-support tools for such complex contexts.

Table 8.6 Results from content analysis of SCM constructs

Primary actor of analysis		Level of analysis		Process of analysis		Function of analysis		Industry focus	
Carrier	8	Chain	9	Plan	21	Logistics	15	Automotive	2
Distributor	1	Dyad	12	Source	8	Network design	11	Energy	7
Manufacturer	15	Network	41	Make	–	Pricing	1	Food and bev.	7
Retailer	1			Deliver	11	Production	2	Metal	3
Warehousing	–			Return	–	Sourcing	8	Retail	2
Wholesaler	–			n/a	22	SCM	12	Transportation	8
Various	23					Technology and IT	3	Other[a]	5
n/a	14					Various	4	Various	3
						n/a	6	n/a	25
Total	62	Total	62	Total	62	Total	62	Total	62

[a]One paper each: agriculture, apparel, chemicals and pharmaceuticals, electronics, pulp/paper

About one third of all papers (22 papers) do not focus on a particular *process of analysis*. The remaining models most often support supply chain planning processes (21 papers) which is not surprising since quantitative models represent the backbones of advanced planning systems. Papers that quantitatively assess sourcing (8 papers) and delivery (11 papers) processes are settled at the interface of an organization to its suppliers and customers, respectively.

The dominant *functions of analysis* are related to logistics (15 papers) or SCM (12 papers), which represent approaches to coordinate and control interorganizational supply chain processes. Furthermore, network design (11 papers) and sourcing (8 papers) decisions are supported by formal SSCM models. Technology-related models (three papers) or approaches with an exclusive focus on production (two papers) are underrepresented. Regarding the *industry of analysis*, the transportation sector (eight papers), the food and beverages industry, as well as energy provision (seven papers each) are most often in focus. Twenty-five papers do not address a specific industry, and the remaining 15 models deal with different sectors.

In addition to the one-dimensional analysis of observed construct frequencies, a two-dimensional TSC analysis is conducted to understand which *model type* is applied for the assessment of a particular *level of analysis*. The analysis of this combination of structural dimensions yields four clusters. As shown in Table 8.7, clusters 1 and 2 comprise normative-deterministic models that mainly focus on the network level. The remaining twelve network-related papers (clusters 3 and 4) include seven descriptive-deterministic and five stochastic models. This indicates that optimization of networks is yet more important than just describing them. Moreover, it is found that uncertainty added to network-related models is implemented by descriptive-stochastic models (four papers).

Table 8.7 Cluster analysis of model type and level of analysis

Cluster		1	2	3	4
Cluster size		8	29	17	8
Level of analysis	Dyad	5	–	4	3
	Chain	3	–	6	–
	Network	–	29	7	5
Model type	Descriptive-deterministic	–	–	17	–
	Descriptive-stochastic	–	–	–	6
	Normative-deterministic	8	29	–	–
	Normative-stochastic	–	–	–	2

Table 8.8 Results from content analysis of TBL dimensions

TBL dimensions	Number of papers
Purely environmental	8
Purely social	–
Economic-environmental	38
Socioeconomic	3
Socio-environmental	–
Holistic	13
Total	62

8.4.2.3 Sustainability Dimensions

The analysis of the *sustainability dimensions* of the triple bottom line of sustainability (see Table 8.8) suggests that a majority of models assesses eco-efficiency (38 papers) or exclusively focuses on environmental factors (8 papers). In contrast, social aspects (3 papers) are almost completely neglected, but 13 models incorporate all 3 TBL dimensions holistically.

To get further insight into the preferred *model type* for focused or holistic modeling of *TBL dimensions*, a second TSC analysis yields three clusters as depicted in Table 8.9. Cluster 1 includes all 13 holistic TBL models that are deterministic and mainly normative (8 of 13 papers), thus striving for optimization of all three TBL dimensions without taking uncertainty into account. The lack of stochastic holistic TBL models (2 of 13 papers) can be explained by their inherent complexities that drastically increase the model size and require larger computational capacities to solve such kinds of models. The remaining 29 focused normative-deterministic models are grouped in cluster 2. Cluster 3 contains the remaining 20 focused models that are either descriptive-deterministic or stochastic.

Table 8.9 Cluster analysis of model type and holistic or focused TBL dimensions

Cluster		1	2	3
Cluster size		13	29	20
TBL	Holistic	13	–	–
	Focused	–	29	20
Model type	Descriptive-deterministic	3	–	14
	Descriptive-stochastic	2	–	4
	Normative-deterministic	8	29	–
	Normative-stochastic	–	–	2

Table 8.10 Results from content analysis of pressures and incentives for SSCM

Pressure and incentive for SSCM	Formalized
Government[a]	17
Customers[a]	9
Other stakeholders[a]	2
All factors	2
Not modeled	39

[a]Multiple classification possible

Table 8.11 Cluster analysis of model type and pressures and incentives for SSCM

Cluster		1	2	3	4
Cluster size		15	22	17	8
Pressures and incentives	Holistic	2	–	–	–
	Focused	13	–	4	4
	None	–	22	13	4
Model type	Descriptive-deterministic	–	–	17	–
	Descriptive-stochastic	–	–	–	6
	Normative-deterministic	15	22	–	–
	Normative-stochastic	–	–	–	2

8.4.2.4 Sustainable Supply Chain Management Dimensions

The frequencies of formally modeled *pressures and incentives* (see Table 8.10) indicate that a considerable amount of models does not integrate any stakeholder triggers for SSCM. However, it is remarkable that governmental and other regulatory pressures and incentives are most prominent (17 papers) followed by customer requirements (9 papers) and other stakeholders (2 papers).

A third TSC analysis is carried out for a combined assessment of the *model type* and the *pressures and incentives for SSCM*. This analysis results in four clusters (see Table 8.11). Cluster 1 consists of all 15 normative-deterministic models that take

Table 8.12 Results from content analysis of SSCM risks

SSCM risks	Formalized
Economic risks[a]	14
Environmental risks[a]	9
Social risks[a]	5
Holistic risk management	4
Not modeled	46

[a]Multiple classification possible

Table 8.13 Cluster analysis of model type and SSCM risks

Cluster		1	2	3	4
Cluster size		8	29	15	10
SSCM risks	Holistic	4	–	–	–
	Focused	2	–	–	10
	None	2	29	15	–
Model type	Descriptive-deterministic	–	–	15	2
	Descriptive-stochastic	6	–	–	–
	Normative-deterministic	2	29	–	6
	Normative-stochastic	–	–	–	2

into account pressures and incentives, while the remaining 22 normative-deterministic models that belong to cluster 2 and most descriptive-deterministic models in cluster 3 (13 of 17 papers) do not consider those triggers. Cluster 3 comprises the remaining four descriptive-deterministic models that only focus on single pressures and incentives and furthermore. Cluster 4 groups the eight stochastic models, four of them reflecting pressures and incentives. These results suggest that so far pressures and incentives are predominantly measured in a deterministic way and that normative approaches prevail among them.

The integration of *SSCM risks* (see Table 8.12) into quantitative models is observed in only 16 papers. In these models, the consideration of economic (14 papers) and environmental (9 papers) risks dominates, while social risks are formalized in only five models.

Combining *model type* and *SSCM risks* for a fourth TSC analysis leads to four clusters (see Table 8.13). Cluster 1 consists of normative-deterministic and descriptive-stochastic models that take into account holistic or single aspects of sustainability-related SCM risks. A larger portion of normative-deterministic models (29 papers) and most descriptive-deterministic models (15 papers) exclude SSCM risks and are grouped into clusters 2 and 3. The fourth cluster comprises the remaining two stochastic models and eight deterministic models that reflect risk aspects in SSCM. It can be concluded that normative-deterministic models are more adequate to assess sustainability risks in SCM than descriptive-deterministic ones.

Table 8.14 Results from content analysis of sustainable supplier management

Sustainable supplier management	Number of models
Supplier selection[a]	15
Environmental standards[a]	9
Social standards[a]	4
All factors	4
Not modeled	47

[a]Multiple classification possible

Moreover, stochastic models are equally suitable for modeling sustainability risks. However, the overall small number of papers that present model-based approaches for sustainable supply chain risk management indicates the need for further research.

A large majority of 47 modeling papers does not consider the *sustainable management of suppliers* (see Table 8.14). Sustainability in supplier selection is formalized in 15 models that support supplier selection decisions. Models that operationalize supplier management with regard to environmental standards are suggested by nine papers, and four publications present models that reflect social factors in supplier management. Since this structural dimension allows multiple classifications and because categorization as "focused" or "holistic" is not applicable in this case, cluster analysis was not employed for the combination of *model type* and *sustainable supplier management*. Overall it can be concluded that model-based decision-support tools for sustainable supplier management which consider both environmental and social standards for supplier selection are still scarce.

8.5 Discussion

In accordance with Seuring (2013) and Brandenburg et al. (2014), SSCM modeling is identified as a comparably young field of research with a strongly increasing relevance over the last 5 years. In contrast to company-specific or macroeconomic approaches to sustainability in supply chains, nearly all formal SSCM models for the interorganizational level were published after 2001. Similar to the findings of Hassini et al. (2012), the results of content analysis reveal a preponderance of operations research journals in comparison to SCM-related periodicals. Surprisingly, the *Journal of Cleaner Production* has a considerably lower relevance for this interorganizational model-based SSCM research. This is in contrast to findings of broader literature reviews on SSCM models at various levels of analysis (Min and Kim 2012; Hassini et al. 2012; Seuring 2013; Brandenburg et al. 2014). As observed by Brandenburg et al. (2014), most formal SSCM models are published by North American or European research institutions.

The examination of modeling dimensions shows that normative models are more often employed than descriptive ones and that stochastic models are most under-

represented. This is in line with findings by Brandenburg et al. (2014), but normative models in the paper sample at hand prevail in a greater proportion. Thus, interorganizational approaches seem to be more focused on optimizing performance according to distinct objectives rather than only describing the state and development of SSCM-related processes and performance.

While most SSCM models aim at trade-offs between sustainability dimensions, approaches that contribute to win-win situations or minimum performance standards are seldom observed. Similar results were obtained by Seuring (2013), whereas Seuring and Müller's (2008) comprehensive review of conceptual, empirical, and model-based SSCM research detected a dominant orientation toward win-win situations.

Most observations of the SCM dimension confirm findings of Brandenburg et al. (2014). Formal SSCM models most often support planning processes and focus on manufacturing companies as well as various or unspecified actors while neglecting distributors, wholesalers, and retailers. The functional emphasis is put on general SCM or more specifically on logistics, sourcing, and network design. Decision-support tools for the interorganizational SSCM are surprisingly often applied in the transportation sector, the food and beverages industry, and the energy sector. This observation is in contrast to Brandenburg et al. (2014) who found many applications in the electronics industry and in the agriculture sector.

The analysis of the sustainability dimension clearly shows that formal SSCM models most often comprise environmental factors, while social aspects are widely neglected. Quantitative approaches that consider all TBL dimensions are found comparably seldom, and mostly deterministic models are employed for these holistic approaches. Overall, these observations are in line with conclusions by Seuring (2013) and Brandenburg et al. (2014).

The novelty of the study at hand is the assessment of interorganizational SSCM models and their elements that represent pressures and incentives for SSCM, sustainable risk and supplier management. Stakeholders' pressures and incentives, particularly governmental regulations, are comparably often reflected in formal SSCM models. This confirms the findings of a broader review that includes firm-specific and interorganizational as well as macroscopic SSCM models (Brandenburg and Rebs 2015). However, these governmental pressures and incentives are less often operationalized in quantitative approaches than being elaborated in conceptual and empirical studies for SSCM. In nearly every second paper reviewed by Seuring and Müller (2008), regulations from legal authorities, customer demands, or responses to other stakeholders are considered in context to SSCM. Similarly, supplier management for risks and performance has a higher relevance for SSCM research in general than for related formal models in particular. Seuring and Müller (2008) have detected that every third SSCM research paper reflects cost- or complexity-related barriers and several supporting factors, such as management, monitoring, or reporting systems, for SSCM. In contrast, the study at hand shows that sustainability risks or the sustainable management of suppliers plays subordinate roles in related model-based research.

8.6 Conclusion

In this chapter, 62 formal models for the sustainable interorganizational management of supply chains were reviewed. Content analysis and cluster analyses were performed to elaborate recent developments and future trends of related research. Four recommendations for future research are derived from the findings of this study:

1. More stochastic approaches are needed for model-based SSCM research. Especially in context to sustainability risks, which stem from uncertainties, stochastic methods could prove their advantages compared to deterministic ones.
2. The imbalance between environmental and social factors needs to be resolved. Sustainability aspects of supplier management can be seen as one application area for models that support socially responsible decision-making in supply chains.
3. The focus of SSCM models should move from assessing trade-offs between sustainability goals to determining win-win(-win) situations regarding the three dimensions of the TBL of sustainability.
4. The application area for formal SSCM models should be broadened to technology-related industries. Although qualitative approaches to decision-support systems are often applied in the automotive or in the chemicals and fuel industries, formal SSCM models are less often employed in these sectors.

Overall it is concluded that quantitative approaches to support sustainable decision-making on the interorganizational supply chain level offer large potential for research and application.

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Chapter 9
Supply Chain Risk Management in Sustainable Sourcing

Challenges and Opportunities of Sustainable Requirements in Purchasing

Eric Sucky and Immanuel Zitzmann

Abstract Sustainability requirements are of growing importance and must be considered by companies. Since supply chains ultimately range from raw material suppliers to consumers, all value-adding members must meet social and environmental commitments, which lead to specific sourcing challenges. However, sustainable sourcing faces a variety of risks. The purpose of this paper is to examine these risks and give insights about supply chain risk management in sustainable sourcing.

Keywords Sustainability • Supply chain • Sourcing • Risk management

9.1 Introduction

Value creation, innovation, and competitive advantages are no longer realized at the regional or national level in today's globalized environment. They are forged internationally in networks that run around the world (Selzer 2009). In its 2010 report on general economic and industrial policy, the Federal Ministry for Economic Affairs and Technology of Germany established that industrial production as a whole is now shaped by global value creation networks (BMWi 2010). These general conditions apply to the production of virtually all goods – from motor vehicles to children's toys or foodstuffs. Products made and sold with the aim of contributing to sustainable development are also subject to these parameters. The organizational structures and processes that enable global value creation are coordinated within the

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framework of supply chain management (Thomas and Griffin 1996). A supply chain describes the value creation network behind a given product (Sucky 2004). Its elements are linked through flows of goods, information, and money across enterprise boundaries. Such value creation systems begin with the producer of the raw materials and end with the final customer. In recent years, weak points and negative effects of such networks have become increasingly apparent. Supply chains optimized for efficiency are vulnerable to disruption and uncertainties (Jüttner et al. 2003). Negative effects also arise in the environmental and social spheres (Südwind 2012). Securing prosperity in the long term requires solutions that address risks not only to humans and the environment but also to business success. As global supply chains are highly complex, examining them holistically is rarely possible; this explains the emergence of supply chain management as a field focused on analyzing links between value creation elements (Thomas and Griffin 1996). The associated tasks can be allocated to such areas as the enterprise function of sourcing (Bogaschewsky and Kohler 2007).

This paper explores risk management in the area of sourcing in the context of the supply chain. In particular, it sets out to investigate whether sourcing risks associated with sustainable products and their management differ from supply chain risk management in procurement of conventional products. In addition, potential opportunities in managing sustainable sourcing risks are highlighted.

Section 9.2 lays the foundation of this paper by explaining the key terms of supply chain management, sourcing, and sustainability. It also shows what sustainable sourcing means. In Sect. 9.3, risks in the supply chain and especially in sourcing are reviewed. This includes an analysis of differences between risks in sourcing of conventional supply chains to sourcing in value creation networks that are supposed to be sustainable. Section 9.4 presents strategies for supply chain risk management. These strategies will be applied to sourcing. Here again, differences in conventional and sustainable sourcing are analyzed. Suggestions on how risk management in supply chains can profit from sustainability are also presented. Section 9.5 summarizes the insights.

9.2 Sustainable Supply Chain Management and Sourcing

Numerous definitions, conceptions, and views of both supply chain management and sustainability exist. This paper does not set out to add to this already extensive body. Existing definitions will be used as reference points and are presented in the following subsections. Section 9.2.1 starts with the definition and explanation of supply chain management and sourcing. Sustainability and its components are the focus of Sect. 9.2.2. Section 9.2.3 brings both topics together and defines sustainable supply chain management and sustainable sourcing.

9.2.1 Supply Chain Management and Sourcing

According to Christopher (2005) and Lambert and Cooper (2000), supply chain management is tasked with "[…] the integration of key business processes from end user through original suppliers that provides products, services, and information […] to deliver superior customer value at less cost to the supply chain as a whole […]." Figure 9.1 shows the potential reach of a supply chain from the perspective of a focal enterprise (Lambert et al. 1998).

From the enterprise perspective, supply chain management is typically limited to the internal or direct supply chain illustrated in Fig. 9.1. Supply chain management tasks are handled by organizational units within individual enterprises (Sucky 2004; Thomas and Griffin 1996). In other words, communication and coordination with other supply chain partners are the responsibility of an enterprise's functional interfaces with the outside world. From the perspective of the individual enterprise, procurement manages the upstream value chain leading back toward suppliers (Thiemt 2003). The focus of this paper is on this function.

Arnold (1997) views sourcing as including all enterprise- or market-related activities that serve to make objects available that a firm requires but does not produce itself. Such objects include materials, goods for resale, spare parts, and services (Grün and Brunner 2013). The basic goal of sourcing in the narrowest sense of the word is the acquisition of the goods required to manufacture products and render services. These goods must be of suitable quality, and they must reach the right place at the right time and at the lowest cost possible (Porter 1999). Concomitantly, procurement is increasingly expected to assume responsibility for the quality of the goods acquired; as the proportion of components, modules and

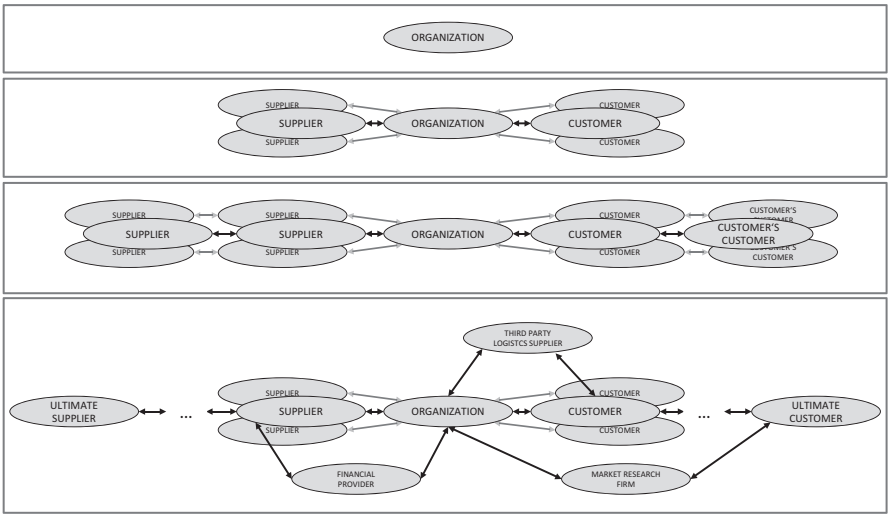

Fig. 9.1 Reach of a supply chain (Mentzer et al. 2001)

systems sourced from outside rather than being produced in-house rises, and the quality of goods procured increasingly determines the quality of a procuring company's own products. Against this background, Hamm (1997) ranks ensuring supply security, reducing costs, and achieving improvements to quality and service quality among the fundamental goals of procurement derived from enterprise objectives.

The responsibilities of procurement at the strategic level also include identifying and securing access to sources of goods that are of present or future relevance. As such, procurement is tasked not only with ensuring the capacity of an enterprise to operate in the short and medium term (through organizing the supply of materials required in a manner commensurate with the immediate goals of the enterprise) but also with ensuring that enterprises become and remain competitive in the long term (Large 2009). Against the background of this comprehensive and strategically significant shift in the perception of procurement and its tasks, the role of suppliers has also evolved dramatically. A short-term perspective of minimizing the costs of purchasing has been replaced by an approach that takes a longer view. Building up long-term relationships makes it possible for procuring enterprises to benefit not only from suppliers' products and materials but also from their efficiency, their improvements in production, and their innovations, flexibility and optimized logistics. The latter aspects can, in the long term, represent a strategic competitive advantage complementing consistently excellent product quality (Arnolds 2010). It follows that building up and maintaining supplier-buyer relationships are a key component in comprehensive, goal-oriented, and systematic supplier management.

Within the framework of modern procurement management, knowing the suppliers of suppliers (together with their suppliers in turn) and making use of their capabilities also matter (Fawcett and Magnan 2002). The importance of this competence in complex and tightly interlinked supply chains has become increasingly obvious in recent years. The structure of global value creation networks can lead to relatively minor disruption at an upstream supplier, thus triggering severe supply shortages in a focal enterprise. Moreover, knowing suppliers is important not only to avert the risk of shortages but also to foster working conditions; suppliers and the environmental impact of upstream production processes are other examples of sources of risk that merit consideration (Südwind 2012).

9.2.2 Sustainability

Sustainable development "[…] meets the needs of the present without compromising the ability of future generations to meet their own needs […]" (WCED 1987). This statement from the Brundtland report is at the bottom of every discussion of sustainability. However, the definition gives rise to a further question: what are the needs that should be satisfied in the context of the drive for sustainability, and what resources can be drawn on to this end? It has become generally accepted that resources must be viewed in terms of their environmental and – advancing beyond this – their social components as well as in purely economic terms. This is reflected

in triple bottom-line thinking (Elkington 1998). Whether these components can be substituted for one another is the subject of some controversy (Döring and Ott 2001). Weak sustainability concepts assume that trade-offs are possible between the three areas. The opposing approach, i.e., strong sustainability, denies this.[1] Regardless of which approach is advocated, the triple bottom-line approach describes sustainability only in very general terms. The idea of sustainability is, as it were, an umbrella term under which hugely diverse approaches, concepts, products, and ideas can be subsumed (Bretzke 2014). A product that meets customer requirements and demonstrates improved environmental and social qualities can be considered sustainable (Seuring and Müller 2008). Sustainable production pursues the goal of minimizing negative impacts on the environment during both the harvesting of resources and the subsequent processes that add value (Shrivastava 1995). It follows that no sustainable products can exist without sustainable supply chains: only once all processes and their integration meet sustainability criteria a product can be described as sustainable (Miemczyk et al. 2012). Enterprises striving to offer sustainable goods and services must address the challenge from two angles: as well as working to make their own internal processes sustainable, they must also restrict their purchases to goods that can be described as sustainable since these goods ultimately form part of their own products. Achieving this latter aim falls within the responsibility of procurement (Bretzke 2014).

9.2.3 Sustainable Supply Chain Management and Sourcing

Sustainable supply chain management can be defined (Seuring and Müller 2008) 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 sustainable supply chains, environmental and social criteria need to be fulfilled by the members to remain within the supply chain, while it is expected that competitiveness would be maintained through meeting customer needs and related economic criteria." This definition embraces both the component of supply chain management and the three-pillar model of sustainability (Carter and Rogers 2008). Sustainable sourcing can also be understood (with Meehan and Bryde 2011) as "[…] the process used to secure the acquisition of goods and services (products) in a way that ensures the least impact on society and the environment throughout the full life cycle of the product […]". As such, sustainable sourcing initially operates

[1] A critical discussion of this approach is beyond the scope of this essay. It can be noted, however, that the triple bottom-line concept (environment – economy – society) represents a significant paring back of the five-pillar approach developed at the 1992 Rio Earth Summit. This set sustainable development in the context of environmental, economic, social, cultural, and ethnic development (Flämig 2015).

under the same conditions as traditional purchasing departments, which include sourcing risks. These conditions are supplemented by the environmental and social criteria that are brought to bear on judging the quality of goods and their production and transport. As a rule, this leads to the number of potential suppliers being narrowed down to quite a small number.

Section 9.4 will proceed from these definitions and examine sourcing management, especially with regard to strategies of managing sourcing risks in conventional and sustainable supply chains. Before that, however, the risk categories in conventional and sustainable supply chains must be identified. This will be done in Sect. 9.3.

9.3 Risks in Conventional and Sustainable Sourcing

Risks in sustainable sourcing can be derived from the general risks that supply chains are subject to. This will be explored further in Sect. 9.3.1. Section 9.3.2 will then use the categories of sourcing risks to analyze whether risks differ between conventional and sustainable sourcing. The evaluation will be supported by the case of Fairphone.

9.3.1 Risks in Supply Chains and Procurement

Risks are part of doing business in a world marked by uncertainty (Simangunsong et al. 2012). Supply chain risks, in turn, can be categorized systematically in multiple ways (Sodhi and Tang 2012). The most commonly used approach takes the structure of the supply chain as its departure point. Figure 9.2 visualizes this categorization. The first distinction that is made is between supply chain external and internal risks

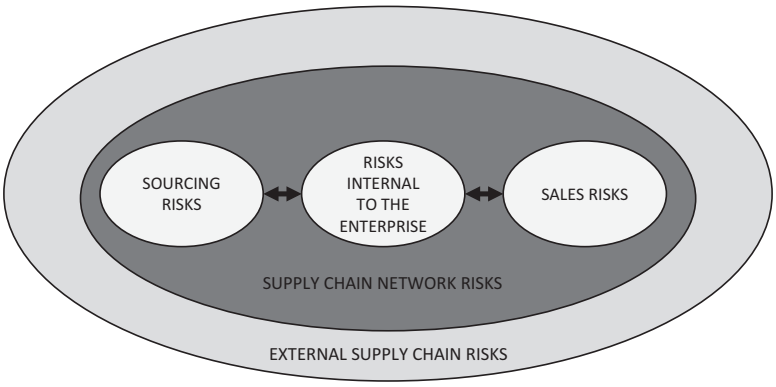

Fig. 9.2 Supply chain risk categories (Christopher and Peck 2004; Jüttner et al. 2003)

(Mason-Jones and Towill 1998; Jüttner et al. 2003; Peck 2005; Christopher and Peck 2004). The former category covers the environmental risks a supply chain is subject to. These can include not only natural catastrophes such as earthquakes and floods but also human-induced events such as terrorism or strikes. Corruption or legal uncertainty can also fall into this latter category. Internal supply chain risks, also called supply chain network risks, can be subdivided into risks internal to an enterprise, as well as into sourcing and sales risks (Christopher and Peck 2004). The focus of this paper are risks in sourcing.

Sourcing relates to the availability and quality of goods required by an enterprise to create its own products or services. They can be subdivided, as shown in Table 9.1, into five categories of quality, quantity, time, price, and transport risks (Thiemt 2003; Rogler 2002).

The types of sourcing risks listed in Table 9.1 are also applicable in the context of sustainable procurement, although they may differ in intensity. The case of Fairphone will be used as an example to analyze risk in sustainable procurement.

The Fairphone supply chain has been forged by the manufacturer bearing the same name (Fairphone 2016). The company founded by Dutchman Bas van Abel has set out (Bernau 2013) to produce a smartphone fairly and sustainably. This means sourcing conflict-free minerals and ensuring fair working conditions in the manufacturing plants (Struller 2014). In addition, the environment should be spared through a long product life span, design that makes repairing or replacing individual modules feasible, and recycling (Schmitt 2013). From the viewpoint of purchasing, the supply chain for tin can be seen in Fig. 9.3. The metal is sourced from conflict-free mines located in the Democratic Republic of the Congo. The manufacturing process takes place in China. Here, only companies that guarantee social and environmental standards are used. One notable feature of the Fairphone business model is that initial production took place on a make-to-order basis: the first generation of Fairphones was only manufactured once 5000 preorders had been received (D'heur 2014).

Table 9.1 Categories of sourcing risks

Type of risk	Description
Quality risk	The quality supplied does not meet requirements
Quantity risk	The required quantities cannot be acquired
Time risk	The delivery date does not conform to the planned delivery time
Price risk	The price to be paid for the goods to be procured is higher than expected
Transport risk	The goods are destroyed or damaged during transport from the supplier to the purchaser

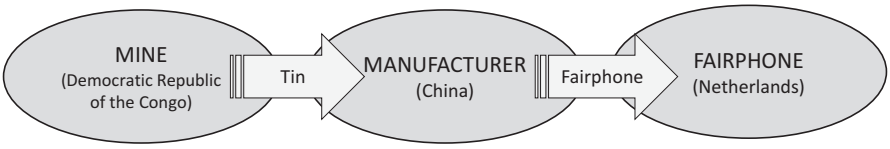

Fig. 9.3 Fairphone supply chain

9.3.2 Differences in Conventional and Sustainable Sourcing Risks

With the help of the Fairphone supply chain, this paragraph analyzes differences between conventional and sustainable sourcing risks. It is structured according to the five sourcing risks in Table 9.1:

Quality Risk In both conventional and sustainable procurement, the quality of components and raw materials is measured according to their ability to fulfill the technical purpose for which they are required. On average, a product life cycle of a smartphone is approximately 2 years; thus, materials and components that function as reliably as possible over this timespan are sourced and used (Schmitt 2013). A longer functionality is not necessary from an *economic* point of view. The *environmental* perspective looks quite different: every product that is disposed of and replaced by a new product consumes considerable resources. It follows that the quality standard for materials used in the Fairphone is necessarily a higher one. This in turn means that the risk of these high standards not being met also rises. Direct environmental impacts must also be considered from a quality perspective. The production of smartphones can, for example, lead to the contamination of soil or water during the extraction of raw materials or to the emission of harmful greenhouse gases during the manufacturing process. Procurement is tasked with vetting and monitoring the compliance of suppliers with relevant criteria. In addition to economic and environmental quality requirements and the risks flowing from them, *social* quality risks also arise. As the producer of a sustainable smartphone, Fairphone and its procurement department must oblige suppliers to comply with social standards.

Quantity Risk In a conventional smartphone supply chain, the quantity risk is particularly apparent (Spiegel Online 2012; Handelsblatt 2013) in the period before a new model comes on the market. Demand often exceeds the quantities made available by procurement. This is due to the limited capacity of the manufacturers and the limited supply of raw materials. Quantity risks in this form do not arise in the Fairphone supply chain – the small number of units made to date can be assembled by manufacturers without difficulty. However, small quantities are problematic in another way: they present the risk (D'heur 2014) that suppliers may view the manufacturer of the sustainable smartphone as a minor player of little importance. This introduces the risk that Fairphone will not receive deliveries when it is forced to compete against global players in the sector for production capacity. As such, the quantity risk can be reframed as the risk of Fairphone receiving no units at all because of the low quantities that are ordered.

Time Risk Late deliveries move the point at which enterprise production can begin into the future. In the worst-case scenario, customer requirements cannot be fulfilled. Smartphone supply chains are vulnerable to supply delays (Handelsblatt

2013) because of volatile demand and high cost pressures. Procurement is therefore tasked with ensuring that the required goods are made available in a timely fashion. The Fairphone supply chain is less affected by this risk as it is the only sustainable smartphone on the market, and customers are drawn to it precisely because of this sustainability; they are willing to tolerate longer delivery periods. The first generation of Fairphones did not even go into production until preorders for 5000 units had been received. In this light, it can be said that time risks exist for procurement in the context of the production of the Fairphone but that the quality of goods ranks higher than their availability in this case.

Price Risk In both conventional and sustainable production, all manufacturers are exposed to the risk of rising prices for components to be procured. The raw materials needed for the manufacturing process are particularly subject to price fluctuations (Statistisches Bundesamt 2004). Fairphone may be able to dampen price fluctuation for some raw materials through direct contact with several mines. However, increasing production costs cannot be offloaded onto suppliers in the context of a sustainable business policy. As such, the Fairphone supply chain is vulnerable to price risks.

Transport Risk Both the Fairphone and the devices produced by companies that do not focus on sustainability are manufactured in China. As such, both are subject to identical transport risks on the way to their ultimate markets.

Table 9.2 summarizes the conclusion of the analyses regarding differences in sourcing risks between conventional and sustainable supply chains. The content is based on the case study of the Fairphone.

The case study of Fairphone shows that sourcing risks in sustainable supply chains differ from those in conventional supply chains, but that they still exist and in some areas are even higher. Therefore, the question arises as to whether supply chain risk management tools can still be applied in a sustainable environment or if such a supply chain even provides opportunities in risk management that a conventional supply chain does not.

Table 9.2 Differences in sustainable sourcing risks

Type of risk	Fairphone sourcing risks
Quality risk	Considerably higher, as social and environmental quality requirements must also be adhered to
Quantity risk	Present in another way; being seen as an insignificant bit player may lead to suppliers not prioritizing deliveries
Time risk	Low impact, as products are made to order for delay-tolerant customers
Price risk	Exists, must be borne by focal enterprise to some extent for reasons of sustainability
Transport risk	Identical to risk in conventional smartphone supply chains

9.4 Supply Chain Risk Management Applied in Sustainable Sourcing

This section analyzes the potential of supply chain risk management strategies to address sourcing risks in sustainable supply chains. Section 9.4.1 will therefore introduce seven risk management strategies in supply chain management. Their benefit for sustainable sourcing will then be verified for all sourcing risks in Sect. 9.4.2. Possible opportunities arising from sustainable sourcing for risk managements are addressed in Sect. 9.4.3.

9.4.1 Risk Management Strategies in Supply Chains

On a general level, supply chain risk management addresses the management of risks in value creation networks (Jüttner et al. 2003). The process of supply chain risk management can be divided into multiple steps; the precise number of steps suggested varies from author to author (Kouvelis et al. 2012; Manuj and Mentzer 2008; Waters 2007). What all approaches have in common, however, are the three core elements of *identifying risk*, *analyzing risk,* and determining *countermeasures* (e.g., Waters 2007 or Ziegenbein 2007). In the first step, the possible risks the supply chain is exposed to are listed (Kouvelis et al. 2012). These can be described using the categories introduced in Sect. 9.3.1. In the second step, the risk analysis phase, the risks that have been identified are assessed (Kouvelis et al. 2012; Waters 2007; Ziegenbein 2007). As a rule, risks are evaluated on the basis of the likelihood of their occurrence and the potential severity of their impact (March and Shapira 1987). This facilitates prioritization of supply chain risk management measures. Particular emphasis is placed on measures geared toward preventing the materialization or minimizing the impact of risks with high probabilities and a strong impact on the supply chain (Kouvelis et al. 2012). The third step in supply chain risk management involves selecting and implementing the right steps to manage risks (Waters 2007). As with the categorization of risks, different frames of reference can be used (Waters 2007; Faisal et al. 2006). Table 9.3 illustrates a concept utilizing seven types of strategies (Manuj and Mentzer 2008; Jüttner et al. 2003). Section 9.4.2 will investigate whether and to what extent these strategies can also be deployed in a risk management framework in sustainable supply chains and more particularly in sustainable sourcing. Again, the case study of Fairphone will be used for the evaluation.

Table 9.3 Supply chain risk management strategies

Risk management strategies	Description
Avoidance	A conscious decision to refrain from activities (entering new markets, becoming more active in particular countries, new supplier relationships) because of the risks that are present
Postponement	Moving a final decision about performance specifications to the latest possible point in time
Speculation	Creation of competitive advantages through early decision-making on the basis of predicted demand
Hedging	Reduction of risk by spreading risk with the help of dual sourcing or flexible factories
Control	Vertical integration or flexible supply agreements enable capacity management and the balancing of power positions
Transferring	Transferring of risks to suppliers or service providers through outsourcing or offshoring
Security	Deployment of sensor technology to monitor freight and detect disruption at an early stage

9.4.2 Supply Chain Risk Management Strategies in Sustainable Sourcing

The following analysis is structured according to sourcing risks. The use of an application of each strategy will be evaluated for every risk. This includes an analysis of whether the strategy is of any use in general and in sustainable supply chains in particular.

