THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

Sustainable Manufacturing Strategy; Identifying Gaps in Theory and Practice

NAGHMEH TAGHAVI

Department of Technology Management and Economics

CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden 2015

Sustainable Manufacturing Strategy; Identifying Gaps in Theory and Practice
Naghmeh Taghavi, 2015

ISSN 1654-9732
Technical report no L2015:077

Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

Printed by Chalmers Reproservice
Gothenburg, Sweden 2015

Sustainable Manufacturing Strategy; Identifying Gaps in Theory and Practice

Naghmeh Taghavi

Department of Technology Management and Economics

Chalmers University of Technology

Abstract

Since the introduction of sustainable development in 1972, an increasing number of companies have striven to create a competitive position by means of sustainability in their operations. Sustainability has become part of a firm's business strategy; therefore, strategic alignment of the manufacturing function to the business strategy's vision and goals regarding sustainability has become essential for manufacturing companies. Hence, the purpose of this thesis is to investigate the integration and operationalization of environmental and social sustainability into the manufacturing strategy to obtain a holistic view and to shape an agenda for future research.

The research was conducted through four studies. One structured literature review and three exploratory empirical studies were used to collect the data. To investigate the integration of sustainability into the manufacturing strategy and how to close the gap in the operationalization of the sustainable manufacturing strategy, Vickery's (1991) proposed process model of manufacturing strategy based on the production competence theory has been used to analyze the findings. Based on the findings, some gaps in the literature and practice and the future research agenda were identified.

The research results show that sustainability is not yet part of the formal manufacturing strategy, and neither social nor environmental sustainability is a top competitive priority for manufacturing firms. However, environmental sustainability supports achieving other competitive priorities, such as cost and quality. Moreover, sustainability is to some extent operationalized in manufacturing firms' day-to-day decisions and activities through improvement programs and initiatives, integrated management systems, and employee involvement. It is also shown that to ensure the operationalization of sustainability, it is necessary to align the sustainability measures with strategic goals and decisions.

This study contributes to the literature on sustainable manufacturing strategy by bringing together the current developments concerning the topic in existing literature and practice and extending the perspective of sustainable manufacturing strategy and its operationalization. Moreover, the findings open up new questions and directions for future research in the field.

Keywords: manufacturing strategy, environmental and social sustainability, operationalization, production competence theory

List of appended papers

Paper 1: Taghavi, N. (2015) "Sustainable production competence: investigating process model of sustainable operations strategy."

An earlier version of this paper was published in the Proceedings of the 1st International Euroma Sustainable Operations and Supply Chain Forum, March 2014, Groningen, Netherlands.

Paper 2: Stahl, B., Taghavi, N., Winroth, M. and Kjellsdotter Ivert, L. (2014) "Manufacturing strategy: missing link between sustainability in corporate strategy and sustainable production."

Paper accepted and published in the Proceedings of the 21st EurOMA Conference on Operations Management in an Innovation Economy, June 20–25, 2014, Palermo, Italy.

Paper 3: Taghavi, N. (2015) "Key performance indicators of social sustainability in operations management."

The paper is a combination of two previous conference papers.

The first paper was accepted and published in the Proceedings of the Sixth Swedish Production Symposium (2014), Gothenburg, Sweden as:

Taghavi, N., Adams, C., and Berlin, C. "Social sustainability KPIs in operations management: a gap between the reactive and the proactive stance." Swedish Production Symposium 2014, SPS14, September 2014.

The second paper was accepted and published in the Proceedings of the International Conference on Advances in Production Management Systems (2015), Tokyo, Japan as:

Taghavi, N., Giovanna Barletta, I. and Berlin, C. "Social implications of introducing innovative technology into a product-service system: the case of a waste-grading machine in electronic waste management." Advances in Production Management Systems, September 2015.

Acknowledgments

It has already been two and a half years since I began as a PhD student at Chalmers University of Technology. Writing these last lines of my licentiate thesis makes me think that I could not have reached halfway through the PhD process if it was not because of a large number of people.

I would like to thank my supervisors. Mats, I am very grateful for the opportunity of earning this PhD. Thank you for believing in me and supporting me during this process. Linea, thank you for always being there for me, for your constant support and feedback. Cecilia, thank you for all the inspirations and ideas and for being such a source of energy. Torbjörn and Peter, thank you for being part of this process and helping me. I am also indebted to Patrik for helping me develop my thoughts and for your patience in putting up with my confusion.

I express my gratitude to all my colleagues at Technology Management and Economics for making the PhD process an interesting experience. Specially, thank you, Magnus, for always being an understanding and great boss. Ida, thank you for all your time, support, encouragement, and making me feel special. You have always been so kind. I am grateful as well to Yvonne and Birgitta for all their support. I also appreciate my fellow PhD students who helped me through all the ups and downs with their friendship. This would have been an impossible journey without you being part of it.

This research is carried out within the Sustainable Production Initiative and the Production Area of Advance at Chalmers University of Technology. The support is gratefully acknowledged by the author.

Last but not least, my biggest thanks go to my family. Thank you, Mom and Dad, for being the best parents possible and making me believe I can accomplish anything I want. Ghazal, thank you for being there and always understanding me. Finally, Alirad, thank you for all that you are. I would never be the person that I am without having you by my side. You are my source of inspiration and energy, and I love you with every beat of my heart, forever. I can't wait to experience new chapters of our life together.

Table of Contents

1 Introduction 1

1.1 Background 1

1.1.1 Production competence theory 1

1.1.2 Manufacturing strategy 2

1.1.3 Sustainable development in manufacturing context 3

1.2 Scope and limitation 6

1.3 Purpose 7

1.4 Research questions 7

1.5 Thesis outline 7

2 Methodology 9

2.1 Research process 9

2.2 Research approach 10

2.3 Research design 10

2.3.1 Goals 10

2.3.2 Conceptual framework 11

2.3.3 Research question 11

2.3.4 Validity 12

2.4 Data collection and analysis 12

2.5 Author's contributions to appended papers 14

2.6 Research quality 14

2.6.1 Credibility 15

2.6.2 Transferability 15

2.6.3 Dependability 15

2.6.4 Confirmability 15

3 Frame of reference 17

3.1 Production competence theory and process model of manufacturing strategy 17

3.2 Manufacturing strategy 18

3.2.1 Definition of manufacturing strategy 18

3.2.2 Manufacturing strategy content and process 20

3.3 Sustainable manufacturing strategy; structured literature review 21

3.3.1 Integrating sustainability into strategy development 23

3.3.2 Sustainability and manufacturing competitive priorities 24

3.3.3 Integrating sustainability into strategic decisions and strategy implementation 26

3.3.4 Investigating sustainability's relation to performance measures 27

3.4 Sustainability in related fields 29

4 Summary of appended papers 31

4.1 Paper 1 31

4.2 Paper 2. 32

4.3 Paper 3. 33

5 Discussion 35

6 Conclusion 43

7 References 45

1 Introduction

This section presents the background of the research problem, focusing on sustainability in the manufacturing strategy and highlighting the relevance of this research. This leads to the formulation of the research scope, purpose, and research questions. The thesis outline is presented at the end of this section.

1.1 Background

According to Porter (1996), the ultimate goal of every manufacturing firm's strategy is to enable thinking and acting over the long term, creating a competitive position on a set of performances. Since the 1990s, sustainable production and products have become a selling argument and part of the business strategy of many companies (Elkington, 1997; Bansal and Roth, 2000; Sharma, 2000; Porter and Kramer, 2006; Albino et al., 2009; Moore and Manring, 2009). Global restrictions, legislation, and customers' awareness of sustainability, together with the worldwide competitive environment, have forced companies to recognize their impacts on the triple bottom line i.e. environment, society, and economy (Elkington, 1997). Including sustainability as a new paradigm for manufacturing companies, which is supposed to enhance business growth and competitiveness by means of environmental and social soundness, has created new opportunities and challenges for firms. Sustainability will be the key strategy for companies in designing products, as well as managing and operating productions and supply chains (World Economic Forum, 2012). According to Elkington (1994, p. 99), "successful companies will have little option but to get involved in this rapidly emerging area" of taking care of sustainability in their business. Thus, the concept of sustainable development has emerged in manufacturing since the late 1990s and has focused on increasing competitiveness by improving environmental and social performance in an economic way. Given manufacturing's role on companies economy, together with its impact on the environment and people (United Nations Environment Programme [UNEP], 2011; EuroStat, 2012; World Economic Forum, 2012), it plays a critical function in modern socioeconomic systems (Haapala et al., 2013). Thus, more companies strive to create a competitive position by means of sustainability (Lawn, 2004; Lovins, 2008; Mirvis et al., 2010; Haanaes et al., 2011; Lubin and Esty, 2014), and the strategic alignment of the manufacturing function to their business strategies' vision and goals regarding sustainability has become essential for manufacturing companies. Firms that are capable of translating sustainability into their strategies and transforming long-term plans into strategic initiatives in general are outperforming their competitors (Drake and Spinler, 2013). According to Johansson and Winroth (2010, p. 881), "In order to sustain or enhance competitiveness, companies must cope with the environmental pressures in a way that supports long-term business goals."

1.1.1 Production competence theory

Production competence is defined as "the degree to which manufacturing supports a firm's business strategy" (Vickery et al., 1994, p. 308) and evaluates manufacturing strengths and weaknesses for

certain performance objectives (Cleveland et al., 1989). Previous research defined the constructs for production competence as follows: 1) identification and weighting of manufacturing competitive priorities, 2) strategic manufacturing decision making, 3) implementation (e.g., projects and programs), and 4) manufacturing performance measurement (Vickery, 1991). With more firms worldwide transitioning to include sustainability in their business strategies, it seems necessary to do so with these different constructs in order to develop and implement manufacturing strategies and thus make firms competitive.

1.1.2 Manufacturing strategy

The foundation of manufacturing strategy is based on Skinner's (1969) argument that manufacturing is often missed in the corporate strategy although they affect each other. In 1994, Hayes and Pisano claimed that manufacturing companies would need strategies to stay competitive, which should specify both the markets' competitive advantages and the way to achieve those. Based on Dangayach and Deshmukh's (2001) research, among many studies on manufacturing strategy from 1969 to 1999, most of the authors defined it similarly as Swamidass and Newell (1987, p. 509) did: "the effective use of manufacturing strengths as a competitive weapon for the achievement of business and corporate goals."

To remain competitive, companies must understand market requirements, customers' needs and expectations, and competitors' performance. Manufacturing strategy can be used to create this fit between market requirements and operations' resources (Slack and Lewis, 2011). Despite many researchers' definitions of manufacturing strategy from different angles, its core concepts remain the same, and its common theoretical distinction consists of content and process (Leong et al., 1990; Mills et al., 1995; Dangayach and Deshmukh, 2001; Slack and Lewis, 2011). Introduced by Leong et al. (1990), the predominant construct of manufacturing strategy content comprises strategic decisions, that is, "the set of actions that help achieve the operations and corporate goals" and competitive priorities, that is, the "collection of goals pursued by the operations function of any organization" and "[…] define[s] the areas in which the operations must be focused on to be able to provide organizational competitive advantage" (Martín-Peña and Díaz-Garrido, 2008, p. 200). Process is how the manufacturing strategy is developed, consisting of the ways for its formulation and implementation (Mills et al., 1995; Dangayach and Deshmukh, 2001; Slack and Lewis, 2011). Although the manufacturing strategy concept is attractive to many firms, its operationalization on the factory floor remains problematic. According to Kim and Arnold (1996, p. 46), operationalization refers to "the decisions that manufacturing executives have to make" and requires constant interpretation of highly abstract competitive priorities in terms of more tangible and measurable decisions and actions.

While the earlier evolution of the field was around the manufacturing function (Skinner, 1969, 2007), and historically, *manufacturing strategy* had been the term used, now the term *operations strategy* coexists with it, and both are used interchangeably. One major reason might be that

operations cover a wider area of activities (e.g., purchasing, logistics, etc.) than the core manufacturing process (Slack, 2005). In this thesis as well, the terms are used interchangeably.

1.1.3 Sustainable development in manufacturing context

The United Nations (UN) introduced the concept of sustainable development in 1972. In 1987, the World Commission on Environment and Development (WCED) published "Our Common Future" (also known as the "Brundtland Report"), which defined the concept as follows:

"Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs" (Brundtland, 1987, p. 43).

However, the most recognized definition of sustainable development, which comes from the same report, is:

"[…] development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Brundtland, 1987, p. 15).

The main idea behind this concept is how it would be possible to achieve development and growth without damaging and over-consuming natural resources, which was introduced at the World Summit on Sustainable Development in 2002 in Johannesburg. The common framework for. sustainable development consists of three encompassing dimensions—economic, environmental, and social—although two new dimensions have been more recently added to the framework, that is, technology and education (Garetti and Taisch, 2012). Considering these different dimensions, sustainable development proposes economic growth that protects the environment and requires a stable relationship between human activities and the natural world (Almström et al., 2011). Given this general definition and framework, a sustainable firm will be one that maintains its financial growth and makes a profit while meeting its environmental and social goals. However, this does not necessarily lead to a sustainable world.

Over the last few decades, many subconcepts have been developed for different purposes and have been used interchangeably in research around the concept of sustainable development. Examining the evolution of sustainable development since the 1980s shows that the concept has steadily advanced from "green minority" and "green evolution" in the early and late 1980s, respectively, to "ethical consumer" behavior in the early 1990s and afterwards, to international policies (Elkington, 1994; Young et al., 2010; Quental et al., 2011).

In 1997, Elkington tried to transform the general concept of sustainable development into the business context and introduced the *triple bottom line or 3Ps*. Borrowing the term "bottom line" from accounting, which means profit or loss, Elkington (1997) defined the triple bottom line as

"profit, planet, and people", which has been widely used since. Elkington's perspective focused on adding social and environmental values to companies' economic vision and finding a balance. McDonough and Braungart (2002) later adopted the term "triple bottom line" for the purpose of creating products and services that would create economic value, sustain the environment, and foster social fairness. This has led to the new concept of *triple top line or cradle-to-cradle*.

This evolution has caused the introduction of new research topics, such as "green product" (Baumann et al., 2002), "sustainable product development" (Van Weenen, 1995; Berchicci and Bodewes, 2005), and "sustainable operations management" (Kleindorfer et al., 2005). Alongside these concepts, different tools and methodologies, mostly for improvement, have been used to secure product sustainability, for example, life cycle assessment (LCA), which is used to assess the environmental aspects of manufactured products and processes (Kaebernick et al., 2003). Examining the manufacturing improvement tools (e.g., lean, Six Sigma, robust design methodology) will make it clear that all these can be used to gain sustainability since they all aim to increase productivity and reduce waste and defects. However, all these aspects, tools, and methodologies attempt to "reduce unsustainability". Although it is essential to integrate existing tools and methodologies with sustainability and enhance them toward sustainable product development, according to Evans et al. (2009), the approach to sustainability needs to undergo radical change. This means that the idea of "less bad is good enough" has to be reviewed. "We have to look creatively at rethinking the full cycle of designing, making and serving, at rapid innovation in the products of the current system as well as the development of new models for satisfying human needs and desires through different systems of production and consumption. We need step changes in performance of the system as a whole" (Evans et al., 2009, p. 8). It is necessary to "optimize and use sustainability to create competitive advantages rather than simply focusing on reducing unsustainability" (Moore and Manring, 2009, p. 277). "This requires a fundamental re-think in the design of a product to take account of all stages of a product life cycle, and a shift in manufacturing processes from cleaning technologies to clean technologies which reduce the actual level of emissions produced and the energy and other resources used during processing" (O'Brien, 1999, p. 3). This new way of thinking about integrating sustainability in all stages of a product's life cycle has led to a new level of sustainability in firms, called "sustainable production."

The concept of sustainable production systems as a subset of sustainable development was introduced and defined as the "systems of production that integrate concerns for the long-term viability of the environment, worker health and safety, the community, and the economic life of a particular firm. Sustainable production is a system that unifies the typically fragmented components of environmental and occupational health and safety and uses their interdependence to the advantage of each of these areas of concern" (Quinn et al., 1998, p. 298).

Gimenez et al. (2012) defined sustainability dimensions related to manufacturing based on the triple bottom line: "Economic sustainability is usually well understood. At the plant level, it has been operationalized as production or manufacturing costs. […] At the plant level, environmental

sustainability refers to the use of energy and other resources and the footprint companies leave behind as a result of their operations. Environmental sustainability is often related to waste reduction, pollution reduction, energy efficiency, emissions reduction, a decrease in the consumption of hazardous/harmful/toxic materials, a decrease in the frequency of environmental accidents, etc. Social sustainability shifts the focus to both internal communities (i.e. employees) and external ones […]. Social sustainability means that organizations (and manufacturing plants) provide equitable opportunities, encourage diversity, promote connectedness within and outside the community, ensure the quality of life and provide democratic processes and accountable governance structures" (p. 150).

In 2005, Kleindorfer et al. tried to integrate internal and external stakeholders into the traditional operations management (OM) definition. Considering the company's impact on these stakeholders and its environment, they defined the term *sustainable operations management* as "the set of skills and concepts that allow a company to structure and manage its business processes to obtain a competitive return on its capital assets without sacrificing the legitimate needs of internal and external stakeholders and with due regard for the impact of its operations on people and the environment" (Kleindorfer et al., 2005, p. 489). Internal and external stakeholders are individuals and groups with some sort of interest in the operations. Previous research considered the stakeholder's point of view an important aspect in achieving sustainability (Brown, 1996; Florida, 1996; Azzone et al., 1997; Hanna et al., 2000; Corbett and DeCroix, 2001; Daily and Huang, 2001; Boudreau and Ramstad, 2005; Corbett and Klassen, 2006). Angell and Klassen (1999) proposed a transformation model for an environmental OM, which would include the relationship to suppliers, customers, the environment, and other stakeholders, such as the government, the public, and so on. Table 1 lists typical stakeholders and their relationships with company operations regarding sustainability.

Table 1. Stakeholders and their relationships with company operations regarding sustainability

Internal and external stakeholders	**Relationship with company operations regarding sustainability**
Employees	Employees require job satisfaction, safe and healthy work conditions, and fair wages and work hours. On the other hand, they influence sustainability by their decisions and actions.
Customers	Customers demand sustainable products and services.
Suppliers	Suppliers influence a firm's sustainable OM with their activities and supplies. On the other hand, they demand fair and ethical deals from companies.
Governments	Governments provide guidance through laws and regulations and require companies' compliance.
Society	Society demands benefits for the community and ethical behavior from companies.

The concept of *sustainable production* has gradually developed over the years, and the UN highlighted it as part of overall sustainable development several times, such as in the Stockholm Conference in 1972 and especially by the Brundtland Commission in 1987 (Brundtland, 1987). Sustainable production was even more in focus at the UN Conference on the Human Environment in 1992 in Rio de Janeiro. The Oslo Roundtable on Sustainable Production and Consumption proposed the following definition: "The production and use of goods and services that respond to basic human needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations" (UN, 1992). In research, sometimes the term *sustainable manufacturing* is used interchangeably with *sustainable production* and is defined as developing socially and environmentally sound techniques to transform materials into economically valuable goods.

In this research, sustainable manufacturing is discussed according to Kleindorfer et al.'s (2005) definition, involving environmentally and socially sensitive decisions and actions, which allow the manufacturing company to pursue its economic benefits without sacrificing the legitimate needs of internal and external stakeholders. Later, one of the included studies (Study 3) provides a more specific definition of companies' socially sustainable work system, with the following characteristics:

- meet the fundamental needs of their employees at present, such as fair pay and healthy and safe workplaces;
- contribute to the future state of workplaces by meeting the needs of current employees, through initiatives such as active participation and competence development; and
- simultaneously attract future generations of new workers to ensure the companies' continued social growth and development.

1.2 Scope and limitation

This research focuses on sustainability in the manufacturing strategy. Hence, the theoretical scope of this research is positioned within the OM domain, specifically from the manufacturing strategy perspective. Regarding sustainability, since the dominant paradigm in the last century was economic growth, most of the manufacturing policies and research efforts addressed this need (Jovane et al., 2008). Thus, the economic aspect of sustainability is somehow tackled in the traditional manufacturing strategy literature in terms of costs. On the other hand, sustainability in this thesis refers to environmental and social dimensions.

1.3 Purpose

The purpose of this study is to investigate the integration and operationalization of environmental and social sustainability into the manufacturing strategy to obtain a holistic view and to shape an agenda for future research.

1.4 Research questions

This research has a twofold objective. First, it aims to gain a holistic perspective on how sustainable manufacturing strategy exists in the current body of knowledge and in practice. Second, it intends to identify the related areas that are important for future research. For these purposes, the research questions (RQs) of this thesis are as follows:

RQ1: How is environmental and social sustainability captured in the manufacturing strategy in theory and practice?

To answer RQ1 and to close the gap in the operationalization of sustainable manufacturing strategy, Vickery's (1991) proposed process model of the manufacturing strategy, based on the production competence theory, is used to analyze the findings from the literature review and empirical studies. This question identifies some gaps in the literature and practice, which leads to the next research question:

RQ2: Which areas of sustainable manufacturing strategy are overlooked in the current body of knowledge?

1.5 Thesis outline

This compilation thesis consists of the main text and three appended papers. The thesis is structured as follows:

Chapter 1 (Introduction) presents the research background and introduces the purpose and scope of the thesis, as well as the research questions.