Quality Risk Technical function compliance with environmental and social standards must be ensured in sustainable sourcing. The risk of quality deficits also encompasses deficits relating to these requirements. The risk management strategy of *avoidance* means that collaboration with suppliers who do not meet required quality criteria has to be avoided. This can be achieved through careful supplier selection. However, this has the disadvantage of reducing the number of possible suppliers and reinforcing dependence on the already small supply base of Fairphone. Vertical integration represents an instrument that can be used within the framework of a *control* strategy. If such a strategy is realized, influence can be exerted on quality standards and their implementation. However, this is only an option for selected goods. Integration throughout the entire supply chain is not feasible, nor is it intended by sustainable producers, as their business model is based on fair relationships to supply chain partners rather than on takeovers and control. Opportunities may exist to deploy sensor technologies and freight monitoring to conduct checks on social standards such as driving times or on aspects such as emissions. Such technologies are part of a *security* risk management strategy. The remaining strategies do not relate to quality risks and are consequently of no relevance to reducing them. Postponement and speculation relate to internal decisions on the point in time

when final decisions are to be taken. These are not linked to the quality of goods to be purchased. Hedging leads to the spreading of risk, but quality risks still exist in relation to each individual supplier. As such, multiple sourcing does not reduce these risks, nor can the quality risk be transferred to suppliers.

Quantity Risk The strategy of *speculation* can be used to minimize the risk of shortages. This involves placing long-term orders with suppliers on the basis of demand predictions. That will ensure that companies with small order quantities such as Fairphone will be supplied. Short-term orders may be ignored if they compete with orders of big players. Long-term orders have the additional effect that extra shifts, short-time work, extra journeys, and express deliveries can be avoided. That strengthens the social and ecological pillars of sustainability. *Hedging* can also be deployed to mitigate quantity risks. Dual and multiple sourcing makes it possible to compensate for shortages by drawing on alternative suppliers. This can also be achieved through the flexible supply contracts provided for in the *control* strategy. However, the deployment of both of these strategies is only possible to a limited extent in sustainable procurement as the requirements that sustainable products must meet already impose strict limits on the number of potential suppliers; the application of the suggested instruments is frequently impossible. Avoidance leads to greater dependence on a small number of sources, so it is not a suitable strategic approach toward reducing quantity risks. The same can be said for postponement. The risk of not receiving goods in the necessary quantities is always present in the focal enterprise. As such, a policy of transferring risk cannot be applied. Sensor technology can only be used to establish that the quantity delivered does not correspond to the quantity ordered; quantity risks cannot be reduced with security measures.

Time Risk To reduce time risks, manufacturing processes can be planned in such a way that decisions on product specifications are made at the latest possible point in time. Sourcing is then tasked with making standard goods available, and these are then customized to meet specific customer requirements at a relatively late stage in production. Supplier delays can be compensated more easily in such a system. This is a form of *postponement* as a strategy for reducing time risks. This is applicable in both conventional and sustainable supply chains. The case of Fairphone shows that postponement can be applied in an extreme manner: the production and procurement process was started only after 5,000 phones were sold. If delays arise, other countermeasures are available. Using flexible factories or multiple sourcing within the framework of a *hedging* strategy can make switching to alternative sources of supply on short notice easier. For sustainable goods, however, the restrictions that were relevant to quantity risks also apply here. What was said above about *control* policies is also applicable to delay risks. *Security* systems make it possible to recognize and respond to delay risks early. This is not entirely good, however, since short-term reactive measures such as follow-up orders, extra deliveries, and overtime negatively impact the social and environmental balance sheet of the enterprise. As with quantity risks, avoidance does not reduce the risk of delayed deliveries. A speculation strategy affords suppliers' planning reliability, but if a supplier delivers late in spite of this, alternatives are usually absent. Again, this type of risk is not

transferable. As a general principle, it can be observed that on-time delivery performance ranks below quality in sustainable supply chains. Customers interested in purchasing sustainable products are demonstrably willing to put up with longer delivery periods or even waiting periods, if they can rest assured, in exchange, that social and environmental standards have been adhered to. In consequence, delay risks exist in sustainable procurement, but to some extent, it appears that they are not decisive competitive factors.

Price Risk Three of the risk management strategies can be deployed in the context of price risks. If a policy of *speculation* is used to determine prices as well as quantities at an early stage, this can prevent short-term fluctuations in prices. This can also be achieved with the help of *hedging*. Alternative supply relationships reduce dependence on individual suppliers and make enterprises less vulnerable to price increases affecting specific sources of supply. *Transferring* is a suitable means of risk reduction as it can be deployed, for example, in the form of outsourcing with the goal of eliminating the risks of price fluctuations. Limitations on the deployment of all three strategies within sustainable procurement processes exist. Social criteria mean that passing the risk of rising raw material prices onto suppliers does not constitute fair business practice. Moreover, the limited number of possible suppliers also means that switching to alternative sources of supply is often impossible. The other four strategies do not represent suitable approaches to minimizing price risks in either sustainable or conventional procurement. Avoidance leads to greater dependence as it involves a conscious decision to withhold sourcing material from alternative sources. Postponement has no influence on the price of goods. Since neither flexible supply agreements nor vertical integration can prevent prices from rising, control policies have no effect here. Security also has no impact on prices.

Transport Risk In addition to the risk of goods being lost or damaged, the transport risk in sustainable supply chains also encompasses the risk of the means of transport used causing social or environmental harm. This could relate, for example, to emissions or noise pollution. Consciously rejecting the use of certain transport options such as air freight can reduce these risks in the context of an *avoidance* strategy. Outsourcing transport services to service providers reduces the impact of transport risks that materialize. If attention is paid to the sustainability of service providers in the context of such a *transferring* strategy, this approach can also be deployed in sustainable procurement. *Security* solutions do not reduce the transport risk itself, but they can help to manage its impact at an early stage. Whether it lends itself to use in sustainable procurement or not depends on the specific measures under consideration. Postponement, speculation, hedging, and control strategies have no bearing on transport. As such, they cannot reduce risk in this area.

The remarks on the applicability of risk management strategies to sustainable supply chain management in this section have highlighted two points. It is clear that not all strategies can be applied to every risk. This holds true for both conventional and sustainable procurement. It has also become evident that additional caveats that further reduce the number of suitable instruments apply to sustainable processes. Table 9.4 summarizes where these reductions occur.

Table 9.4 Suitable risk management strategies in conventional and sustainable sourcing

Type of risk	Suitable strategies in	
	Conventional sourcing	Sustainable sourcing
Quality	Avoidance, control, security	Avoidance, security
Quantity	Speculation, hedging, control	Speculation
Delay	Postponement, hedging, control, security	Postponement
Price	Speculation, hedging, transferring	–
Transport	Avoidance, transferring, security	Avoidance, transferring

9.4.3 Opportunities for Risk Management in Sustainable Sourcing

The analysis leads to the conclusion that risks in sustainable sourcing differ to some extent in character from risks in conventional supply chains. Paying attention to social and environmental standards impacts quality and transport risks in particular. As a consequence, not all strategies that can be used for particular risks in conventional sourcing can be used in sustainable procurement. New methods have to be developed. Two areas were this is possible can be identified:

The small supply base that a sustainable supply chain such as Fairphone relays on can be used for close cooperation. While managing good relationships with supply chain partners is difficult, it is possible if there are only a small number of partners. It will help to reduce quality and quantity risks. As sustainability is based on fair and trustful relations, such supply chains can use cooperation with partners to reduce risks in sourcing.

Customer expectations on sustainable products differ from expectations of conventional products. As a general principle, it can be observed that fast availability and minimum prices rank below quality in sustainable supply chains. Customers interested in purchasing sustainable products are willing to tolerate longer delivery periods and higher prices if they can be assured that social and environmental standards have been adhered to. Consequently, delay risks exist in sustainable procurement, but to a certain extent, it appears that they are not decisive competitive factors. It may also be possible to transfer price risks to the customer. This will only be possible if it can be shown that the reason for the increase improves sustainability.

9.5 Summary

This paper examines risk management in sustainable supply chains by focusing on sourcing risks and supply chain risk management strategies. Since a good can only be sustainable if both its production processes and resources meet social and environmental standards, sourcing plays a key role in their manufacturing. Therefore, Sect. 9.2 explains the relationship between sustainable supply chain management

and sustainable sourcing. The purchasing department has to ensure that suppliers treat their employees and the environment according to sustainable aspects. This task includes the consideration of risks in sourcing. Section 9.3 identifies different sources of risks in supply chains as well as in sourcing. Differences in the intensity of sourcing risks between conventional and sustainable supply chains could also be recognized. For this analysis, the case of Fairphone was examined. It indicated that differences exist in both quality and time risk. Section 9.4 analyzes whether sustainable sourcing risks can still be addressed with supply chain risk management strategies. This is possible only to a certain degree. In all five categories of sourcing risks, the application of the strategies is limited. The main reason for this limitation is the small number of sustainable suppliers and fair long-term relations that forbid risk transfers to supply chain partners. However, there are also opportunities for risk management in sustainable sourcing. Sustainable supply chains include fair relationships and conditions from which everyone can profit. These circumstances provide an environment that reduces both quality and quantity risks in sourcing. Different customer expectations on sustainable products also help risk management. Consumers buying sustainable goods want social and environmental standards to be met. They are willing to pay more and even wait longer for such products. Sustainable sourcing is therefore able to address time and price risks more easily.

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Chapter 10
Management of Conflict Minerals in Automotive Supply Chains: Where to Start from?

Morgane M.C. Fritz and Niklas Tessmann

Abstract With the US Dodd-Frank Act, the first legally binding regulation that forces American companies to ensure their products are conflict-free, transparency in supply chain management has been challenged. The European Commission being about to release a similar regulation for European companies makes this challenge almost global. The electronics industry has been the first sector under pressure to take initiatives against conflict minerals in products. Due to close interrelations, the automotive industry is also strongly impacted, but research has not been focusing on implications for this sector so far. With the use of concepts from the stakeholder management theory, this chapter shows the importance of identifying conflict minerals stakeholders within and outside the supply chain of the automotive sector to determine where to start from and whom to engage in the automotive sector. The analysis based on a literature review, expert interviews and information disclosed online by the five largest car manufacturers shows that stakeholders engaged by the automotive sectors are limited to suppliers, industry groups and the electronics sector. However, two specific areas of development within the automotive industry are identified, namely, awareness raising of suppliers and methods to trace conflict minerals along the supply chain. It is argued that a supply chain perspective enables to identify a wide variety of stakeholders with whom the automotive industry may find synergies. The analysis also reveals that so far miners and their communities, one of the most affected stakeholders, are not being engaged sufficiently to support conflict-free mining.

Keywords Conflict minerals • Stakeholder identification • Supply chain management • Sustainability

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10.1 Introduction

The purpose of this contribution is to show that traditional approaches of stakeholder management and identification do not enable to comprehensively address sustainability issues related to a product, in this case conflict minerals, in the automotive industry.

Conflict minerals (CM) are also known as 3TG, which refers in the USA to tin, tantalum, tungsten and gold. These so-called CM are sourced from the Democratic Republic of Congo (DRC) and its neighbouring countries. In the upcoming EU regulation on CM, the list of minerals concerned is expected to be longer, the definition of CM will be different and no specific geographical zone will be defined. Other guidelines define the term in a broader way too like the London Bullion Market Association (LBMA) that considers conflict as an weapon-based aggression between two or more stakeholders leading to human rights abuses and where government, militia, organised criminals or terrorists may be involved (LBMA Responsible Gold Guidance, Version 6, 2015).[1]

In recent years this topic became more popular since new regulations like the US Dodd-Frank Act and guidelines like the Organisation for Economic Co-operation and Development (OECD) Due Diligence Guidance for Responsible Supply Chains of Minerals from conflict-affected and high-risk areas (OECD 2016) or the Conflict-Free Sourcing Initiative (CFSI) with its Conflict-Free Smelter Program[2] were introduced by governments, intergovernmental organisations and industry groups. The reason for the rising amount of legislations and interest in the field, particularly in the Western world, is the increased mediatisation and awareness on human rights abuses and violent conflicts on some mining sites where armed groups take over the benefits from the sales of minerals (Cook 2012; Ille 2016). Although the local situation may be much more complex and linked to geopolitical reasons and site-specific circumstances (Chase 2015; Ille 2016), several stakeholders like non-governmental organisations (NGOs) and civil society are pushing companies, with a focus on the electronics industry, to be more transparent all along their supply chain and refuse conflict minerals. New laws and guidelines are supposed to force companies prove they manufacture conflict-free products and do not source from conflict-affected mines (OECD 2016; Young 2015). As a consequence, companies in various sectors joined voluntary initiatives to share knowledge and best practices that would enable them to comply with regulations and the general public pressure.

Although a focus has been set on the responsibility of the electronics industry, various other industries are also using conflict minerals or components that contain conflict minerals such as the health care, the aviation or the automotive sector. The automotive sector is particularly interesting because it is closely linked to the

[1] See http://www.lbma.org.uk/assets/market/gdl/RGG%20v6.0%20201508014.pdf (accessed 2 December 2016).

[2] See http://www.conflictfreesourcing.org/conflict-free-smelter-program/ (accessed 2 December 2016).

electronics sector due to the electronics components used in cars. Also, the sector is represented by the Automotive Industry Action Group (AIAG),[3] a non-profit trade association founded in 1982, which is particularly active in supporting companies in quality, supply chain and corporate responsibilities issues, including conflict minerals. The AIAG develops methods to request and receive 3TG declarations from suppliers in a standardised way. This trade association also provides training and reports on conflict minerals for the automotive industry. Additionally, a survey conducted by the AIAG among 550 representatives of the automotive sector and related industries indicates that conflict minerals have been defined as the most important challenge for the automotive industry in 2014, which shows that the topic is of high relevance (Hower 2014). However, little is known about the automotive sector and conflict minerals stakeholders since it is less mediatised. However, the situation may change due to the recent scandals in the automotive sector, and eventually, consumers may be looking for conflict-free cars as well. It is hence important for the automotive sector to identify CM stakeholders, their present and future roles, as well as potential synergies among automotive companies or other sectors. The purpose of this book chapter is hence to analyse which stakeholders are in place in the field of conflict minerals and identify potential synergies for the automotive sector. More specifically, the following research questions are addressed: since CM imply a variety of stakeholders, which ones shall be addressed by the automotive sector? What are current practices and how could the challenge of building conflict-free supply chains be achieved without harming any stakeholders?

Traditional stakeholder identification methods are often company-centred approaches (e.g. Harrison and St John 1998) that do not enable to comprehensively identify which stakeholders are in place in multilevel issues such as CM. Company-centred approaches imply that one company has to fulfil the needs and wishes of all its stakeholders which is not appropriate in the context of CM since a variety of industries such as the jewellery or electronics sectors are also sourcing these minerals. It is hence argued from the method side that the issue of CM and stakeholder identification shall rather be addressed from a supply chain perspective where the product, in this case CM, is the starting point of the analysis and where stakeholders having a direct or indirect role in the trade of CM shall be identified, as well as stakeholders being affected by CM (e.g. Vos 2003). In order to do so, a literature review has been conducted with the keywords "tin/tungsten/tantalum/gold" and "supply chain" AND "conflict". This leads to the identification of 12 papers that were analysed to map a first set of stakeholders at a local, regional, national and international level and define their roles. This analysis provided a basis to draw a stakeholder supply chain diagram which is a visual representation of the stakeholders in place. In parallel, experts in CM were identified through the 2015 Top 100 Conflict Mineral Leaders List,[4] and all persons working in companies, industry groups and NGOs were selected to identify CM stakeholders and map them according

[3] See www.aiag.org (accessed 30 November 2016).

[4] http://www.assentcompliance.com/conflict-minerals/top-100/#/downloadhttp://www.intel.com/content/www/us/en/corporate-responsibility/conflict-free-minerals.html

to their knowledge (N = 32 persons). In total, two experts from the electronics industry and one expert in corporate investment participated in the process (see Table 10.3 in Appendix). The additional stakeholders identified were then integrated into the supply chain diagram resulting from the literature review. Finally, the stakeholders identified have been compared with stakeholders identified by the five largest automotive companies on their websites (i.e. policies, sustainability reports).

The following presents at first the stakeholders identified through the literature review and the expert's interviews. Then the stakeholders addressed by the largest five automotive companies are presented and discussed. Finally, conclusions and recommendations are drawn on the importance of identifying stakeholders and synergies for the automotive industries and the need to enlarge the responsibility for conflict-free products to other supply chains and stakeholders.

10.2 Conflict Minerals Stakeholders: Literature Review and Experts' Perspective

The term "conflict minerals" is being used since the late 1990s in the elaboration of voluntary agreements and regulations for supply chain governance (Ille 2016). It is currently used to refer to tin, tungsten, tantalum and gold (3TG) that originate from DRC or its neighbouring countries and are related to the financing of civil conflicts (Fitzpatrick et al. 2015; Coghlan et al. 2006). These conflicts do not occur in each mining sites of the DRC and neighbouring countries but only in some of them, especially in areas that are rich in minerals and where the socioeconomic context of the activity is delicate (i.e. poverty, corruption, land right disputes, forced and child labour, theft extortion or ethnic conflicts like between the DRC and Rwanda) (Fitzpatrick et al. 2015; Autesserre 2012; Chase 2015; Connors 2012).

Since the 1990s, several guidelines, regulations and voluntary initiatives were implemented for companies to source from conflict-free areas. Table 10.1 provide an overview of these initiatives, the concerned regions and their legal status.

In addition to regulations, Young (2015) provides a detailed analysis of 16 certification programmes for conflict minerals and conflict-free sourcing of 3TG. His analysis shows that there are a wide variety of programmes in place for different industries, especially for the electronics and the jewellery sectors and for each of the different 3TG. Also, it is worth noting that specific industries integrated the topic into existing structured such as the AIAG for the automotive sector. This wide variety of certification programmes, standards, regulations and guidelines has been rising over the last few years to discourage the use of CM, but their success is mitigated by the level of market participation (Fitzpatrick et al. 2015). Also, conflict minerals are being used by industries that have not been communicating extensively on their involvement in conflict-free initiatives such as the aviation, aerospace or food industries that may however use larger amounts of CM than the electronics (Expert 2).

Table 10.1 Overview of the main guidelines, regulations and voluntary initiatives for conflict-free mineral sourcing

Name of initiative	Type of initiative	Concerned region or sector	Legal status
US Dodd-Frank Act	Regulation	Companies in the USA and companies in their supply chain	Legally binding
OECD Guidance	Guidance	For companies that need conflict minerals for their products	Not legally binding
EU Commission initiative (in planning)	Regulation	European Union	Legally binding
International Conference on the Great Lakes Region (ICGLR)	Pact on security, stability and development in the Great Lakes Region	The 12 Member States grouped in an IGO	Legally binding
Extractive Industries Transparency Initiative (EITI)	Global standard	Extractive industries and their supply chain, engaging with governments, companies and civil society	Not legally binding
Conflict-Free Smelter Program	Programme	Electronics industries using CM and brand-name manufacturers	Not legally binding

The 12 Member States of the ICGLR are: Angola, Burundi, Central African Republic, Republic of Congo, Democratic Republic of Congo, Kenya, Uganda, Rwanda, Republic of South Sudan, Sudan, Tanzania and Zambia (see http://www.icglr.org/index.php/en/background, Accessed 1 December 2016)
The ICGLR includes mechanisms that are mandatory for member states such as the Regional Certification Mechanism (Ille 2016)

The review of existing literature on conflict minerals and supply chains shows that there are a variety of stakeholders involved at different levels. Figure 10.1 summarises this analysis.

Local stakeholders are stakeholders that are part of the upstream supply chain (from mine to smelters and refineries) and multilevel stakeholders that aim at supporting artisanal miners and ensure a conflict-free activity (e.g. NGOs, IGOs like UN peacekeeping groups). Local stakeholders typically consist in artisanal miners, armed groups, communities, governments and other stakeholders (Ille 2016). Among them, artisanal and small-scale miners play a central role since they mine and extract the minerals. They are also among the most affected stakeholders since they earn their living often exclusively on their mining activity, on which their families and local businesses are also depending (Chase 2015). One main issue concerning artisanal miners is that they often work informally, without any fix salary or social insurance making their activity very risky. Several stakeholders and initiatives intend to support a more formalised activity of miners in order to integrate them better into the formal economy (e.g. the Responsible Jewellery Council (RJC)

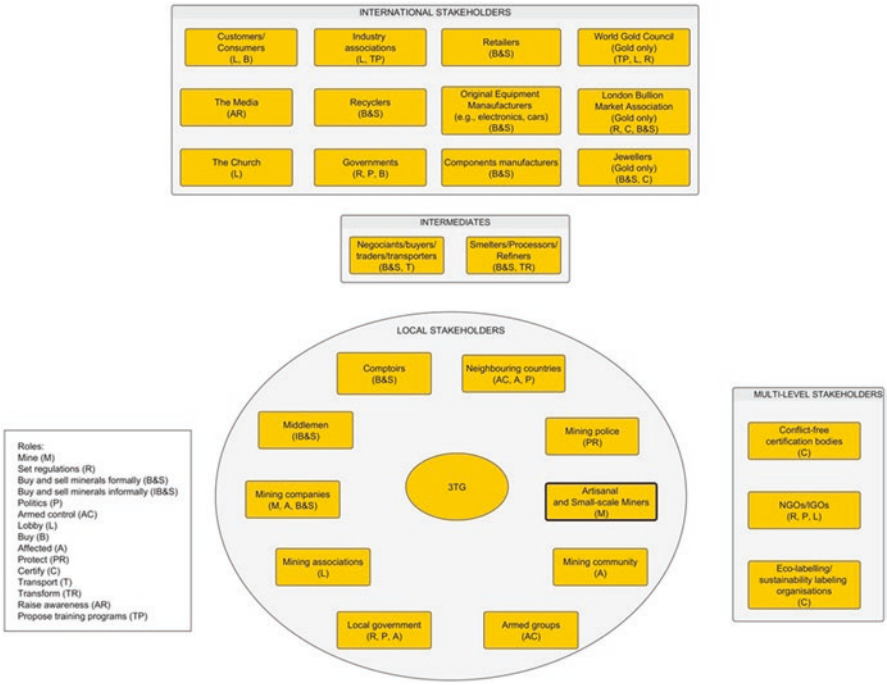

Fig. 10.1 Local, regional and international stakeholders (Source: authors' own illustration based on Young (2015), Hofmann et al. (2015), Ille (2016), Bleischwitz et al. (2012), Chase (2015), and Moran et al. (2014), Expert 1, Expert 2, Expert 3)

with its Chain-of-Custody Certification Handbook (RJC 2012)[5]; OECD 2016; the Fairmined Gold Standard v2.0 (ARM 2014)[6]; LBMA, 2015). Also, the development of "Non-state armed groups or public or private security forces" may support miners by protecting them and the transporters of minerals (Ille 2016). According to several researchers, formalisation activities have been particularly pushed by organisations such as Global Witness, Partnership Africa Canada (PAC) or Enough Project (Ille 2016; Chase 2015; Young 2015). The issue of informal trade via so-called middlemen or smugglers is also important and is a challenge to ensure the traceability of minerals along the supply chain (Bleischwitz et al. 2012).

International stakeholders are a very diverse group of stakeholders. Some of them are part of the downstream supply chain (from smelters to end users). Among them, the electronics industry has been playing a major role since it was the target of several campaigns against CM like the ones led by the Enough Project, and this has put pressure on suppliers along the supply chain (Mackay and Simandl 2014).

[5] See http://www.responsiblejewellery.com/files/G003_2012_RJC_CoC_Cert_Handbook_PM.pdf (accessed 2 December 2016).

[6] See http://www.responsiblemines.org/images/sampledata/EstandarFairmined/Fairmined%20Stnd%202%200_2014_.pdf (accessed 2 December 2016).

However, as highlighted by Fitzpatrick et al. (2015), "consumer electronics are typically responsible for only a portion of the total use of conflict minerals (no more than 15% of global consumption for tantalum and 5% for the other 3TG metals)". Hence consumer pressures on the consumer electronics sector may not be the most effective way to tackle the issue of CM, and these pressure shall rather target industries using a larger share of 3TG (Fitzpatrick 2014). To support that, the media plays an important role to convey messages to the end-consumers that may encourage them to purchase more ethically and to require more transparency in other sectors as well (Fitzpatrick et al. 2015). This ethical consumerism is also behind the motivation for governments to encourage companies to report on their sourcing practices (Ille 2016). Following the initiatives of some NGOs or international projects, communication about conflict minerals has sometimes been oversimplified, assimilating the DRC to conflict minerals and human rights abuses that end up in every smartphone, computer and other electronics devices. Such a trend has been called "humanitarian porn", and the stakeholders behind that trend are perceived as negative stakeholders, trying to justify their collection of funding with hot topics and oversimplification of facts (Expert 2). There is hence a need to involve other stakeholders like the commercial customers (Expert 3) who have a large bargaining power along the supply chain since industries using a larger share of 3TG like the aerospace sector are more focussing on business to business relations than business to consumers (Expert 2).

Other international stakeholders play a role both at the local level and the international level. This is the case for governments, for instance, and politicians that took part to the development of the Dodd-Frank Act Section 1502. Although they are not on-site, they impact miners and their communities since their decision to force American companies to prove that they are conflict-free encouraged several of them to abandon sourcing from the DRC (e.g. Malaysia Smelting Corporation) (Chase 2015). Local stakeholders like miners or governments have not been much involved in this process, especially in the DRC, leading to unforeseen socioeconomic consequences for miners and their communities (Chase 2015; Expert 2). For instance, before 2011 the Malaysia Smelting Corporation was buying 80% of DRC's tin, and miners received about 9$ per kilo for it. Since 2011, this price has fallen to 1.50$ per kilo, and an estimated number of 5–12 million people were negatively affected since miners could not sell their tin at a decent price anymore (Chase 2015). Hence some miners continued their activity and sold their mineral on the informal market via, for instance, smugglers and other joined informal military groups to defend their territory being invaded by neighbouring countries like Rwanda, trying to get control over the mineral mines (Chase 2015). This situation in turn forced some governments to intervene to stop informal activities, exacerbating violence in the region and increasing the insecurity of miners being deprived of their previous source of revenues (Ille 2016). Mineral buyers and intermediates in the supply chain such as smelters, processors or refiners hence simply tried to avoid sourcing from the DRC and its neighbouring countries to ensure conflict-free mineral use in their supply chains (Young 2015). The management of CM is hence a very complex and multilevel issue.

The price of metals set by organisations like iTSCi[7] for tin or Pan-African Canada (PAC) also has an impact on the activity since the higher the market price, the more miners are joining the activity like in the case of tantalum in the 2000s in the DRC, and this may lead to some tensions due to the limited availability of lands (Moran et al. 2014; Expert 2). Also, specific stakeholders like Chinese buyers have a strong bargaining power along the supply chain which makes it complex to manage since the local governments are often weakened by their instable institutions, like informal mineral trade (Young 2015). Some authors argue that reducing the trade of conflict minerals reduces the funding sources of armed groups and can hence reduce conflicts in a specific region (Moran et al. 2014). This is the direction taken with the US Dodd-Frank Act and the upcoming EU regulation. However, some researchers disagree with this approach since it may cause significant harm to the mining communities (Moran et al. 2014).

In order to ensure that supply chains are conflict-free, independent third-party audits are an important tool (Ille 2016; Fitzpatrick et al. 2015). Some audit processes for minerals are defined, for instance, by certification schemes (e.g. the Kimberley Process Certification Scheme) and guidelines (e.g. OECD 2016; Ille 2016). In addition to audits, another challenge is to identify and increase the number of conflict-free mineral sources (Fitzpatrick et al. 2015). Moran et al. (2014) also believe that Life-Cycle Assessment (LCA) may be useful to understand better the flows of conflict minerals along supply chains. However, if all supply chains would be able to be conflict-free, there would still be the challenge to support mining communities that are suffering from conflicts (Expert 2).

The strong focus on conflicts led by armed groups as emphasised by some NGOs puts aside complementary issues that need to be tackled as well such as labour rights, privatisations and investments, environmental contamination and the active engagement of local governments (Ille 2016; Young 2015). It is not clear how effective the Dodd-Frank Act has been so far, some researchers showing a higher number of conflicts and significant economic losses for miners in the DRC (e.g. Chase 2015), converting the Act in a kind of ban of minerals from the DRC (Fitzpatrick et al. 2015). Others show that the impact of the Dodd-Frank Act made the activities of armed groups significantly decrease in the production of tin, tungsten and tantalum (e.g. Bafilemba et al. 2014). By engaging more local stakeholders, Expert 2 also sees, for instance, the opportunity for large-scale companies to eventually employ local artisanal miners and provide them with a decent pay, better mining tools, health and safety equipments and private security forces. “Non-state armed groups or public or private security forces” are also recognised as a legitimate stakeholder on-site by the OECD Guidance (OECD 2016) to protect miners and the transportation of minerals (Ille 2016).

[7] See https://www.itri.co.uk/itsci/itsci-project-overview/itsci-project-overview (accessed 2nd December 2016).

10.3 Tantalum and Gold-Specific Stakeholders

Several stakeholders are common to all 3TG. Nevertheless, the literature review and experts interviews show that tantalum and gold have also specific stakeholders. Tantalum has often been assimilated to "blood diamonds" and has been particularly in the focus of NGOs and consumer campaigns (Moran et al. 2014). Gold has also been targeted by the "No Dirty Gold" campaign aiming at raising awareness of consumers in the jewellery sector on the environmental impacts of mining in the 2000s and giving birth later to the multi-stakeholder engagement with the Initiative for Responsible Mining Assurance (Young 2015).

According to Mackay and Simandl (2014), the tantalum used in 2012 is originating from tantalum mines (40%), recycling (30%), tin slag refining (20%) and secondary mine concentrates (10%). It is a very important mineral for the production of capacitors, for instance, for which the electronics industry is one of the major users for the manufacture of mobile phones, laptops, digital cameras, GPS navigation systems, computer hard drives and airbag triggers (Mackay and Simandl 2014; Expert 2). This shows the close link between the electronics and the automotive sectors. Additionally, Mackay and Simandl (2014) underline that tantalum is used in "medical implants, super alloys used in jet turbine and rocket nozzle production, corrosion prevention in chemical and nuclear plants, as a sputtering target and in optical lenses". This implies that many other industries, namely, the medical sector, the army, the aviation, and the public sector, are purchasing products containing this mineral, and further research would be needed to determine the amount of tantalum this represents and analyse their degree of involvement in supporting conflict-free minerals initiatives. Most tantalum producers are localised out of the regions defined from the Dodd-Frank Act (i.e. Brazil, Mozambique and China; Mackay and Simandl 2014) which may explain why no emphasis has been set so far in the involvement of these additional sectors in research and in the media. However, with the EU regulation on conflict minerals, this may change since the geographical area will not be limited to the DRC, and its neighbouring countries and "conflict" may also be understood as negative environmental and social impacts (Expert 2). Tantalum is also particular since it is one of the minerals where success in building transparency along the supply chain has been the highest, with about 95% of producers being compliant with the Conflict-Free Smelter Program, which is not the case for other minerals like gold (Young 2015).

10.4 Conflict Minerals Stakeholders and Implications for the Automotive Industry

While it is obvious from the previous analysis that CM are a multi-stakeholder issue, the analysis of declarations and actions from the five largest companies in the automotive sector (see Table 10.2) shows different degrees of disclosure on the issue.

Table 10.2 Top five largest car companies and their disclosure of information on conflict minerals

Largest car companies	Country of origin	Unit sales in 2014	Number of employees	Reference to conflict minerals
Toyota Motor	Japan	10.2 million	330,000	Yes
Volkswagen Group	Germany	10.1 million	592,586	Yes
General Motors	USA	9.92 million	216,000	Yes
Renault-Nissan Alliance	France, Japan	8.47 million	450,000	Yes
Hyundai Motor Group	South Korea	7.71 million	249,366	No

According to http://www.tharawat-magazine.com/facts/10-largest-car-companies/#gs.Asx251o (Accessed 17 November 2016)

Toyota Motor, the leading company in the sector, addresses the issue of conflict minerals on their website and developed its own policy on conflict minerals with due diligence practices since 2013. The company developed guidelines in order to track the use of conflict minerals along its supply chain and is also engaged in raising its suppliers' awareness. Internally, Toyota has a specific in-house system, and externally, the company is active in collaborating with industries and takes part, for instance, in the Public-Private Alliance for Responsible Minerals Trade (PPA). The company also reports to the US Securities and Exchange Commission (Dodd-Frank Act regulation). It is clearly stated online that the company aims at sourcing and using minerals originating from the DRC or neighbouring countries that are conflict-free and not associated to any illegal practices or violation of human rights. Suppliers, companies from the automotive sector, and other organisations are considered as stakeholders for Toyota to work with. Beyond the Conflict-Free Sourcing Initiative (CFSI) launched by the USA, similar initiatives are also in place in Japan for the automotive and electronics industries (i.e., the Japan Conflict-free Sourcing WG) and these initiatives are interacting with each other to source conflict-free 3TG.[8]

Volkswagen Group, the second largest company in the sector, also refers to conflict minerals on their website and developed the Volkswagen Conflict Minerals Policy.[9] The company is engaged in the Extractive Industries Transparency Initiative (EITI) since 2013, cooperates with the UN Global Compact advisory body with regard to sustainability activities with suppliers and is a member of the Rohstoffallianz GmbH, an organisation providing new methods to German companies for sourcing raw materials. The Group is also working on human rights issues in global supply chains with multi-sector groups such as econsense and CSR Europe.

[8] http://www.toyota-global.com/sustainability/society/human_rights/conflict-minerals-issues/ (Accessed 17th November 2016)

[9] http://www.volkswagenag.com/content/vwcorp/info_center/en/publications/2015/12/Conflict_minerals.bin.html/binarystorageitem/file/Volkswagen+Conflict+Minerals+Policy.pdf (accessed 17th November 2016)

General Motors is necessarily involved in the reporting of 3TG used in its supply chain since it is an American-based company and is therefore expected to comply with the Dodd-Frank Act. They do not communicate about a specific conflict minerals policy but have a conflict minerals compliance programme and include the topic under their Supply Chain Responsibility.[10] General Motors reports to the Securities and Exchange Commission (SEC) according to the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010. In their declaration, they specify how they organised themselves internally with a person assigned to work full-time on the issue of conflict minerals, assisted by a Conflict Minerals Compliance Committee "composed of representatives from Global Purchasing and Supply Chain, Public Policy, Finance, Legal, Information Technology, Communications, SEC Reporting and Material Engineering functional areas" that share their expertise to comply with the company's conflict minerals compliance programme and a "Conflict Minerals Executive Steering Committee composed of Executive Directors in Global Purchasing and Supply Chain, Legal and Public Policy" which supervises the conflict minerals compliance programme. The company makes use of the Conflict Minerals Reporting Template (CMRT) developed by the Conflict-Free Sourcing Initiative (CFSI) to request information from first-tier suppliers. However, they were not able to determine the origin of the 3TG they use. Externally, General Motor is also a member of the Automotive Industry Action Group (AIAG)[11] aiming at developing standardised methods to request and receive 3TG declarations from suppliers in the automotive industry and providing training and reports on conflict minerals for the automotive industry. The company itself encouraged about 40 non-certified smelters and refiners to join the Conflict-Free Smelter Program and work with its suppliers to do the same and develop a list of conflict-free smelters/refiners.