Chapter 2 (Methodology) describes how the thesis has been planned and what decisions have been made.

Chapter 3 (Frame of reference) summarizes the previous research that has shaped this study. It also includes the findings from Study 1, which is a literature review on the topic of sustainable manufacturing strategy. At the end of this chapter, research questions are developed and presented.

Chapter 4 (Summary of appended papers) summarizes each of the three papers appended to this thesis.

Chapter 5 (Discussion) answers and discusses the research questions in relation to previous research.

Chapter 6 (Conclusion) concludes the thesis and highlights its contributions.

2 Methodology

This chapter describes the research process and design to clarify what decisions have been made and their underlying reasons.

2.1 Research process

The research process started in February 2013 as part of an initiative of Chalmers Production Area of Advance. The overall purpose of Chalmers Production Area of Advance is to explore new approaches to achieve industrial competitiveness and resource-efficient product and production development processes.

According to the defined purpose of Chalmers Production Area of Advance, a "working purpose" for the research was formulated: "to explore and increase the understanding of how sustainability can be integrated into a manufacturing firm's strategies." It was called the "working purpose" since it had been changed during the research process and was mainly intended to help the researcher stay focused. The final purpose of this thesis—"to investigate the integration and operationalization of environmental and social sustainability into the manufacturing strategy to obtain a holistic view and to shape an agenda for future research"—is supposed to contribute to the growing body of knowledge on manufacturing's role in achieving sustainability. The strategy has been to start wide to be able to search for interesting problems and issues within the phenomenon of "*sustainable manufacturing strategy*."

The research consisted of four independent studies. It started with a structured literature review of "sustainable manufacturing strategy" as Study 1. The aim was to increase my personal knowledge about the subject area, as well as to structure the literature's content in terms of how sustainability was incorporated into the body of knowledge on the manufacturing strategy. This literature scan was helpful in identifying the study's theoretical relevance and defining gaps in the current body of knowledge. However, it was kept in mind that one common critique against management research is that it has not produced knowledge of value for managers. Mintzberg (1995, p. 61) explained it as "[…] impractice, because the problems grow out of the disconnection between management and managed.” The disconnection occurs when management is treated as an end in itself instead of a service to organizations and their customers, similar to what Starkey and Madan (2001) noted as a relevance gap. Moreover, "for a theory to receive attention and establish a new theoretical school, it must differ significantly from, and at the same time be connected to established literature in order to be seen as meaningful" (Alvesson and Sandberg, 2011, p. 247). Therefore, since this research aimed to help the operationalization of sustainability and as mentioned earlier, this seemed to be a problematic practical gap for manufacturing firms, Study 2 was designed to help investigate this gap in two case studies. Study 3 was later designed and executed, involving a multiple case study of six manufacturing companies to examine different contexts. Moreover, based on one of the identified gaps in the literature and in the cases, Study 4

was performed to investigate social sustainability, using related key performance indicators (KPIs). All studies were brought together in this cover to answer the defined research questions.

2.2 Research approach

The openness and broadness of the research purpose called for an approach that would enable the formulation of research questions based on generated and accumulated knowledge throughout the study. According to Marshall and Rossman (2014), when the studied phenomenon is not well understood in previous research, exploratory research will fit. Since this research tried to make sense of a phenomenon that had not been thoroughly understood, the exploratory qualitative approach seemed an appropriate choice to help obtain a holistic view through the literature and several cases in different contexts. The qualitative approach was also suitable in the exploration and investigation aspects, which were the goal of the research questions.

As mentioned earlier, the study started with a literature review as the basis for further investigation. Later, empirical data was gathered, whose findings helped find the further path through the literature, and theory was constantly used to guide the analysis. Thus, the use of the theory in this study had neither a clear inductive nor a deductive approach but a back-and-forth movement between theory and empirical data (Maxwell, 2012). This helped with the explorative nature of the research.

2.3 Research design

Maxwell (2012) proposed an interactive research model for qualitative research, which tied together several research components. Consisting of goals, research questions, the conceptual framework, methods, and validity, this model was followed to define these components in this research.

2.3.1 Goals

Goals clarify a study's relevance, consisting of personal, practical, and intellectual aspects (Maxwell, 2012). As humans, we will neither stop producing goods nor consuming them. This entails a significant need to move toward more sustainable manufacturing systems to reduce our detrimental influence on earth, which I regard as a real problem. Here lay the motivation to conduct this research from a personal perspective. As mentioned earlier, this research was financed by Chalmers Production Area of Advance, which aims to explore new approaches to achieve industrial competitiveness and resource-efficient product and production development processes. The practical and intellectual goals of this research are related to Chalmers Production's purposes. The mentioned practical gap, which is the challenge faced by manufacturing companies in realizing their vision of sustainability in day-to-day operations, and the existing literature's lack of understanding of the phenomenon, are both covered in the research purpose.

2.3.2 Conceptual framework

According to Maxwell (2012), four main sources construct a conceptual framework, as follows:

Experiential knowledge. I have worked in the manufacturing sector for a few years and have experienced the difficulties of involving manufacturing in corporate strategy setting. I also completed my master thesis in the field of quality management and OM, aiming to develop a sustainable approach for the robust design methodology. This knowledge cannot be ignored and can be considered an advantage, but at the same time, it should not be allowed to influence the research too much (Maxwell, 2012).

Prior theory and research. According to Maxwell (2012), prior research and theory are important to justify the research and make decisions regarding the method, data sources, and theory generation. At the initial stage of this research, there was a need to explore and delve deep into the current body of knowledge. This called for a structured and systematic literature review, focusing on the theoretical field of sustainable manufacturing strategy (Jesson et al., 2011). This choice of methodology would provide knowledge and awareness of the current state of the study field, which would later help frame the research (Croom, 2009). Study 1, a structured literature review, provided this knowledge.

Pilot and exploratory research. To understand what was happening in the industry and to define relevant problems, studies 2, 3, and 4 were performed as exploratory case studies. These were not structured case studies but more of open-discussion interviews with the people involved in relevant matters to increase the understanding on the field.

Thought experiments. These were tried through supervision and workshops with other researchers.

2.3.3 Research question

Research questions guide decisions about the literature, data collection, data analysis, and results presentation and are supposed to be the starting point of the research process (Bryman and Bell, 2011). Maxwell (2012) considered research questions as the heart of the research design but emphasized the fit between research questions and other parts of the model.

According to this study's defined purpose, the research questions have been formulated as:

RQ1: How is environmental and social sustainability captured in the manufacturing strategy in theory and practice?

RQ2: Which areas of sustainable manufacturing strategy are overlooked in the current body of knowledge?

These questions support the explorative nature of the research purpose and approach and help achieve a holistic view of sustainable manufacturing strategy.

2.3.4 Validity

Validity refers to "the correctness or credibility of a description, conclusion, explanation, interpretation or other sort of account" (Maxwell, 2012, p. 122). The main challenge of this research was that due to its broad topic and undefined focus in the beginning, during the process, a vast range of topics and issues was touched on but not studied in-depth. However, since the purpose was to obtain a broad picture, these wide-ranging topics helped gain a holistic perspective. Section 2.6 (research quality) presents a more detailed discussion regarding validity.

2.4 Data collection and analysis

Study 1 involved a systematic literature review to identify how sustainability was integrated into the manufacturing strategy studies. The sources were peer-reviewed journal articles, which were searched via keywords through Scopus and Science Direct and also by secondary references. Besides, well-known journals in the field, including JOM, IJOPM, and JCP, were checked issue-by-issue in the volumes published over a 25-year period to avoid missing any related articles. The inclusion criteria for considering articles in the study were 1) articles published from 1990 to 2015 and 2) keyword search in the titles, abstracts, or keywords. The keywords were "manufacturing or operations strategy" in combination with "sustainable development, sustainability, environmental, or social." The papers found were then assessed by reading each abstract and scanning through the whole article, based on two major criteria: 1) The papers should have operations/manufacturing strategy as their research theme. This was first checked by looking for operations/manufacturing strategy as a keyword of each paper. Later, some papers that did not mention operations/manufacturing strategy as a keyword but stated it in their abstracts as their focus were also added. Thus, the papers that did not explicitly mention operations/manufacturing strategy as their focus were excluded. 2) The papers should have sustainability as a concept related to environmental or social issues in manufacturing but should not have used the term as an expression for a firm's long-term survival. In total, 39 articles were selected and reviewed.

The selected articles were then analyzed by moving back-and-forth between deductive and inductive thinking (Flick, 2014). First, the categories were defined prior to the analysis, with the help of the production competence theory, a deductive approach. Then the articles were read several times, and the categories were adjusted so that some were mixed and renamed to provide a better representation of the papers' contents, which used an inductive approach to test the categories.

Since the research attempted to explore and understand a phenomenon and obtain a holistic view of the reality in the industry, it called for a data collection method involving practitioners that had collaborations with the industry. Thus, case studies seemed an appropriate method, which would

also support the abduction approach (Voss et al., 2002). Therefore, Study 2 was exploratory, through empirical case studies of two companies. This was a suitable choice due to the lack of theoretical concepts or well-structured descriptions of the phenomenon under study; the sustainable manufacturing strategy and exploratory case study methodology would be valid options when the phenomenon under study had not been thoroughly understood (Merriam, 1998; Gerring, 2007). According to Karlsson (2008), one of the most common challenges in conducting case studies is access to the required and relevant data. This issue can be solved through "convenience sampling" or "purposeful sampling," which entails the voluntary involvement of the case companies (Maxwell, 2012). Two case companies in Sweden, in the water and construction industries, respectively, accepted to participate in this study. Both had 1) a proven record of working actively in sustainability, for example, included in the Dow Jones Sustainability Index and 2) integrated sustainability in their documented business strategy, so it was already part of the business strategy. Since the purpose of this study was clarification and exploration rather than any form of preferences, interviews seemed a suitable data collection choice. To ensure sharing of a vast amount of information and the possibility of further discussions between the interviewer and interviewees, it was decided that in-depth semi-structured interviews would be used (Flick, 2014). Although the interviews were the main means of data collection, reviews of the company websites' archival data and annual reports, as well as visits to the production sites were used as secondary and supplementary data.

The interview data from Study 2 was analyzed through pattern matching (Yin, 2009); the data was matched with the defined categories from the production competence theory. Both within-case analyses (based on case descriptions) and cross-case analyses (to find common patterns in the within-case analyses) were presented.

Study 3 was also explorative and based on the case study methodology to complement the previous studies. The data from semi-structured interviews conducted in six manufacturing companies based in Italy, with different organizational and technological characteristics (e.g., centralization and decentralization, as well as functional, divisional, and matrix organizations and firm size, according to the European Commission), was used in this study. Additional sources were also used for data triangulation, including the company websites, publicly available documents regarding company performance and sustainability activities, internal documents about policies, strategies, meeting discussions, and improvement programs.

In Study 3, the case specifics were analyzed and presented as within-case analyses to investigate the entities in a stand-alone manner (Eisenhardt, 1989). The idea was that the organizational characteristics might influence the manufacturing strategy definition and implementation and the sustainable orientation of the company. Therefore, each case was analyzed according to four defined constructs: 1) competitive priorities, 2) formulation process, 3) organizational structure, and 4) sustainability orientation.

In Study 4, a literature review was first conducted to gain a better understanding of the concepts of socially sustainable manufacturing, social sustainability KPIs, reporting methods, and key characteristics of desired workplaces. The literature review was carried out by searching scientific papers and other contemporary, popular literature formats, such as surveys and reports, if they were deemed to add a relevant perspective. Since the concept had not been comprehensively defined, different broad terms were searched in databases such as Google Scholar and Scopus (e.g., "attractive workplace," "employee expectations," "social sustainability and demographics," etc.) to identify the main characteristics of a desired socially sustainable workplace. Through the literature review, a framework of a "desired socially sustainable workplace" was defined, and a set of KPIs for achieving it was proposed. Later, the proposed KPIs were tested in a pilot case study through semi- and unstructured interviews and visits to an electronic waste management facility. The framework of social sustainability KPIs was employed as an interview guide, with the help of a company representative who elaborated on how each proposed KPI was affected in the case. Therefore, the preliminary analysis of the interview data was started while transcribing the interviews, where notes were taken based on the interview guide.

2.5 Author's contributions to appended papers

Paper 1: single author. This is based on a previous conference paper presented at the First International Euroma Sustainable Operations and Supply Chain Forum. The original paper was co-authored with Mats Winroth and Linea Kjellsdotter Ivert. Therefore, the data collection was a joint effort. However, the appended paper was written by Taghavi.

Paper 2: second author, written together with Bojan Stahl, Mats Winroth, and Linea Kjellsdotter Ivert. Stahl collected the data in Italy. However, the research design, literature review, case analysis, and writing of the paper were the authors' joint efforts.

Paper 3: first author. The paper is a combination of two previous conference papers. The first paper was presented at the Sixth Swedish Production Symposium and co-authored with Cecilia Berlin and Caroline Adams. The second paper was submitted to the International Conference Advances in Production Management Systems and co-authored with Cecilia Berlin and Ilaria Giovanna Barletta. The research design, data collection, analysis, and writing of these papers were the authors' collaborative efforts. However, Taghavi wrote the appended version.

2.6 Research quality

This research follows a qualitative approach, so the conventional quality criteria of internal and external validity, reliability, and objectivity cannot be used to judge it (Flyvbjerg, 2006). Therefore, the proposed criteria for evaluating the trustworthiness of this research are discussed, including credibility, transferability, dependability, and confirmability (Halldorsson and Aastrup, 2003; Bryman and Bell, 2011).

2.6.1 Credibility

The credibility aspect of trustworthiness concerns how much the presented results of the research match the constructed realities of the respondents and can be ensured through the respondents' validation and use of triangulation (Bryman and Bell, 2011). Therefore, this aspect could not be addressed in Study 1, which is a literature review. In Study 2, credibility was assured through 1) the respondents' validation, where the key interviewees were asked to review the case stories, and 2) the supplementary use of archival data, annual reports, and visits to the production sites for data and method triangulation. In Study 3, triangulation was used to attain credibility, by interviewing multiple persons in each firm and using secondary data sources. In Study 4, the visit and observation were mixed with interviews to ensure triangulation.

2.6.2 Transferability

The transferability aspect of trustworthiness relates to the generalizability of the findings, so the research results can be transferred to other settings and general claims about the world (Halldorsson and Aastrup, 2003). This aspect is to some extent constrained in this research due to the limited number of cases in Studies 2 and 4 and having one case from each context in Study 3. However, according to Bryman and Bell (2011) and Eisenhardt (1989), highlighting the case context and providing thick case descriptions can help readers transfer the findings to their specific situations. Thus, in this research, descriptive and detailed case descriptions were supposed to help achieve transferability. Moreover, due to this study's explorative nature and purpose to obtain a holistic view of the field, generalization was not considered crucial.

2.6.3 Dependability

Dependability refers to data stability over time. It indicates that the research process and decisions, such as problem formulation, selection of research participants, interview transcripts, and data analysis, are recorded and documented (Bryman and Bell, 2011). This research ensured this aspect of trustworthiness in two ways. For Study 1, the literature review was described in detail in terms of the search keywords, databases used, time spans, and criteria for choosing the materials. In Studies 2, 3, and 4, dependability was addressed by recording and transcribing the interviews, as well as taking interview notes.

2.6.4 Confirmability

Confirmability is trustworthiness in addressing the integrity of the findings by tracking back the data to the sources and avoiding research bias (Halldorsson and Aastrup, 2003). Study 1 tried to achieve confirmability by means of repeated readings of the reviewed articles. Since semi-structured interviews were used as the main method of data collection in Studies 2, 3, and 4, it seemed impossible for the researcher to be completely neutral and not influence the interviewees. However, the researcher endeavored to minimize this influence by setting aside personal values.

3 Frame of reference

This chapter reviews the theoretical field on which this thesis is based. This chapter first provides an overview of the current body of knowledge on the production competence theory, manufacturing strategy literature, and sustainable OM, which are the foundations of this research. Second, the findings of Study 1, which is a literature review on "sustainable manufacturing strategy," are presented. Finally, the research questions are defined, based on the frame of reference and practical needs.

3.1 Production competence theory and process model of manufacturing strategy

Cleveland et al. (1989) proposed the theory of production competence as the "manufacturer's overall ability to support and prosecute the firm's business strategy" (p. 658). The manufacturing strategy should not be developed independently but "in the context and concomitantly with a firm's business strategy and other functional strategies as well" (Vickery, 1991, p. 639). Two viewpoints regarding production competence prevail among scholars. For Hayes and Wheelwright (1979), competence is something that a company either has or lacks. On the other hand, Cleveland et al.'s (1989) definition of production competence is a variable rather than a fixed attribute, which involves a manufacturer's preparedness, skill, or capability to employ a product- and market-specific business strategy relative to its competitors. Based on Cleveland et al.'s (1989) perspective, Vickery (1991) proposed a micro-process model for the manufacturing strategy. This process model pays attention to the consistency among internal processes, instead of only focusing on translating the business strategy into the manufacturing strategy. Based on this model, the main constructs of production competence are identification and weighting of manufacturing competitive priorities, strategic manufacturing decision making, implementation (e.g., projects and programs), and manufacturing performance measurement (Figure 1). According to Vickery's (1991) model, bridging the gap in operationalizing the manufacturing strategy requires consistency among manufacturing competitive priorities, manufacturing strategic decisions, and allocation of resources to related improvement programs and projects.

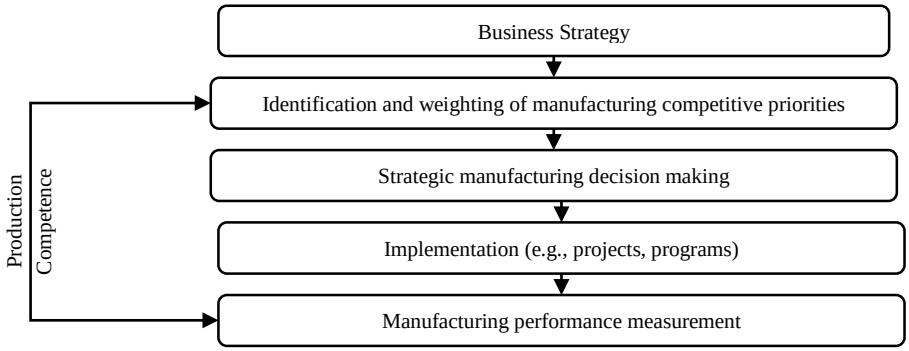

Figure 1. Process model of manufacturing strategy and production competence construct (adopted from Vickery, 1991)

Vickery's (1991) model is similar to the most common theoretical distinction for the manufacturing strategy, which consists of its content and process (Leong et al., 1990; Mills et al., 1995; Dangayach and Deshmukh, 2001; Slack and Lewis, 2011). However, this distinction has been criticized by some scholars, who have argued that content and process are best explored simultaneously (Pettigrew, 1992). This is mainly because the distinctions are not always relevant in practice. Thus, Mintzberg and Lampel (2012) stressed the need for more attention to strategy formation as a whole; "we must concern ourselves with process and content, statics and dynamics, constraint and inspiration, the cognitive and the collective, the planned and the learned, the economic and the political". Vickery's model proposes a more integrated view by translating manufacturing strategies' competitive priorities into manufacturing decisions and strategic initiatives, which are handled in the implementation phase. These initiatives are mainly improvement projects and programs aiming to maintain competitive priorities and "to raise the capabilities of the levers in a production system or a manufacturing network in order to raise the levels of the factory or network outputs" (Miltenburg, 2005, p. 245). In Vickery's model, performance measurement is also considered a main construct of the production competence to help the integration view.

3.2 Manufacturing strategy

The research domain of the manufacturing strategy has been an important part of OM for almost 50 years, since Skinner (1969) identified manufacturing as a missing link in corporate strategy and associated long-term decisions in manufacturing with corporate strategy to create competitive advantages (Skinner, 1969; Slack et al., 2010). The field has gone through a long journey and has been one of the most researched areas within OM (Amoako-Gyampah and Meredith, 1989; Pilkington and Meredith, 2009; Taylor and Taylor, 2009). During this period, various scholars have attempted to review the field to summarize its current achievements and key findings and provide research lines (Swamidass and Newell, 1987; Anderson et al., 1989; Dangayach and Deshmukh, 2001; Taylor and Taylor, 2009). While the earlier evolution of the field concerned the manufacturing function (Skinner 1969, 2007), and historically, manufacturing strategy had been the term used, now the term operations strategy coexists with it, and both are used interchangeably. One major reason might be that operations cover a wider area of activities (e.g., purchasing, logistics, etc.) and include strategies within the service sector, not just the core manufacturing process (Slack, 2005). In this work as well, the terms are used interchangeably.

3.2.1 Definition of manufacturing strategy

The research domain of manufacturing is traced back to Skinner (1969, 1974), when he highlighted manufacturing's potential for a competitive edge. Manufacturing companies constantly have to make decisions on the production level, which stem from their business strategies. These decisions, which include the organizational structure, equipment and process policies, workforce management policies, production scheduling and control, and quality control, are vital since they are not reversible in a short time and without large amounts of investment capital, and they can create a competitive advantage for the companies to move toward outperforming their competitors.

Skinner suggested more involvement and interest from top management in order to translate business strategy to manufacturing policymaking.

Following Skinner's work, various researchers defined manufacturing strategy, with similar core concepts but described from different angles. Table 2 presents a summary of the most common definitions.