Renault-Nissan Alliance. No reference to conflict minerals was found in the sustainability report or website of Renault-Nissan Alliance. However, the group has a Corporate Social Responsibility Guidelines for Suppliers and requires that suppliers sourcing from countries facing human rights or environmental issues to source in alternative countries or find substitutes.[12] Specific activities regarding conflict minerals are more detailed when looking at Nissan only. Nissan has indeed developed the Action Against Conflict Minerals and the Nissan Procurement Policy.[13] Here, although the company is not American and hence has no legal obligations to comply with the Dodd-Frank Act, it is stated that efforts are being done to raise awareness among supply chain partners by conducting conflict mineral surveys not

[10] http://www.gmsustainability.com/impacts/supply-chain.html#initiatives (accessed 17th November 2016)

[11] Non-profit automotive industry trade association

[12] Renault-Nissan Corporate Social Responsibility Guidelines for Suppliers. Available at: http://www.nissan-global.com/EN/DOCUMENT/PDF/SR/CSR_Alliance_Guidelines.pdf (accessed 19th November 2016)

[13] http://www.nissan-global.com/EN/CSR/STRATEGY/VALUE_CHAIN/ and http://www.nissan-global.com/EN/DOCUMENT/PDF/SR/Conflict_Minerals_e.pdf (accessed 17th November 2016)

only in Japan, the USA and Europe but also in other Asian countries. The company also intends to share its activities regarding conflict minerals on its website in order to raise awareness along its entire supply chain, particularly in Asia. This information is also available in the Nissan Motor Corporation Sustainability Report 2016.[14] According to Expert 2, most minerals extracted from Africa are being smelted and refined in Asia, but little is known about their activities. This focus on Asian supply chain members may hence be relevant. Moreover, Nissan started to investigate the presence of conflict minerals in its supply chain in 2013 and works with a variety of stakeholders in working groups. These are mainly located in Asia such as the Japan Automobile Manufacturers Association, the Japan Auto Parts Industries Association or the **Japan Electronics and Information Technology Industries Association**. They work together on finding the best methods to trace conflict minerals along the supply chain and share information. One may note that the company identified synergies with the electronics sector, which is not the case for all the other four companies. So far, the company has not found any smelter/refiner in its supply chain that is related to armed groups and compromises itself to further request information to its suppliers. The company aims at making its supply chain 100% free from CM by working together with the automotive and electronics industry.

Finally, **Hyundai Motor Group** does not communicate about conflict minerals on their website, and no other information was found with regard to the topic for this company.

10.5 Discussion, Limitations and Need for Further Research

First, this work has several contributions to the field of stakeholder management. It shows that in order to identify the stakeholders of the CM's supply chain, it is not sufficient to start at the company level. As underlined by Achterkamp and Vos (2007), Salado and Nilchiani (2013) or Pouloudi and Whitley (1997), there is a need for more holistic perspectives that enable to take into account the ones that affect the trade of CM and the ones that are affected by this trade (Vos 2003). Starting the analysis at the product level, in this case CM, and analysing the stakeholders within and outside, the CM supply chain is one way to overcome the limitations of company-centred approaches as suggested in this paper. The analysis also shows that the various sources of data collection (scientific literature, experts interviews, companies' websites) all bring similar and different stakeholders, which emphasises the need for triangulation of methods and rigour in the stakeholder identification process which often simply consist in unstructured brainstorming (Reed et al. 2009). This also means that interactions with different stakeholders are useful to understand better the stakeholders in place and their stakes.

[14] http://www.nissan-global.com/EN/DOCUMENT/PDF/SR/2016/SR16_E_P070.pdf (accessed 17th November 2016)

Second, the theoretical contributions of this paper emphasise also relevant points for the automotive sector but also for all the other industries using CM to identify synergies and avoid overlapping of initiatives and programmes, one of the main challenges of developing sector-specific initiatives according to Expert 1. It may be valuable for the automotive industry to research how other industries tackle the issue. CM have been an important subject, for example, in the electronics industry or the jewellery sector. Importing current standards and initiatives could be a tremendous support and shortcut for the automotive industry. There might be no need to reinvent the work on CM. Slight adjustments of other industries' efforts to the automotive sector can already be a significant improvement. Cooperation often is key in these questions, and the learning effect might be very important for the automotive industry and the cooperating industries. Among the five automotive companies analysed, synergies and collaborations are identified with the electronics sector (in the case of Toyota, Nissan), industry groups working on the 3TG (Toyota, Volkswagen, General Motors, Nissan) and IGO (Toyota, Volkswagen), but no other sectors are referred to. This is explained by the fact that the electronics sector is considered as a leader in auditing and developing tools for traceability of CM along the supply chain (Fitzpatrick et al. 2015; Expert 2).

Also, one may note that the activities the automotive companies refer to are strongly emphasising the development of guidelines or methods to trace CM along the supply chain (Toyota, Volkswagen, General Motors, Nissan), the awareness raising or training of suppliers (Toyota, General Motors, Nissan), the development of an information system (Toyota) and awareness raising of smelters (General Motors). The strong focus of Nissan on raising awareness among Asian suppliers is particularly relevant since according to Expert 2, most minerals extracted from Africa are being smelted and refined in Asia, but little is known about their activities. This focus on Asian supply chain members may hence be profitable not only for the automotive sector but also to all other sectors sourcing their minerals from smelters located in Asia. Furthermore, since the analysed companies seem to have a strong interest in developing methods to trace CM along the supply chain, there shall be a strong interest in collaborating on this issue, as well as on raising awareness and training suppliers. This is particularly needed because of the rising information requests suppliers are receiving on CM from different customers (Fitzpatrick 2014). Suppliers may welcome harmonisation and standardisation of information request on CM along the supply chain (Fitzpatrick 2014). Collaboration to develop traceability systems may also go beyond the CM issue and consider systems that are already in place for other regulations like the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) or the Restriction or Use of Hazardous Substances Directive in Electrical and Electronic Equipment (RoHS) (Fitzpatrick 2014).

What can also be observed is that there are no concrete measures to support the miners and their communities in the DRC except for Toyota that clearly state that they are still willing to source from conflict-free areas in the DRC. Out of the five companies analysed, we can distinguish three different degrees of engagement: very engaged (having activities internally, along the supply chain and with other sectors

like Toyota), engaged (having activities with suppliers and working groups in the automotive sector) and (supposedly) not engaged in the case of Hyundai.

When coming back to the literature review and the expert's interviews, some companies seem to try to simply avoid the issue of CM in their supply chains by, for instance, stopping sourcing from the DRC or conflict-affected regions, which is not a solution (Expert 2). By doing this, the exploitation still goes on, just in different industries or companies. The automotive industry needs to get involved and not simply avoid some states where conflicts occur. Working with local governments and people is crucial here. This is all the more relevant with the upcoming EU regulation that will pressure all industries using CM even more. Therefore, it is crucial to even accelerate the efforts of the affected companies. Additionally, companies should not be the only ones who work on the topic of conflict minerals. Especially governments and NGOs that passed laws regarding CM should play a significant role (Expert 2). According to Fitzpatrick et al. (2015), regulations like the Dodd-Frank Act shall go further than requesting conflict-free and more transparent supply chains. Regulations shall also develop mechanisms to provide economic incentives that support the selling of minerals like gold from the DRC on the formal market and support miners in the DRC looking for other alternatives to earn their living (Fitzpatrick et al. 2015). For Expert 2, miners and their communities could be supported by paying a premium to minerals originating from conflict-free areas. This implies that stakeholders like PAC or iTSCi who are fixing the mineral market prices shall be engaged, and the willingness of companies to pay shall be measured, which requires further research (Expert 2).

Another important recommendation concerns the voluntary initiatives that push the work on the issue even further. A very positive example is the European Partnership for Responsible Minerals (EPRM). This initiative brings together governments, companies and also the civil society (including researchers) to work on the issue and find solutions (Expert 1). Bringing together these stakeholders offers new input and the generation of new ideas that might also be beneficial for the automotive sector. As a consequence, a support of these voluntary initiatives should always be considered.

Through the conducted interviews, we also found out that other sectors like the aviation, using much larger capacitors containing minerals, may also have a larger share of responsibility in the CM issue as well as the food industry with the use of tin cans, totally ignored in the debate so far (Expert 2). As stated in Fitzpatrick et al. (2015), "simple narratives around a single sector create a risk for not fully addressing the problem". The automotive industry is part of a larger group of industries using CM, and therefore the responsibility to avoid CM in products and to support miners and their local communities should be shared among many other industries in the process. Synergies need to be found and created to efficiently tackle the issue and not load of the weight on one industry alone. Large economic pressures on global supply chains are more effective when they are organised and concentrated

(Fitzpatrick et al. 2015). In order to organise initiatives, there is however still the need to uncover industries using CM that have been addressed to a very limited extent in research so far such as the aviation, aerospace, health and military sector.

The limitations of this research are the number of conducted interviews and the absence of CM experts from the automotive industries among the interviewees to confirm or infirm the findings specific to the automotive sector. The analysis of stakeholder engagement and activities to trace CM in the automotive industry relies solely on information available on the companies' websites, and not all activities concerning CM may be disclosed online. But, this also shows an important factor in the industry. To reveal the industry's efforts, it is absolutely needed to communicate about it so that the public and the stakeholders are able to follow the steps being taken by each company. Working transparently creates credibility and shows that the issue is being tackled and is not being ignored.

10.6 Conclusions

The conducted literature review and the interviews with experts show that CM involve a wide variety of stakeholders at multiple levels. The analysis of information disclosed by the largest five car manufacturers however shows the consideration of very automotive-specific stakeholders and sometimes refer to the electronics industry stakeholders as well. Hence synergies and mutual learning among sectors and stakeholders are limited in the automotive sector in general, but different companies have a different degree of involvement which are summarised into very engaged, engaged and not engaged. Most companies however show a strong interest in developing methods to trace CM along the supply chain and to raise awareness among and train their suppliers, even for companies not being subject to legally binding regulations. While these two areas of development for the automotive sector are certainly relevant for the issue of CM and offer several opportunities of collaboration and synergies within and beyond the automotive sector, solutions need also to be found to support miners on-site and their communities to avoid the "DRC-free" sourcing approach of several companies across multiple sectors. This implies that the responsibility of conflict-free sourcing shall not only be the one of companies but also of institutions such as governments, NGOs, IGOs or consumers making it a collective effort of public and private institutions at a local, regional, national and international level as encouraged by the Sustainable Development Goal n°17.

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Appendix

Table 10.3 Experts' profiles

Expert	Current industry	Experience in the industry	Experience with conflict minerals
Expert 1	Electronics (Intel)	16 years	10
Mr. Julian Lageard			
Director, Government and Policy Group, Europe, Middle East and Africa			
Expert 2	Electronics	20 years	7
Anonymous			
Expert 3	Responsible investment	20 years	8
Anonymous			

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Chapter 11
Implementing Sustainable Supply Chain Management: A Literature Review on Required Purchasing and Supply Management Competences

Heike Schulze and Lydia Bals

Abstract Implementing social and environmental dimensions in global supply chains remains a major challenge in practice. While processes and actions needed to implement sustainable supply chain management (SSCM) have been subject to more research in the last years, the question who implements these in practice is much less understood. Purchasing and supply management (PSM) stands out as a function with particular influence on the global supply base. Thus, there is a central connection between SSCM implementation and PSM as a function. While the organizational level has usually been in focus of research on sustainability issues in PSM, it is ultimately the individual buyer who implements specific processes and performs specific actions. Therefore, this chapter seeks to shed light on the relationship between SSCM implementation requirements and PSM competences needed on an individual buyer level. Based on a literature review, the current coverage of PSM competences in relation to SSCM is presented in order to discuss further avenues for research.

Keywords Literature review • Purchasing • Supply management • Sustainability

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11.1 Introduction

The current global business environment holds many social and environmental challenges. Existing or expected scarcity of resources like water or fossil fuels as well as increasing ecological damage is triggering social and ecological conflicts and fostering the discussion on how to ensure appropriate living conditions globally on a long-term base (BMU 2012; ERD 2012). In turn, businesses are increasingly feeling the impact of political frameworks and growing reporting requirements and legal regulations on their day-to-day operations. The 2030 Agenda for Sustainable Development adopted by the United Nations in 2015 with the agreement on new global sustainable development goals (UN General Assembly 2015) and the commitment of the United Nations community to the Paris Agreement and its efforts to combat climate change explicitly postulate the responsibility of businesses to support the social and ecological goals (UN 2015). These political frameworks not only focus on the level of a focal firm but clearly state a companies' responsibility to promote ecological and social standards within its entire supply chain. Also, since 2016, the European Union Directive on Nonfinancial Information Disclosure (European Parliament and Council 2014), for example, requires companies with more than 500 employees to report annually on environmental and social matters and also with regard to their business relationships. Therefore, transparency within supply chain networks will increasingly be required for businesses to fulfill their regulatory requirements as well as their stakeholder expectations.

When considering which functions influence the implementation of environmental and social aspects in supply chains, purchasing and supply management (PSM) stands out as an area with particular influence on the external supply base of the firm. More than half of the total turnover of a modern industrial firm in Europe is directly transferred to suppliers (Laios and Moschuris 2001). This has even been estimated as high as 60–80 % more recently (e.g., Monczka et al. 2010; Van Weele 2010). The PSM function manages the firm's supplier relationships. Moreover, the bulk of supplies now is no longer of domestic origin but international. As this network economy with a low depth of production and high reliance on international suppliers is a recent phenomenon that has emerged in the last two decades (Van Weele and Van Raaij 2014), firms are still struggling to find effective and efficient ways to manage it.

In this overall context, purchasing organizations are additionally faced with the requirement to manage sustainability aspects and risks within their supply chains. The scope of sustainability management in PSM can be defined as "(…) the consideration of environmental, social, ethical and economic issues in the management of the organization's external resources in such a way that the supply of all goods, services, capabilities and knowledge that are necessary for running, maintaining and managing the organization's primary and support activities provide value not only to the organization but also to society and the economy" (Miemczyk et al. 2012, 489).

Purchasing organizations will be even more challenged in the near future due to the abovementioned scarcity of resources, stakeholder expectations, and growing legal regulations. This was also emphasized in 2012 in the work by Schneider and Wallenburg (2012, 243), in their article directly headlined with the question "Implementing sustainable sourcing – Does purchasing need to change?", in which stakeholder management capabilities in PSM were emphasized as essential to address sustainability objectives.

Despite the growing importance of both social and ecological aspects on supply chain management, companies still tend to handle sustainability issues with a risk-oriented approach or even on an ad hoc base when issues occur (Harms et al. 2013). While SSCM has been defined to include a triple bottom-line perspective (TBL; economic, environmental, and social, Elkington 1998) 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" (Seuring and Müller 2008, 1700), the coverage of the economic and environmental aspects prevails over coverage of the social and/or multidimensional (Hutchins and Sutherland 2008; Müller and Stölzle 2015; Yawar and Seuring Forthcoming).

Sustainable supply chain management (SSCM) seems to remain predominantly focused on how to manage currently unsustainable supply chains in a more compliant matter, rather than how to establish an innovative SSCM approach (Pagell and Shevchenko 2014). Consequently, it has been suggested to "(…) move the field from studying how to manage unsustainable supply chains in a more sustainable manner, to managing truly sustainable supply chains" (Pagell and Shevchenko 2014, 45).

Together with the aspect of how truly sustainable supply chains might be characterized, also the understanding of sustainability itself has been recently shifting to a new paradigm: from a triple bottom-line approach that equally emphasizes economic, social, and environmental aspects (Elkington 1998) to new prioritizations such as an ecologically dominant logic (Montabon et al. 2016). According to the ecologically dominant logic, environmental and social interests supersede economic interests, and managers should first check environmental and then social and finally economic viability of a decision. As these authors suggest: "(…) we offer an alternative logic, which we call Ecologically Dominant (ED), that we argue can lead to truly sustainable supply chains" (Montabon et al. 2016, 11f.).

While overall the performance implications of sustainable supply chains (e.g., Hart 1995; Campbell 2007; Halme and Niskanen 2001) and other aspects such as the ecological performance of supply chains (e.g., Sundarakani et al. 2010; Mallidis et al. 2012, 2014) or sustainability implications of certain raw materials like the so-called conflict minerals (OECD 2016; Hofmann et al. 2015) have been discussed in the literature, the aspect of how to successfully implement SSCM in practice remains largely unaddressed. In their study on dynamic capabilities needed to perform sustainable global supplier management, Reuter et al. (2010, 52) proposed that "PSM's capability to respond to alternating stimuli from globally dispersed

stakeholders determines the effectiveness of SGSM [Sustainable Global Supplier Management] to mitigate sustainability related risks in global sourcing." Although this statement is made with an organizational-level analysis in mind, the same competence requirements can be inferred for the individual level.

While sustainability in supply chains is indicated as a major challenge faced by organizations, currently to our knowledge, there is only little research dealing explicitly with individual competences that are relevant for buyers to design and execute sustainable supply chain relationships and networks. Employee competences in general do play an important role in SCM and logistics (Hohenstein et al. 2014; Ellinger and Ellinger 2014; Fisher et al. 2010). Also, previous research has already emphasized the role of human resources in PSM (e.g., Knight et al. 2014; Giunipero et al. 2006; Giunipero and Pearcy 2000). However, while such research has mainly concentrated on the organizational level, the individual-level capabilities of employees for implementing sustainability are more recently coming into focus, which has also been coined the micro-foundations of CSR (Aguinis and Glavas 2012; Tate and Bals Forthcoming).

Therefore, this research focuses on individual-level factors of PSM personnel to act successfully in the interplay of targets and actors in SSCM. It strives for answers to the following research question: "Which PSM knowledge and competences described in literature can promote a professional and successful management of social and environmental targets in supply chains?"

11.2 The Role of PSM and Buyers in SSCM

When referring to PSM and SCM, we herein follow the so-called unionist perspective (Spina et al. 2013; Larson and Halldorsson 2002), in which PSM is a subset of SCM in terms of a discipline. Turning toward the scope of SCM and SSCM, this then entails implementing triple bottom-line criteria both upstream and downstream. Generally speaking, the tasks of implementing sustainability along this scope may then be organizationally allocated to various functions such as SCM, PSM, logistics, quality, and/or a central staff department for sustainability. The latter may have the role to initiate, design, and communicate SSCM, but implementation occurs at the operational level. While the authors certainly acknowledge that how these responsibilities are allocated in practice specifically depends on the individual company setup, within this domain, PSM's focus usually lies on the upstream supplier network. This typical denomination of responsibilities is shown in Fig. 11.1.

Turning toward the operational execution, the upstream part of SSCM relates to PSM: PSM has an important role in avoiding reputational damage and image loss of a company by preventing sustainability issues in the supply chain (e.g., Reuter et al. 2010; Carter and Jennings 2004; Handfield et al. 2002). The format and framework of the business relationship to suppliers fundamentally impacts the implementation of SSCM. PSM coordinates this relationship based on more traditional performance indicators like cost quality and delivery (Tsoulfas and Pappis 2006). In addition,

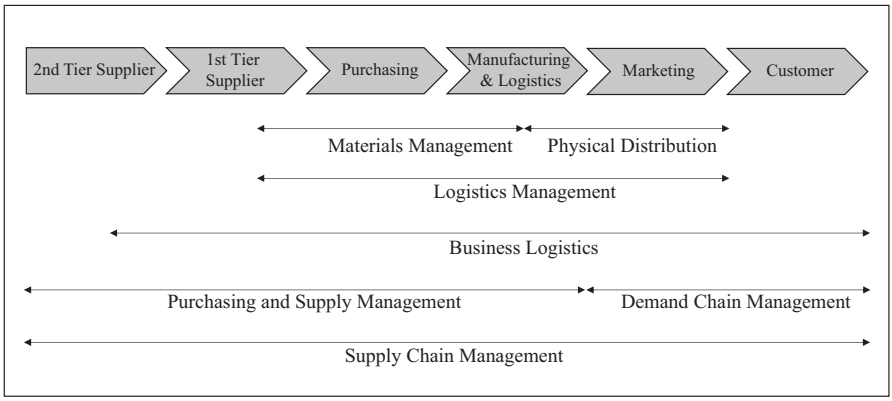

Fig. 11.1 Typical scopes of various functions' domains (Adapted from: Van Weele 2002, 207; Chopra and Meindl 2013, 15)

PSM is increasingly required to contribute to SSCM and eventually to the sustainability strategy of a company by including environmental and social aspects into the design of supplier relationships (e.g., Carter and Rogers 2008).

11.2.1 PSM's Processes in the Context of SSCM

Considering the scope of SSCM and delimiting it from the scope of sustainable PSM, Fig. 11.2 provides an overview of previous' research understanding of SSCM tasks, specifically for bringing environmental and social sustainability into supply chains. It is striking how many of the responsible supply chain actions outlined in it directly correspond to working with suppliers.

From the upstream supplier network perspective, it becomes apparent that two activities depicted in Fig. 11.2 directly fall into PSM's scope: environmental/social supply chain monitoring and environmental/social supply chain management systems (Marshall et al. 2015). Additionally, specifically for managing social issues in the supply chain, Yawar and Seuring (Forthcoming) have highlighted that both the managements of the external and internal stakeholder network are important. Although they do not discuss who/which function should perform these actions, they clearly define three responsible supply chain actions: (i) communication strategies (e.g., reporting), (ii) compliance strategies (e.g., codes of conduct, auditing, monitoring), and (iii) supplier development strategies. The tasks of both Marshall et al. (2015) and Yawar and Seuring (Forthcoming) have been combined in Fig. 11.2. Herein, particularly the second and third can be readily linked to PSM. For implementation of SSCM via PSM, these activities underline an extended view over the supply chain entities to be monitored as well as that of the internal company network of stakeholders. In line with this, research on sustainable sourcing has been

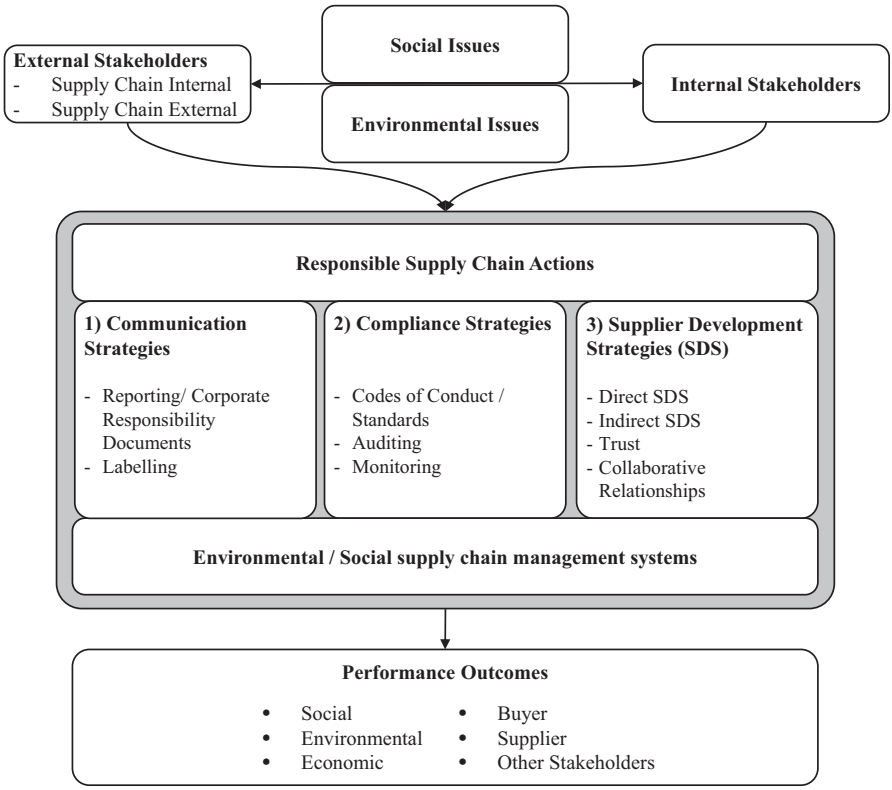

Fig. 11.2 Framework for environmental and social supply chain sustainability actions, own illustration (Adapted from: Marshall et al. 2015, 674; Yawar and Seuring Forthcoming)

mainly utilizing stakeholder theory as its theoretical foundation (Johnsen et al. 2016), which will be discussed further below.

Regarding the operational responsibilities of PSM, these in general terms comprise the management of external inputs – materials, services, capabilities, and knowledge – that are required for building, running, and maintaining the focal firm's processes (Van Weele 2010) while simultaneously managing the external and internal stakeholder network with an extended upstream supply network understanding. When turning toward how to depict its processes in brevity, Fig. 11.3 provides an overview of the overall procure-to-pay process, divided into the strategic sourcing part (source-to-contract) and the transactional processing part (purchase-to-pay).

Apart from the top and bottom processes, the middle of Fig. 11.3 depicts PSM department activities and processes, which are not necessarily related to any specific requisition or purchase order. The most direct linkages to the sustainability actions previously mentioned are through "supplier relationship management" and "sustainability/compliance" activities which directly refer to the "environmental/social supply chain monitoring"/"supplier development strategies" and "compliance

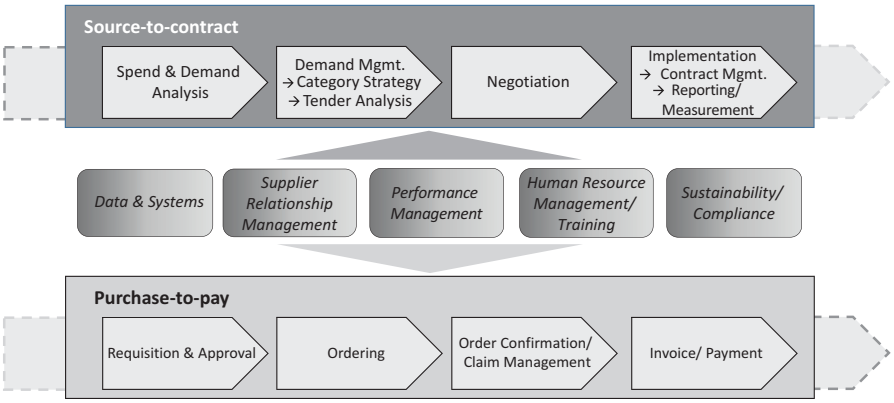

Fig. 11.3 The procure-to-pay purchasing process, own illustration (Adapted from Van Weele 2010; Monczka et al. 2010)

strategies" mentioned in Fig. 11.2. There are also other interfaces: "Environmental/social supply chain monitoring" can also be regarded as connected to "implementation" in the source-to-contract process, when it comes to contract management and reporting/measurement. This aspect is also relevant for "data and systems," as high-quality monitoring data is a prerequisite for needed transparency and serves as basis for corrective actions.

What is interesting to note is that the SSCM actions shown in Fig. 11.2 above did not yet specifically address earlier parts of the source-to-contract process, though they hold potential to promote sustainability both through the internal and external stakeholder network: internally, in "demand management," because PSM has an opportunity to ensure specifications also reflect sustainability standards during the demand clarification process, and externally in "tender analysis," as during the tender phase sustainability criteria can be brought in, and also in "negotiation," as this could provide an opportunity for joint exchange about finding ways to commonly avoid waste, increase output, etc. as part of the dialogue toward a final contractual agreement.[1] Also, measures like supplier communication on sustainability standards and expectations as well as capability building like supplier trainings are not addressed in Fig. 11.2. In general, there might be potential to put PSM into a broader and more proactive position with regard to SSCM rather than solely focusing on control and compliance.

The importance of the external and internal stakeholder network for successful SSCM implementation warrants to further elaborate on it. Figure 11.4 below illustrates PSM's interconnectedness.

[1] In line with that, both "supplier selection and evaluation" and "supplier development" have been discussed in previous research as key processes to achieve sustainable global supplier management (Reuter et al. 2010, 54f.).

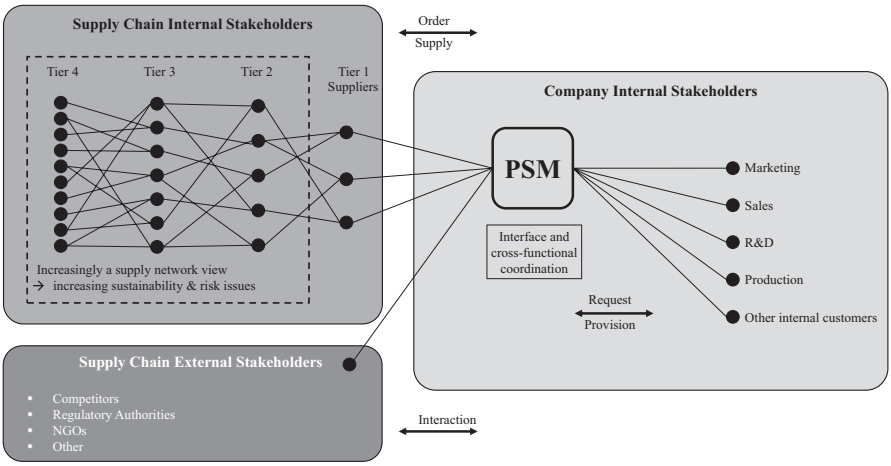

Fig. 11.4 PSM as the interface between the company internal and upstream supply chain actors, own illustration (Adapted from: Kummer et al. 2009; Schneider and Wallenburg 2012)

As shown in Fig. 11.4, the internal network comprises all other functions for which PSM procures materials, goods, and services. Externally, Fig. 11.4 highlights that PSMs extend beyond dealing with the tier 1 suppliers, spanning a network of n suppliers (here for illustration just until tier 4). While PSM in the past might have dealt mostly with tier 1 suppliers, more recently due to supply chain disruptions and scandals (such as the collapse of Rana Plaza in Bangladesh in 2013, which exposed subcontractors in the garment industry, or the contamination of Mattel's toys in 2007 that happened beyond their tier 1 suppliers), the necessity to look beyond the closest tier and adopt a comprehensive network view has been reemphasized (Wilhelm et al. 2016). Related to stakeholders and their connection to sustainability, Van Weele and Van Raaij (2014, 61) suggested that "When we adopt this [external stakeholder] perspective, suppliers should not only create value for the firm's markets (customers), but also help the buying firm in creating value for society (all stakeholders representing social and environmental concerns) and for those who invested financial resources in the firm (shareholders and investors)." Apart from the company-internal and supply chain-internal stakeholders beyond the own firm such as suppliers, there is also a plethora of supply chain-external stakeholders such as competitors, regulatory authorities, and NGOs that have to be taken into account in sustainable sourcing (Schneider and Wallenburg 2012). Toward creating TBL shared value in such a network, all three dimensions – environmental, social, and economic – become represented as stakeholders (Bals and Tate 2016; Tate and Bals Forthcoming).

Not surprisingly, previous research has therefore emphasized stakeholder management and internal cooperation as capabilities of value in the context of sustainability, though further research on additional ones has been suggested (Schneider

and Wallenburg 2012). This chapter takes this as a starting point to create a literature-based overview of buyer capabilities required for SSCM implementation.

11.3 Buyer Competences for Sustainability: The Current State of Research

The preceding sections elaborated on the increasing expectations toward the sustainability performance of companies and their sustainable supply chain management and how this affects the role and responsibility of PSM as a department. It was already emphasized that buyers are the ones who execute SSCM in PSM on the individual level. However, there is no complete picture yet on the knowledge and competences they require to successfully perform the respective activities. To help address this, the authors performed a systematic literature review of current academic research to find and summarize the current state of research and build a foundation for further research.

11.3.1 Definitions

When applying the terms "competence" and "knowledge," this study refers to two main concepts. First, "competence" is defined as a comprehensive combination of individual knowledge, skills, and abilities (e.g., Mirabile 1997; Barnes and Liao 2012). Second, "knowledge" is further specified in the areas of explicit and tacit knowledge, relying on the knowledge-based theory of the firm (Grant 1996). Explicit knowledge is defined as "knowing about facts and theories (…) and is revealed by its communication" (Grant 1996, 111). To give an example, within this study buyer knowledge about international standards for labor conditions or about environmental standards like ISO 14001 would be defined as explicit knowledge. The application of this knowledge in specific situations when communicating with a supplier to implement social or environmental standards is defined as tacit knowledge, the "knowing how" (Grant 1996, 111). Competences linked to tacit knowledge are, for example, interpersonal communication and conflict management. Taking additionally into consideration the influence of "individual desire" on behavior (Von Rosenstiel 2011), the authors follow the approach to differentiate tacit knowledge into two categories, which means to complement the abovementioned "knowing how" with the cognitive dimension (Nonaka and Takeuchi 1995; Giunipero et al. 1999). The "cognitive dimension reflects our perspective of the world around us as it exists and what it ought to be" (Giunipero et al. 1999, 44). This cognitive dimension of tacit knowledge is revealed by individual motivations, beliefs, or values.

These definitions and concepts build the foundation of the systematic literature review of this study and additionally provide the framework for the evaluation of the results. Concerning the latter, the identified competences and knowledge will be discussed regarding their explicit versus tacit properties.

11.3.2 Systematic Literature Review: Methodology

A systematic literature review usually is conducted as one of the first steps within a research process. The aim of this method is to identify the current state of academic research and its key scientific contributions with regard to a defined research question. The review adopts a replicable, transparent, and scientific process and follows certain steps that need to be clearly defined and described (e.g., Tranfield et al. 2003). The first stage of a systematic literature review defines the research question, the keywords for the search process, the selection of data sources, and the search concept. Next, selection and reading of the matching studies is done in the second stage, followed by the final data evaluation and dissemination (Tranfield et al. 2003).

It is crucial for a systematic literature review to execute every step in a transparent manner and to document the researcher's decisions and actions to cope with the weakness of this research method: It will always be a one-time screening of a predefined sample set in a selected database, conducted by individuals with a certain research interest, cultural background, language preference, and other influencing factors.

To evaluate the state of research on competences and knowledge for sustainability within PSM, the researchers defined the following strategy and core elements for the systematic literature review:

- **Overall research question:** "Which competences and knowledge are required to support sustainable buyer behavior?"
- **Keyword, definition**: Three main terms or term clusters were derived out of the research question, i.e., "sustainability," "competence and knowledge," and "purchasing and supply management." Synonyms to those keywords have been identified based on literature, common linguistic usage, and experience of the researchers. All keywords were discussed with a panel of experts to ensure appropriate coverage of the review and enhance the quality of the process and the results. After the first set of keywords was identified, a test search run revealed a few of them to be too generic and to result in a very high number of unrelated hits (e.g., social, value chain). These keywords were taken out of the final set. The review was eventually conducted with a set of the following keywords, shown in Table 11.1
- **Bibliographic sources:** The Web of Science database was used in a first step, as it is an established source of data in business and management and at the same time includes articles from a broad range of academic disciplines (see, e.g., Johnsen et al. 2016; Osagie et al. 2016). In a second step, the search was dupli-

Table 11.1 Keywords and search terms

Keywords	Search terms
Sustainability	Sustaina* OR responsib* OR ethic* OR green OR "corporate social responsib*" OR CSR OR "triple bottom line" OR TBL
Competence and knowledge	Competenc*, knowledge, skill*, capabil*, abilit*, know-how, qualification, attitud*, behavio?r, belief*, attribute, "intellectual capital," maturity
Purchasing and supply management	Purchas* OR sourcing OR procurement OR "supply chain management" OR buy* OR "supply network"

cated in EBSCO host to verify and complement the results in the EBSCO databases on business and education research.