Table 2. Most common definitions of manufacturing strategy

References	**Definition**
Skinner (1969)	Exploiting manufacturing as a competitive weapon
Hayes and Wheelwright (1984, p. 85)	"A pattern of decisions suggests criteria that might be used to evaluate the appropriateness of a given manufacturing decision."
Swamidass and Newell (1987, p. 509)	"Effective use of manufacturing strengths as a competitive weapon for the achievement of business and corporate goals."
Platts et al. (1998, p. 517)	"A pattern of decisions, both structural and infrastructural, which determine the capability of a manufacturing system and specify how it will operate, in order to meet a set of manufacturing objectives which are consistent with the overall business objectives."
Marucheck et al. (1990, p. 104)	"A collective pattern of coordinated decisions that act upon the formulation, reformulation, and deployment of manufacturing resources and provide a competitive advantage in support of the overall strategic initiative of the firm."
Hill (1994, p. 12)	"Manufacturing needs to be involved throughout the whole of the corporate strategy debate to explain, in business terms, the implications of [the] corporate marketing proposal and, as a result, be able to influence strategy decisions for the good of the business as a whole."
Slack and Lewis (2011, p. 2)	"[…] the total pattern of decisions which shape the long-term capabilities of any type of operation and their contribution to overall strategy."

Swamidass and Newell's (1987, p. 509) definition was the one mainly used in this research (see Table 2).

3.2.2 Manufacturing strategy content and process

Leong et al. (1990) introduced the predominant construct of the manufacturing strategy content, which is composed of competitive priorities and strategic choices. Competitive priorities are manufacturing objectives that "denote a strategic emphasis on developing certain manufacturing capabilities that may enhance a plant's position in the market place" (Boyer and Lewis, 2002, p. 9). Typically, scholars agree that the four major competitive priorities are cost, flexibility, quality, and delivery (Hayes and Wheelwright, 1984; Schmenner and Swink, 1998). Some studies add innovation or service as competitive priorities (Thürer et al., 2013); others include environmental protection (de Burgos Jiménez and Lorente, 2001; Martín-Peña and Díaz-Garrido, 2008; Da Silva et al., 2009) and social solidarity (Brown, 1996; Wilkinson et al., 2001). Previous research focused on investigating the relationships among competitive priorities, with two different viewpoints. The first emphasized tradeoffs among the competitive priorities, and the second proposed cumulative models such as the sand-cone or competitive progression theory (Ferdows and De Meyer, 1990; Boyer and Lewis, 2002; Rosenzweig and Roth, 2004).

It is worth mentioning that the terms *competitive priorities* and *competitive capabilities* are not clearly differentiated in the literature. According to Rosenzweig and Easton (2010, p. 136), "the literature sometimes investigates priorities, sometimes capabilities, sometimes both, and at times, confuses the two by operationalizing priorities using capabilities and vice versa."

Priorities help decision-makers through a pattern of decisions (Rosenzweig and Easton, 2010). The strategic decisions made in a manufacturing strategy are generally classified into structural and infrastructural areas (Hayes and Wheelwright, 1984; Rudberg and Olhager, 2003). Decisions in the structural area influence the physical resources and include aspects such as capacity, sourcing and vertical integration, facilities, and information and process technology (Hayes and Wheelwright, 1984; Slack and Lewis, 2011). These decisions are usually hard to change and require huge investments. On the other hand, infrastructural decisions impact tactical activities within operations and are easier to change. These decisions include elements such as resource allocation and capital budgeting systems, planning and control systems, quality systems, and organization (Hayes and Wheelwright, 1984; Slack and Lewis, 2011).

The manufacturing strategy content mainly deals with what the strategy is about. On the other hand, the manufacturing strategy process consists of formulation—focusing on linking strategic decisions to capabilities and formalizing the process—and implementation, which is how the decisions are transferred into actions on the operational level (Rytter et al., 2007; Rosén, 2011; Slack and Lewis, 2011). Many authors have noted that the process aspect has been neglected in research and needs more attention (Anderson et al., 1989; Dangayach and Deshmukh, 2001; Brown et al., 2010; Bouquet and Birkinshaw, 2011).

3.3 Sustainable manufacturing strategy; structured literature review

To investigate the current status of sustainable manufacturing strategy and due to the lack of publications summarizing this field, a systematic literature review was conducted. In total, 39 papers were found and reviewed from different journals since 1995, which had manufacturing/operations strategy as the theme and focused on sustainability as a concept. Table 3 presents the reviewed papers.

Table 3. Papers included in the literature review

Year	Author/s	Category					Research method				Sustainability dimension		
		Integrating sustainability into strategy development	Sustainability and manufacturing competitive capabilities/priority	Integrating sustainability into strategic decisions	Sustainability strategy Implementation	investigating sustainability's relation to performance measures	Literature review	Conceptual	Survey	Case study	Environmental	Social	Both
1995	Gupta	×						×			×		
	Sarkis	×						×			×		
1996	Newman and Hanna	×						×			×		
	Brown		×					×				×	
	Gupta and Sharma	×						×			×		
1997	Hitomi	×						×					×
1999	Angell and Klassen	×						×			×		
	Klassen and Whybark					×		×			×		
	Mohanty and Deshmukh	×								×	×		
2000	Pagell and Handfield	×				×			×			×	
2001	Klassen								×		×		
	Hill	×						×			×		
	Sarkis	×						×			×		
	de Burgos Jiménez and Lorente		×				×				×		
2002	Inman	×						×			×		
2006	Fai Pun	×					×				×		
2007	Crowe and Brennan		×			×			×		×		
	Rusinko		×						×		×		
2008	Martín-Peña and Díaz-Garrido		×						×		×		
	Angel del Brio et al.					×				×	×		
	Jovane et al.	×						×					×
2009	Da Silva et al.		×				×				×		
	Anussornnitisarn et al.		×						×		×		
	Pagell and Gobeli					×			×				×
2010	Avella and Vázquez-Bustelo		×			×			×		×		
	Li et al.				×					×	×		
	Johansson and Winroth			×			×				×		
2011	Díaz-Garrido et al.		×			×			×		×		
	Avella et al.		×						×		×		
2012	Jabbour et al.		×						×		×		
	Baines et al.	×					×		×		×		
	Gimenez et al.					×			×				×
	Gunasekaran and Spalanzani	×					×						×
	Schoenherr					×			×		×		
2013	Schoenherr and Talluri					×			×		×		
	Thürer et al.		×						×		×		
2014	Schrettle et al.				×			×					×
	Longoni et al.					×			×				×

3.3.1 Integrating sustainability into strategy development

The papers in this category introduce the idea of adding sustainability as a new phenomenon to the manufacturing strategy and its importance for operations.

Gupta (1995, p.50) provided an overview of environmental management from an operations perspective and suggested, "Operations strategies, objectives and decisions must be reviewed continuously in the light of environmental opportunities so that the acquired manufacturing capabilities can be used to gain a competitive advantage and new manufacturing capabilities be identified for long-range corporate planning". He later reported that a number of companies that had implemented environmental changes had seen significant improvements in their four operational objectives (cost efficiency, quality, delivery, and flexibility). Digging deeper into the topic, Gupta and Sharma (1996) discussed the application of environmental OM at the strategic level and linked it to manufacturing strategy as an opportunity for improvement. At almost the same time, Sarkis (1995) presented environmental consciousness issues regarding manufacturing and OM and shaped the future research agenda for strategic management of environmentally conscious programs and projects. Sarkis (2001) pointed out that profitability, productivity, and environmental consciousness were viewed as integral goals for manufacturing companies in the new millennium and discussed the challenge of integrating environmental issues into manufacturing strategies. He evaluated a number of environmental business practices from the manufacturing context.

Newman and Hanna (1996) attempted to integrate the concept of environmental management into two existing manufacturing strategy models. They first identified the environmental factors relevant to the manufacturing strategy from the perspective of order-winning criteria, order-qualifying criteria, and their impact on the process choice (as presented by Hill, 1994) and later offered a framework built on the four stages of manufacturing strategy development and integration into the corporate strategy (presented by Wheelwright and Hayes, 1985). Similarly, Angell and Klassen (1999) tried to integrate environmental issues into OM and manufacturing strategy to shape the future research agenda in the field. Hitomi (1997) discussed future manufacturing strategy perspectives, including computer-integrated manufacturing, high added-value production, resource savings, and environment-preserving production, and concluded that socially appropriate production would be an important strategy for manufacturing companies.

Hill (2001) provided insights into the growing demand for environmental sustainability that was addressed to operations managers and strategists, highlighting the importance of their awareness of the consequences of their decisions on cost, location of capacity, and technology selection. The paper also demonstrated the necessity of expanding operations managers' view to reduce greenhouse emissions. Likewise, Inman (2002) discussed the implications of increased environmental interest and change for OM in the areas of manufacturing strategy, production, and inventory management and Operations Research techniques, as well as proposed some relevant research questions. Later in 2006, through a literature review, Fai Pun determined the factors of

environmentally responsible operations, which were grouped as policy, product/process, and performance evaluation. This study proposed an agenda for future research on the areas involving the environmental, quality, and operations management interface.

Mohanty and Deshmukh (1999) discussed a world-class manufacturing strategy's paradigm shift to green productivity and socially appropriate production and consumption. They pointed out the important role of resource conservation and value addition for corporate strategic situations and found that their case companies' productivity management had not totally dealt with these two aspects. They suggested incorporating green productivity as an integral part of strategic thinking and decision making to boost this emergent movement. Jovane et al. (2008) presented the necessity for manufacturing companies to shift from economic growth to a new competitive scenario based on sustainable development. They proposed a reference model for proactive action in the definition, promotion, implementation, and evolution of competitive sustainable manufacturing. Furthermore, they reviewed strategies to pursue competitive sustainable manufacturing at the macro–meso-field level.

Baines et al. (2012) reviewed the current literature on green production and explained its role in competitiveness, based on Azzone and Noci's (1998) study. Gunasekaran and Spalanzani (2012) also reviewed the literature on the sustainability of manufacturing and services to suggest future research directions. They stated that "sustainability concepts should be considered as operations strategies similar to agile manufacturing, lean production and business process reengineering. This will help not only enhance the financial performance of an organization, but also satisfy social and environmental objectives and regulations. Though the subject of sustainability is being studied with an eye to practical applications, sustainability as a corporate/business/manufacturing strategy has yet to be studied or practiced" (Gunasekaran and Spalanzani, 2012, p. 36).

Pagell and Handfield (2000) explored the effect of unions on manufacturing strategy deployment. They suggested that for unionized firms to gain competitive advantage, it would be important to either capitalize their efficiency or change their relationship with the union since they limit the prevailing managerial functions as they are now.

3.3.2 Sustainability and manufacturing competitive priorities

The papers in this category either proposed sustainability as a new manufacturing competitive priority or investigated sustainability's relationship with other manufacturing objectives and looked for the possible logical sequence to improve them.