- **Search strategy:** Various tests with the defined sets of keywords resulted in the decision to conduct a block search strategy (see, e.g., Casimir and Tobi 2011; Osagie et al. 2016). A block search strategy allows to combine keywords with different search areas. The keyword family determined to be the most important for the research project was searched in the title of articles, the other keywords in the topic. This allowed to further narrow the number of relevant findings, as some of the final keywords continue to be generic and used in the context of multiple research areas (e.g., "capabil*"). The keyword family around "competence and knowledge" was split up in two search approaches to cover the knowledge area as well as the area around attitudes and characteristics.

The block search strategy helped to focus the search; nevertheless, further refinement in terms of the subject areas of the search results was needed (see Table 11.2), as a significant portion of the initial results covered other research areas like consumer behavior, economic development, or medical sciences. In the end, due to the small number of final articles that exactly met the research question, decision was taken not to restrict either time given for the literature review, nor to restrict journals in scope for the review.

- **Selection of articles:** The selection process of articles was twofold. First, one researcher screened the title, keywords, and abstract of all articles that resulted out of the search. Articles that were out of scope were delisted (e.g., sustainable food supply, open source in information technology). Articles that covered one or more keywords of the search in the title or abstract and seemed to refer to the research question were selected. The total of 2,118 articles that resulted out of the block search as outlined in Fig. 11.1 resulted in a list of 102 papers. In a second step, the researcher prioritized the papers according to their fit to the research question. Those that covered all search terms of the block search were taken in the scope of this review, resulting in a total of 35 articles. As even this reduced list of articles revealed that only some of them explicitly fit to the research question, an evaluation scheme was developed that allowed to group the articles in four research areas, based on the search terms they met (shown in the next section as Fig. 11.5).

Table 11.2 Systematic literature review – search approach, refinement, and results

Block search Keyword combination	Refinement criteria	Database and search date	# of results
Search block 1:	Languages: English and German	Web of Science, September 27, 2016	352 results – 20 articles selected
Focus: competenc* OR knowledge OR skill*+ capabil* OR abilit* OR know-how OR qualification	Publication source types: academic articles	EBSCOhost; September 29, 2016	563 results – 51 articles selected
Attributes: sustaina* OR responsib* OR ethic* OR green OR "corporate social responsib*" OR CSR OR "triple bottom line" OR TBL	Subject area: exclude research areas like consumer behavior, media sciences, and others		
Demarcation: purchas* OR sourcing OR procurement OR "supply chain management" OR buy* OR "supply network"			
Search block 2:		Web of Science, September 29, 2016	341 results – 11 selected
Focus: attitud* OR behavio?r OR belief* OR attribute OR "intellectual capital" OR maturity		EBSCOhost, October 3, 2016	862 results – 20 articles selected
Attributes: sustaina* OR responsib* OR ethic* OR green OR "corporate social responsib*" OR CSR OR "triple bottom line" OR TBL			
Demarcation: purchas* OR sourcing OR procurement OR "supply chain management" OR buy* OR "supply network"			

The selection of studies for research areas 1–4 was based on the following approach:

Research area R1: "Competences/knowledge + sustainability +PSM," all articles that met the research question precisely.

Research area R2: "Competences/knowledge + sustainability," all articles that matched with these keywords were taken into the scope of the review.

Research area R3: "Sustainability + purchasing and supply management," these keywords yielded the highest number of results. Therefore, not all of them were selected for the final review. Only articles that included hints in the abstract that they either impact the research questions with their findings or looked promising for a later review of their reference lists were selected for the final research set.

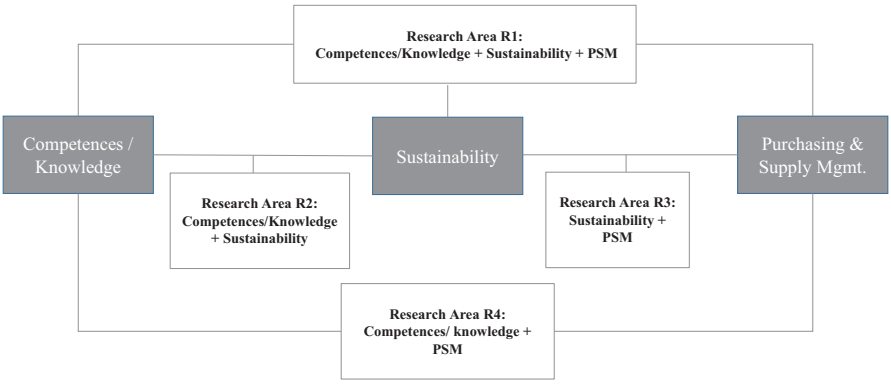

Fig. 11.5 Keyword combinations and research areas identified

Research area R4: "Competences/knowledge + PSM," the articles that were selected for further review gave an indication that they might give input on the individual competence and knowledge area adaptable to the research question.

11.3.3 Overview of the Current State of Research

As outlined in Sect. 11.3.2, the combinations of keywords could be conceptualized into four research areas, which are shown below in Fig. 11.5.

The systematic literature review delivered a broad range of studies with findings that impact a sustainability competence and knowledge profile for buyers but that are nevertheless focused on the organizational level phenomena (see research area RA3 in Fig. 11.5). Other papers deal with knowledge and competences generally in the context of PSM, very often related to performance (research area RA4 in Fig. 11.5). Dedicated research on the breakdown of ecological or social aspects in purchasing to the individual buyer level though seems to be still in its beginning (RA 1 in Fig. 11.5). Also, definitions of sustainability knowledge and competences in a broader scope, be it in an organizational or educational context, seem to be an evolving research area (see research area RA2, Fig. 11.5). As the later mentioned research areas 1 and 2 showed the best alignment to the research question and therefore for the development of a competence model for buyers with respect to sustainability, the following evaluation focuses on those two fields of study.

11.3.4 Social and Environmental Knowledge and Competences in PSM (Research Area 1, Fig. 11.5)

Only a limited sample of papers precisely meets the research question of this paper, covering each of the three term clusters with regard to sustainability, knowledge/competence, and PSM. The paper of Grandia (2016), for example, encompasses sustainable public procurement behavior regarding environmental criteria, whereas others focus on selected aspects of sustainability knowledge and competences in private PSM. Research identified in this area mostly covers either one aspect of the triple bottom line, particularly the environmental pillar (e.g., Bowen et al. 2001), or centers on sustainability knowledge specifically needed for certain products (e.g., Börjeson et al. 2015) or certain complex situational requirements like decision-making and trade-offs with regard to conflicting interests (e.g., Wu and Pagell 2011; Eltantawy 2016). It is interesting to note that these papers are mostly published over the last 5 years.

Studies found in this research area cover the organizational level as well as the individual level of influence on behavior. Grandia (2016), for example, assumes that individual knowledge on sustainability issues, combined with a commitment to change and believe in the benefits of sustainability, promotes sustainable public procurement behavior which finally results in die application of sustainable public procurement. Bowen et al. (2001) list a set of main competences and resources. Some of them, "liaison between purchasing and other functions" or "a collaborative partnering approach with suppliers" or "detailed purchasing policies and procedures," refer to the organizational level. Two impact factors that are mentioned in the study explicitly relate to individual skill requirements: "an understanding of environmental issues and how they affect supply" and "the technical skills of purchasing personnel" (Bowen et al. 2001, 176–178).

As this research is based on the knowledge-based theory of a firm (Grant 1996; see Sect. 11.3.1), the authors' intention is to derive knowledge and competence indicators out of the studies found in the systematic review and to group the findings into tacit or explicit knowledge areas. All papers that were identified to deal with buyer competences for sustainable PSM listed facets of *explicit knowledge* in the meaning of "knowing about facts and theories (…)" (Grant 1996, 111). Knowledge about environmental or social impacts of the products buyers purchase is one clearly explicit knowledge area. As mentioned earlier, Bowen et al. define the "understanding of environmental issues and how they affect supply" (Bowen et al. 2001, 177) as one of their key capabilities for green supply. In the same manner, the study of Börjeson et al. (2015) specifies the knowledge on product specifics regarding sustainability issues, like components and their effect on health and safety or working conditions to manufacture or gain the product as one determining requirement for responsible supply chain management of chemicals in the textile industry, accompanied by knowledge on respective regulations and policies (Börjeson et al. 2015). The paper of Eltantawy (2016) explores managers' competences and resilience needed to manage ambidexterity regarding sustainability in supply management.

She describes the "access to keystone vulnerability competency" as one fundamental knowledge area in this context. It is specified as a capability to identify and manage operational and managerial aspects that have the potential to perturb or strongly impact the system (Eltantawy 2016, 128), therefore applying a risk management-driven lens. The gathering and acquisition of knowledge on sustainability aspects for the PSM department is also mentioned in some studies as a key competence. For example, Bowen et al. (2001) outline the need to collect and integrate data for green supply into PSM and relate this to the technical skills of purchasing personnel. This is further supported by Grandia (2016) mentioning the knowledge for professional procurement of services and goods as an impact factor for sustainable behavior. As a result, general knowledge about procurement can be named as one explicit knowledge area that enables buyers to purchase in a sustainable manner.

A significant number of papers cover the *explicit as well as the tacit* aspects of knowledge. As mentioned earlier, tacit knowledge encompasses the "knowing how" (Grant 1996, 111) as well as the dimension revealed by individual motivations, beliefs, or values (e.g., Ginuipero et al. 1999). Eltantawy's framework (2016) already mentioned earlier is a rich and comprehensive source to derive buyer competences that are explicit as well as tacit. Based on the theoretical framework of dynamic capabilities (e.g., Barney 1991), the model describes four competence areas that lead to supply management resilience: "cultural competency," "operational competency," "situational awareness," and "access to keystone vulnerabilities," the latter already described above being a rather explicit knowledge sector (Eltantawy 2016, 126). Nevertheless, all of these competence areas have explicit as well as tacit knowledge aspects. Cultural competence, for example, is described as the ability of a buyer to recognize changes in his/her network regarding all triple bottom-line dimensions and to adapt business processes accordingly (Eltantawy 2016, 125). Communication skills, building trustful relationships, or being able to achieve compromises might be competences residing on the tacit side. Conversely, explicit skills in this context can be data evaluation, knowledge on product specifics, or stakeholder mapping. Decision-making especially in trade-off situations (e.g., Wu and Pagell 2011) is another competence that combines both explicit and tacit knowledge elements. Again, information generation to prepare decisions can be mentioned as the explicit aspect of decision-making. The tacit equivalent is more about commitment, standing, as well as communication as part of individual decision-making in the context of sustainable purchasing and in the face of conflicting goals or uncertainties (Wu and Pagell 2011).

Tacit knowledge and competences required for buyers in the sustainability context embrace a wide variety, as already indicated in the preceding paragraphs. Networking and building as well as maintaining far-reaching relationships (e.g., Börjeson et al. 2015), commitment to change (e.g., Grandia 2016), or resilience are key tacit competence areas. Eltantawy (2016) defines two types of resilience: "Supply Management engineering resilience describes the capacity to adapt to turbulent change and underlies the buyer's cultural and operative competences. Supply Management ecological resilience determines the capacity to transform in the face

of turbulent change and unpredictability and underlies the buyer's situational awareness and access to keystone vulnerabilities competencies" (Eltantawy 2016, 130).

Especially, the tacit knowledge areas that were identified in this preliminary evaluation of current research correlate in some aspects with the notion of PSM being the interface to a broad network of internal and external players (see Fig. 11.4). Consistent with the majority of the studies (e.g., Eltantawy 2016; Wu and Pagell 2011), networking, relationship management, communication, or dealing with unclear situations seem to be competences that are crucial for PSM personnel to fulfill this moderating role in a complex stakeholder network also with regard to sustainability. However, it is not elaborated in more detail which specific aspects of the networking competence are needed depending on the role and responsibility of a buyer related to the steps in the purchasing process (see Fig. 11.3).

11.3.4.1 Competences and Knowledge Requirements for Sustainability in General (Research Area 2, Fig. 11.5)

Very few papers were found that matched with the keywords "knowledge," "competences," and "sustainability," all of them having been published recently. They focus on competence profiles of personnel in roles dedicated to corporate sustainability or in general management positions.

Osagie et al. (2016) or Wesselink et al. (2015), for example, studied individual competences that support the implementation of corporate social sustainability (CSR) within companies, based on a systematic literature review and interviews with CSR managers. They deduce lists of specific CSR-related competences. Other studies like the one from Maletic et al. (2014), elaborating on the relationship between sustainability practices and performance on the organizational level, derive certain sustainability competences as being relevant impact factors. Maletic et al. (2014) outline competences for sustainability exploitation as well as sustainability exploration: "While sustainability exploitation is characterized by practices aimed at making an organization more efficient through incremental improvements in processes and outputs (products/services), sustainability exploration is concerned with challenging existing sustainability solutions with innovative concepts and developing capabilities and competencies for sustainability-related innovation" (Maletic et al. 2014, 183).

Summing up some of these findings and applying the results to the notion of tacit and explicit knowledge, the outcome is fairly comparable to the analysis of buyer-specific sustainability knowledge and competences. The *explicit* knowledge elements apply to the area of data and information sources for procurement (e.g., Craig and Allen 2013), project management, leadership, and communication, reflecting a certain professionalism that is required in the job. "Understanding CSR drivers, CSR standards, and CSR regulations" (Osagie et al. 2016), "managing CSR projects and programs" (Osagie et al. 2016), and "embracing diversity and interdisciplinary" with labels like "facilitating dialogue" or "involving stakeholders" (Wesselink et al. 2015, 504) are to be mentioned.

Certainly, some of those competences comprise at the same time *explicit and tacit* knowledge aspects. Exemplary, "managing CSR projects and programs" does also incorporate tacit knowledge areas like "build critical alliances" or "take action despite inconclusive evidence" (Osagie et al. 2016, 241). Stakeholder orientation (e.g., Maletic et al. 2014, Wesselink et al. 2015) includes the more explicit knowledge of stakeholder mapping or communication tools, as well as implicit knowledge regarding relationship management of conflict resolution. Notably, literature delivers more competences and knowledge requirements that one would certainly see on the tacit category, certainly emphasizing the individual beliefs or values. Toward the latter "systems thinking" or "interpersonal competence – empathy and compassion" (Wesselink et al. 2015, 504), self-reflection of "balancing personal ethical values and business objectives" (Osagie et al. 2016) is suggested as being relevant competence area.

11.3.5 Limitations of the Systematic Literature Review

Although considerable effort was made to ensure that the review would be all-inclusive, it is possible that some relevant research studies may have inadvertently been omitted, posing a limitation. The restriction to articles written in German or English language and therefore the focus on authors as well as journals that publish in these languages is certainly to be taken into consideration. Also, some cultural and disciplinary bias of the researchers during the information selection approach cannot be completely ruled out. However, the authors consider that this review is an accurate representation of the body of research on sustainability in relation to PSM competences published during the specific time frame when the review was conducted. The study gives a preliminary overview of PSM competences for SSCM provided in current literature. It is meant to serve as an overview and starting point for future research suggestions.

The dedicated focus on social and environmental sustainability and the intentional exclusion of the economic aspect of SSCM did narrow the outcome of the review to only two of the triple bottom-line aspects. Although some sources rely on surveys, future research should validate the results by additional empirical data, taking into consideration the management of the extended upstream supply chain.

11.4 Conclusions, Outlook, and Opportunities for Further Research

11.4.1 Conclusions and Outlook

This research started out with the research question "Which PSM knowledge and competences described in literature can promote a professional and successful management of social and environmental targets in supply chains?"

The analysis of current research did show that the influence of individuals on sustainable performance of organizations or specifically of the PSM function is recognized in recent studies. This includes the recognition that the impact of individuals is twofold, i.e., based on knowledge and based on motivation. Also, there is evidence of explicit as well as tacit knowledge areas in the context of sustainability, with even an emphasis on the tacit knowledge. The deduction of knowledge areas to build competence profiles especially for sustainable purchasing nevertheless seems to be an evolving research area.

In the comparison of studies on competences for buyers with those that evaluate on profiles for CSR managers, there are indications of an intersection especially in the tacit knowledge area. Further evaluation is needed on the precise definition and indicators for these knowledge areas, referring to different buyer roles according to the PSM process (see Fig. 11.3).

In line with the presented reflection on the role of PSM in SSCM in the second section of this chapter, the identified knowledge and competence areas emphasize some tacit areas such as stakeholder management or decision-making with regard to conflicting goals but also others more in the explicit area such as knowledge about components of products and their potential environmental or social impacts.

Moreover, in comparison to the broader level CSR profiles, it is interesting to note that the buyers' position being the moderator within an internal and external stakeholder network seems to require comparable competences and knowledge, like "interpersonal competence" (Wesselink et al. 2015, 504) to a CSR manager when it comes to sustainable supply chain management, especially on the tacit side. It might be beneficial to evaluate how competences like "foresight thinking" or "systems thinking" (Osagie et al. 2016) can be executed on the buyer level. Vice versa, Osagie et al. (2016, 242) even apply the supply chain dimension to the profile of a CSR manager: "The CSR professional must understand the role of supply chain and how the company should work together with other actors in its supply chain to address common CSR challenges."

11.4.2 Future Research Suggestions

Looking toward future research suggestions, there are various avenues that can be put forward. These center around (1) further broadening the coverage of competences, knowledge, and values required to implement SSCM via PSM (suggestions 1–4 in the following paragraphs), (2) challenging current scopes of TBL sustainability in supply chains (suggestion 5), and (3) taking a closer look at factors influencing the development and retention of required competences, knowledge, and values for achieving such goals (the final suggestion below).

First, the competence profile for the sustainable buyer should be further complemented and developed based on studies focusing on organizational capabilities of sustainability in PSM (e.g., Klassen and Vereecke 2012) and studies dealing with general PSM knowledge and competences (e.g., Giunipero and Pearcy 2000). The

latter were indicated as research areas 3 and 4 in Fig. 11.1 and should be further analyzed regarding their relationship to sustainability. Valuable input is also expected from research on PSM and sustainability training formats in academic or professional education.

Second, as it was highlighted in Sect. 11.2, there is an intrinsic connection between SSCM and sustainable PSM. To further clarify how the PSM competences relate to what has to be done in terms of responsible supply chain actions (Marshall et al. 2015; Yawar and Seuring Forthcoming) warrants further research. The current divide between the two research areas SSCM and sustainable PSM could be overcome by shedding more light on the question who implements such sustainable supply chain actions in practice, and bringing PSM as a department and ultimately the individual buyers, into focus.

Third, regardless of the exact departmental home of who is actually implementing responsible supply chain management actions, further research should shed more light on individual motivation, values, and attitudes (e.g., Swaim et al. 2016). With a focus on sustainable PSM, the question arises which individual motivation, values, and attitudes promote sustainable buyer behavior. This could provide implications for personnel selection processes within PSM as well as for talent development. This might stimulate an interdisciplinary research (education, psychology, marketing/research on consumer behavior) and dialogue on competences and further understanding of the influencing factors like individual motivation, attitudes, and values.

Fourth, a success factor for a sustainability competence profile for PSM is its adaptation to different roles and functions covering the procure-to-pay process (see Fig. 11.3). As was discussed in Sect. 11.2, many aspects of SSCM are not necessarily connected to a specific source-to-contract process; however, they are an integral part of an SSCM strategy of an organization. So in general, there might be potential to put PSM into a more proactive position with regard to SSCM rather than focusing on control and compliance. How competences covering the various responsible supply chain management actions and sustainable sourcing can be allocated to specific job profiles within PSM holds a lot of practical interest. For this purpose, future studies could analyze how companies particularly successful or particularly unsuccessful in reaching SSCM targets have internally allocated such responsibilities to individual job profiles, highlighting specific competences, knowledge, and values. Related to this, the question arises how the latter are ensured in the workforce, i.e., hired and/or trained, and how in doing so companies cope with the point that so many of the identified aspects are tacit. Also, the implications for academic curricula to prepare future talent to be able to perform sustainability tasks need to be discussed.

Fifth, the mentioned new paradigms questioning the TBL approach (e.g., Montabon et al. 2016) might initiate research on an even broader and changed set of knowledge and competences needed for responsible supply chain actions and sustainable buyer behavior. Based on such a paradigm shift, to implement sustainability in purchasing organizations implies that "[t]he switch in logics need not to change the practices that are conducted, but it will change how they are done and

how their effectiveness is measured" (Montabon et al. 2016, 21). Instead of reducing harm, preventing harm before doing business is the new paradigm. The aspect of measuring effectiveness raises the question how incentives are designed within organizations. Moreover, that requires changed behavior and decision-making from purchasing managers: "The Ecologically Dominant logic also pushes managers to think about time differently" (Montabon et al. 2016, 21), meaning that managers are required to make decisions with a longtime horizon to prevent harm. Consequently, "(…) a change in logic, even if it is imposed from the outside, would require changes in managerial cognitions in terms of how to manage supply chains as well as changes in technology" (Montabon et al. 2016, 23). Toward such a more proactive approach to SSCM, it has been suggested that companies should rather design their value chains for sustainability versus retrofit them gradually to be less unsustainable (Bals and Tate 2016). In line with PSM's role discussed in this chapter, this could be something in which the individual buyers play a pivotal role. Following the view that implementing TBL sustainability requires individual competences along all three TBL dimensions, i.e., economic, social, and environmental capabilities (Tate and Bals Forthcoming), which competences in these three areas are required to enable PSM to successfully implement SSCM would be particularly interesting.

Finally, a generally interesting area for future research is factors influencing the development and retention of knowledge, competences, and values required for successful implementation of SSCM and sustainable sourcing. Herein, previous research has noted that organizations may display different archetypes of sustainable sourcing profiles (Schneider and Wallenburg 2012). The earlier mentioned paradigm shift by Montabon et al. (2016) actually implies that ideally the target state would be the same for all companies, i.e., ensure environmental, then social, and then economic sustainability to be checked in that sequence and to be achieved simultaneously. This represents the ideal to overcome tensions between the three dimensions, which currently are often still seen as trade-offs (Epstein et al. 2015), and mostly corresponds to the archetype coined "all-round perfectionist" in Schneider and Wallenburg's (2012) classification. Nevertheless, the full array of archetypes of sustainable sourcing profiles[2] that they put forward holds a very interesting thought: Even if – ideally – all companies would target full completion according to Montabon et al. (2016), their current organizational sustainable sourcing profile surely reflects very different coverage and gaps of competences. As Schneider and Wallenburg (2012) highlighted in their eight archetypes, there might be some that hardly cover any dimension (the "minimalist"), such that mainly cover social (the "social activist") or, for example, mostly the economic and environmental dimensions (the "environmental economist"). Taking the "environmental economist" as an example, competences in the environmental and economic dimensions would be advanced, but competences for the social dimension would be underdeveloped. It might well be argued that these archetypes mark the starting point for further development of competences, knowledge, and values. At the same time, this is

[2] That is, that there can be very differing configurations of how far companies address the three sustainability dimensions

important to be aware about as a contingency factor when doing data collection as just mentioned with regard to the fifth aspect. Depending on the overall "archetype" that a company currently mostly resembles, the competences, knowledge, and values and the respective allocation to job profiles would highly differ. Also, the question arises how the overall corporate sustainability profile and the PSM archetype relate to and influence each other.

Also to the point of such contingencies, the type of firm may influence these results: It is a traditional commercial model versus an NGO versus a social business. As also highlighted in the chapter by Tate and Bals (2017), the latter hold a lot of potential for research on SSCM and looking at the individual level, especially when they actually follow triple bottom-line objectives (despite the "social" highlighted in their name). Further, other contingency factors would be the size of firms as well as their geographic scope. Regarding the latter, much research has centered on studying Western companies and deriving prescriptions based on that versus we might find other insights if we would actually more look at other settings, such as developing countries, emerging markets, or bottom of the pyramid settings (Touboulic and Ejodame 2016).

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Chapter 12
Social and Environmental Impact of Advances in Economically Driven Transport Optimization: Case Study in Automobile Distribution

Thomas Wensing

Abstract Contemporary optimization methods have shown to save costs and increase revenues in many operative fields of application. While human planners tend to focus on parts of the overall problem, these methods use the computational power of modern computers to deeply explore the solution space and thus enable decision-making on a superior level.

The methods itself are well explored by the operations research community, where much less is known about their effect on problem aspects that are not directly focused. This study examines the impact of improvements in optimization methods on the economic, social, and environmental dimension within the context of a realistic case in automobile distribution.

Two planning methods are compared. The first adapts a step-by-step planning technique typically used by human planners; the second addresses the problem from an overall perspective. The comparison is based on two scenarios. One assumes that a fixed amount of transport orders has to be fulfilled, while the other considers a freight market from which transport opportunities can be freely selected for fulfillment.

When the workload is fixed, advancements appear to be beneficial in the economic, social, and environmental dimension at the same time. In contrast the economic dimension is improved disproportionately in the freight market scenario. It can be shown that the objectives of the economic dimension are in conflict to a certain extent with those of the other two dimensions.

Keywords Transport operations • Finished vehicle logistics • Capacitated vehicle routing problem

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12.1 Introduction

It is a widespread tendency to consider advances in operative transportation optimization that enable more efficient transport order fulfillment as beneficial for all parties involved. The transport company profits from lower costs and may also create higher revenues, e.g., when truck utilization is improved. At the same time, the drivers' productivity is increased which can justify better payments and/or less working time. Customers potentially benefit from faster fulfillment and more reliable arrival estimates. Finally, well-utilized distance-minimal trips also reduce emissions, noise, and road utilization which creates a positive effect on the environment.

It seems like a clear issue that any initiative to improve operative transport efficiency is beneficial for multiple parties involved. The aim of this study is to examine this assumption more carefully in terms of testing the following hypothesis:

Hypothesis 12.1 *Optimization advances in transport operations planning – in terms of increasing the potential to create efficient trips – induce improvements in an economic, social, and environmental sense at the same time.*

Against the backdrop of distributing cars via road from a terminal to a network of dealerships, it will be shown that the hypothesis can be supported if the workload may not be changed. When orders emerge from a freight market and may thus also be rejected, the three dimensions do not share a common objective anymore. The observed phenomenon relates to the well-studied rebound effect in the energy sector; see Greening et al. (2000).

The paper is organized as follows. Section 2 defines the underlying problem of planning automobile transports on a daily basis. The relevant literature is reviewed in Sect. 3, and this study's contribution to it is clarified. Section 4 establishes the study case by describing the data generation process, performance indicators, and scenarios that will be explored. Section 5 presents two planning methods, a basic method that creates one trip at a time and an advanced method that creates a whole transport plan of multiple trips simultaneously from a holistic perspective. In order to test Hypothesis 12.1, the solution quality of both methods is experimentally compared in Sect. 6. Finally, Sect. 7 summarizes the results and implications.

12.2 Problem Definition

Road transports of cars require special trucks and trailers called car transporters that cannot be used for other types of freight. As a result, the empty mile factor is much higher than in the general freight sector. This circumstance in connection with the inherent problem complexity of feasibly matching cars with suitable transporters creates interesting opportunities for decision support methods.

The practical planning problem considered in this study emerges from the short-term dispatch operations of a car transporting company. It comprises the day-to-day planning of car transports from a single terminal to a number of contracted dealerships. The task can be subdivided into four levels as depicted in Fig. 12.1. On level A, cars are selected for shipment either from the available stock of contracted cars or from a market place. Each selected car has then to be assigned to a transporter (level B). Knowing the set of cars to deliver, a stop sequence can be created for each transporter (level C). Finally, the packing problem is solved on level D, i.e., it is decided, where each car should be placed on the particular transporter.

Several types of restrictions limit the possible combination of cars that may be loaded on a trailer. For simplicity, this study only considers the capacity aspect of the transporter, where the following capacity model is used. Each car is mapped to a proper size category so that a feasible load of a transporter can be expressed by a combination of these categories, called a load pattern. For example, such a pattern may state that a transporter is capable of holding five medium- and four large-sized cars. The overall capacity is represented by the set of all feasible load patterns. To allow substitution, each car may also belong to multiple size categories of which only one needs to be covered by a pattern.

Examples of further restrictions that have been addressed in recent INFORM projects are the following. It may not be allowed to assign two vehicles to the same transporter, e.g., if different brands must not be mixed. A transporter may be unsuitable to approach a certain dealership, e.g., because it is too large to maneuver on the site. Road segments like tree-lined avenues or narrow bridges may not be passed by a transporter with its top deck loaded. Dealerships may exhibit opening hours beyond which a transporter cannot be received. Finally, the driver must take frequent breaks from driving and working, required by law in many countries and induced by common sense everywhere.

For the purpose of this study an optimization model is considered that covers levels A, B, and C. The objective is to maximize overall profits defined by total revenue for successful deliveries minus total direct costs that are incurred per trip, per dealer stop, and per kilometer traveled. There is a homogeneous fleet of trans-

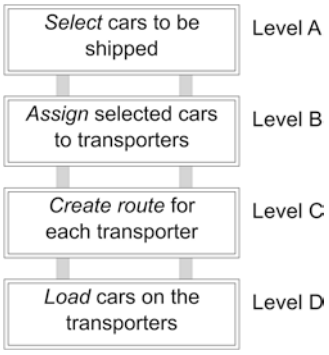

Fig. 12.1 Levels of day-to-day planning based on (Agbegha et al. 1998)

porters which is assumed to be sufficient to cover any amount of trips per day. The capacity of the transporters is modeled via load patterns as described above. No further constraints are considered.

12.3 Literature

There is a substantial literature on providing decision support to the operative planning of finished vehicle transports.

The earliest works are due to Agbegha et al. (1998) and Agbegha (1992). They focus on the packing aspect of the problem, i.e., level D in Fig. 12.1. They assume that a transporter's capacity can be modeled as a set of slots that are suitable to hold certain vehicles, where a slot may block another slot, in the sense that the former must be cleared before a vehicle assigned to the latter can be unloaded. The model and solution approach aim to minimize reload operations for a given set of vehicles to be delivered in a fixed sequence. The authors develop an exact branch-and-bound algorithm to determine blocking-minimal assignments. The same problem is later revisited by Lin (2010).

Tadei et al. (2002) study the problem of building delivery loads against the backdrop of a real-world case in Italy. They address levels A, B, and C of Fig. 12.1 as follows. The selection (level A) is controlled via delivery revenues and an urgency factor for each car reflecting the costs of postponing the order fulfillment to the next day. The capacity aspect (level B) is linearized by introducing single-dimension *length equivalents* for both the transporters and typical vehicle models. The routing aspect (level C) is eliminated from the problem by creating tight regional clusters, where a trip may only visit locations that belong to the same cluster. The minimization of the number of different dealerships to be visited is part of the objective, where the actual routing costs within a region are neglected. The problem is heuristically solved by combining a matheuristic, using a MIP solver for the loading problem, with a neighborhood search method.

Dell'Amico et al. (2014) address levels B, C, and D, where they extend the focus of Tadei et al. (2002) in two ways: They represent the capacity requirements (levels B and D) in a more detailed fashion and consider routing costs (level C) explicitly without defining regional clusters. Their capacity model combines the approaches described above in the sense that they divide the available space on the transporter into platforms. Each platform is modeled as in Tadei et al. (2002), and a platform blocks another one analogously to the slots in Agbegha et al. (1998) and Agbegha (1992), where blocking is completely prohibited here. The problem is solved by an iterative local search heuristic using a branch-and-bound algorithm for the loading problem.

Cordeau et al. (2015) study the problem considered by Dell'Amico et al. (2014) in a multi-period context with uncertainty. They use a framework similar to that of Dell'Amico et al. (2014) to solve the daily planning problems with preselected vehicles. In addition they also address level A by a rule-based selection routine that

distributes the available cars over the remaining days and particularly selects the volumes to be considered in the current run.

A real-world case in China addressing levels B and C is studied by Hu et al. (2015). Analogously to this paper, they model the transporter's capacity via loading pattern sets. All available cars must be delivered. Splitting loads for the same dealer is not allowed, and the objective is to minimize the total travel distance of all transporters used. The problem is solved heuristically by an evolutionary algorithm.

The contribution of this study to the existing literature is twofold. Firstly, the daily problem scope addressed in Hu et al. (2015) is extended to the selection of vehicles (level A) and studied moreover within a multiple-period context. Secondly, the sociological and environmental impact of economically driven optimization advances is studied by the example of a realistic case in vehicle routing.

12.4 Case

The overall case is based on 269 cities in the German state of North Rhine-Westphalia that are delivered with cars by a transport company. Every working day, around 250 cars newly arrive and are ready for shipment, which means a rate of 1.5 cars per 100,000 inhabitants per day. Each city's demand is proportional to its population. Details on data generation are given in Sect. 4.1. According to the German national agency for road transport, the Kraftfahrt-Bundesamt, 633,643 cars were licensed in North Rhine-Westphalia in 2015, which is around 2000 cars per working day including Saturdays, i.e., the study considers a market-share of 12.5%.

Hypothesis 12.1 is tested within the context of two scenarios; see Sect. 4.2. One scenario comprises a fixed set of transport orders that must be fulfilled, whereas the other scenario also allows the rejection of orders. The impact is monitored by three performance indicators that represent the transport company's profitability (economic dimension), driver productivity (social dimension), and environmental load (environmental dimension); see Sect. 4.3. For a clearer focus, the customer perspective is not directly represented.

One may argue that an increase of productivity will always have the negative social effect of reducing the required workforce. In contrast, this study follows the premise that there is no reason to fulfill a task with more effort than is necessary. Increasing an employee's performance capability is thus preferred over generating a long-term stable amount of work from equivalent sets of tasks.

12.4.1 Data Generation

Daily transport orders are sampled as follows. There are 292 dealerships in total, where there is at least one dealer in each of the 269 cities plus one or more additional dealers per 200,000 inhabitants in the larger cities. A dealership is chosen

with 30% probability to exhibit demand on the particular day, so that on every day there are new arrivals for approximately 100 cities. The amount of cars per selected dealership is drawn from a normal distribution with mean $\mu = 3.5 \cdot pp$ and covariance $Cov = 0.5$, where pp is the associated population in 100,000 inhabitants. Samples are rounded up or down with equal probability, where numbers lower than or equal to zero cause that the according dealership is skipped. Two model sizes (medium and large) are distinguished that arrive in equal fractions. The transport company uses transporters of a single type that may carry nine medium-sized cars, seven large-sized cars, or a mixed load of five medium- and three large-sized cars, where a medium-sized car may substitute a large-sized car. The payment per delivery consists of a fixed sum, randomly sampled from €[25,40], and a kilometer-dependent fraction, where the price per kilometer is randomly sampled from €[0.7, 0.9].

For simplicity, the distance (d) between two dealerships is approximated by the direct distance (dd) with correction factors: $d = 1.2 \cdot dd + 5$ [km]. Each trip creates fixed costs of €50, plus €20 per dealer stop plus €2 per kilometer driven from terminal via the assigned dealers back to the terminal.

12.4.2 Scenarios

Two scenarios are considered, both comprising 10 days:

- In *Scenario 1* the transport company has to immediately ship a car on the day of its arrival on the terminal. Such a requirement may directly be prescribed by transport contracts, but it can also result from tightly limited terminal space combined with a high transshipping rate, where cars have to be sent out quickly to create space for new arrivals.
- *Scenario 2* considers the same transport orders as Scenario 1, but the transport company may freely reject or accept to transport a newly arriving car and thus realize or lose its revenue. Rejected cars will be taken care of by competitors, so they do not reappear on the next day.

12.4.3 Performance Indicators

The following figures are used as performance indicators for the economic, social, and environmental dimension of the considered application.

- The *economic* impact is measured by the *overall profit* that is created for the transport company. Overhead expenses are excluded for the purpose of this study, so that the profit is defined as revenue minus direct costs, i.e., fixed costs per trip plus costs per stop and per kilometer driven.

- The *social* dimension is represented by the driver's productivity, which is defined as the ratio of *revenue per working time* required for order fulfillment in this context. It is assumed that transporters travel at 60 km/h on average including breaks. Each trip creates an organizational overhead of 30 min, and 20 min is required to access and leave a dealership. Finally, handling per car, i.e., loading and unloading, takes 10 min overall. The productivity is obviously directly correlated with the maximum payment that the transport company may afford which makes it an important social factor.
- Emissions, noise, and resource consumption are summarized by *travel distance per order distance* here, to characterize the *environmental* impact in relation to the basic effort of a transport order. Travel distance (of a trip) refers to the total distance covered by the transporter when going from the terminal via the dealerships to visit back to the terminal. Order distance is the distance from the terminal to a car's destination if it gets delivered without detour.

12.5 Solution Methods

Two solution methods are compared, a greedy algorithm (Sect. 5.1) that uses a trip-for-trip strategy to create a solution, and a more advanced method (Sect. 5.2) that creates solutions from a holistic perspective.

12.5.1 Greedy Algorithm

Experienced dispatchers know what quality they may expect of trips that go to a certain dealer region. Once they have enough cars at hand to form a *good* trip, they just create it more or less independently from other opportunities and remaining truck capacities.

The greedy algorithm used in this study adapts this widespread manual planning technique. Algorithm 12.1 outlines the heuristic principle. Candidate trips are built by first selecting the dealership to which the most profitable direct trip can be created with the remaining cars. To these seeded trips, the nearest (primary criterion) and most profitable (secondary criterion) cars are added that still find place on the transporter. The resulting trip is locally searched, i.e., the drops are arranged according to the distance-minimal sequence, and non-beneficial stops are removed. In Scenario 1, the trip is then assigned to the transporter and thus added to the solution in any case. In scenario 2, it is only added if it positively contributes to the overall profits. Otherwise the trip is dissolved, and the dealership is not further considered as seed for a trip.

In case that the best possible solution is dominated by one- or two-stop trips, the greedy algorithm is already suitable to create solutions very close to optimality.

```
Create set seeds containing all dealerships;
Create new empty solution sol;
for each transporter t do
    Create new empty trip t_best;
    Create variable d_best to remember a seed;
    for each dealership d in seeds do
        Create new empty trip t_cand;
        for each unassigned car uc going to d sorted by revenue do
            if uc may be assigned to t_cand then
                assign uc to t_cand;
            end
        end
        if benefit(t_cand) > benefit(t_best) then
            t_best = t_cand;
            d_best = d;
        end
    end
    for each unassigned car uc sorted by (1) proximity to d_best and (2)
     revenue do
        if uc may be assigned to t_best then
            assign uc to t_best;
        end
    end
    search(t_best);
    if benefit(t_best) > 0) then
        sol.add(t_best);
    else
        remove d_best from seeds;
        if seeds is not empty then
            reconsider t;
        end
    end
end
```

Algorithm 12.1 Greedy algorithm

12.5.2 Holistic Optimizer

The advanced method is a specific configuration of the vehicle routing solver for automobile distribution used within INFORM. It consists of a set of construction, local search, perturbation, and recombination methods. Algorithm 12.2 depicts the overall procedure. Each iteration may comprise the independent construction of new solutions as well as the deduction of solutions from the pool by perturbation or recombination. All methods are strengthened by a local search method that tries to improve a given solution by relocating and swapping cars either within a trip or between two trips.

In the following, the three subroutines construction, perturbation, and recombination are described on a principle level. Algorithm 12.3 shows the construction subroutine. New solutions are created via one of several implemented construction methods. One of them is the greedy method outlined above; others use different variants of best insertion procedures. All methods can be randomized so that multiple calls may lead to different solutions. Each new solution is locally searched until no more improvements can be found. It is added to the pool of solutions if its objective meets the current acceptance threshold and deleted otherwise.

The perturbation subroutine (Algorithm 12.4) comprises several methods to remove assignments from a given solution, e.g., the random removal of dealership visits from a trip. After perturbation, the new solution is locally searched. It replaces the original solution in the pool if it exhibits a lower objective value.

Finally, the recombination subroutine (Algorithm 12.5) comprises a set of methods to interchange or combine promising structures of two or more (parent) solu-

Algorithm 12.2 General outline of the holistic optimizer

```
Create new empty set of solutions pool;
for 1 to numIterations do
    construction();
    perturbation(pool);
    recombination(pool);
    parameterAdjustment();
end
```

Algorithm 12.3 Construction subroutine

```
for 1 to numConst(iteration) do
    select construction method cm;
    newSolution = cm.createSolution();
    search(newSolution);
    if obj(newSolution) < threshold(pool) then
        pool.add(newSolution);
    end
end
```

```
for 1 to numPert(iteration) do
    select perturbation method pm;
    origSolution = selectSingle(pool);
    newSolution = pm.perturbSolution(origSolution);
    search(newSolution);
    if obj(newSolution) < obj(origSolution) then
        pool.replace(origSolution, newSolution);
    end
end
```

Algorithm 12.4 Perturbation subroutine

```
for 1 to numRec(iteration) do
    select recombination method rm;
    setOfSolutions = selectMultiple(pool);
    newSolution = rm.recombineSolution(setOfSolutions);
    search(newSolution);
    if obj(newSolution) < obj(origSolution) then
        pool.replace(setOfSolutions, newSolution);
    end
end
```

Algorithm 12.5 Recombination subroutine

tions from the pool. Here, for example, new child solutions are generated by mixing the trips of two or more parents. The new solution replaces the whole set of parent solutions if it is better than the best of its parents.

12.5.3 Numerical Example

Figures 12.2 and 12.3 illustrate the solution quality of the methods described in this section by the example of 25 cars that should be transported from Aachen to 11 destinations in North Rhine-Westphalia. One drop is depicted as a small circle, two drops as a larger circle, and three drops as two nested circles. For each delivery, a relatively high revenue of €100 is realized so that it is beneficial in any case to fulfill all transport orders.

The greedy algorithm (Fig. 12.2) first considers the southernmost trip with three stops and a total of nine drops that create revenues of €900 at costs of 50€ for organizing the trip plus 60€ for visiting three dealers plus 312€ for driving 156 km. The trip thus generates profits of €478. Second, it creates the northernmost trip with four stops and also nine drops inducing profits of €278. Finally, it finds a last trip cover-

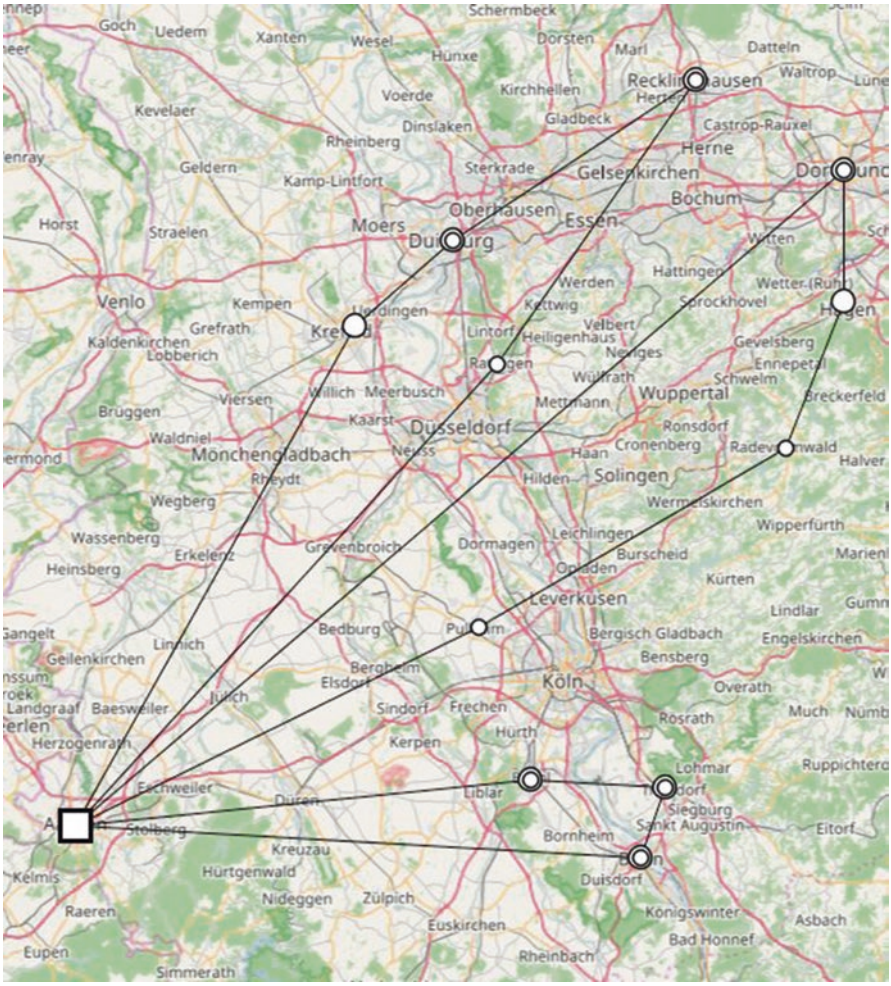

Fig. 12.2 Example solution of the greedy algorithm

ing the remaining seven cars that are delivered to four destinations at a profit of €40. In total, the greedy algorithm arrives at profits of €796 for delivering all 25 cars.

The holistic optimizer (Fig. 12.3) also considers the southernmost trip in its solution, where the two other trips are rearranged. Here, the nine-drop trip going to the northeasternmost dealers creates profits of €210, which is €68 less than the second trip created by the greedy algorithm. However, the remaining seven cars are covered by a trip that creates profits of €182 (vs. €40) leading to an improved overall result of €870.

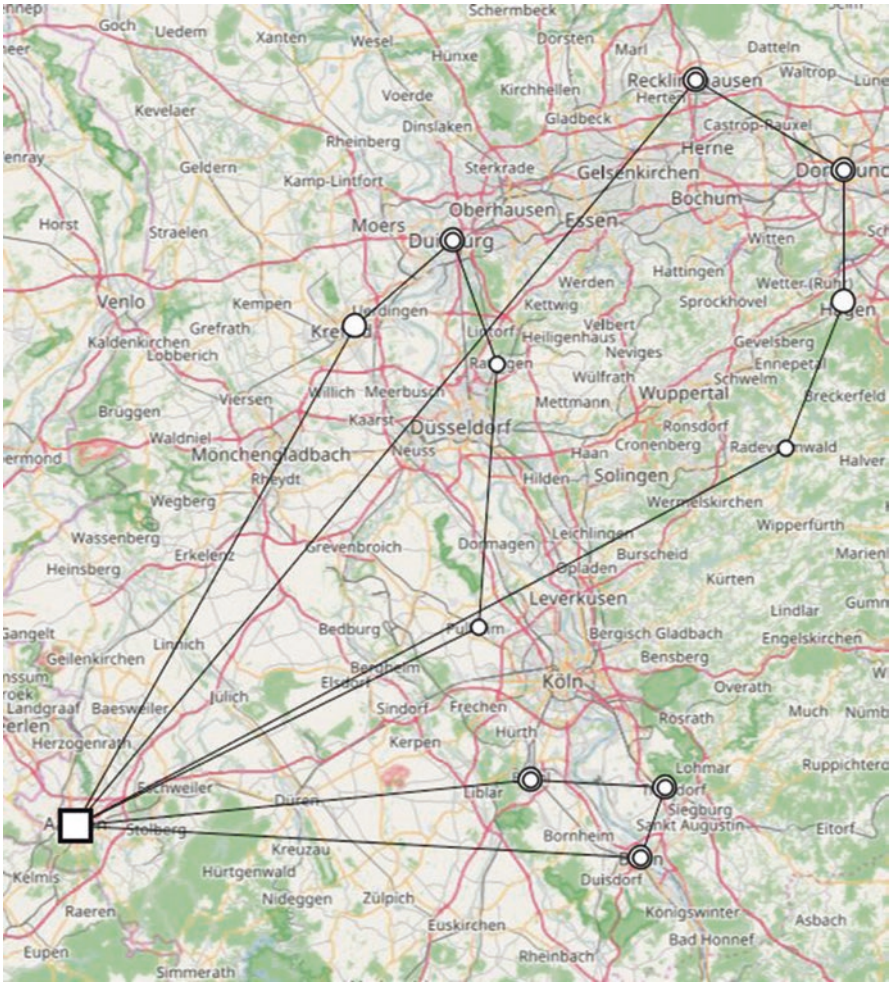

Fig. 12.3 Example solution of the holistic optimizer

12.6 Experiments

On basis of Sects. 4 and 5, Hypothesis 12.1 is replaced by the more focused Hypothesis 12.2 for the experimental part of this study.

Hypothesis 12.2 *Changing the planning principle from the greedy algorithm to the holistic optimizer positively influences profits, driver productivity, and environmental load even if the only explicit objective is to maximize profits.*

To test the hypothesis, each 10-day scenario is once planned by both methods outlined above, where an additional third experiment is conducted on Scenario 2,

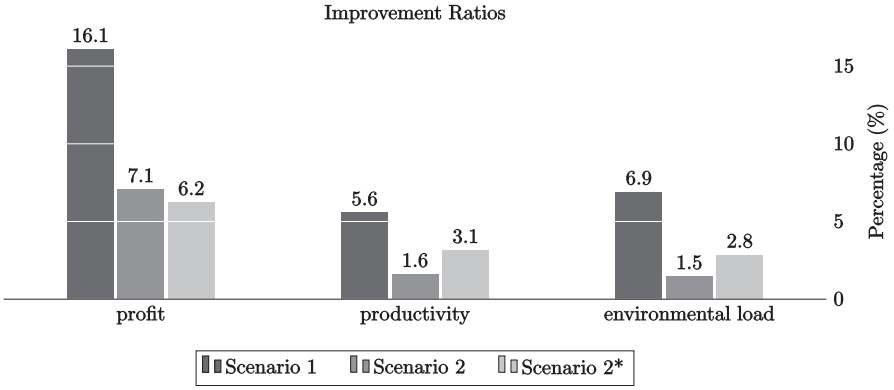

Fig. 12.4 Comparison of performance indicators

referred to as Scenario 2* in the following. The greedy algorithm terminates in a few seconds, while the holistic optimizer requires a run time of approximately 10 min per day of a scenario on a single core of an Intel i7-6820HQ CPU with 2.70 GHz. The improvements within the three considered dimensions are compared in Fig. 12.4. Table 12.1 summarizes the results of the three experiments in detail.

In Scenario 1, every order must be fulfilled on the same day that it becomes available. The only way to improve is therefore to reduce costs. The holistic optimizer creates significant cost savings of 6.9% which increase profits by 16.1%. The improvement potential is partly due to a structural deficit of the greedy algorithm that the holistic optimizer overcomes. By myopically seeking the best dealership to seed a trip in every step, the greedy algorithm tends to create an increasingly heterogeneous set of remaining cars. Since every car must be shipped in this scenario, the according orders finally get covered by very inefficient trips at the cost of the overall solution quality. Besides an increased profitability, there are also substantial improvements in the social and environmental dimensions. Driver productivity is raised by 5.6%, and environmental load is dropped by 6.9%, i.e., at levels comparable to the cost reduction. Since the increase of profits is leveled by the fixed revenue, it is not comparable with that in productivity, emissions, and costs. The results of Scenario 1 therefore support Hypothesis.

Two experiments on Scenario 2 reveal a different picture. Profits are increased by 7.1% when the holistic optimizer is applied to the plain scenario, i.e., at levels comparable to the cost reduction in Scenario 1. However, improvements in the social (1.6%) and environmental dimensions (1.5%) significantly lag behind. The holistic optimizer accepts 3.3% more transport orders than the greedy algorithm in its solution. Therefore, one may speculate that these additional 81 orders only marginally improve profitability at the cost of worsening the possible social and environmental benefits.

To explore the effect in more depth, an additional experiment (Scenario 2*) is conducted for which the rejection rate of the holistic optimizer is increased by inter-

Table 12.1 Summary of the experimental results

	Scenario 1			Scenario 2			Scenario 2*		
	Greedy	Holopt	Ratio	Greedy	Holopt	Ratio	Greedy	Holopt	Ratio
Deliveries	2,563	2,563	±0%	2,405	2,486	3.3%	2,405	2,366	−1.6%
Revenue	370,296	370,296	±0%	349,898	360,450	2.9%	349,898	344,484	−1.6%
Trips	361	352	−2.6%	333	340	2.1%	333	322	−3.4%
Stops	815	733	−11.2%	698	686	−1.7%	698	618	−12.9%
Distance	115,403	107,959	−6.9%	102,215	103,492	1.2%	102,215	97,569	−4.8%
Costs	276,916	259,028	−6.9%	245,350	247,964	1.1%	245,350	232,998	−5.3%
Working time	168,163	158,809	−5.9%	150,215	152,272	1.4%	150,215	143,249	−4.9%
Profit	93,380	111,268	16.1%	104,548	112,486	7.1%	104,548	111,486	6.2%
Productivity	2.202	2.332	5.6%	2.329	2.367	1.6%	2.329	2.405	3.1%
Env. load	0.322	0.301	−6.9%	0.301	0.297	−1.5%	0.301	0.293	−2.8%

nally reducing all revenues to 90% of the original value. Each order thus has to contribute more substantially to the overall result to be accepted for fulfillment, so that the ones that only marginally improved the result in Scenario 2 are most likely rejected now. The solution is evaluated with the original revenues.

As expected, the adjustment leads to a decrease in overall revenues; in fact they even drop by 1.6% compared to the greedy algorithm's solution. Improvements in profitability are only slightly reduced to a ratio of 6.2% which shows that the now rejected cars would indeed only marginally increase overall profits. As a further consequence, improvement ratios of productivity and environmental load are almost doubled to 3.1% and 2.8%.

12.7 Conclusion

The aim of this study was to explore the side effects of economically driven advances in operative transport optimization. Experiments were conducted against the backdrop of a realistic case in automobile distribution that mainly revealed two insights.

When there is a fixed volume of orders to fulfill, advances turn out to be beneficial throughout the economic, social, and environmental dimensions in the considered field of application. Comprehensive benefits are realized even when the objective is to only maximize profits. This is mainly due to the fact that improvements are only possible by reducing costs in this case, which are highly correlated with individual trip efficiency and the reduction of environmental load.

The situation is more ambivalent if revenues are also subject to the optimization. The higher level of efficiency that the optimization advances establish is at least partly used to extend the overall workload. Transport orders whose relatively low margins caused them to be rejected by the greedy algorithm can now be fulfilled profitably. While these additional orders slightly increase overall profits, they worsen presumably the individual trip efficiency. Therefore, the unadjusted holistic optimizer creates significantly less improvement in the social and environmental dimensions when applied to the market-based scenario.

Even though all three dimensions are better served by the holistic method, the additional experiment on Scenario 2 shows that they are in conflict to some extent. By forcing the optimizer to be stricter with the acceptance of transport orders, productivity and environmental load are substantially improved – at the cost of losing profit.

Current developments in the transportation industry suggest that methods like the holistic optimizer presented in this paper will increasingly be used in the near future to support day-to-day planning. To prosper in a competitive industry, companies will have to use the according advances to stabilize or even increase their profits. By showing how economic, social, and environmental aspects may be in conflict, this study stresses the importance of explicitly regarding the effects of advances in optimization methods in all relevant dimensions.

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Chapter 13
Sustainability and New Product Development: Five Exploratory Case Studies in the Automotive Industry

Harald Gmelin and Stefan Seuring

Abstract Purpose – Companies receive growing pressure from customers, non-governmental organizations, and public administration through legal acts to generate products both providing value to the customers and being sustainable. This requires a move beyond green products, which are therefore not perceived as sufficient anymore. Hence, research on new product development toward the aspects of sustainability attracts more attention. The purpose of this study is herewith to analyze how sustainability influences new product development (NPD) and companies manage this challenge.

Design/methodology/approach – A multi-case study approach with a total of 19 interviews in five automotive manufacturing companies has been conducted. The data originates from preinterview questionnaires, publicly available data, and semi-structured interviews with departments focusing on sustainability and product design.

Findings – The findings of this chapter refine the understanding of a sustainable new product development. NPD success factors are closely linked with the triple-bottom-line dimensions. The case studies show that the social aspect is hardly present in NPD. Nevertheless, it becomes evident that strategic management for sustainability and new product development has to be aligned closely to reach sustainable products.

Research limitations/implications – The chapter uses a case study approach, so generalizability of the study is limited. This approach enables to examine explicitly the relationship between sustainability and NPD, where empirical research is lacking.

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Originality/value – The chapter contributes to prior research in sustainability and new product development by analyzing the interconnection of NPD and the triple bottom line on a success factor level and provides case studies for justification.

Keywords Corporate sustainability • New product development • Automotive industry • Case study

13.1 Introduction

Engineering, operations management, and nearly all processes in a company are driven by the growing request for sustainability (Sarkis et al. 2011), since economic, social, and ecologic factors are relevant across the entire company. Focusing on engineering, there are entire product life cycles from design to disposal affected by sustainability (Graedel and Allenby 2009). This trend toward being sustainable is caused by the rising demand of consumers for sustainable products, as well as by pressure from nongovernmental organizations, and respective legislation (Bevilacqua et al. 2007). Research in corporate sustainability has attracted a large community in academic literature (e.g., Sarkis 2001; Wilkinson et al. 2001; Hult 2011; Seuring 2011) caused by its high managerial and strategic relevance for process improvement (Bateman and David 2002; Schneider and Meins 2012). Nevertheless, there is little academic literature on the interface between new product development (NPD) and sustainability (Ferguson et al. 2010), although the opportunity to influence a product's performance is seen as prevalent in the design phase, which holds for cost (Hoffman 1997) as much as for sustainability (Evans et al. 2007). New product design and development predetermine the sustainability performance over the whole product life cycle (Gmelin and Seuring 2014a, b).

Green products, green product development (Bansal and Roth 2000; Baumann et al. 2002; Golden et al. 2011), and green supply chain management (Simpson et al. 2007; Seuring and Müller 2008; Vachon and Klassen 2006) have been researchers' focus in order to respond to an increased attention to environmental regulations (Albino et al. 2009). In today's competitive global market, however, enterprises ought to design, manufacture, and deliver products both providing new value to the customer and being sustainable (Esslinger 2011). Sustainability is referred to the triple bottom line (TBL) of an organization (Elkington 1997; Dyllick and Hockerts 2002; Kleindorfer et al. 2005), which encompasses the three dimensions of economic, social, and ecologic sustainability. Green products without social or economic factors are therefore not sufficient anymore. Henceforth, NPD needs to be addressed with a cross-disciplinary sustainability point of view and not solely from a green perspective. By focusing on sustainability in new product development, the call for a more holistic focus on product sustainability is followed (Golden et al. 2011).

This leads to the research question addressed: How do companies integrate the strategy-oriented sustainability dimensions into the complex activities of new product development? In this chapter we seek to answer this question by drawing on insights from five case studies in the automotive industry. This industry is known for complex products and processes (Thun and Hoenig 2011) as well as for strong sustainability efforts (Hootegem et al. 2004; Simpson et al. 2007) so that robust data are expected. The intention of this research is to connect NPD and sustainability on grounds of NPD success factors being linked to the TBL dimensions of sustainability. This connection is addressed by drawing on a multi-case study research design. Given the early stage of research in this field, we would argue that a step toward (pre-)theory building is taken, so that a first conceptualization is offered (Meredith 1993).

The remainder of the chapter is structured as follows. Section 13.2 introduces the literature on (1) new product development and (2) sustainable development. This is then integrated into a research framework. In Sect. 13.3, the methodology of the case study is described and justified. Section 13.4 presents the findings from the cases, while Sect. 13.5 provides the discussion. The conclusion and further research opportunities are given in Sect. 13.6.

13.2 Literature Review

13.2.1 New Product Development

Research in new product development (NPD) has been of interest for several decades (Griffin 1997; Everaet and Bruggeman 2002; Richtner and Ahlström 2010) with the following academic communities dominating marketing (Ernst et al. 2010), operations management (Hill 2001; Ferguson et al. 2010), and engineering (Danese and Filippini 2010).

New product development means a "transformation of a market opportunity and a set of assumptions about product technology into a product available for sale" (Krishnan and Ulrich 2001, p.1) with quick development cycles (Atuahene-Gima and Murray 2007). Quick development cycles are an essential aspect with regard to time-to-market pressures in NPD (Afonso et al. 2008). In order to mitigate this pressure, globally acting companies depend on quick information flows among development partners (Parker et al. 2008).

The currently dominating research in NPD is given by green product development, in which several terms such as green design, ecological design, and design for environment are used for similar concepts. Design for environment signifies the systematic process of developing a product in an environmentally conscious way (Sroufe et al. 2000). One of the most important tools to evaluate environmental design is seen in life cycle assessment (LCA) (Baumann et al. 2002), which helps to make decisions toward an environmental-friendly design (Fullana et al. 2011). In

connection with LCA, the cradle-to-grave approach is often mentioned (Hoffman 1997; Sarkis 2001) indicating that a LCA has to incorporate all life cycle stages from design to disposal (Rebitzer et al. 2004). The concept of cradle-to-grave approach has been extended to a cradle-to-cradle approach in order to reach zero emissions and eco-efficiency (Braungart et al. 2007) so that material flows are in regenerative closed-loop cycles (McDonough et al. 2003). The cradle-to-cradle approach is therefore seen as one step toward a product design for the next generation of green product development (Rossi et al. 2006) to reach a sustainable product development.

NPD defines the success of a product across the entire life cycle and lays the foundation of a company's success (Hult 2011). Developing products is costly and risky (Everaet and Bruggeman 2002; Marion et al. 2012); thus companies are eager to find approaches in minimizing the risk of failure. Consequently, NPD success factors have been developed, which have been condensed and justified over the time in NPD research papers, so the following ones are established (Griffin 1997; Cooper 2001; Marion et al. 2012): (1) cross-functional work, (2) top-management support, (3) market planning, and (4) formalized processes. Details to the success factors can be seen in Table 13.1. These success factors cover the two fundamental aspects for mitigating successful products of (1) doing the project right and (2) doing the right project as indicated by Cooper (2001). Cross-functional work and formalized processes support doing the project right, and top-management support and market planning focus on doing the right project (Marion et al. 2012). Against the analysis of Cooper (2001) and Marion et al. (2012), it can be said that all relevant success factors for a NPD are covered in this study. The single factors will be explained in greater detail below, when their integration with sustainability is discussed.

Table 13.1 NPD success factors

Success factor	Description	Examples
Cross-functional work	People from different functional areas work jointly toward a new product	Pagell and Wu (2009)
		Wang et al. 2009
Top-management support	Sponsorship by company's senior staff to enable NPD activities	Salomo et al. (2010)
		Slotegraaf and Atuahene-Gima (2011)
Market planning	Evaluation of the current market needs with the company's capabilities to fulfill these needs	Lambert et al. (1998)
		Hult (2011)
		Esslinger (2011)
Formalized processes	Well-defined routines toward a dedicated output being agreed by all development partners	Singhal and Singhal (2002)
		Grieves and Tanniru (2008)

Based on Cooper (2001) and Marion et al. (2012)

13.2.2 Sustainable Development

The Brundtland Commission defined sustainable development as "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987, p. 42). It is often seen as a very broad definition (Callens and Tyteca 1999), so that it gives room for interpretation. One of the most accepted interpretations is the TBL approach in economic profitability, respect for the environment, and social responsibility (Elkington 1997; Dyllick and Hockerts 2002; Kleindorfer et al. 2005). The connotation of each TBL aspect is provided in Table 13.2. Companies are able to gain competitive advantages through sustainability (Campbell 2007) by implementing business practices aiming for positive sustainable reputation, success, and operation management (Kleindorfer et al. 2005; Schneider and Meins 2012). Corporate sustainability has not merely a positive impact on the company but also on all involved collaboration partners (Vachon and Mao 2008; Jeffers 2010; Seuring 2011). It is even stated that a company is dependent on the sustainability efforts of their business partners (Ron 1998), because a company can only be sustainable if the suppliers also provide sustainable products or components (Pagell and Wu 2009).

The need for green products has led to the emerging area of eco-innovation (see, e.g., papers in Azevedo et al. 2014). However, focusing on sustainable NPD, it is necessary to also incorporate the social factor and not only the environmental aspect (Aguilera et al. 2007). Previous studies in marketing already addressed social factors in NPD (Varble 1972); however that research led into the area of social competency in NPD (Mu et al. 2011).

Table 13.2 The triple bottom line

Triple bottom line	Description	Example
Social	Skills, motivation, and loyalty of employees and business partners	Elkington (1998)
	Integration of public services	Dyllick and Hockerts (2002)
		Kleindorfer et al. (2005)
Environmental	Reduction of the consumption of natural resources below the natural reproduction	Elkington (1998)
		Dyllick and Hockerts (2002)
		Kleindorfer et al. (2005)
Economic	Guaranteed cash flow at any time while producing return to shareholders	Elkington (1998)
		Dyllick and Hockerts (2002)
		Kleindorfer et al. (2005)

Based on Dyllick and Hockerts (2002)

Table 13.3 Sustainable NPD matrix

	Social	Environmental	Economic
Cross-functional work	Employee skill enhancement by cross-functional work	Joint development actions for environmentally friendly products	Joint development actions for cost-efficient products
	Employee motivation by new cross-company integration		
Top-management support	Approval for intense product test toward safer products	Internal pressure for environmental-friendly design	Approval for higher investments in sustainable design
	Initiation of employee-friendly working conditions	Approval of costly eco-design	Approval of external NPD/sustainability experts
Market planning	Development of necessary products within the firm's community	Evaluation of internal capabilities for environmental design	Evaluation of potential new market share
	Local employee sourcing		Evaluation of external expert availability
Formalized processes	Employee-friendly process design to protect their health	Design for environment	Clear process sequences for quick development cycles
		Cradle-to-grave approach	
	Employee-friendly process design to protect their physical health	Cradle-to-cradle approach	

13.2.3 Toward a Sustainable New Product Development

The purpose of this study is to link new product development and sustainability; hence the approach is to connect NPD success factors from previous studies with the TBL dimensions. This serves as conceptual integration among the so far separate fields. The resulting matrix is shown in Table 13.3, which provides details on the intersection of the TBL and NPD.

The following sections will explain the intersections of the sustainable NPD matrix and their justification. The sections will be led by the NPD success factors as the challenge is to incorporate the TBL in NPD.

13.2.3.1 Cross-Functional Work

The importance of cross-functional work is seen as a major improvement in effectiveness and efficiency in NPD (Marion et al. 2012). Cross-functional work does not only imply collaboration across internal functions to enhance team effectiveness (Maylor 1997; de Bakker 2002); it also integrates suppliers into NPD in order to achieve a sustainable product design (Becker and Zirpoli 2003). Cross-functional work is vital to achieve sustainability in NPD (Daily and Huang 2001) because all departments and partners involved are required to follow the same sustainability requirements.

Social cross-functional work influences the skills of a company's employees, because the employees can enhance their skills by learning from other companies' employees (Kale and Singh 2007). By working together with different functions, the employee's skills and capabilities are improved. Besides the knowledge enrichment, the motivation of an employee is enforced due to the opportunity to work together with new partners (Chabowski et al. 2011). Subsequently, the employee's satisfaction rises and its willingness to contribute to a successful NPD.

From an environmental perspective, it can be said that cross-functional work supports idea generation for environmentally friendly design solution (Daily and Huang 2001). New ideas are an important cause for NPD to provide product improvements (Bunduchi 2009; Danese and Filippini 2010) and to follow customers' requirements. Relying solely on ideas within one department can block creativity and innovation competencies.

Cross-functional work can positively impact the economic part of a company (Brettel et al. 2011). On the one hand, there are development partners to share the development costs with. On the other hand, there are further resources with additional capabilities that can provide development solutions without having to source costly external experts (Cousins and Lawson 2007).

13.2.3.2 Top-Management Support

Exhaustive product tests can maximize a product's safety for users and herewith improve a product's social characteristics. However, these tests are linked with higher development costs for which the top-management approval is vital (Salomo et al. 2010). In addition, for improving internal working conditions, the top-management has to drive organizational changes (Carter and Easton 2011). Other employees would not have the organizational execution power.

Internal pressure exists for environmental-friendly products because the reputation of a company is one of the most important factors a top-management has to take care of (Baumann et al. 2002). With regard to environmental aspects, top-management is very cautious of environmental figures that need to be presented (Rebitzer and Buxmann 2005). Achieving lower performance than competitors may risk reputational damage and result in a loss of market share. Nevertheless, reaching

good environmental results necessitates investments in eco-design causing costs, which need top-management approval.

Both social and environmental involvement cause higher costs, due to that they impact the economic factor. Consequently, top management has to justify higher development costs due to a sustainable NPD against shareholders and has to support internal functions in executing a sustainable NPD (Slotegraaf and Atuahene-Gima 2011). The support includes the approval of external experts when qualified capabilities are not available internally. Nevertheless, external experts can also foster knowledge creation for a sustainable NPD (Koners and Goffin 2007; Richtner and Ahlström 2010).

13.2.3.3 Market Planning

NPD has to be based on the market demand so that product planning is essential for a successful product launch and market acceptance (Cooper 2001).

Dyllick and Hockerts (2002) state that social sustainable companies are furthering the societal capital of the communities they operate in. It can be said that focusing on local employee sourcing supports this aspect. The aspect of market planning also directs toward discovering a potential new market (Marion et al. 2012). In combination it would mean that companies need to analyze what products are needed in their community, evaluate if they can fulfill this need, and finally start developing products for this region.

The company needs to have the capabilities to develop environmental-friendly products (Esslinger 2011). That means the company needs to be able to source environmental-friendly components, design it, and be able to evaluate environmental impacts. Sustainability already starts with environmental-friendly sourcing (Vachon and Klassen 2006). This emphasizes the previously mentioned point of ensuring sustainable suppliers (Pagell and Wu 2009).

Besides ensuring the internal capabilities of an environmental NPD, companies need to evaluate the market if it necessitates sustainable products. Thus, if there is no market potential, companies should rather neglect the investment for not doing misinvestments. This requires the awareness of sustainable products and the willingness of market participants to buy these products even for higher prices (Huang and Rust 2011). The evaluation of the internal capabilities can also have an impact on the economic aspect. External experts need to be detected if the internal evaluation was not successful.

13.2.3.4 Formalized Processes

Formalized processes in NPD aim to reduce time and cost (Al Shalabi and Rundquist 2009). The aspect of time to market is of growing importance today (Afonso et al. 2008).