This move was started by Brown (1996), who proposed expanding the competitive priority construct to include social sustainability and workplace safety as its dimensions. She suggested quality movement, changes in technology, and changes in operational practices as factors embedded within the operations function and whereas workforce diversity and organized labor interests were associated with the human resource function but had a link to the operations function.

Similarly, de Burgos Jiménez and Lorente (2001) reviewed the literature on OM and environmental issues and justified the need for including environmental performance as an operations objective, that is, the measure of the extent to which a firm contributes toward maintaining or improving the environment. They suggested that environmental performance was not incompatible with other objectives but could reinforce them. They pointed out the necessity for further research on a fit model between business strategy and manufacturing strategy, taking environmental dimensions into account. They also recommended future studies to analyze this objective's relationship with other objectives and look for the possible logical sequence to improve them. Moreover, Da Silva et al. (2009) assessed how companies incorporated their environmental performance as an emerging competitive priority. They analyzed the relationship between environmental issues and production function in previous literature.

Many other scholars have followed de Burgos Jiménez and Lorente's (2001) suggestion to investigate whether sustainability would be a new competitive priority, to examine the logical sequence of competitive priorities for manufacturing to overcome tradeoffs, or to investigate the relationship of sustainability practices with other competitive priorities. However, their research findings were sometimes contradictory.

Crowe and Brennan (2007) aimed to establish a link between environmental management and firm innovation and performance through the manufacturing strategy of a minority of firms that emphasized environmental management in their competitive priorities. They concluded that innovation and performance indicators did not point to the prominence of environmental management in the manufacturing strategy. Anussornnitisarn et al. (2009) used an analytical hierarchical process and correlation analysis to investigate how well environmental sustainability integrated with other competitive priorities and its importance. They found that environmental dimensions were not highly important compared to other priorities and there was no clear linkage with other priorities. Moreover, Jabbour et al. (2012) investigated whether environmental management could be considered a new manufacturing competitive priority. They concluded that "environmental management present[ed] a preventive approach [… that] potentially [would] not create a competitive advantage" (p. 11) and was therefore not a new competitive priority. However, they suggested that environmental management might positively influence the other manufacturing priorities. Later, Thürer et al. (2013) examined and identified the competitive priorities of small manufacturing companies in Brazil. Their findings suggested that innovativeness was considered a new, important competitive priority in addition to cost, quality, flexibility, and delivery. However, they found little evidence that confirmed the proposed priorities, such as security and sustainability.

In contrast, Avella and Vázquez-Bustelo (2010) looked into the production competence theory based on Kim and Arnold's (1996) study to empirically investigate the manufacturing capabilities' impact on business performance. They justified environmental protection as a new manufacturing objective that might enhance the measurement of production competence. Avella et al. (2011)

analyzed the two opposing models regarding manufacturing capabilities (tradeoff and sand-cone models) and proposed and tested an extended sand-cone model, which included environmental protection as a manufacturing capability. Their study resulted in a cumulative model with the following sequence: quality, delivery, flexibility, environmental protection, and cost. In contradiction with Anussornnitisarn et al.'s (2009) findings, those of Avella et al. (2011) showed some positive linkage between environmental protection and other competitive priorities. Similarly, Martin-Peña and Diaz-Garrido (2008) reviewed the manufacturing strategy content literature and performed a cluster analysis on survey data to classify competitive priorities, including cost, quality, flexibility, delivery service, and environmental protection. They concluded that "companies [were] developing and competing effectively on multiple priorities, overcoming trade-offs" (p. 471), which confirmed a cumulative model. Díaz-Garrido et al. (2011) also used the production competence approach and proposed an indicator for positioning firms based on their competitive priorities, which confirmed environmental protection as a competitive priority and also identified its relationship with business performance.

In 2007, Rusinko presented an exploratory study based on a survey on the relationships between specific, environmental manufacturing practices (e.g., pollution prevention and product stewardship) and competitive outcomes (e.g., production cost and product quality). The findings showed that pollution prevention practices were associated with decreasing production cost. Product stewardship was highly practiced but did not significantly increase product quality. However, both pollution prevention and product stewardship practices were positively associated with competitive outcomes, including the company image, new customers, and innovative ideas in the company.

3.3.3 Integrating sustainability into strategic decisions and strategy implementation

These papers investigated sustainability in the manufacturing strategy process, through either strategy formulation or implementation. However, not many papers had been published in these categories.

Li et al. (2010) explored the planning and implementation of green manufacturing strategies among Chinese firms. They pointed out the complexity of implementing green manufacturing strategies in the studied cases and proposed an integrated model at the whole-system level for planning and implementing those strategies. Their model had a five-layer structure, consisting of 1) the enterprise's strategic goal of harmonizing economic and sustainable development benefits; 2) the enterprise's operational objectives, including time, quality, cost, service, resource consumption, and environmental impact; 3) product life cycle orientation, including raw material supply, manufacturing process, product assembly, product packaging, product usage and maintenance, and disposal after its useful life; 4) product design process orientation; and 5) the enterprise's information systems, including a green design supporting system, a cleaner production supporting system, a management information system, an environmental impact assessment system, and so

on. Johansson and Winroth (2010) presented a framework illustrating the implications of environmental issues on the manufacturing strategy formulation process, showing the interrelationships among drivers, effects on competitive priorities, and decision areas. Later, Schrettle et al. (2014) tried to shed more light on how manufacturing firms adjusted their strategies according to the sustainability challenge. They studied the operationalization of sustainability by identifying sustainability drivers and explaining how decisions on sustainability moves were motivated and which dimensions in the firm were affected by these moves. They described sustainability moves as comprising initiatives on the adoption of new manufacturing technologies, the development of new, sustainable products, or the integration of green practices into the supply chain. They then explained firms' decisions concerning sustainability moves according to their past performance, company size, and current level of sustainability action.

3.3.4 Investigating sustainability's relation to performance measures

Klassen and Whybark (1999) developed a new construct for the resource-based view of the manufacturing strategy, which was the environmental technology portfolio. They then explored the environmental technologies' impact on performance outcomes. This environmental technology portfolio included pollution prevention technologies (comprising product and process adaptation and management systems) and pollution control technologies (comprising remediation and end-of-pipe technologies). They concluded that performance improved in plants where pollution prevention technologies were introduced. In contrast, performance worsened in plants that introduced pollution control technologies.

Schoenherr (2012) investigated environmental management's impact on manufacturing plant operations' performance. In this study, environmental initiatives included ISO 14000 certification, pollution prevention, recycling of materials, and waste reduction; plant performance was assessed through the four competitive capabilities of quality, delivery, flexibility, and cost. They found that plants located in emerging economies more strongly emphasized environmental initiatives compared to industrialized and developing nations. Moreover, the influence of the initiatives was greater for plants in emerging and developing economies compared to those in industrialized nations.

Schoenherr and Talluri (2013) studied the impact of an explicit set of environmental sustainability initiatives—recycling, waste reduction, pollution prevention, ISO 14000 certification—on efficiency as a performance measure. They used the resource-based view in their rationalization and concluded that a higher level of efficiency could be achieved in plants that were more engaged in environmental sustainability initiatives.

Klassen (2001) identified and measured the impacts of plant managers' personal views and plant-specific factors, such as production outlook, equipment age, plant size, and recent history of environmental crises, on environmental performance. His findings suggested that plant managers' increasing emphasis on short-term economic value fostered a more reactive environmental

management. In contrast, plant managers' focus on ethical values led to a more proactive orientation and better environmental performance.

Angel del Brio et al. (2008) conducted an exploratory case study to identify the key factors related to organizational culture and human resource management that would impact environmental performance. They found that factors such as communications, teamwork, and environmental rewards contributed to improved environmental performance, but other factors, such as the high average age of employees or unionization, acted as barriers.

Pagell and Gobeli (2009) examined operational managers' perceptions about employee well-being and environmental issues and their relationship with operational performance. According to their findings, employee well-being and environmental performance had significant effects on operational performance. However, they pointed out that operations mangers did not think in sustainability terms, and there was a need for a more complete and holistic understanding of sustainability.

Gimenez et al. (2012) analyzed the data from a survey in 19 countries to investigate the impacts of environmental and social programs on the three dimensions of the triple bottom line. Their findings suggested that while environmental programs had positive effects on economic, social, and environmental performance, social programs positively influenced environmental and social performance only.

Longoni et al. (2014) investigated the roles of human resource management and practices related to new forms of organizations, such as teamwork, training, and employee involvement, in social and environmental performance. Their survey results indicated that training positively affected both social and environmental performance. Employee involvement and incentives positively influenced social performance only, while teamwork only impacted environmental performance when used as a relevant practice for implementing environmental sustainability action programs.

Summary of structured literature review

Since the first attempts to include sustainability in the theoretical field of manufacturing strategy, many researchers have emphasized the importance of green manufacturing and thus, incorporating environmental management into manufacturing strategies. These articles either explained the importance for manufacturing to take care of the environment and how manufacturing would be affected by doing so (Gupta, 1995; Gupta and Sharma, 1996; Newman and Hanna, 1996; Sarkis 1996; Hill, 2001; Inman, 2002; Baines et al., 2012) or tried to identify the emerging topics on this incorporation (Sarkis, 1991; Angell and Klassen, 1999; Pun, 2006; Gunasekaran and Spalanzani, 2012). These were mainly conceptual papers and literature reviews aiming to enrich existing theories on the manufacturing strategy by adding environmental management as a new

phenomenon. No other papers had the same focus on social sustainability other than that of Pagell and Handfield (2000).

The second group of papers mainly concentrated on quantitative empirical data to investigate sustainability's relationship with other manufacturing objectives. The first attempts were to include social sustainability, workplace safety (Brown, 1996), and environmental sustainability (de Burgos Jiménez and Lorente, 2001) as new competitive priorities for manufacturing. Since then, other researchers had tried to examine whether environmental sustainability would be a new competitive priority (Anussornnitisarn et al., 2009; Jabbour et al., 2012; Thürer et al., 2013), to investigate sustainability practices' relationship with other competitive priorities (Rusinko, 2007; Martin-Peña and Diaz-Garrido, 2008; Vázquez-Bustelo, 2010; Avella et al., 2011), or to study the effect of having environmental sustainability as a competitive priority on performance (Crowe and Brennan, 2007; Díaz-Garrido et al., 2011). No studies empirically investigated the same issues regarding social sustainability.

The third group of papers examined environmental sustainability in the manufacturing strategy process, either by including environmental sustainability in strategic decision making (Johansson and Winroth, 2010; Schrettle et al., 2014) or exploring the implementation of green manufacturing strategies (Li et al., 2010). All these were theoretical papers; no empirical ones existed in this category. Moreover, no article focused on social sustainability in this category.

The last group of papers investigated the relationship between some explicit sustainability practices in manufacturing and performance. Some papers highlighted the effects of some social sustainability practices, including human resource management, organizational culture, and plant managers' personal views, on the environmental performance of firms (Klassen, 2001; Angel del Brio et al., 2008; Longoni et al., 2014) Longoni et al. (2014) also studied the influence of human resource management and organizational culture on social performance. Other researchers examined the effects of some environmental practices, such as environmental technologies, ISO 14000 certification, pollution prevention, recycling of materials, and waste reduction, on efficiency and operational performance (Klassen & Whybark, 1999; Schoenherr, 2012). However, no study proposed and investigated a complete set of performance measures for social and environmental sustainability and the effect of operational performance in the manufacturing strategy field.

3.4 Sustainability in related fields

The literature review study (Study 1) covered the papers with the manufacturing strategy as their main theme. It showed that some aspects regarding sustainability were not fully addressed in the manufacturing strategy literature, which are explained more in Chapter 5 (discussion). However, since manufacturing strategy is closely related with and guides process technologies, production design, planning and control, performance management, supply chain management, and so on (Hayes and Wheelwright, 1984), many other papers might have tackled some of these aspects in

related fields. This section summarizes recent reviews of sustainability in some related fields, such as supply chain management and purchasing.

In 2008, Seuring and Müller reviewed 191 papers published from 1994 to 2007 in the field of sustainable supply chain management. Their findings pointed out that sustainable development did not hold a holistic comprehensive view in this field and mostly focused only on environmental issues, which were similar to the field of manufacturing strategy. They also mentioned that the theoretical background was often missing in this area of research, and more empirical research was needed to build on the theoretical basis from OM and supply chain management, as well as other fields, such as institutional economics and strategic management (Seuring and Müller, 2008). More recently, Hohenstein et al. (2014) conducted a systematic literature review in the same field but focused on human resource management in articles published from 1998 to 2014. They developed an analytical framework based on seven research streams of human resource management in the sustainable supply chain literature, as follows: 1) skills, knowledge, and abilities; 2) training and development; 3) human resource management's impact on performance; 4) education and teaching; 5) hiring and recruiting; 6) compensation and pay; and 7) global mindset. Based on their findings, the most researched streams were skills, knowledge, and abilities; training and development; human resource management's impact on performance; and education and teaching; the other streams were underrepresented in the research. They also noted that although this research field was recently gaining more attention, there was a need for more explorative case studies, and they proposed future research on identifying best practices (Hohenstein et al., 2014).

In the field of sustainable purchasing and supply management, Miemczyk et al. (2012) conducted a structured literature review of 113 articles on three levels of sustainability: 1) dyadic relationships between two actors—customer and supplier, 2) supply chains with a focal firm, and 3) industrial networks and stakeholders with a nonfocal approach. In their research, they found no common definition and taxonomy for sustainable purchasing and supply. Most of the publications emphasized dyadic relationships, not supply chain and network levels. Moreover, similar to supply chain management, environmental aspects, including internal generic processes, management of materials, waste and recycling, were dominant, as opposed to social sustainability. They concluded that the major focus of existing research was on the selection and contracting process and the evaluation process of suppliers; only few papers addressed other purchasing processes, such as supplier development, spending analysis, supply market analysis, and sustainability in the order cycle (Miemczyk et al., 2012).

4 Summary of appended papers

This chapter summarizes the three appended papers in terms of their purposes and main findings.

4.1 Paper 1. Sustainable production competence: investigating process model of sustainable operations strategy

The purpose of this study is to adopt Vickery's (1991) micro-process model of manufacturing strategy and apply it to the sustainability context in order to investigate the integration of sustainability into a process model of manufacturing strategy. The paper also developed more detailed questions for future research. Two companies were studied in an exploratory manner to investigate broadly how sustainability was integrated into the different constructs of the process model of manufacturing strategy and whether these constructs interacted regarding sustainability.

The study showed that sustainability was already part of the firms' vision and business strategies, and the top management focused and exerted pressure on sustainability issues. However, there was relatively little documentation of sustainability aspects at the lower organizational levels, where the companies had difficulties in translating and integrating these strategies. This indicated that sustainability followed a more top-down approach. The companies did not consider sustainability a top competitive priority since it was not part of customer requirements. Thus, sustainability was excluded from the formal manufacturing strategy. This showed that incorporating sustainability in the business strategy did not directly lead to sustainability's integration into functional strategies, such as manufacturing strategy. Although sustainability was neither a competitive priority nor part of the formal manufacturing strategy, it was at some level being carried out in the operations, and sustainability-oriented initiatives still occurred in parallel and besides the existence of a formal manufacturing strategy. Therefore, sustainability-oriented initiatives were not derived directly from a formal manufacturing strategy but could support it. Management systems seemed on the way of operationalizing sustainability in the studied companies. Moreover, although sustainability was being measured partly through some KPIs, it seemed that no holistic performance measurement system was in place regarding sustainability and the measured factors were not linked back to decisions and actions.

Both studied companies regarded employees as core members who help achieve sustainability in their operations and significant enablers of attaining operations competence in the sustainability context. The employees at different organizational levels were the ones affecting strategy implementation by their decisions and activities. Providing a safe and secure work environment was one of the main focuses for both companies. To support their employees in making decisions regarding sustainability, the companies urged them to ensure that everyone shared the same understanding of the goals and visions.

4.2 Paper 2. Manufacturing strategy: missing link between sustainability in corporate strategy and sustainable production

The purpose of this study is to investigate the integration of sustainability into the manufacturing strategy formulation and implementation process in conjunction to shed light on the operationalization of sustainable manufacturing strategies by answering the research question: How is sustainability integrated into the manufacturing strategy, and how do companies translate their sustainable manufacturing strategy into operational actions? The study had a twofold theoretical contribution: 1) It considered manufacturing strategy content and process issues at the same time, which had been widely neglected in the field (Mintzberg and Lampel, 2012). 2) It bridged the under-researched gap between the definition and implementation of sustainable manufacturing strategy. The data from six manufacturing companies based in Italy, with different organizational and technological characteristics, was analyzed to answer the research question.

The study showed that sustainability was not necessarily a top competitive priority per se for manufacturing companies. However, sustainability was included as a subpart of the production cost or quality in some companies, while others pursued it inherently.

The study found a discrepancy between the understanding of business and manufacturing strategy in practice and among the companies. Although scholars strictly distinguished between business strategy and manufacturing strategy, the real-life context was much more complex. Decisions and distinctions were overlapping and not always clearly differentiated in the cases. However, sustainability-oriented programs for capability building, maintenance, and improvement were in place besides a formal manufacturing strategy. They might support a firm's intended manufacturing strategy but were not consciously included in the formation process although they occurred in parallel to it.

The cases also confirmed differences in how the companies tackled sustainability, depending on firm size. While large companies had the instruments to act according to the principle of indiscriminate all-around distribution, for small and medium enterprises, the full adoption of certifications and conformance to regulations constituted a burden rather than an opportunity. The main obstacles had been excessive bureaucracy and costs.

Another finding was the absence of a common definition of sustainable operations, in contrast to established manufacturing improvement programs, such as total quality management or lean manufacturing. The investigated firms mostly created their in-house terminology to communicate different concepts. Some extreme cases even had a misalignment between a firm's beliefs or statements about sustainability and its actions.

4.3 Paper 3. Key performance indicators of social sustainability in operations management

The purpose of this study is to explore the currently agreed social sustainability KPIs in the literature to investigate whether the prevailing KPI-oriented approach to social sustainability was supportive enough to direct operations toward the desired future state as attractive workplaces. To do so, this paper provided a preliminary picture of the current landscape of social sustainability KPIs through a literature study. Key characteristics for a socially sustainable manufacturing work system that could combat the aforementioned demographic challenge, by meeting the needs of both current and future employees, were identified to propose a set of social sustainability KPIs.

The study showed that although sustainability reporting initiatives, such as the Global Reporting Initiative's latest list of recommended KPIs known as the GRI4, provided companies with a good initial platform for recognizing measurable improvement areas, they might provide too little decision support. This was mainly because the KPIs were intentionally broad to increase applicability, but this made them too unspecific or too narrow to truly guide OM's efforts toward the desired social sustainability visions for their workforce. The review of the social sustainability KPIs indicated the existing frameworks' focus on the current fundamental needs of employees, such as fair pay and healthy and safe workplaces, but not much emphasis on aspects such as knowledge transfer, employee empowerment, and supporting work-life balance. The study raised the idea that to integrate social sustainability thinking into a company's long-term vision for success, the operations leadership must seek ways to recognize social sustainability as "closer to home" at the factory level.

Next, the proposed KPIs were used to investigate the social impacts in the case that introduced a new technology (in the form of waste-sorting equipment) into electronic waste management. In this particular case, the framework clearly highlighted the advantages and disadvantages of implementing the technology for operators. Based on the interview results, the authors noted that some additional conditions, which the technology itself could not provide, needed to be secured by the organization to ensure the implementation of social sustainability, as follows:

- Education and training must be provided to employees using the equipment to prevent injuries and to ensure that the aggregated data is exploited well.
- Workers should be made aware that new responsibilities are expected of them, such as analyzing the data and coming up with new ideas, to gain the advantages of more varied and meaningful work, increased participation, and empowerment.
- Tradeoffs between a number of job opportunities and meaningful work content must be managed by companies.

5 Discussion

This chapter answers the defined research questions of the thesis. First, based on the frame of reference and the papers' findings, the integration of sustainability into each component of the manufacturing strategy's process model and their possible linkages are discussed (RQ1). Based on this discussion, the gaps in theory and practice are identified, and future research proposals are generated (RQ2).

RQ1: How is environmental and social sustainability captured in the manufacturing strategy in theory and practice?

To answer RQ1, the manufacturing strategy's process model, proposed by Vickery (1991) and based on Cleveland et al.'s (1989) production competence theory, is used. To prepare a manufacturing company to operationalize a specific strategy, four components should be developed and linked together, as well as to business strategy and performance. These four components are *competitive priorities*, which shape manufacturing strategy content; *strategic manufacturing decision making* and *implementation* (e.g., projects and programs), which shape the manufacturing strategy process; and *manufacturing performance measurement*, which is the method to assess and improve manufacturing strategy. Therefore, if sustainability is claimed to be a new part of the business strategy, it should be integrated into these components, and the links should exist. However, the analysis of the findings on how this integration is done in theory and practice shows that not all the components and links regarding sustainability are in place, which affects the operationalization of sustainability in a manufacturing firm's day-to-day activities and decisions. Table 4 summarizes the findings of the literature review and empirical findings from Studies 2, 3, and 4.