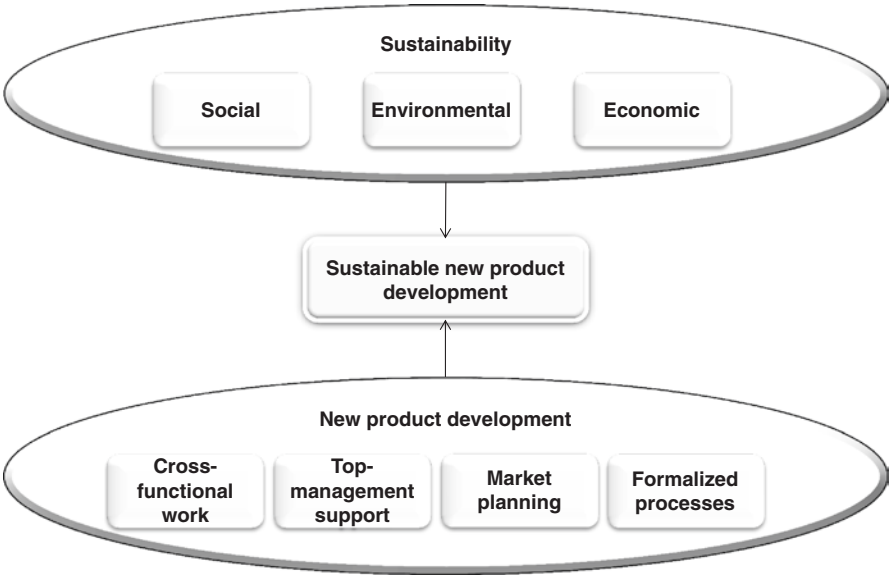


Fig. 13.1 Sustainable NPD research framework

Social processes have to be integrated with manufacturing aspects so that manufacturing processes are not harming the employees' health; thus noxious substances have to be avoided, nor should they impact their physical health negatively (Braungart et al. 2007). Negative physical impacts can be circumvented by processes not asking the employee to carry heavy things or having to work overhead.

Environmental processes can be formalized by implementing design for environment or cradle-to-grave approaches (Shrivastava 1995; Graedel and Allenby 2009). Design for environment incorporates the environmental conscious design of a product and process to avoid pollution across the life cycle-based evaluations. Besides design for environment, the cradle-to-grave approach focuses on ensuring the recyclability and disposal of substances used in a product (Braungart et al. 2007). Consequently, product developers have to ensure that the designed product can be recycled when being disposed.

Formalized processes represent clearly structured process sequences; thus each involved development partner knows exactly the next tasks. This prevents developers from executing tasks too early, which might cause rework and additional costs. By establishing clear sequences and tasks, the development process can be accelerated, and herewith development cycles can be quicker.

Figure 13.1 provides a framework based on the previous sections. This is intended to be justified and refined with the help of the case studies.

13.3 Research Methodology

13.3.1 Research Design

The objective of this study is to explore how companies combine the complex activities of NPD with sustainability. As presented in the previous sections, this connection has not been analyzed in depth before; however, it reflects a contemporary circumstance. The use of case studies has been encouraged as a method of choice when studying a phenomenon in the real-life context (Yin 2013; Voss 2009). Case studies are well suited for complex structures, since they allow intense interaction with the informant, which is not possible for, e.g., surveys (Eisenhardt and Graebner 2007), and they draw on multiple sources of information leading to robust data. Interaction with an informant helps to reduce misunderstandings and antagonizes social-desirability bias in the sustainability topic (Bagozzi 2011). The intention of our research is directed toward exploring the interconnection of sustainability and NPD and herewith to drive related theory (Marion et al. 2012).

13.3.2 Case Selection

The focus of the study lays on the automotive industry for the following reasons. Firstly, new product development is of strategic relevance in this industry because it decides on the future success of the company. Secondly, green approaches have been of interest in that industry due to the high amount of users and the herewith connected pollution potential. Thirdly, to remain competitive in this vastly competitive market, companies are forced to establish a positive sustainability image and innovation. Thus, they need to incorporate the TBL of sustainability. Lastly, the automotive industry has been in focus for NPD studies before (Petersen et al. 2003; Becker and Zirpoli 2003; Hootegem et al. 2004).

A multilevel case selection process was followed in order to get robust case data to gain sufficient insights while minimizing the number of cases (Perry 1998). Based on the reviewed literature and expert information, a sampling frame was developed. Companies were selected being recorded in the Dow Jones Sustainability Group Index (DJSI) or FTS4Good (López et al. 2007) in order to comply for sustainability. Following the sampling criteria, the leading worldwide acting automotive companies were approached via email or business platforms (Brettel et al. 2011) and follow-up phone calls. Five companies agreed to take part in our study, providing access to the relevant interview partners within NPD and sustainability, as

Table 13.4 Case characteristics

Firm	Alpha	Beta	Gamma	Delta	Epsilon
Firm size [employees][1]	~30.000	~100.000	~250.000	~8.000	~100.000
Informant job title	Product data manager	Process manager	Product data manager	Sustainability manager	Process manager
	Project manager	Controlling manager	Product development manager	Process manager	Product and process manager
	Sustainability manager	Product data manager	Sustainability manager	Project manager	Sustainability manager
		Project manager	Process manager	Product data manager	
		Sustainability manager			
Executed interviews	3	5	4	4	3
Company type	OEM	OEM	OEM	OEM	OEM

[1]Approximated figures due to confidential restrictions

well as in further departments, like controlling, to receive multiple points of view. Further companies did not take part in the interviews because of lack of resources, sensitivity of the topic, or that they generally do not take part in studies. Details on the participating case companies and the interview partners can be seen in Table 13.4.

Data collection can be stopped when no significant new insights can be taken (Yin 2013). This however is a qualitative criterion and cannot be pinned down by a certain number of cases. Other researchers argue that a multi-case analysis providing four to ten cases provides a good research basis (Eisenhardt 1989; Gibbert et al. 2008).

13.3.3 Data Collection

Primary data collection was executed in two phases in order to follow a theoretical sampling approach (Eisenhardt 1989). The interviewees were asked to complete a basic pre-interview informative questionnaire with questions regarding their role, tasks, and structure of the NPD and sustainability departments. This approach provided first information of the interviewees, e.g., their hierarchical position within the company, their experience with sustainability-related processes and functions, as well as their experiences in NPD. Subsequently, Perry's (1998) approach was adopted, so that guiding questions for the semi-structured interviews based on the interviewees' responses were developed. Thus, the interview subject was thoroughly outlined (Voss et al. 2002). At least 3 interviews were conducted per

Table 13.5 Validity and reliability details

Criteria	Case research phase			
	Design	Selection	Collection	Analysis
Reliability	Develop case study protocol	Selection based on notation in DJSI and FTS4Good	Pre-interview questionnaire and semi-structured interview	Involvement of authors who did not gather data
Internal validity	Theoretical research framework	Sampling criteria recorded in case study protocol	Recording of interview details	Triangulation of multiple data sources
Construct validity	Adaption of constructs from previous works in NPD and sustainability	NA	Multiple sources of information	Chain of evidence
External validity	Sampling within automotive industry	Description of case context	NA	Cross case analysis

Based on Yin (2013)

company with a maximum of 5; hence 19 interviews are the basis for the case study. The interviews were conducted on site in order to gain deeper insights of survey results and lasted between 60 and 90 min.

A case database was established with interview notes, pre-interview questionnaire data, content from the company's websites, annual reports, and sustainability reports (if not included in the annual reports) to account for reliability (Gibbert et al. 2008). In the case of inconsistencies between the data sources, clarification was given in follow-up phone calls with the case contacts. This approach is based on the recommendations by Yin (2009) in order to comply for data triangulation (Gibbert et al. 2008). The incorporation of secondary data is important as it is more objective and counters interviewee bias (Busse 2010). The use of multiple data types and respondents helps to mitigate social-desirability bias and single-informant bias (Eisenhardt and Graebner 2007). Validity and reliability aspects are summarized in Table 13.5.

Once all primary and secondary data were collected, the available information was structured according to the mentioned framework. The same procedure was executed for all cases. The overall data analysis was accomplished in two phases. Within-case analyses have been conducted to develop individual profiles in order to become acquainted with each case. Then, the cross-case analysis has been executed

to detect communalities and differences in NPD and sustainability behavior across the studied cases (Eisenhardt and Graebner 2007).

13.4 Findings from the Case Studies

In order to elucidate the findings from the case study and to facilitate the readability of the paper, the following sections are divided into the subsection already being used in Chap. 2.3. That means the intersections of the sustainable NPD matrix (see Table 13.3) are addressed by following each NPD success factor along the TBL dimensions.

13.4.1 Case Analysis of Cross-Functional Work

- Social

Social cross-functional aspects are rather underrepresented in the case companies. At *Gamma* and *Epsilon*, the opportunity to learn from cross-functional collaboration is seen as relevant. During the interview *Beta's* project manager realized that cross-company collaboration could be used more for skill enhancement. Fewer actions are seen in employee motivation. Only *Gamma's* project manager confessed that some employees are proud of representing the company and are more motivated. Nevertheless, all case companies stated that they need to talk to their employees on that point to get further insights.

- Environmental

At all five case companies, the informants highlighted that an environmental NPD is today hardly possible without cross-functional work. Cross-functional work includes joint development actions with suppliers (all case companies). At *Beta* they claim that for new product development processes, their IT department has to provide a data management application being able to store all product relevant information to the business. This department is herewith seen as a very important collaborator to gain advantages in environmental data provisioning. *Alpha*, *Beta*, *Gamma*, and *Epsilon* integrate customers in their design process through workshops providing feedback to the current and planned products. By doing so, they integrate even customers in the NPD process to receive future requirements.

- Economic

The core aspect for all case companies is sustaining economic success. *Delta's* product manager brings it to the point: "Social engagement and environmental protection is important, but in the end it is all about making money." This expression is supported by the other case companies arguing that new product development is

from their point of view not merely directed toward developing new products for the market, but also reducing development costs and development time to be able to push a product to the market early. *Beta* and *Gamma* emphasize that short time-to-market cycles are only reachable since the development teams consist of all necessary departments. *Beta's* sustainability manager states that there is no department blocking the development process when they are all responsible for the development success. Despite that, cross-functional work with suppliers may also reduce costs. *Epsilon's* process manager reported from strong initial discussions with suppliers regarding collaborative NPD. With an ex post reflection, he thinks that the effort has paid off as all development partners can nourish from it by sharing knowledge and saving costs.

13.4.2 Case Analysis of Top Management

- Social

The case companies kept a low profile regarding the social contribution of the top management. All case companies assured to execute product tests but did not want to specify this topic. Employee-friendly working conditions are of course relevant, indicates *Epsilon's* sustainability manager. However, if they are really initiated by top management is difficult to say. He furthermore states that a driving factor for employee-friendly working conditions is the worker's council.

- Environmental

Top management is eager to provide good environmental figures in the annual report; hence investing in good environmental actions is of strategic relevance, states *Gamma's* product development manager. On the one hand, top-management wants good figures, but on the other hand, they have to save costs. This trade-off cannot be done in the product development department; it must be decided by top management (all case companies).

- Economic

Sourcing components in a socially fair way and meanwhile saving the environment during production and product usage requires high investments (*Beta's* product manager). Having the sustainability and product development manager in the board of directors supporting the development ideas is of great help, reports *Epsilon's* product manager. Without top-management approval and support, they could not spend that amount of money they have to for being more social and ecologic. *Alpha's* product manager explains that an environmental NPD approach requires top-management involvement, since environmentally friendly components are often impacting financials. The trade-off between cost-sensitive NPD and consumers' requests for eco-friendliness cannot be made by product design independently (*Gamma's* product manager).

13.4.3 Case Analysis of Market Planning

- Social

The development of products being needed in the company's community sounds nice, however is not practical, *Gamma's* project manager says. Products are sold all over the world and cannot be solely focused on a small region (*Gamma* and *Epsilon*). The market would be too small. Besides that, it is each company's intention to employ people living closely to the company. If employees have to travel long distances, they are already tired and unmotivated, declares *Beta's* project manager. Thus, it is a company's intention to employ local employees (*Gamma's* sustainability manager).

- Environmental

While *Beta* and *Epsilon* involve the users directly in their market planning activities, *Alpha*, *Gamma*, and *Delta* mainly rely on market analyses. At *Beta* the perception of a direct exchange of market demand and planned supply with the customer is seen as highly valuable. For them it is a first evaluation of the market reaction for a new product, especially regarding their plans for electro-mobility. Environmental aspects can herewith be discussed and also explained to the customer. The customer himself can directly provide feedback to the plans.

- Economic

Sustainable economic success in a market is regarded as the core factor a company has to strive for (*Gamma's* sustainability manager). Competitors and the threat of new entrants, especially from India and China, are watched thoroughly. Strategies are being developed how to distinguish from them and sensitize the market to sustainable products. Unfortunately, due to confidentiality of these strategies, further insights of these differentiating approaches in new product development were not received. Nevertheless, *Beta* and *Epsilon* nourish from external expert knowledge. *Delta's* product manager affirmed that using new materials like carbon without experts would be too complex and risky.

13.4.4 Case Analysis of Formalized Processes

- Social

Alpha focuses on establishing safer production processes; hence employees are more preserved from accidents. Healthier processes are the intention at *Gamma* and *Delta*, so that substances harmful to the employees' health are avoided as much as possible. *Beta* otherwise sets the main focus on user safety in making the car safer

during usage for the driver and the people being around. In order to reach safer cars, *Beta* invests into technological support like computer-aided design and finite element method to simulate component and product characteristics in accidents. Based on these simulations, they improve the automobile to be safer. Automobiles producing less unhealthy particulate matter or less noise can be tested and improved virtually. Real tests would be too costly and time consuming, says *Beta's* sustainability manager.

- Environmental

Environmental formalized processes are present at companies for quite a while. Even before the sustainability discussion appeared, design for environment was used (all case companies). For reaching green products, you need to follow a design for environment approach, *Gamma's* product data manager argues. In the case of cradle-to-cradle approach, not all case companies are really involved. *Alpha*, *Delta*, and *Epsilon* have heard of it but are not familiar in what way it should be used. *Beta* and *Gamma* otherwise see some potential in it, however are not sure if it is not just another nice name for a concept companies already follow.

- Economic

All case companies stated that social activities in NPD and social impacts depend on cost and time. Additional safety applications are costly, can influence an automobile's design, and impact the price of an automobile. *Beta's* process manager also adds that these additional factors need to have support in the market and that internal marketing has to praise it for sales.

After having presented all intersections of Table 13.3 with regard to the case companies' results, a cross-case comparison table is given in Table 13.6. The table shows the case companies supporting the sustainable NPD matrix in each intersection. Due to indistinct feedback from the interviewees, the intersection of social and top-management support is marked with no result.

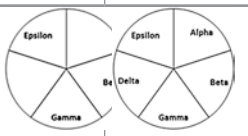
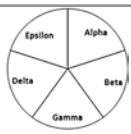
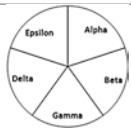
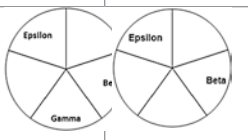
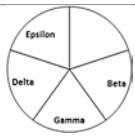
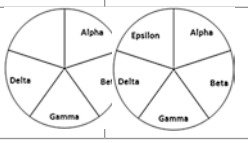
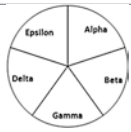
The interconnections of NPD success factors and the TBL dimensions as illustrated in Fig. 13.2 are derived by merging the findings from the case study with the research framework of Fig. 13.1.

13.5 Discussion

As a result, this chapter contributes to the existing literature on the interface of sustainability and NPD by integrating the dimension of both concepts with each other. Based on the extant literature in each area, the sustainable NPD matrix has been developed. The connection to real cases from the automotive industry gives the opportunity to reflect the theoretical framework.

The case studies illustrate that the integration of internal as well as external development partners in a cross-functional collaboration is vital from several aspects (Maylor 1997; Daily and Huang 2001). On the one hand, the integration

Table 13.6 Cross-case comparison

	Social	Environmental	Economic
Cross-functional work			
Top-management support	n/a		
Market planning			
Formalized processes			

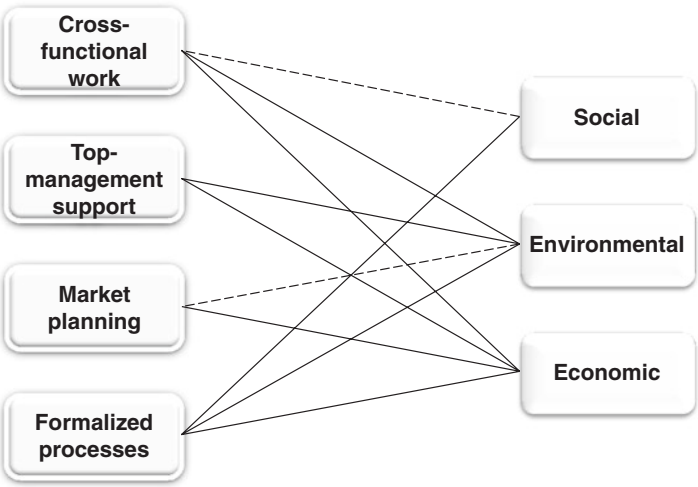


Fig. 13.2 Interconnections of NPD and sustainability

provides clear product data for environmental assessments of all components including supplied ones. These assessments help to sell the product in the market. On the other hand, the case studies show that integrating suppliers into the development process and herewith sharing the responsibility of the product's success reduce development time and development costs because all parties commonly want the

success. Cost targets and time-to-market pressure have already been high in NPD (Everaet and Bruggeman 2002). Hoffmann (2008) focuses in her study on the consumer integration, which is helpful in order to guide the customers toward sustainable products. However, more focus should be set to collaborative NPD activities with suppliers. Despite supplier integration in NPD (Danese and Filippini 2010) and supplier relationships in green supply chains (Simpson et al. 2007), little can be said on the integration of suppliers in sustainable NPD. Research by Pagell and Wu (2009) suggests incorporating partners into a sustainable supply chain, whereas the research study presented here specifically requests this behavior for a sustainable NPD. A sustainable NPD has to be established before a sustainable supply chain management can be reached.

Consumer safety and the reduction of health-impacting effects are often mentioned. One could argue that this has been in focus for years but not been emphasized. Nevertheless, technology has improved in that way that virtual simulations are possible and more effort can be put into these aspects. Thus, the ability for these tests requires technology being able to create competitive advantages (Jeffers 2010). Crash tests were and are expensive and need to be done, but virtual pretests provide the chance for a better user protection with reduced costs. Hutchins and Sutherland (2008) did not include the user in their subthemes of social sustainability, nor did Labuschagne et al. (2005). From our point of view, it is relevant and important as the case studies show.

In the majority, the case companies thoroughly watch the market and the actions of their competitors. This seems to be reasonable since each company strives for competitive advantages in the market place. Green practices used to create competitive advantages (Daily and Huang 2001; Simpson et al. 2007). Sustainable activities provide a source for a new way to gain a competitive advantage (Kleindorfer et al. 2005). Thus, companies compare their developments and market acceptance with each other. In our case, they compare their products with each other. It can be questioned if this is the right way to evaluate sustainability efforts in the automotive industry, because relative measurements are used and therefore a relative measure of sustainability. If companies are only in competition with direct competitors, sustainability improvements will probably be just marginal. They will probably only invest in sustainability improvements for just being better than the competitors. However, they do not have pressure for larger improvement steps. Constraints from customers as well as from legislation can establish objective factors and measurement. However, ways need to be found to make regulations binding for everyone to keep market conditions equal.

Summing up, it can be stated that a sustainable NPD is dependent on cost awareness, quality, flexibility, and environmental issues plus the awareness of social attributes. While these insights might almost seem straightforward, no related empirical research and no conceptual framework have been presented addressing this intersection. As already pointed to in the introduction, we are well aware that this would only be a first step in building respective theory. This is in line with the arguments put forward by Meredith (1993), and our study might serve as a first step.

With regard to the research question and research design, case study research was seen as being well suited to investigate how companies manage the integration of sustainability requirements in the complex structures and processes of product development. However, we are aware that limitations exist and encourage further research. One limitation is that the case studies were only focusing on the automotive industry, which limits the generalizability of the study. The framework of a sustainability-driven NPD should therefore be analyzed in other industries, too.

13.6 Conclusion and Further Research

This chapter presents the approaches of five global automotive manufacturing companies to continuously meet the challenge of satisfying sustainability requirements in NPD. In particular, it examines how they integrate the TBL in their NPD processes. The contribution of the paper is twofold. Firstly, it elaborates on the NPD processes and on sustainability from an operations management perspective by developing a sustainable NPD matrix. By doing this the call for more information in the interface of NPD and sustainability has been followed (Ferguson et al. 2010). Secondly, by means of the case study, practitioners can realize that a cooperation of sustainability and NPD is important in order to follow customer's demand for sustainability in the sense of the TBL of sustainability.

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Part III
Covering the Social Dimension of Sustainability

Chapter 14
Sustainable Supply Chain Management at the Base of Pyramid: A Literature Review

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Abstract In recent years, establishing partnerships with actors from the so-called base of the pyramid (BoP) has become a pivotal task for firms that operate or do business in developing countries. By engaging in BoP markets, firms are able to meet their own growth targets while simultaneously stimulating the economic development of poor countries. Due to the increasing relevance of sustainability, business decisions have to be made under consideration of economic, environmental, and social criteria. As a consequence, new challenges for supply chain management (SCM) arise. Even though these management theories are somehow connected, only little attention has been given to linking BoP research and sustainable supply chain management (SSCM) yet. This chapter sheds light on this research area. A systematic review and content analysis of 76 related papers is presented to examine the state of research. The examination of sustainability constructs reveals a clear dominance of social aspects and a deficit in environmental sustainability consideration in SCM, while the integration of all three dimensions of sustainability is still occasional. The study contributes to research by analyzing the coherence of sustainability, in particular its social and societal aspects, and SCM at the BoP. Practitioners gain insights on social and societal aspects of SCM in context to poverty alleviation and making business with the poorest members of the world.

Keywords Base of pyramid • Supply chain management • Sustainability • Social responsibility • Literature review • Content analysis

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14.1 Introduction

Poverty alleviation through profit has caught increased interest in recent years (Khalid et al. 2015). It aims at reducing poverty by serving the poorest members of the world population, the so-called base of the pyramid (BoP), and improving of living standards by including the BoP members in global supply chains (SCs) (Agnihotri 2013). Its development led to an inclusive approach of creating fortune with the BoP, combining both economic and social goals (Calton et al. 2013). By engaging in BoP markets, firms are able to stimulate economic development in poor countries and successfully meet their targeted level of growth (Seelos and Mair 2007). Thus, identifying, building, and maintaining partnerships with actors from BoP became pivotal tasks for firms when implementing BoP projects (Hahn and Gold 2014).

In parallel, growing relevance of sustainability is evident in business and research. This is indicated by rising awareness of business sustainability and by growing importance of sustainable supply chain management (SSCM) as well as by a growing number of journal publications (Schaltegger and Harms 2010). SSCM complements the economic framework of traditional supply chain management (SCM) by environmental and social aspects that become tremendously important in today's global SCs (Seuring and Müller 2008).

The integration of sustainability into SCM and poverty alleviation through business at BoP are very current issues, and linking these areas to SCM opens the door to an interesting research stream. However, little attention has been given to the coherence of BoP and SSCM so far (Khalid et al. 2015). This chapter assesses recent developments, current status, and future trends of SSCM research in BoP context. A literature review is presented that elaborates on three research questions:

1. SSCM context: What are the aspects for SSCM at the BoP?
2. BoP context: What is the motivation behind firms' orientation towards BoP and who is benefitting from organizations serving the BoP?
3. Application context: What are the pressures hampering and the incentives supporting the SSCM implementation at the BoP?

The remainder of this chapter is organized as follows. Background information on (sustainable) SCM and the BoP is given in Sect. 14.2, while Sect. 14.3 introduces the research method and in particular the structural dimensions and analytic categories of the content analysis. Results of the descriptive analysis and the content analysis are presented in Sects. 14.4 and 14.5, respectively. Concluding remarks are given in Sect. 14.6.

14.2 Background

14.2.1 Sustainability

The concept of sustainability was firstly introduced in 1713 by Carl von Carlowitz who described a type of forest management which only allowed the extraction of trees as much as can grow again in the same period of time, as to ensure the conservation of the forest as a source for the raw material wood (Schuler 2000). Following this idea, a system is called sustainable if it supports the permanent and viable development of human existence (Enquete-Kommission des Bundestags 1998), in other words if it "meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Work Commission on Environment and Development 1987). Sustainable businesses need to be profitable while considering environmental aspects and allowing better social outcomes (Pava 2008). These approaches to economic, social, and environmental sustainability form the triple bottom line (TBL) framework (Elkington 1998, 2004). Economic sustainability establishes business models that generate more value with less resource consumption at a robust rate of economic growth (Jamali 2006). Environmental sustainability focuses on the preservation of non-sustainable resources, the regeneration of renewable resources, and the pollution and degradation caused by energy and material consumption (Alshuwaikhat and Abubakar 2008). Social sustainability aims at creating and promoting awareness of social relationships, interactions, and institutions affecting sustainable development (Jamali 2006).

14.2.2 Sustainable Supply Chain Management

A supply chain (SC) is defined as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services finances, and/or information from a source to a consumer" (Metzer et al. 2001: 4). SCM affects all entities within the SC and requires their efforts (Metzer et al. 2001). Consequently, the consideration of sustainability in SCM affects all entities within the SC, and a sustainable development requires each entity to be sustainable, delivering economic, social, and environmental benefits. According to Seuring and Müller (2008: 1700), SSCM is comprehended 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." Nowadays, the integration of social, environmental, and economic responsibilities in SCM has become a pivotal challenge for firms and a highly relevant research area (see, e.g., Seuring and Müller 2008; Brandenburg et al. 2014; Brandenburg and Rebs 2015).

14.2.3 Base of the Pyramid

The expression "base (or bottom) of the pyramid" can be traced back to its earliest use by US President Franklin D. Roosevelt in a radio address on April 7, 1932, in times of the great depression, referring to the American poor as the "forgotten man at the bottom of the economic pyramid" (Vachani and Smith 2008). In 1998, the development of BoP concept was started by Coimbatore K. Prahalad, Stuart L. Hart, Allen Hammond, and others (Kolk et al. 2013). Nowadays, the BoP refers to the world's poorest people, about two-third of the world's population, who live under indecent conditions of extreme poverty (Prahalad and Hart 2002; Prahalad, 2005). According to Prahalad and Hart (2002), the BoP represents the fourth and bottom tier of the world economic pyramid that includes 4 billion people with an annual income of less than US$ 1,500. Tier 1 of the pyramid comprises about 100 million middle- and upper-income people who earn more than US$ 20,000 per year. Tiers 2 and 3 of the pyramid include the poor customers in developed countries (tier 2) and the rising middle classes in developing nations (tier 3). The two middle tiers comprise in total about 1.5 billion people who earn less than the people at the top of the pyramid and more than the people at the BoP.

Moreover, BoP is understood as an environment in which the poor people are generally excluded from formal market transactions (Sesan et al. 2013). Most of the global poor live in developing countries where 40–60 % of economic activity is informal (Vachani and Smith 2008). BoP members often live in rural areas or urban slums where lacking credit availability and widespread illiteracy hamper the establishment of any business and, thus, participate in informal economy which is characterized by corruption, currency fluctuations, and inappropriate infrastructures (Prahalad and Hart 2002).

The BoP proposition aims at alleviating poverty by mutual value creation (Prahalad and Hammond 2002). Multinational enterprises (MNEs) are invited to take advantage of the huge untapped purchasing power at the BoP by developing and selling adequate products and services to the poor. The ventures are expected to generate value for their investors and to increase the prosperity of the poor by meeting their essential needs and by creating employment opportunities. In order to do so, firms need to explore and understand the informal relationship structures in BoP markets (Karnani 2007) which have to be turned into a market-based economy that enables free and transparent private sector competition without corruption (Landrum 2007). From the firm's perspective, engaging in BoP markets means to transform the existing business models and to develop innovative processes and products.

Earlier BoP propositions were very much consumer oriented and thereby were largely criticized for their narrower definition of poverty as insufficient purchasing power and for their exploitative qualities that lack truly sustainable development orientation (Shivarajan and Srinivasan 2013). More recent BoP approaches aim at establishing business partnerships with BoP communities and making them an integral part of the business that generates real income. The poor are considered as suppliers, partners, and entrepreneurs, and sustainable development is to be achieved

by business cocreation with mutual sharing, learning, commitment, and dialogue between firms and BoP communities (Simanis and Hart 2008).

14.3 Methodology

Conducting a literature review allows identifying and conceptualizing the state of research, helps contributing to theory development, and, thus, is adequate to assess specific areas of SCM research (Seuring and Müller 2008; Seuring and Gold 2012). Hence, literature on SSCM in BoP context is systematically reviewed in a content analysis that sheds light on developments and trends of related research (Krippendorff 2013). The content analysis is executed in three steps, namely, (1) material collection, (2) category selection, and (3) material evaluation that are explained in greater detail in the following subsections.

14.3.1 Material Collection

Material, i.e., scientific journal publications, is collected by search in "Web of Science" based on the keywords "base of the pyramid" and "bottom of the pyramid." The paper sample compilation is focused on the research domains "business and economics," "social sciences and other topics," and "operations research and management sciences."

In order to ensure a clear basis for this analysis, each paper of the sample has to match the following criteria:

1. The paper is written in English language and published until 2014.
2. The paper focuses on both areas, SSCM and BoP, while publications that elaborate on only one of these areas were excluded.
3. The paper explicitly refers to SCM and SSCM categories developed by Beske and Seuring (2014), Seuring and Müller (2008), and Chen and Paulraj (2004).

As a result, a sample of 76 papers was obtained.

14.3.2 Category Selection

The paper sample is classified according to categories that represent three sections. The first section, SSCM performance, reflects the three dimensions of the TBL, i.e., economy, environment, and society. The BoP context as second section reveals the beneficiaries and the motivation of business implementation at BoP. The third section is dedicated to sustainability triggers of SCM in BoP context.

Table 14.1 Structural dimensions and analytic categories

Economy	
Financial categories	**Nonfinancial categories**
Cost	Quality
Profitability	Delivery speed
Growth	Delivery dependability
	Flexibility
	Innovative capability
Environment	
Input-related factors	**Output-related factors**
Water	Emissions and pollution
Land	Waste management
Other resources	
Society	
SC-internal factors	**SC-external factors**
Acceptability	Education and literacy
Availability	Infrastructure
Staff training	Health
Wages	Income distribution/purchasing power
Employment	Prosperity
Affordability	Substitution
Child labor	
Human rights	

The structural dimensions and analytic categories as listed in Table 14.1 were deductively derived as well as inductively defined. The economic dimension is split into financial and nonfinancial categories. The environmental dimension separates input-related factors and output-related ones. The social dimension distinguishes SC-internal "social" criteria from SC-external "societal" ones.

The classification scheme related to the BoP context is dedicated to the essential matter of defining (1) the beneficiary and (2) the motivation of the BoP model of development. The beneficiary categories comprise "win-win situation" of two actors or groups that profit from business, one single "actor/organization," the "BoP" community, and "unmentioned" or undisclosed profiting actor. These categories were derived inductively during the coding process.

The SSCM-related structural dimensions and analytic categories are deductively derived from Seuring and Müller's (2008) SSCM framework that links sustainability triggers – pressures and incentives – of government, customer, and other stakeholders to the focal company of a SC and its multitier suppliers.

14.3.3 Material Evaluation

The material evaluation includes a descriptive analysis followed by a content analysis. The descriptive analysis informs about the distribution of papers over time and about most relevant journals as well as about the applied research methods. The content analysis informs about the number of occurrences of every single analytic category in the coding of the paper sample. These numbers of occurrence illustrate the importance of each category and allow for deducting generalized statements on the research field of SSCM and BoP. In addition, detailed information is extracted from the main text of the reviewed papers to reveal additional insights from the paper sample.

14.4 Descriptive Analysis

The distribution of papers over time, as illustrated in Table 14.2, exemplifies the growing relevance of SSCM research in context to BoP. More than 80 % of all related papers are published in the last 5 years of the considered time horizon.

Four journals are identified as highly relevant for the research area in focus. About every third paper of the sample is published in Journal of Business Research (nine papers), Journal of Business Ethics (six papers), California Management Review (five papers), and Journal of Product Innovation Management (four papers). However, the paper sample is compiled from 27 journals that cover a wide range of topics including business studies and strategy, marketing, and product innovation as well as organization and technology development. Surprisingly, hardly any paper of the sample is published in a journal that clearly focuses on operations management or SCM.

As illustrated in Table 14.3, qualitative methods such as case studies or conceptual frameworks are clearly preferred to elaborate on this research area. In contrast, empirical-quantitative studies and formal models are underrepresented.

Table 14.2 Distribution of papers over time

Year	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14
#	–	–	2	–	–	2	1	3	3	3	14	11	21	13	3

Table 14.3 Distribution of papers over research methods

	Empirical	Theoretical	Sum
Qualitative	43	29	72
Quantitative	3	1	4
	46	30	76

14.5 Content Analysis

14.5.1 Sustainability Dimensions: General Context

The Venn diagram depicted in Fig. 14.1 provides an overview on the number of papers addressing economic, environmental, and social sustainability issues.

The social dimension is addressed in 71 papers and, thus, forms the dominant TBL dimension in BoP literature. The challenges corporate firms have to face when establishing business at BoP are mostly of social nature and represented by purely social, socioeconomic, and socio-environmental topics. Economic considerations are taken into account in 67 papers, and profit is identified as main reason why firms do business in the highly complex BoP environment. Compared to the other TBL dimensions, environmental factors are surprisingly less often considered. Ecologic aspects are addressed in combination with social or economic issues (in total five papers). All three dimensions of the TBL are reflected in 24 papers which, thus, can be considered holistic.

14.5.1.1 Economic TBL Dimension

As illustrated in Table 14.4, the economic dimension is separated by financial and nonfinancial categories.

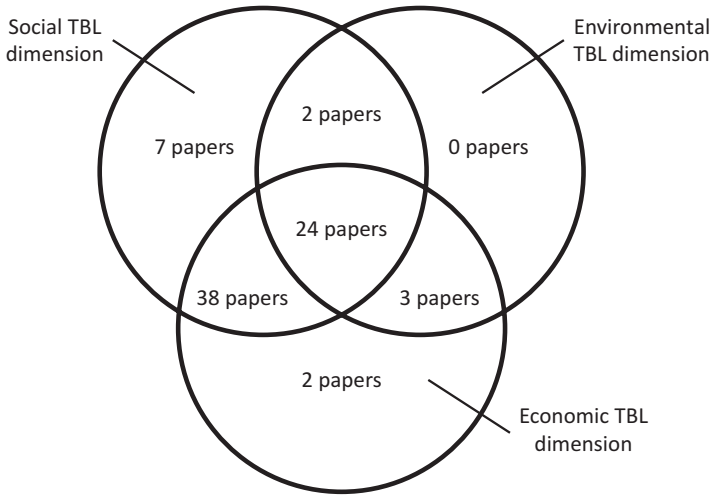

Fig. 14.1 Occurrence frequencies of sustainability dimensions

Table 14.4 Occurrences of economic categories

Category		Number of occurrences
Financial categories	Profitability	46
	Cost	32
	Growth	22
	Thereof firm growth	11
	Thereof economic growth	6
	Thereof firm and economic growth	5
Nonfinancial categories	Innovation capability	37
	Quality	22
	Flexibility	8
	Dependability	2
	Speed	–

Financial Categories of the Economic Dimension

Profitability, measured by indicators such as return on investment, productivity, or revenue, is the dominant economic category. Profitability is the main motivation behind a firm's engagement in BoP environment. It stands for the desire to maximize profits in the BoP markets, simply spoken to make as much money as quickly as possible through business at the BoP. The sustainability of these business activities is questionable because short-term profit maximization and uncertainty avoidance hamper growth and inclusive business in BoP markets and, thus, imbalance financial and social aims (Halme et al. 2012). Profit-oriented activities often result in direct or indirect negative impacts on environment and society (Arnold and Williams 2012). Limiting profit targets for firms is suggested as a possible way to balance economic revenue growth and social value creation (Schrader et al. 2012).

Cost reduction is addressed in 32 papers which cover different cost categories including operating costs (Schuster and Holtbrügge 2012), service costs (Karamchandani et al. 2011), transaction costs (McMullen 2011), research costs (Hudnut and DeTienne 2010), controlling costs (Vachani and Smith 2008), or distribution costs and life-cycle costs (Ray and Ray 2011). From a firm's point of view, decreasing costs results in greater profits. From a BoP consumer-focused perspective, lowering costs allows the firm to offer its products and services at a lower price and, thus, increases the affordability of the poor who as a consequence can purchase more goods from their available incomes (Karnani 2007). Lowering costs during the product innovation process (Ray and Ray 2010) and pursuing standardization and specialization of business operations (Karamchani et al. 2011) are suggested as success factors for business in BoP markets (London and Anupindi 2012).

Growth is addressed in 22 publications in terms of (A) increasing a firm's market share or sales (11 papers) or (B) improving the macroeconomic situation of a country or society (6 papers), while 5 publications promote both (A and B) through an inclusive approach. As developed world markets are saturated, turning to emerging economies has become pivotal for firms' future growth (London and Hart 2004)

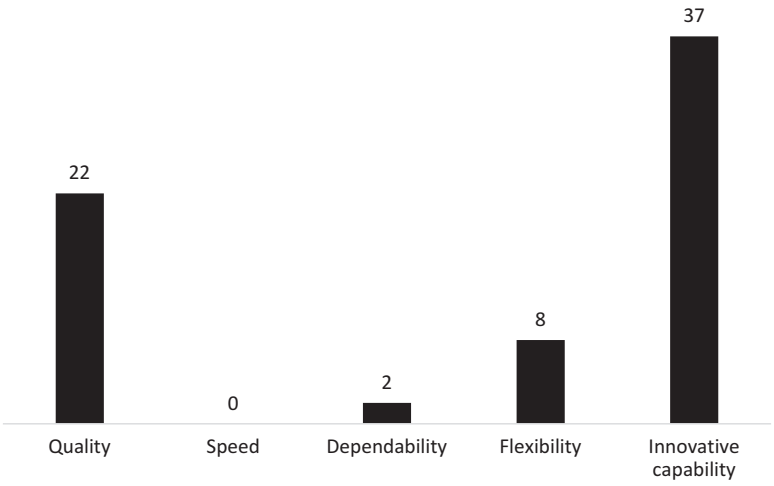

Fig. 14.2 Occurrences of nonfinancial categories

which can be achieved by successful partnerships with local partners at the BoP (Arnould and Mohr 2005). Such alliances enable cost advantages, foster innovation, and facilitate knowledge transfer (Kaplinsky 2011; Murphy et al. 2012). In addition to a firm's growth, including the previously excluded poor in the SC by granting access to market and resources creates jobs and employment (Van Sand and Sud 2012; Halme et al. 2012). Furthermore, micro-entrepreneurial activities and micro-franchising stimulate economic growth at the BoP (Kistruck et al. 2011; Visvanathan et al. 2012).

Nonfinancial Categories of the Economic Dimension

Among the nonfinancial categories of the economic dimension as depicted in Fig. 14.2, innovative capability is most often addressed (37 papers). Engaging in BoP markets requires the development of sustainable products tailored for the unique circumstances of the BoP, and not simply cheaper top of pyramid products (Nakata and Weidner 2012; Ramani et al. 2012). Nevertheless, even the best product innovation is worthless, if not supported by an effective business model (Chesbourgh et al. 2006), e.g., regarding distribution innovativeness or marketing strategies. In 23 out of 37 papers, a strong connection between innovative capability and profitability has been identified, justified mainly by cost innovativeness. Besides, environmental performance and innovative capability are described as complementary (Hart and Dowell 2011). Furthermore, 34 publications demonstrate that innovation has profound effects on social change and is thus an important driver for sustainable social development as well (Hall et al. 2012).

Quality, addressed in 22 papers, mainly deals with the sacrifice of product quality in return for low prices, making products more affordable and enabling BoP

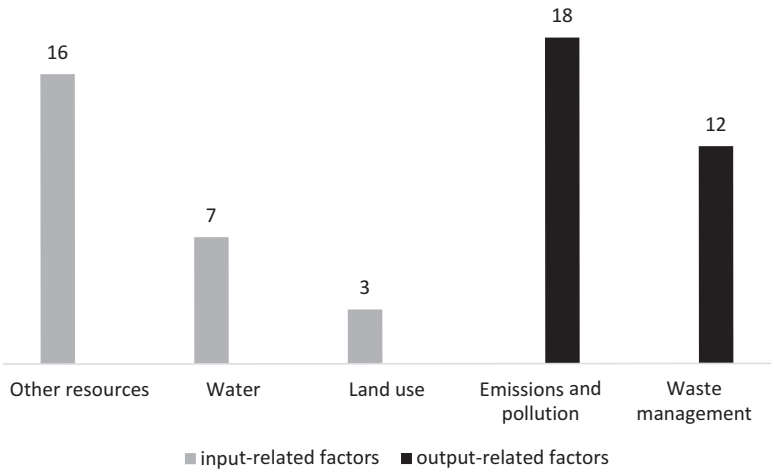

Fig. 14.3 Occurrences of environmental categories

consumers to purchase more with their little incomes thereby leading to firms' business success in BoP markets (Ray and Ray 2011). Standardization and specialization or the establishment of sustainability standards in terms of quality norms can support the protection of BoP consumers (Karamchandani et al. 2011) but also can represent significant barriers for the entry of poor producers into a SC (Perez-Aleman and Sandilands 2008). Quality improvement is needed (see, e.g., Schrader et al. 2012; Visvanathan et al. 2012) as well as regular quality control and the exclusion of non-compliant actors from international markets (Weidner et al. 2010).

Flexibility, addressed in eight papers, is necessary to be successful in the dynamic and complex BoP markets (Hill 2010). Flexible diversity in terms of product offerings and segments served can increase sales and reduce business risks, and, moreover, organizational flexibility can support the innovation process (Halme et al. 2012).

The remaining two nonfinancial factors, dependability (two papers) and delivery speed (not mentioned), are hardly addressed, probably because BoP business development has not yet reached a stage allowing it to work on strategies to optimize the distribution but still rather deals with missing distribution channels.

14.5.1.2 Environmental TBL Dimension

As illustrated in Fig. 14.3, the environmental dimension shows a balance of input- and output-related ecologic factors (26 occurrences vs. 30 occurrences).

Output-related environmental categories are often addressed in a generic way, e.g., by referring to pollution or gas emissions without giving any further concretizations. Schrader et al. (2012) put "emission" in concrete terms of CO_2 emissions

and, thus, represent an exception from the rule. Environmental efficiency is achieved by minimizing pollution and gas emissions (Kaplinsky 2011), as addressed in 18 papers. Pollution increases by worldwide population and urban industrialization. At the BoP, pollution is mainly caused by transportation and by cooking with biomass (Hudnut and DeTienne 2010), while from business' side, profit-seeking multinational companies (MNCs) degrade the natural environment and, thus, socially harm the poor (Arnold and Williams 2012). Pollution prevention is enabled by proactive environmental strategies to minimize process waste and to enhance resource productivity (Hart 2005). Furthermore, environmental reporting and life-cycle assessment (LCA) help mitigating the environmental impact of a firm's products (Olsen and Boxenbaum 2009).

Waste management, addressed in 12 papers, comprises waste disposal, recycling, and reuse. At the BoP, appropriate waste management systems are missing, and, thus, a lack of control over waste generation and inadequate disposal of waste lead to severe environmental burdens and harm to health (Seelos and Mair 2007). The burning of waste is a characteristic of emerging economies (Hudnut and DeTienne 2010). Waste can be reduced by retrofitting and increasing repair rates (Ray and Ray 2010). Moreover, firms could strongly reduce generated waste by modifying production processes (Schrader et al. 2012). In contrast, single sized packaging concepts, the simplest way to increase the affordability of the poor (Karnani 2007; Rivera-Santos and Rufin 2010), result in more waste. However, the proliferation of single size packages has been adopted by many firms (Rivera-Santos and Rufin 2010).

Input-related environmental factors are hardly concretized. Water and land use are comparably seldom mentioned (7 papers and 3 papers), and input factors such as raw materials or fossil fuels are summarized as "other resources" (16 papers). Biomass is the only resource to be concretely addressed. It represents a comparably cheap fuel which is widely consumed by the poor and, thus, becomes an economic-environmental issue. Moreover, inefficient energy conversion methods and unsustainable harvesting link biomass to the social category of health (Sesan et al. 2013).

14.5.1.3 Social TBL Dimension

As illustrated in Fig. 14.4, the occurrence frequencies of SC-internal and SC-external social factors shows a wide spread.

Insufficient infrastructure represents the most often addressed social factor (44 papers). Examples comprise irregular water and electricity supply or missing roads which lead to fragmented market structures and high costs of serving BoP markets (Ray and Ray 2010, 2011) as well as inefficient market infrastructure (Schuster and Holtbrügge 2014) and defective IT infrastructure which have a huge impact on BoP structural characteristics (Rivera-Santos and Rufin 2010). Companies must serve BoP markets with business models that are resilient to poor or nonexistent infrastructure (Hill and Mudambi 2010). Examples for such business models are micro-entrepreneurial activities (Visvanathan et al. 2012), e.g., poor women from rural

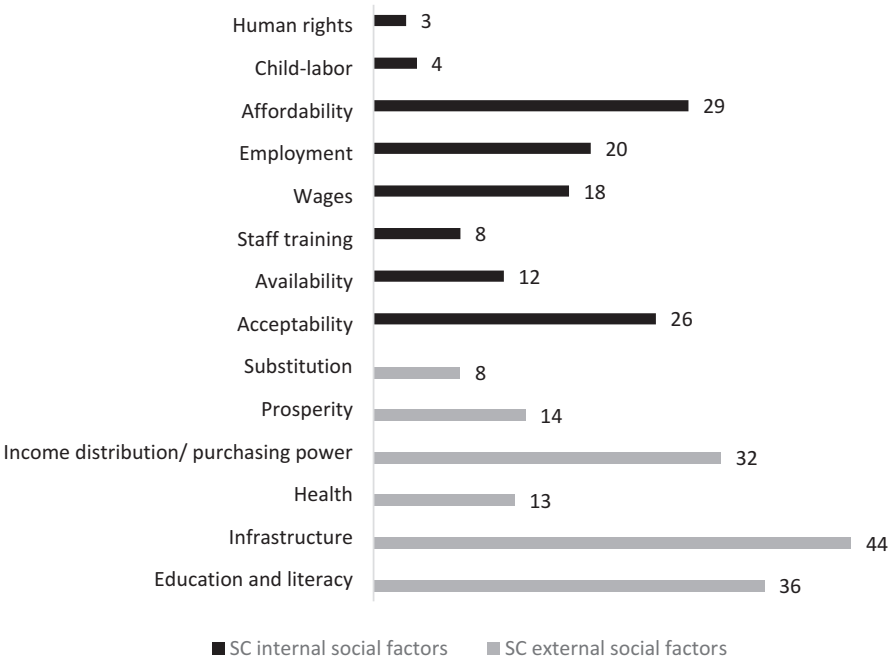

Fig. 14.4 Occurrences of social categories

Brazil who sell Avon's beauty products directly to BoP consumers (Hill and Mudambi 2010), or MNCs that develop new supply and distribution networks, e.g., Nestle's local collection centers for refrigerated milk in reach of farmers in rural BoP areas (Pervez et al. 2013).

Moreover, missing education and low literacy rates, as addressed in 36 papers, are huge barriers for firm's engagement at BoP and detriments of the poor (Berger and Nakata 2013). Lack of education and illiteracy limit a BoP consumers' ability to assess products and services offered by any kind of intermediaries (Ramani et al. 2012), and vulnerability of the poor is a consequence of the lack of education and information and also of missing self-control (Karnani 2007). Thus, MNCs need to set educational programs for illiterate BoP members to make them successful as suppliers, entrepreneurs, and buyers (Hill 2010). Education and literacy in the Brazilian tourism business represents one example (Hall et al. 2012).

Income distribution and purchasing power is addressed in 32 papers, mainly in context to the BoP definition (Karnani 2007), to poverty as the inability to consume (Subrahmanyan and Gomez-Arias 2008), to social issues such as affordability and substitution, or to economic criteria such as cost and profit. Purchasing power can be increased either by growing income, e.g., through the provision of microloans or by increasing wages, or by offering subsidized/cheaper products, e.g., by products that are affordable for the poor and that meet their needs (McMullen 2011). The income distribution at BoP is affected by seasonality, temporality, and regional

variances due to self-employment and employment in informal sector (Ramani et al. 2012). Income disparities characterize the BoP and represent a major challenge for successful industrialization and global integration (Hall et al. 2012). Income disparities are relevant for product innovation, in particular for affordability and acceptability of products (Ray and Ray 2011). Income constraints and low purchasing power of BoP consumers can be tackled by enabling employment opportunities for the poor as producers and suppliers which not only enrich the social life but also increase income and purchasing power (Seelos and Mair 2007).

The remaining SC-external factors are related to prosperity (14 papers), health (13 papers), and substitution (8 papers).

In context to sustainable development at the BoP, prosperity is linked to poverty alleviation programs. Such programs can degenerate into global charity which neither improves the livelihood of the poor nor brings any long-term economic benefit (Ansari et al. 2012). In contrast, integrating the poor into the SC of business seeking firms enables a sustainable development, and, therefore, self-reliance, freedom, self-respect, and responsibility are essential for prosperity and wealth creation (Chatterjee 2014). In addition, increasing the prosperity by a strengthened purchasing power improves the livelihood (Pervez et al. 2013).

Health addresses the lack of medical care, malnutrition, and secure housing as well as social deprivation provoked by stress, anxiety, and uncertainty (Nakata and Weidner 2012). Moreover, waste and odor, leaking and polluted water resources, or diseases caused by gas emissions represent health issues at the BoP that link the social and the environmental dimensions of the TBL (Seelos and Mair 2007).

Substitutive behavior can help the poor overcome their limited purchasing power, but it also can disrupt the social harmony, because branded products such as skin whitening beauty cosmetics are expensive substitutes (Karnani 2007; Ansari et al. 2012). Thus, the fundamental question if business involvement at the BoP creates or destroys social well-being is not yet answered.

In general, the SC-internal social categories are less often addressed than external ones, because external factors such as poor infrastructure and low education form major barriers that prevent firms from investing into business at the BoP. However, SC-internal social issues are not of subordinate importance for SSCM at the BoP.

Affordability, the most prominent SC-internal social factor (29 papers), emphasizes that the opportunity to buy more does not imply the ability to afford more (Ansari et al. 2012). This category clearly splits the opinions of scholars, as exemplified at the concept of single size packaging, which is advocated by some scholars and heavily criticized by others because affordability can only be increased by reducing the price per use and not by small packaging (Arnold and Williams 2012). Furthermore, micro-credits do not improve affordability because affordability is improved by growth and employment at reasonable wages (Karnani 2007), by lower costs (Ray and Ray 2011; Vachani and Smith 2008), or by intelligent pricing mechanisms (Schrader et al. 2012).

Issues related to acceptance of products and business are in focus of 26 papers. Hosting societies have to accept products and business in order to achieve poverty

alleviation. Product acceptability depends on affordability, functionality, and resale value (Ray and Ray 2010, 2011). Hudnut and DeTienne (2010) explain the relevance of acceptability at the example of emission-reduced motorcycles, a technological innovation that meets various TBL objectives but, however, remains unaccepted by the poor due to their lack of willingness to pay for cleaner air. This example exemplifies that need and acceptance of BoP societies are prerequisites of successful innovations. An appropriate marketing in subsistence markets is necessary to achieve business acceptability at the BoP (Webb et al. 2010; Weidner et al. 2010).

Employment, addressed in 20 papers, and wages, reflected in 18 papers, represent two closely related SC-internal social issues which both improve living standards, public health, and life expectations and also decrease illiteracy, fertility rates, and child labor (Ahlstrom 2010; Ansari et al. 2012). Moreover, employment and wages make basic resources such as education accessible and, hence, help alleviate poverty (Arnold and Williams 2012). Due to informal market structures and lack of formal employment, BoP communities show high self-employment rates (Kistruck et al. 2011) which makes the integration of BoP markets into global economy difficult (Hall et al. 2012). Employing the poor as workers often positively influences social inclusive growth at the BoP (Gino and Staats 2013; Hall et al. 2012). In contrast, low income forces BoP producers to use low-quality inputs and, as a consequence, to generate low-quality outputs which in turn limit the income and, thus, the input quality, the productivity, and ultimately the ability of poor producers to participate in global SC (London et al. 2010).

The availability of products and information is content of 12 papers. Based on information on product and manufacturing practices, poor producers can make better-informed decisions about product pricing and quality practices. Information can limit the exploitation of poor farmers by intermediaries, who buy cultivated products at a very low price and sell them at considerably higher price, and, thus, empower BoP producers (Arnold and Williams 2012). Moreover, information flow and transparency link supply and demand and, thus, help bridging the gap between MNCs and the BoP (Reficco and Marquez 2012). Product availability is influenced by the poor road infrastructure and distribution challenges in fragmented BoP markets (Ray and Ray 2011).

The dominant idea behind staff training, considered in eight papers, is to provide skills and information to employees and to suppliers, producers, and entrepreneurs at the BoP (Parthasarathy 2010; Karamchandani et al. 2011; London and Anupindi 2012).

SSCM research seldom elaborates on child labor, considered in four papers, or human rights, discussed in three papers. The lack of labor law enforcement is the main reason for human rights violation and child labor in subsistence BoP markets (Mena et al. 2010). Adequate policies are needed to protect human rights and to eliminate child labor (Hall et al. 2012). Moreover, social and environmental norms or sustainability standards can make global SCs accessible for poor producers (Perez-Aleman and Sandilands 2008). However, communities first have to understand the movement against child labor before it can be eliminated (Mena et al. 2010).

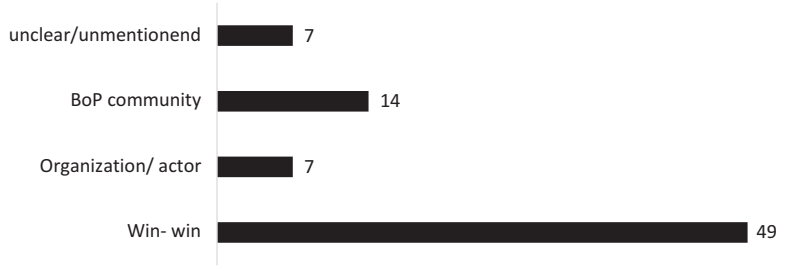

Fig. 14.5 Frequencies of defined beneficiaries from BoP business ventures

14.5.2 BoP Context

The occurrences of defined beneficiaries from BoP business ventures as depicted in Fig. 14.5 show that win-win situations between various involved groups are most often detected (49 papers). In contrast, benefits of BoP community through the presence of MNCs in subsistence markets (14 papers) or gains of firms or their shareholders without consideration of advantages for the BoP community (7 papers) are less often found in the paper sample. Finally, seven papers that focus on social issues like human rights and child labor or environmental aspects do not mention any benefit from business at the BoP.

Financial interest is the main motivation for western firms to engage in rapidly growing BoP markets which provide new business opportunities in an era of globalization and saturation of traditional markets (Arnould and Mohr 2005; Bardy et al. 2012; Nakata and Weidner 2012). To leverage these opportunities, products and services need to be tailored for BoP markets (Ray and Ray 2010), and mutual value creation under consideration of financial and social objectives is crucial for poverty alleviation through profits (London et al. 2010). Thus, MNCs have to strive for an environmentally and socially sustainable development (Olsen and Boxenbaum 2009) and should improve their image and reputation (Schrader et al. 2012). Innovative products for BoP markets combine sustainable corporate growth and social responsibility and, hence, alleviate poverty and generate social inclusion (Hudnut and DeTienne 2010; Reficco and Marquez 2012). Furthermore, empowering the poor with information, literacy, and market access at lowered costs prevents from exploitation by suppliers and intermediaries (Vachani and Smith 2008; London and Hart 2004).

14.5.3 Triggers of Sustainability

According to Seuring and Müller (2008), sustainability activities are triggered by governmental agencies, customers, and other stakeholders. In this analysis, sustainability triggers are categorized as pressures, which include barriers, or incentives.

Table 14.5 Occurrences of sustainability influences of different stakeholder groups

	Pressures and barriers	Incentives	∨
Government	28	20	41
Customer	33	25	40
Other stakeholders	24	52	59
∨	58	67	73

As shown in Table 14.5, nearly all reviewed manuscripts reflect sustainability triggers (73 papers). In general, slightly more interest is given to incentives for sustainability (67 papers) than to sustainability pressures and barriers (58 papers). Customers (40 papers) and governmental authorities (41 papers) represent two important sustainability trigger groups, although most studies elaborate on sustainability influences of other stakeholders (59 papers).

In the following, sustainability influences of different stakeholder groups are assessed in greater detail.

14.5.3.1 Pressures and Barriers

Table 14.5 exemplifies that pressures and barriers of sustainability are more often related to customers (33 papers) than to government (28 papers) or other stakeholders (24 papers).

Customer influences are often related to high affordability which in turn is caused by existing income constraints at the BoP (Seelos and Mair 2007; Ramani et al. 2012; Van den Waeyenberg and Hens 2012) and limits the product demand in low-income countries (Kaplinsky 2011). In this context, usage and penalization of low quality is to be mentioned (Perez-Aleman and Sandilands 2008). Furthermore, behavioral aspects of buyer-seller relationships, in particular "side-selling" of suppliers (Karamchandani et al. 2011), opportunistic intermediaries (Kistruck et al. 2013), or the "sitting back" as potential micro-franchisees behavior (Kistruck et al. 2011), are mentioned. Moreover, lacking education and high illiteracy rates represent barriers that require investments into education and training to implement sustainable business at the BoP (Schuster and Holtbrügge 2012). However, BoP communities receive donations more often than investments (Reficco and Marque 2012), and some BoP members obtain more benefits from sustainable business than others (Ansari et al. 2012).

Governmental aspects are often related to corruption, policy uncertainty, and the absence of governmental regulations (Arnould and Mohr 2005). Firms depend on policies, e.g., favorable tax structures and bankruptcy laws (Webb et al. 2010), and support from governments who, for instance, could enable substantial investments into the infrastructure (Ray and Ray 2011). However, missing institutional stability and governmental instability hinder investments and sustainable development at the BoP (Hill and Mudambi 2010; Arora and Romijn 2012). Governments that refuse to

take responsibility for social inclusion and legal authorities that fail to protect BoP members and their rights in business also hamper the realization SSCM at the BoP (Hill 2010; Arnould and Williams 2012; Hall et al. 2012). The inability of governments to ensure human rights (Mena et al. 2010), property rights (McMullen 2011) and informal rules that replace legal obligations (Ray and Ray 2010) is considered as obstacle to a sustainable development. Moreover, MNCs need to be careful when competing with local firms that are connected to local politicians (Rivera-Santos and Rufin 2010).

Other stakeholders that put pressures include the Central Bank (Berger and Nakata 2013) and NGOs (Karamchandani et al. 2011) and also strong informal, normative, and cognitive institutions (Rivery-Santos et al. 2012). Cultural distance between business partners in the SC and stakeholders can lead to misunderstandings and hamper the establishment of sustainable business relationships (Tashman and Marano 2009). Institutional distance and intraorganizational barriers limit the transferability from traditional developed markets to BoP markets, and other stakeholders involved in business may show objection because of additional costs of sustainability goals (Van Sandt and Sud 2012).

14.5.3.2 Incentives

Other stakeholders, including communities, religious groups (Schuster and Holtbrügge 2012), nonprofit organizations (NPOs), and NGOs, represent the dominant category in this dimension (52 papers). Other stakeholders enhance a firm's ability to identify and exploit entrepreneurial opportunities (Hall et al. 2012: 790) which in turn provides synergies from which firms and BoP communities may benefit. Firms reflecting social and environmental criteria can achieve mutually defined sustainability targets in cooperation with uncommercial partners that provide information on local market conditions, support projects, or give political advice (Hahn and Gold 2014). However, partners need to have an appropriate context-specific knowledge in order to positively influence the business development (London and Hart 2004). Partnerships with NGOs can help firms gathering information on the needs of the poor (Van den Waeyenberg and Hens 2012), gaining knowledge about social structures (Hill 2010), meeting consumers' needs through joint development (Schuster and Holtbrügge 2014), and extending the firm's reach in complex and fragmented BoP markets (Karamchandani et al. 2011) at lower risks and uncertainties (Reficco and Marquez 2012). Besides, firms can reach a greater efficiency when partnering with, e.g., micro-finance institutions (Hudnut and DeTienne 2010). NGOs can fill existing institutional gaps at the BoP and can financially and technically support the poor to implement standards that are required for a sustainable business development in BoP communities (Perez-Aleman and Sandilands 2008; Rivera-Santos et al. 2012). NGOs can help building trust between firms and impoverished BoP entrepreneurs, suppliers, and producers (Schrader et al. 2012). However, alliances with NGOs are complex and, thus, should be treated with caution,

especially because incompatible goals may even lead to alliance failure (Webb et al. 2010).

Governmental incentives for sustainable business at the BoP (20 papers) enable a sustainable development in the least developed countries (Ansari et al. 2012). Legal authorities can ensure the institutional protection against unpredictable changes of regulations (Rivera-Santos et al. 2012) and enable adequate policies and investments that are favorable to sustainable business (Karnani 2007; Seelos and Mair 2007). Governmental organizations can help a firm to adhere to the institutional environment at the BoP (Schuster and Holtbrügge 2014) and to reduce its distance to the BoP communities (Van den Waeyenberg and Hens 2012) which leads to positive impacts on society and business outcomes (Viswanathan et al. 2009). Governmental agencies can cooperate with NGOs, e.g., national aid agencies (Ramani et al. 2012), to improve the infrastructure and to tackle basic social issues (Gold et al. 2013) and ultimately to support the creation of domestic markets (Parthasarathy 2010).

Customers' incentives for sustainability are reflected in 25 papers. Customers need to be centered in development processes (VanSandt and Sud 2012), because cooperation between firms and the poor can support innovators in meeting the needs of the BoP population (Halme et al. 2012). Combining local knowledge with latest technology enables the creation of an economically sustainable and profitable business model (Hill and Mudambi 2010; Pervez et al. 2013).

14.6 Concluding Remarks

The results of the content analysis presented in this chapter inform about insights and gaps of SSCM research in BoP context.

The establishment of businesses in BoP markets is generally justified by the potential economic and social benefits for firms that make profit and hosting societies that alleviate poverty. Next to profitability, innovative capability represents an important economic category. In contrast to barely addressed environmental aspects, the social categories related to, e.g., infrastructure, education, literacy, and affordability dominate literature on SSCM at the BoP. Hence, integrating all three TBL dimensions of sustainability remains a huge challenge, due to (real or perceived) trade-offs between economic, environmental, and social sustainability objectives.

Requirements of BoP consumers do not necessarily have a positive influence on business sustainability. Low purchasing power and the resulting inability to consume hinder the sustainable development of BoP markets. In addition, weak formal institutions, missing governmental regulations, and corruption prevent from establishing sustainable business at the BoP. However, NGOs and other stakeholders provide firms with valuable information on the structure and the needs of BoP markets and, thus, can stimulate and strengthen sustainability at the BoP.

SSCM at BoP represents a young and highly promising field of research which offers large potential to develop a strong theoretical basis. Future research streams

should focus on the advantages and benefits of SSCM, enable the creation of win-win-win situations, and support the development of collective solutions for poverty alleviation. Indeed, environmental sustainability as well as the high contemplation of social sustainability issues needs to be considered in theory and practice. Extending BoP theory toward the simultaneous consideration of economic, environmental, and social sustainability would support SSCM theory development.

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Chapter 15
What Hybrid Business Models Can Teach Sustainable Supply Chain Management: The Role of Entrepreneurs' Social Identity and Social Capabilities

Lydia Bals and Wendy L. Tate

Abstract Integrating triple bottom line (TBL; economic, social, and environmental) sustainability into supply chains is a major challenge. Progress has been made to address the economic and environmental dimensions in supply chain management research; however, the social dimension is still underrepresented. This chapter reflects on research that looked at the literature on hybrid business models and social entrepreneurship in order to bridge these streams of literature to literature on sustainable supply chain management. Following the literature analysis, case-based research related specifically to social businesses in catastrophe-ridden Haiti was performed. The insights provided by the entrepreneurs of these businesses showed organizations that target TBL objectives from their inception, the specific social capabilities employed to obtain the desired TBL objectives, and the specific supply chain structures that were needed to execute and achieve the TBL goals. The purpose of this chapter is to reflect on that research as it relates to the social businesses, consider the primary results of that research, and discuss how those results might guide further research in the field of sustainable supply chain management.

Keywords Sustainable supply chain management • Corporate social responsibility • Triple bottom line • Social entrepreneurship • Shared value • Design

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15.1 Introduction

Assessing worldwide poverty rates and environmental degradation shows that integrating triple bottom line (TBL; economic, social, and environmental; Elkington 1998) sustainability into global supply chains is still a major challenge (UN Water 2013; WWF 2012; World Bank 2015). While sustainable supply chain management (SSCM) is increasingly becoming an important area of research (Pagell and Shevchenko 2014), most still concentrates on economic and environmental aspects, whereas the social dimension is relatively understudied (Yawar and Seuring 2015; Müller and Stölzle 2015; Seuring and Müller 2008).

Research on hybrid business models and social entrepreneurship covers the economic and social dimensions and/or even all three dimensions (e.g., Di Domenico et al. 2010). Therefore, this area of research can offer insights into how a business model is actually conceived and executed if TBL incentives are present at inception rather than having to redesign ex post to adapt to changing stakeholder or regulatory requirements (e.g., in the context of CSR pressure). This chapter seeks to derive lessons to SSCM from this ex ante approach to promote further research, particularly at the interface of SSCM and social entrepreneurship.

Choosing the individual actors and their incentives as the level of analysis can shed light on the social capabilities needed for subsequent supply chain design. Instead of looking at established firms and their existing structures, the social start-up environment allows researchers to study social capabilities in action, while the business is still formed and as it begins operations.

The chapter seeks to build a bridge between SSCM and social entrepreneurship research. For this purpose, it presents the major results of an ongoing research project where social businesses in Haiti were studied. While the results from the research are in focus, one primary goal of this chapter is to make suggestions regarding future research stemming from lessons learned in how to collect data in such a setting and how this cross-disciplinary research has been received at conferences and during the peer-review processes. The chapter begins with some of the conceptual background supporting this research and concludes with a summary of future research directions.

15.2 Conceptual Background

While SSCM research has been mostly covering the economic and environmental dimension and rather centers on how to retrofit existing supply chains according to sustainability criteria, the social entrepreneurship literature offers insights on how to tackle sustainability, including the social dimension, when creating businesses. As background for the following sections, key terms and definitions are first provided.

15.2.1 Sustainable Supply Chain Management and Design

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

Within that research area, to think and act differently in SSCM is increasingly called to the attention of researchers. For instance, in the 50th anniversary issue of the Journal of Supply Chain Management, Pagell and Shevchenko (2014, 44f.) highlighted the need for further research regarding "how to create truly sustainable supply chains" and "what new practices and processes are needed to create truly sustainable supply chains."

The existing SSCM research focuses mainly on the economic and environmental dimensions of the TBL but suggests, "[a] comprehensive analysis of sustainable business operations should consider all three TBL dimensions *simultaneously*" (Wu and Pagell 2011, 589). Therefore, a clear need for additional research regarding "how *to create* [emphasis added] truly sustainable supply chains" (Pagell and Shevchenko 2014, 44f.) can be identified. Similarly, it has been highlighted that as "stewards of knowledge creation and dissemination, it is necessary to conduct in-depth, nuanced research to help decision makers understand how to think, *design* [emphasis added], and deliver differently" (Fawcett and Waller 2015, 238).

So far, research on the TBL performance of supply chains has been predominantly focused on how to improve environmental performance in existing supply chains (e.g., Wu and Pagell 2011; Zhu and Sarkis 2004; Melnyk et al. 2003; Christmann 2000; Handfield et al. 1997) and not on how to design sustainable supply chains. In order to make a contribution toward addressing this gap, this research investigates how supply chains can be deliberately structured to achieve TBL objectives from inception rather than how existing chains try to reduce negative TBL outcomes later (or retrofit the supply chain to meet different stakeholder needs). Therefore, this research's focus is on the design phase.

Supply chain design involves "The design or reconfiguration of a supply chain which is considered as a strategic goal aiming at determining the number, location and capacities of manufacturing plants and distribution centres, the set of suppliers to select and the effective flow of *material* [emphasis added] throughout the supply chain" (Varsei et al. 2014, 243). Literature on supply chain modeling during the 1990s has predominantly focused on costs. Hence, supply chain design (or supply chain network design) literature shows an emphasis on the more traditional metrics of economic performance, resulting in a rather narrow scope of delivery from a TBL perspective.

15.2.2 Social Entrepreneurs

The primary mission of a social entrepreneur is to create social value by providing solutions to social problems (Dacin et al. 2011). The characteristics of the mission-driven entrepreneur are important for successful social business model development. Social entrepreneurs have distinct characteristics that evolve from their perceived membership in a relevant social group (Tajfel and Turner 1979), which drives and helps to develop a strong mission-based approach to solving a social problem (Tajfel 1982). For example, the social entrepreneur may have a background in finance, specifically microfinance, that allows him or her to design and develop social business models that utilize aspects of microfinance to solve the problem (Tyler and Blader 2003). The social entrepreneur may identify with the particular community or context in which the problem resides (Tajfel 2010).

Social entrepreneurs have to have the ability to think and act differently in terms of developing and executing sustainable business models and programs that make them accountable to their stakeholders and for the outcomes (Dees 1998). The entrepreneurs tend to have a strong mission-based approach to creating and sustaining TBL social value (Sullivan Mort et al. 2003). They engage in a process of continuous innovation, adaptation, and learning (Dees 1998). Continuous improvement is designed into the social business models with the recognition that stakeholder relationships also adapt as the models mature.

Social entrepreneurs excel at recognizing and taking advantage of opportunities, without being limited by the resources currently available (Dees 1998), to deliver the social value of their mission (Sullivan Mort et al. 2003). Social entrepreneurs exhibit a high tolerance for risk, innovativeness, and proactiveness (Smith and Woodworth 2012). The notion of balanced judgment and clear purpose is also a critical characteristic (Peredo and McLean 2006). It is the social entrepreneur's identity that helps to deliver these innovative or novel social business models that help to deal with complex TBL needs of emerging or developing economies. These identities also include entrepreneurial spirit and social passion (Moss et al. 2010). For success, the "mission" of the entrepreneurs must be both entrepreneurial and product oriented as well as socially and people oriented (Moss et al. 2010).

Sullivan Mort et al. (2003) argue that social entrepreneurship is a multidimensional construct defined by intersecting these types of individual characteristics. For example, social business entrepreneurs tend to exhibit a balanced judgment, a coherent unity of purpose, and an action in the face of complexity. The social entrepreneur is also well adapted to balancing the interests of multiple stakeholders while maintaining the sense of mission which is a requirement for successful design and execution of the business model (Peredo and McLean 2006). The ability to recognize the various stakeholders and their interests allows them to understand and deliver the appropriate shared stakeholder value. Another key goal of the entrepreneur is to attract funding that sustains the business model from inception to profit. These aspects underline the role of the social entrepreneur for value chain design.

15.2.3 Impact Investing and Hybrid Organizations

An impact investment is defined as an investment with the intent to create measurable social or environmental benefits in addition to financial return (Wood et al. 2013). Impact investing plays a critical role in helping social entrepreneurs source funding to design and execute the appropriate social business models, especially in the early phases of business model development and execution when the social business is most vulnerable (Grabenwarter and Lichenstein 2011).

Traditional commercial investors focus almost exclusively on projects that are attractive purely for their financial returns, such as the natural resource extraction and low-cost manufacturing sectors, with social outcomes as a secondary issue and with lower associated risk (Henisz and Zelner 2010). In contrast, impact investments target social and environmental issues that are largely ignored by existing international development efforts or by other, more profit-driven investment opportunities (Simon and Barmeier 2010); therefore social business models in emerging economies are often targeted and focus specifically on working with sectors that have a significant positive effect on recipients' quality of life or betterment of the community. Figure 15.1 below shows the distribution of social impact investments by sector. Stakeholders play a key role in the type of investment.

Impact investments are made with the expectation of an explicit financial return and are not largely dependent on external subsidies to sustain operations (Simon and Barmeier 2010). Impact investors seek to address problems through market-based, for-profit models that provide both a social and community benefit and the positive financial return necessary to generate a self-sustaining revenue stream and achieve scale (Bugg-Levine and Emerson 2011; Wood et al. 2013).

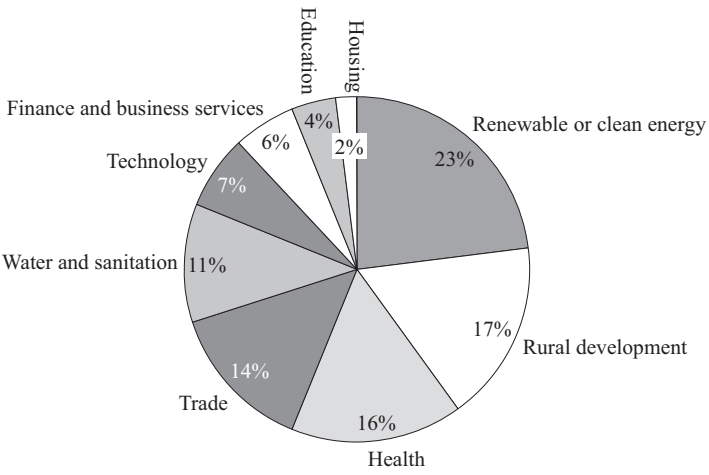

Fig. 15.1 Distribution of social impact investments by sector (Source: Simon and Barmeier 2010, 17)

A hybrid organization is defined as an organization that pursues a dual mission of financial sustainability and social purpose. Because of this hybridity, there are conflicts that arise regarding mission, financial resource acquisition, and human resource mobilization (Gupta et al. 2015). Social entrepreneurs must be able to span the boundaries of the private, public, and nonprofit sectors (Tracey et al. 2011) and face conflicting institutional logic (Pache and Santos 2012).

15.2.4 Social Entrepreneurs in Hybrid Organizations

An organizational form is an "archetypal configuration of structures and practices" that is "regarded as appropriate within an institutional context" (Greenwood and Suddaby 2006, 30). To be categorized as a distinct organizational form, individual organizations manifest those characteristics that are identified with a specific category of organizations (Romanelli 1991). Research has found that internal processes of the organization will mediate the external and internal demands faced by hybrid organizations (Jay 2013). This means that the social entrepreneur must be adept at managing tools, processes, behaviors, and skills to effectively engage stakeholders at multiple levels and meet the multi-perspective demands inherent with the hybrid organization. Hybrid organizational forms are considered structures and practices that allow the coexistence of values and artifacts from two or more conflicting organizational forms (Gupta et al. 2015) and different norms and practices in many different locations (Cooney 2006).

15.3 Research on Social Businesses in Haiti

Based on the background of the sustainable supply chain and entrepreneurship research streams outlined in Sect. 15.2, this research set out to shed light on the two research questions mentioned in the introduction. The following gives an overview of the research design and the data collection and then provides a summary of the main results.

15.3.1 Research Design

The objective of this research project started out as to address the following research questions:

1. How can truly sustainable supply chains be designed?
2. What new practices and processes are needed to design truly sustainable supply chains?

In relation to the individual level, the objective was to use cases to illustrate social identity and capability effects on the level of the individual for successful business model development, with a focus on the physical as well as support chains (information and financial).

This research set out to engage in theory elaboration (Ketokivi and Choi 2014), focusing on the contextualized logic of a general theory, here the theory of the supply chain (Carter et al. 2015) for the question "How can truly sustainable supply chains be designed?" and the resource-based view (RBV) (e.g., Barney 1991; Wernerfelt 1984) for the question "What new practices and processes are needed to design truly sustainable supply chains?" The cases served to elaborate theory and to move it into a different context with structural and boundary implications that vary from the original theory. Based on abductive reasoning, theory elaboration utilizes the interplay between empirical data and theory simultaneously (Dubois and Gibbert 2010). Data is used to illustrate and elaborate (Ketokivi and Choi 2014). For data collection, an interview guide (Appendix A) was developed.

15.3.2 Data Collection

In early 2014, one of the researchers visited various events on social businesses to look for suitable cooperation partners for data collection. One of these events was hosted by Yunus Social Business (YSB) in Frankfurt, Germany. From a SSCM perspective, YSB's way of supporting social businesses to achieve sustainability objectives throughout a wide range of countries reflected the earlier mentioned calls for more research into how sustainable supply chains can be created/designed (Pagell and Shevchenko 2014; Fawcett and Waller 2015). Therefore, YSB was approached right after the event for data collection, and the YSB headquarters in Germany helped to select the appropriate country and the respective social businesses to be analyzed in detail.

Regarding country selection, a sampling criterion was established that the country needed to have social businesses operating for more than 2 years. Additionally, as a second criterion, the specific location had to offer severe resource constraints to observe how supply chains can be designed to overcome those constraints. This led to the selection of catastrophe-ridden Haiti, one of the countries where YSB has its longest presence. Haiti was selected as a research environment due to serious economic, environmental, and social constraints. The people in Haitian communities live in levels of extreme poverty with limited access to goods and services. The 2010 earthquake that hit the country has had lingering environmental, economic, and social impacts. Also, extreme deforestation has resulted in less than 1 % of the natural forests still remaining in Haiti, causing additional TBL challenges. To make matters worse, in 2016, Hurricane Matthew, the most powerful Caribbean storm in at least a decade, devastated Haiti and killed hundreds leaving them in an even more disastrous situation.

As to the selection of specific social businesses for this study, YSB shared their complete portfolio of operating and prospective social businesses in Haiti with the research team. The profiles were screened with regard to their coverage of the three sustainability dimensions and the different business models. Next, the tentative case selection was then reviewed with the Haiti Country Manager at YSB to determine which cases from the Haiti portfolio would satisfy the requirements, i.e., to pursue TBL criteria and already be in the first steps of executing the plan to better understand material, information and financial flows, and stakeholder network connections. Also, YSB noted that it has three different business model types, so cases were selected with this in mind. This resulted in the selection of the three social businesses EPRO, CHIFA, and CLEAPRO (names have been anonymized). The social business EPRO sells cooking (e.g., stoves) and lighting products (e.g., solar lamps). CHIFA is a social business producing chicken meat in order to generate funding for a school. CLEAPRO is a social business offering cleaning products such as detergents, disinfectants, and bleach.

In the course of the analysis of these three social businesses, it became evident that one of them was following a "mixed" model. Therefore, the Haiti country manager helped in selecting a more clear-cut case from their portfolio for additional assessment. This led to further inclusion of COSMO (again, anonymized). COSMO is a social business built around the ingredient castor oil that delivers premium cosmetic products to the US market but in the process creates jobs (particularly for disadvantaged women) and is environmentally friendly. The case companies are briefly characterized in Table 15.1. While EPRO, CHIFA, and CLEAPRO were selected from the start, in the course of the research project, another case – COSMO – was added.

These case studies of social businesses in Haiti were analyzed as exemplars of businesses which have been deliberately set up and incentivized to achieve TBL objectives, in spite of the hardship surrounding the Haitian environment and community. These businesses are not a result of trying to become more sustainable based on a previously established model but were conceived and executed with the primary goal of being TBL sustainable. In line with this, Pagell and Wu (2009, 26) suggested that "…TQM and other continuous improvement focused operational philosophies may be most useful for making an existing supply chain *more* sustainable. However, the same operational philosophy may become a hindrance when the organization needs to radically change what they do to become truly sustainable."

15.3.3 Analysis and Main Results

After receiving the data collection approval by the YSB headquarters, the first step was to contact the Haitian country manager, who provided the researchers with the investor summaries of all social businesses within its portfolio. Based on the earlier mentioned sampling criteria, a first interview with the Haitian country manager was scheduled to review a list of potential cases. In the interview, the results of the

Table 15.1 Brief case overview

Case 1 "Energy Products (EPRO)"	The social business EPRO offers products for cooking and lighting, such as cooking stoves and solar lamps. The cooking stoves are home appliances but also can be used by smaller businesses such as street vendors/small kitchens. Two types of solar lamps are offered and can be used either in homes or for work
	The customer base can quickly see the benefit of their investment. For example, for a street vendor of food, making a switch from coal-based to EPRO's gas-based cooking stoves on average leads to a breakeven (including the payback of the IDE microfinance loan) of 6 months
	Their business case highlights that the poorest households in Port-au-Prince have expenses for coal of about $33 per month, a third of their total budget. From an environmental perspective, deforestation is a severe issue in Haiti, and charcoal is – although illegal – largely coming from the last one-digit percentage of native woods. The solar lamps also help promote the transition to a renewable energy source. On the social dimension, the products leave the customers with better economic prospects (so they can accrue income for other purposes like education). The solar lamps enable people to have light in the evening for work or study. Also, the gas stoves are better than charcoal as it relates to health concerns. An illustrative extract from EPRO's business plan: "The consequences of fuel poverty are dramatic. Harmful emissions of carbon monoxide and micro particles linked to traditional cooking methods cause annual 4 million premature deaths worldwide […]"
Case 2 "Chicken Farm (CHIFA)"	The social business CHIFA produces chicken meat to generate funding for a community school. This is a proven social business model that has been implemented a number of times by YSB. At the time of the interviews, there were several chicken farms as well as a bakery operating in the same fashion
	Despite not being fully organic, CHIFA is not using any chemicals to raise the chicken. At the time of the interviews, CHIFA was building a slaughterhouse to be able to sell the meat directly and until then was still relying on JAMCHI to buy the raised chicken back and slaughter them
	Regarding the economic side, the clear goal is to finance the school with the funds generated (and pay the principal and interests back to YSB, as in all cases). Over the course of 3 years, the model targets coverage of 90–95 % of the school's costs. Regarding the environmental side, the avoidance of chemicals in the chicken meat production and the use of the chicken waste as fertilizer for agriculture are worth noting; further the model leads to a significantly shorter overall supply chain in comparison to the frozen imports, which have to be transported and chilled over long distances, having a significant environmental benefit

(continued)

Table 15.1 (continued)

Case 3 "Cleaning Products (CLEAPRO)"	The social business CLEAPRO sells cleaning products such as detergents, disinfectants, and bleach. Detergents are effective cleansing agents for washing clothes and dishes. Disinfectants are substances applied to nonliving objects in order to destroy microorganisms that are living on these objects. Bleach is a strong and effective disinfectant that can be used to disinfect surfaces, remove stains, whiten clothes, or also purify water for drinking in households. CLEAPRO offers these products with the requirement that customers bring their own packaging, thus eliminating a significant part of the costs (for both the business and customers)
	On the economic side, the company offers products at about 30 % of the usual price, giving families economic access to hygiene products or leaving families with higher disposable income for something else while generating a surplus to compensate for the initial funding including interests. Environmentally, the reuse of packaging by customers leads to fewer plastic bottles being used and, therefore, generating less trash. Socially, the access to hygiene products improves health conditions
Case 4 "Cosmetics Products (COSMO)"	The social business COSMO produces luxury beauty products for the US market, based on a locally harvested ingredient – Haitian black castor oil. There are multiple product lines based on it, such as shampoos and conditioners, body creams, soaps, and candles. Castor meal leftover from oil production can be used as a soil fertilizer or fuel
	The castor oil is sourced from extremely poor, smallholder female farmers working with an agricultural development NGO. The women are otherwise largely denied access to healthcare and water. Through this social business model, they have an opportunity to earn an income and with it improve their access to water and healthcare
	The product is marketed, for example, in spas and health clubs and cosmetics specialty retailers

portfolio analysis conducted by the researchers were discussed (e.g., to ensure that indeed the understanding regarding the coverage of TBL criteria was correct), and three social businesses were selected. Afterward, the country manager established direct contact to each of these three social businesses, and interviews with them were scheduled.

At the same time, the researchers were given the full documentation on the selected businesses including business plans (both text and calculations), profit and loss statements, YSB eligibility and investment criteria, and extended investor summaries (these are standardized documents required by the headquarters in Germany and include objectives, (financial) investment required, context, business model, and social impact). While preparing for the interviews with the entrepreneurs, the two researchers worked through these materials and summarized their current understanding (e.g., regarding the three flows and stakeholder situation). The results were then again critically reviewed in a second interview with the Haitian country manager, who provided additional clarification for all three businesses. With the preparations completed, the researchers proceeded to interview the three businesses.

In order to ensure clarity and accuracy of the information provided, two researchers were present during all the interviews. Additionally, either during or after the interviews, the social businesses also provided some additional materials (e.g., their most up-to-date organizational charts). All of the interviews were transcribed, and field notes were added. While the data collection in the social business interviews followed the interview guide (Appendix A), some questions were open ended. As a means of validation, the interview summaries were sent to the interviewees, and they were contacted for additional information and clarification during the coding process (e.g., some stakeholder names in French had to be clarified).

Additionally, the social business interviewees were also given their respective full within-case assessment to ensure that the analysis of their respective business was accurate. They either confirmed accuracy or gave the researchers instructions on how to correct the results (e.g., when we showed the different flow charts, they would sometimes add another line or box or further specify where cash versus bank accounts are utilized in the financial flow charts).

As mentioned in the data collection section, the analysis of EPRO, CLEAPRO, and CHIFA led to the realization that the case CLEAPRO was a mixed model (see page 11 for more details). After the within-case and cross-case results had been provided, the country manager provided the researchers with the feedback that she thought that YSB would be able to nominate a more clear-cut case for a third model.

Upon reflection of this research's scope and intermediate results, COSMO was offered as a fourth case. As a result, complete information on COSMO was given to the researchers, and the country manager agreed to an additional interview on COSMO. Since a more clear-cut third archetype could be well described from COSMO's materials as well as the interview with interviewee A, it was concluded that further interviews would not be required for COSMO.

Multiple steps were taken to mitigate biases and enhance reliability and validity (Eisenhardt 1989; Jick 1979; Yin 2013) including validating intermediate and final results with the interviewees as well as using multiple sources such as public website information and detailed business data provided by YSB to compare interviewee responses with additional documentation (e.g., on the objectives pursued).

Moving to some of the main results, one of the earlier research models during the research project is depicted in Fig. 15.2. It became clear that there were two different stories that needed to be told. It is worth noting that the left side of that figure is very much within the domain of social entrepreneurship, whereas the right part is already relatively close to the domain of sustainable supply chain management.

As explained earlier, this research elaborates on two different theories. Regarding the left side, as the research progressed, this part was refined to become a RBV model. The right side became the elaboration of the theory of the supply chain. In both cases, the way that the analysis and results have been structured follows Wacker's (1998) four components of a theory. This also corresponds to Whetten's (1989) recommendations to convey a theoretical contribution in terms of the what, how, domain, and why. These two resulting research streams will be discussed next.

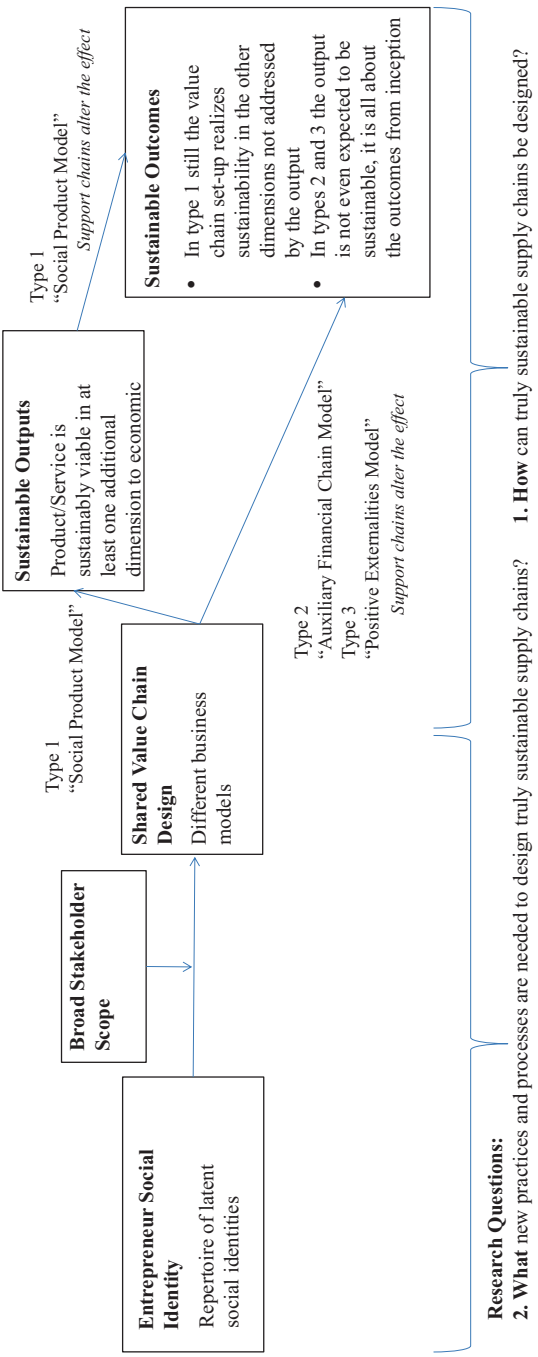

Fig. 15.2 Early conceptual research model

15.3.4 Toward a Theory of Sustainable Supply Chain Design (SSCD)

The purpose of this first research stream (the right side in Fig. 15.2) was to move the theory of supply chain forward into the sustainable supply chain management (SSCM) research agenda by incorporating the physical chain and the information and financial support chain toward a theory of sustainable supply chain design (SSCD). Therefore, it addressed the research question "1. How can truly sustainable chains be designed?" and addressed the sub research questions: *1.1 How are material and support chains of sustainable businesses designed to deliver on TBL objectives?* and *1.2 What are the respective archetypes designed for?*

Recently, Carter et al. (2015) advanced supply chain theory by suggesting a distinction between the physical chain and support chain(s). In their research, the physical supply chain, in which the physical products move from supplier to focal firm to customer, is differentiated from the support supply chain, which relates to the flow of information and finance. The support supply chain is defined as "consisting of nodes through which a product (relative to the focal agents) does not flow, but which support the physical supply chain of that product" (Carter et al. 2015, 91), such as embedded financial institutions. Carter et al. (2015) also proposed that multiple varying configurations of the physical and support supply chain are possible.

What the cases in Haiti underline is that these social businesses seek to achieve both sustainable outputs (particularly via the physical flows) and also sustainable outcomes (particularly via the information and financial flows) via their SSCD. They rather follow an approach in which they formulate TBL sustainable objectives and then think backward which objectives they can directly reach via their product (output; physical flow) and which via the involvement of additional supply chain partners, e.g., such as microcredit institutions to make their products affordable to their customers (outcome; financial flow).

It was also highlighted that there are three main configurations of the physical, information, and financial flows in YSB's portfolio of social business.

1. Social Product Model (e.g., EPRO): For this model, the product/service did not exist before and is now offered by a social business (e.g., case with energy solution). The physical chain directly delivers social products as the main purpose. A supporting financial flow to improve accessibility of the social products has been designed in purposefully.
2. Auxiliary Financial Chain Model (e.g., CHIFA): This model has no operations that service its primary purpose, so there needs to be an auxiliary business that funds the prime activity (e.g., cases of chicken farms for school funding). The physical chain delivers a product, but the financial chains are what fulfill the main purpose of funding education.
3. Positive Externalities Model (e.g., COSMO): Jobs in the value chain are created (e.g., COSMO); the product is not considered a socially focused product/service

per se. The physical chain delivers a product, but the positive externalities of the business to the community are the main purpose.

In this first research stream (Bals and Tate 2015), the elements of theory (Wacker 1998), here the theory of the supply chain in a SSCD context, were methodically addressed. This included:

1. Extending the range of variables by adding outputs versus outcomes and adding information and financial flows to physical flows
2. Extending the domain by including stakeholders with economic, environmental, and/or social stakes
3. Offering propositions on variable relationships and outcome predictions

The latter included linking physical and support flows to deliver TBL outputs and/or outcomes; proposing that support chains might help achieve sustainable outcomes indirectly, even if sustainable outputs are not feasible directly; and proposing the three main configurations.

15.3.5 Toward a Social Resource-Based View (SRBV)

The purpose of the second research stream (the left side in Fig. 15.2) was to revisit both the RBV of the firm and the natural resource-based view (NRBV) of the firm (Hart 1995; Hart and Dowell 2010) to lay the theoretical foundation for exploring how the social dimension might be addressed. Social capabilities were then explored by looking at the social entrepreneurship literature and the cases with the purpose of elaborating RBV and NRBV toward a social resource-based view (SRBV) of the firm. Therefore, it addressed the research question "2. What new practices and processes are needed to design truly sustainable supply chains?"[1] and addressed the sub research questions: *2.1 What capabilities are part of an SRBV?* and *2.2 How can an SRBV be conceptualized?*

There are multiple established theories covering how acquisition and application of resources enable firms to compete: Resource Advantage (Hunt and Morgan 1995), RBV (Barney 1991; Wernerfelt 1984), and Dynamic Capabilities (Eisenhardt and Martin 2000; Teece et al. 1997; Teece 2007). The shared theme across these theories is that an advantage can be gained by firms that develop unique capabilities by bundling resources that are rare, valuable, inimitable/substitution resistant, organizationally specific (Barney 1991), and heterogeneously distributed. In social entrepreneurship and enterprises, managers develop a broad array of capabilities used during concept development, execution, and management of business. Social entrepreneurs must be able to span the boundaries of the private, public, and

[1] At the start of the research project, the intended focus was on practices and processes, but during the refinement of the research approach, the underlying resources and capabilities came into focus. Therefore, the sub questions center on the underlying factors needed to move toward new practices and processes.

nonprofit sectors (Tracey et al. 2011) and face conflicting institutional goals, structures, and processes (Pache and Santos 2012).

In this second research stream (Tate and Bals Forthcoming), the elements of theory (Wacker 1998), here RBV and NRBV, are methodically addressed by extending the range of variables (adding social capabilities), extending the domain (including stakeholders[2] with economic, environmental, and/or social stakes), and offering propositions on variable relationships and outcome predictions (linking social capabilities and shared TBL value creation). Two social capabilities that stand out, in terms of relevance, from the empirical research discussed here are "following a mission-driven approach" and "stakeholder management." Thus, these capabilities are proposed as initial practical starting points for human resource development. If companies target shared TBL value creation, it is recommended that they exhibit the needed social capabilities and other capabilities from all of the three views (RBV, NRBV, SRBV)[3]. It is important to note that this does not imply a separate paradigm that neglects the economic (corresponding to the RBV) or environmental aspects (corresponding to the NRBV). Rather, it was proposed that all three are part of an overall theoretical base for future research. By emphasizing the social capabilities of social entrepreneurs, this research highlights the micro-foundations of Corporate Social Responsibility (CSR), demonstrating the value of individual-level analyses. It offers an SRBV as a theoretical lens to further study these aspects.

15.4 Future Research Directions (FRD)

During the course of the analysis and results discussions, there were a number of topics that could be identified as suggestions for future research. One aspect that kept reoccurring was the aspect of (social) supply chain disruption and how the entrepreneurs where reacting to that. Upon reflection of the research design, this type of research would be more toward the humanitarian supply chain/logistics arena. In the cases studied in this research, the severity of constraints was pronounced, but the data collection was not performed immediate to any particular disruption. Therefore, for future research on how to react to disruptions, what role the social identity of the entrepreneur plays and what resources and capabilities might be mobilized in order to find a way to get toward a resilient and adapted supply chain that is (still) geared toward TBL sustainability would be highly interesting. These thoughts are summarized below in Fig. 15.3 and explained in the following.

[2] Building on stakeholder research (e.g., Clarkson 1995; Freeman 1984)

[3] In line with this research, a study conducted by other researchers in parallel and with an overall business model instead of supply chain focus has also found that certain resources (e.g., "network" and "managerial resources") are employed by social enterprises to achieve competitive advantage (Roy and Karna 2015).

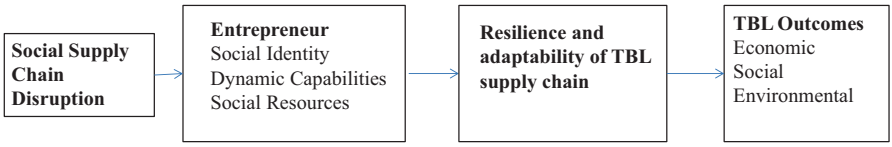

Fig. 15.3 Future research directions

Table 15.2 Missions, interviewees, stakeholders, and models

Case	Mission	Characteristics (identity)	Key stakeholders	Stakeholder-model links
EPRO	It was a personal challenge to start a business that provides energy to the Haitian population – believes this is the single most important problem in Haiti	Agronomist	Agriculture credit	
Energy products		Energy degree	Energy business	Physical chain
			Climate and energy Haiti	
		Economist		
		Microfinance	Microfinance institution	Incorporated financial support chain
CHIFA	Looked at it as a personal responsibility to help the people of Haiti and believes that the most important thing is to empower the people	Haitian	Community	Became financial support chain
Chicken farms			JAMCHI	Physical chain
			YSB	
		International development	Heifer	
			HNGO (Haiti NGO)	
CLEAPRO	Believes that money can be used to deliver products to the people at the right time, the right place, and the right price to promote social good. Financial sustainability is key for success	Product knowledge	Haitian product mfg	Physical chain
Cleaning products			JAMPRO	
		Financial background	YSB	

15.4.1 FRD1: Social Identity in the Light of Supply Chain Disruption

Table 15.2 illustrates the connection between the mission and the characteristics of the interviewees (social identity) on the one side and key stakeholders and chain elements considered on the other. This table emerged during the course of analysis,

but ultimately we did not collect enough data on social identity to drive this idea further. Therefore, it is suggested for further research to shed more light on the connections between individual social identity, which resources and capabilities are mobilized and how the attainment of TBL sustainability objectives is linked to that.

While this is interesting in and of itself, the context of supply chain disruption might help bridge such insights into the research area of humanitarian supply chain/logistics, also driving individual-level insights in that field.

15.4.2 FRD2: Hybrid Business Models and Impact

With regard to the outcome variables, this research proposed that shared TBL value is operationalized in environmental, economic, and social terms for a broad stakeholder base but did not investigate how these relate to each other. For instance, should they be all equally important or should one be prioritized over the others, if so by what measure(s)? Future research could investigate this aspect by considering recent work on the anthropocentric versus ecocentric perspective (Borland et al. 2016) as well as the ecologically dominant logic (Montabon et al. 2016). An additional question for further investigation is whether these outcome variable relationships are consistent across all organizations or may differ between public companies, B-Corps, social businesses, and nonprofits (Tate and Bals Forthcoming).

15.4.3 FRD3: From Sustainable Supply Chain Design (SSCD) to TBL Shared Value Chain Design

In order to realize SSCM, it is proposed that the design stage is central and that embedding all three flows as well as both the supply-side and demand-side considerations would pave the way for shared value chain design (Bals and Tate 2016). The shared value term builds on the work by Porter and Kramer (2006, 2011). While the two terms "supply chain" and "value chain" are often used synonymously, they actually differ in that the supply chain focuses on transferring products or materials to a final point without necessarily adding value in the process, whereas a value chain adds value at multiple points (Gereffi et al. 2005). As a result, in order to get to a very comprehensive understanding of what to design and how, "TBL shared value chain design" is a topic of increasing importance and interest. Looking even further ahead, the challenge of the future will be to identify ways to close the loop for the involved flows and advance the idea of a circular economy further (Bals and Tate 2016).

15.5 Conclusions and Outlook

The overall research project started out with an interest to better understand how social businesses can help sustainable supply chains. As shown in Fig. 15.2, this was captured in the two broad research questions "What new practices and processes are needed to design truly sustainable supply chains?" and "How can truly sustainable supply chains be designed?," which guided the design of the interview guide. As a result, based on the case studies in Haiti, two theories were elaborated: Toward the first of these two questions, focused on the "what practices and processes?," the theory of supply chain (Carter et al. 2015) was elaborated toward a theory of SSCD. Toward the second question of the "how?," this led to a deeper investigation of individual-level resources and capabilities led to the elaboration of the RBV and NRBV toward an SRBV (Tate and Bals Forthcoming).

Based on the experiences with the overall research process as well as when presenting this research at conferences and working toward publication of the results, the following suggestions for future research can be summarized, in addition to the future research directions that were mentioned in the previous section.

First, as a fundamental suggestion based on this research, it can be said that social business and hybrid models offer an interesting **sampling pool** for sustainable supply chains, related practices, and capabilities. Instead of doing less of harm, they offer insights into a laboratory of how to set up your model if you want to achieve TBL sustainability from the start.

Second, the whole area of **trade-offs and tensions** in sustainability (e.g., Battilana et al. 2014; Hockerts 2015; Smith et al. 2013; Stevens et al. 2015) is an interesting area of future research. In the social businesses that were analyzed here, the entrepreneurs were intrinsically motivated and showed related social capabilities (e.g., to pursue a mission-driven approach) to reach TBL sustainability. Even though they are motivated on the individual level, YSB as an intermediary facilitates on an organizational level that each social business fulfills clear criteria from the start and states specific KPIs how it will achieve TBL sustainability. Whether and how that combination of individual-level capabilities with organizational level guidance can be transferred to larger organizations and/or more established organizations warrants further research.

Third, to achieve further insights into social capabilities, it becomes interesting to have a more detailed look at the **social identity of** the entrepreneurs. How are their social capabilities formed? Under which conditions do they form? Can they be trained? The social entrepreneur's role in successfully establishing organizations that are geared toward TBL sustainability highlights that **individual capabilities** could be of much more interest to SSCM research, too. Also, as mentioned earlier, the "mission-driven approach" that we see in the cases actually could be further studied in the context of the "ecologically dominant logic," which Montabon et al. (2016) have recently proposed in JSCM.

Fourth, methodologically, there are a number of suggestions that can be derived for future research: While we had sampled with the intents that were laid out earlier

in the methodology section, during presentations and review processes, a number of questions kept recurring. One of those was whether this research was particularly about a bottom of the pyramid context, about a humanitarian supply chain/logistics context, or about a developing countries context. This leads us to suggest to be even more outspoken and detailed about **sampling** when doing interdisciplinary research than usual.

The specific contexts just mentioned each hold potential for future research in itself. For example, taking humanitarian logistics as the example: Under states of emergency (e.g., due to political disruption or natural catastrophes), which other social capabilities may play a role or might their importance be amplified (e.g., does stakeholder management become the essential social capability when ensuring swift communication flows as quickly as possible becomes a matter of life and death?). With hurricane Matthew hitting Haiti in October 2016, it has once more become a context for such a research setting. Another methodological point is the sampling of respondents versus informants (Van Weele and Van Raaij 2014): Depending on the research question, it really makes a difference whether one gathers information on the organizational versus individual entrepreneur level. For example, in future studies about the social identity linkage, the logical consequence would be to center on social entrepreneurs for data gathering.

Finally, there are also some general lessons learned for future cross-disciplinary projects in that area. In order to position the research clearly, it is even more central than when publishing in one's usual domain to promote **terminological clarity**. For example, the terms supply chain versus value chain versus business model already pose both opportunity and bane. On the one hand, there is a great opportunity to bridge between different literature streams to come to a more holistic overview of what has been done and found in previous research while at the same time facing the danger of comparing pears and apples. In these regards, it is very helpful that work is being published (e.g., for a comparison of sustainable business models versus sustainable supply chain conceptions, see Luedeke-Freund et al. 2016) that helps disentangle such terms, so that the basis for such interdisciplinary projects can be set up clearly right from the start. Another suggestion is the careful delimitation **of units and levels of analysis**, as SSCM research often centers on the organizational level, while social entrepreneurship literature can be about the level of the business (organizational) or entrepreneur (individual).

Acknowledgments As interdisciplinary research poses particular challenges, we would like to explicitly thank a number of people who have been critical to perform this research project and/or significantly helped to take it forward since its inception in 2014: Yunus Social Business, both headquarters in Frankfurt as well as the Haiti subsidiary, for graciously offering their time, social business portfolio, and insights for this research project; Helen Walker, Britta Gammelgaard, Joseph Sarkis, Robert Klassen, and other colleagues for their comments offered during the ERS conference 2015 in Copenhagen, the IPSERA conferences 2015 in Amsterdam and 2016 in Dortmund, as well as the ISVC annual meeting 2015 in Eschborn/Frankfurt; Tobias Hahn and Brent Beal for their detailed comments during the 2015 AOM SIM (Social Issues in Management) paper development workshop in Vancouver; Yvonne Kreis for a very thorough friendly review of the research stream on creating an SRBV; Cory Searcy and the two reviewers at the Journal of

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Interview Guide

Background Questions

1. State your name and describe your position in the business and how long you have been part of this business?
2. What is your professional background prior to establishing this business?
3. Describe the structure of the business (if possible and then provide an organization chart).
4. Approximately how many employees are involved in the business at all locations?

Understanding the Network and Setup of the Business

5. How did this idea to establish the chicken farms in order to finance schools come up? *[This question was always adapted to the specific business, here exemplary for CHIFA.]*
6. Describe in your own words the process steps involved in implementing and maintaining a successful social business model and a little bit of what is involved (and who is involved) in each step. Start from the time that the funding/loan is approved.
7. Discuss the amount of time involved in each step.
8. Discuss the stakeholders that are directly or indirectly involved in the business.

Your Social Business

9. What was your specific motivation for this social business?
10. How did you learn about YSB? How did you get in touch?
11. How has YSB helped you in establishing the business?
12. Who else has helped/played a major part in establishing the business?
13. How do you define "success" in your social business model?
14. Do you consider the success so far sustainable?
15. What do you see as the primary barriers to success?
16. What are the primary facilitators of success?
17. Can you describe the environmental, social, and economic impacts of your social business?
18. Were there differences between the planned and actual outcomes? How were these differences addressed?
19. Are there measures and metrics used to validate your performance and the business model's performance?

Material/Service Flows

20. Discuss the process flows for materials and services – in terms of plan, source, make, and deliver.
21. Is there any type of advertising? What are the main attributes attracting customers?
22. What is the variety of the offering (narrow versus broad)? Are there plans to make any changes to these offerings?

Financial Flows

23. Discuss the flow and frequency of both upstream and downstream financial flows.
24. Are the investments given in a "lump sum" to the entrepreneur? If so, who manages the money?
25. How are payments made to suppliers, employees, and investors?

Information Flows

26. Describe and discuss the flow of information both upstream and downstream.
27. What types of information are shared?
28. How often is that information shared?
29. What means of communication are used?

Wrap-Up

30. From your perspective, is there anything that we should have asked about that we didn't that might be relevant for the research?
31. As additional questions arise, can we follow-up with you?

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