Table 4. Findings from literature review and empirical studies

Components	Findings from literature review (Studies 1 and 4)	Findings from empirical data (Studies 2,3, and 4)
Competitive priorities	Social sustainability Workplace safety has been proposed as a new competitive priority.	Social sustainability Not considered a competitive priority
	Environmental sustainability Proposed as a new competitive priority and investigated empirically	Environmental sustainability Not considered a competitive priority but can affect production cost and quality
Strategic manufacturing decision making	Social sustainability Not discussed	Social and environmental sustainability Linked to decisions through management systems Not part of day-to-day decisions but part of decisions that need large investments
	Environmental sustainability Implications of sustainability on manufacturing strategy decision areas have been proposed.	
Implementation	Social sustainability Not discussed	Social and environmental sustainability Through improvement programs, initiatives, and employee involvement
	Environmental sustainability A five-step model for planning and implementing the environmental manufacturing strategy has been proposed. Discussed according to past performance, firm size, and level of sustainability actions	
Performance measures	Social and environmental sustainability Set of performance measures has not been proposed. Environmental or social performance's link to operational performance measures has been studied.	Social and environmental sustainability Measurements exist, not to judge the sustainability level, but mainly for other reasons. Existing social sustainability measures do not help firms attain the desired socially sustainable workplace.

The literature from Study 1 provides contradictory findings regarding sustainability being a competitive priority, in addition to cost, quality, flexibility, and delivery, for manufacturing companies. First, researchers had not previously investigated social sustainability as a competitive priority although Brown (1996) proposed workplace safety. The interviewed companies do not consider sustainability a competitive priority, either. Second, while some authors had been able to confirm environmental protection as a competitive priority (Martín-Peña and Díaz-Garrido, 2008; Avella and Vazques-Bustelo, 2010; Avella et al., 2011), this research could not confirm this finding. None of the analyzed cases in Studies 2 and 3 has competed based on environmental protection, similar to other researchers' results (Anussornnitisarn et al., 2009; Jabbour et al., 2012; Thürer et al., 2013). The reason might be that although general awareness about sustainability has

increased among customers, they still do not prioritize it. However, this might differ according to the industry, which has not been investigated in this study. Moreover, although environmental protection is not considered a competitive priority, some of the cases in Studies 2 and 3 mention the positive effects of their environmental management efforts on quality and production costs. Therefore, the findings from both the literature and empirical studies show that *neither social nor environmental sustainability is a top competitive priority for manufacturing firms, but environmental sustainability supports achieving other competitive priorities.*

The literature from Study 1 does not provide much insight into how to integrate sustainability into the manufacturing strategy process, which the production competence theory identifies as two components of strategic manufacturing decision making and implementation. Few studies have discussed the implications of sustainability on manufacturing strategy decision areas (Johansson and Winroth, 2010) and the implementation of sustainability (Li et al., 2010; Schrettle et al., 2014) in order to operationalize it. None of the analyzed cases in Studies 2 and 3 has integrated sustainability into their day-to-day operational activities and decisions other than when making decisions that need large investments. However, it has been operationalized to some extent, mainly through improvement programs and environmental and social initiatives. A main driver that has forced companies to take action regarding sustainability is linked to legislation and the pressure for sustainability reporting to enhance the corporate reputation and public image, as mentioned by Beder and Beder (2002). One common way for the analyzed companies in Study 2 to operationalize sustainability to some extent is through integrating sustainability into their management systems. However, this thesis has not investigated how management systems can help operationalize sustainability in day-to-day operations. The companies in Study 2 also mention employees' (as core members) involvement in achieving sustainability in their operations. The cases in Study 3 also show that company size can have an effect on the degree to which the firms integrate sustainability into their decisions and activities. Smaller companies experience greater difficulties related to bureaucracy and costs in taking care of sustainability in their operations. This outcome was also previously discussed by Schrettle et al. (2014). Thus, the findings indicate that *sustainability is not yet operationalized in manufacturing firms*' *day-to-day decisions and activities through their manufacturing strategy. However, sustainability is implemented to some extent through improvement programs, initiatives, and integrated management systems.*

Both the literature (Study 1) and empirical studies (Studies 2, 3, and 4) indicate that companies constantly quantify their actions, which they measure to assess their performance. Financial measures, also related to sustainability, have for long been well established in companies to monitor their economic performance and profitability. Furthermore, regarding environmental and social sustainability, different KPIs have been proposed in fields other than manufacturing strategy (Veleva and Ellenbecker, 2001; Winroth et al., 2014). Some of these measures have been used by the companies in Study 2. However, Study 2 also shows that these performance indicators do not measure the outcome of production to judge sustainability. Rather, they either gather sustainability reports or address the issue due to their dependence on other important aspects of manufacturing

strategy, such as cost and quality. Particularly, several environmental performance indicators already proposed in the literature, which are also measured by the companies, can be directly linked to cost and quality, for example, reducing usage of materials, energy consumption, and waste. Thereby, these factors can affect performance, as previously studied by Schoenherr and Talluri (2013). Regarding social sustainability, Study 4 shows that the existing measures in both the literature and studied companies mainly regard employees' fundamental needs, such as health and safety. Thereby, *a clear connection to the assurance of the firms' social sustainability cannot be observed*.

These findings show the lack of a holistic approach for judging and improving the sustainability of a company's production. This may lead to decisions on sustainability that do not reflect the measures applied. The empirical findings in Study 2 also note a disconnection among different levels and functions; the data collectors seem disconnected from the decision makers who influence sustainability choices. Furthermore, no clear links among measures, goals, and strategic decisions have been observed. What has been shown is that due to interdependencies among individual measures and measures affecting different sustainability pillars, it is not easy for the companies to obtain a holistic view of their sustainability measures. These findings indicate that *to ensure operationalization of sustainability, it is a necessary step to assure the alignment of measures, goals, and strategic decisions.*

RQ2: Which areas of sustainable manufacturing strategy are overlooked in the current body of knowledge?

By analyzing the findings from the literature review (Study 1) and the empirical material (Studies 2, 3 and 4), major areas of sustainable manufacturing strategy that need more attention are described, and possible future research questions are generated.

Despite the clear need for sustainability, it is not yet easy for manufacturing firms to grasp and approach the concept. One reason might be that the definition of sustainability still seems fuzzy when translated from the top or national level (i.e., Brundtland definition) to the bottom or the firm and manufacturing level (Van Marrewijk, 2003; Berns et al., 2009). As stated by Dahlsrud (2008), "[…] we have looked for a definition and basically there isn't one" (p. 1). The different, manifold definitions and terminologies and lack of clear guidelines make it difficult to implement sustainability. From the corporate perspective based on surveys, scholars have pointed out the absence of a single accepted definition of sustainability; the term can be used to refer to any environment- or society-related activity (Berns et al., 2009; Haanaes et al., 2011). Each of the analyzed companies in Studies 2 and 3 has its own in-house terminology about sustainability, which could also differ, based on the subject of discussion. In some cases, there could even be a difference between what the firms believe or say about sustainability and what they do about it. This leads to the need for future research on finding a common definition and taxonomy regarding sustainability in manufacturing. Consequently, one overlooked question:

- What is a standardized, common definition of sustainability in manufacturing firms?

The theoretical field of manufacturing strategy is well established. Traditionally, manufacturing strategy has been associated with linking and creating a fit among corporate strategy, market requirements, and operational resources in the competitive environment (Slack and Lewis, 2011). However, it is still a challenge to empirically investigate the field and its relationship with other disciplines. According to Slack et al. (2004), the theory and practice of the manufacturing strategy are not yet synchronized. Adding sustainability as a discipline to the field has also been associated with some difficulties. According to Gunasekaran et al. (2013, p. 805), "Sustainable development remains a major challenge and opportunity for global firms. However, the role of operations research and operations management is yet to be studied in depth." According to Drake and Spinler (2013, p. 11), "Many decisions that determine a firm's sustainability impact also naturally intersect with established OM streams." One problem is that the manufacturing strategy has become an isolated field that has lost its interaction with other fields and disciplines, including strategic management, stakeholders' theory, organizational theory, supply chain management, organizational behavior, human resource management, and so on (Leong et al., 1990; Pilkington and Meredith, 2009; Taylor and Taylor, 2009). Moreover, manufacturing strategy, especially its formulation and implementation, remain somehow undeveloped and need closer academic attention (Dangayach and Deshmukh, 2001; Pagell and Shevchenko, 2014). Thus, there is a need to integrate sustainability into other operations' models, metrics, and tools to implement and operationalize it (Ferrer, 2008; Singh et al., 2009). Therefore, the field calls for multidisciplinary studies to deal with enhancing the formulation and implementation of sustainability in the manufacturing strategy.

- How can other fields of research be used to enhance the formulation and implementation of sustainability in the manufacturing strategy?

Most of the research in sustainable OM has focused on the firm level, not primarily on the operational level; there is a lack of understanding about implementing and improving sustainability on the operational level (Baumgartner, 2014). Lubin and Esty (2010) pointed to the isolated manner of sustainability initiatives, and some were implemented without any connection to visions and strategies. According to Newman and Hanna (1996), sustainability issues are not integrated with functional strategies, and from the operations managers' perspective, the matter is someone else's concern. The empirical findings from Studies 2 and 3 also show that although the literature makes a clear distinction between business and manufacturing strategy, the companies do not distinguish between the two. Consequently, no translation of sustainability as a strategy into the content of functional manufacturing strategy has been observed. Thus, manufacturing strategy research needs to understand ways to foster sustainability initiatives and build manufacturing capability (Klassen,

2001) for creating a competitive position by means of sustainability (Narasimhan et al., 2005) on the plant level (Rusinko, 2007).

While incorporating sustainability into the manufacturing strategy as an imperative or a new competitive priority has gained extensive research attention, "there are not many articles that deal with modelling and analysis of sustainable operations management decision making at strategic, tactical and operational levels that are important for implementation" (Gunasekaran and Irani, 2014, p. 801). In the early 1990s and 2000s, many publications focused on describing sustainability as a new phenomenon in the manufacturing strategy and called for considering sustainability a new competitive priority (Griffin and Puia, 2009; Eweje, 2011; Gunasekaran and Spalanzani, 2012). However, by the end of the 2000s, the research has mainly focused on investigating if sustainability is really a competitive priority. According to Lubin and Esty (2010), companies need to tackle both issues of developing a strategic sustainability vision and determining how to carry it out simultaneously. Although companies may benefit from answering the "if" question, scholars have pointed out the utmost importance of "how" sustainability is integrated into the manufacturing strategy and implemented in corporate decisions and actions (Minarro-Viseras et al., 2005; Bettley and Burnley, 2008; Hopkins, 2009). Recent research has identified a gap between sustainability vision and action and the challenge faced by companies to translate their vision into day-to-day actions despite having a formal strategy and commitment to sustainability (Epstein, 2008; Epstein and Buhovac, 2010; Kiron et al., 2013). The following research questions can help operationalize sustainability in manufacturing:

- How is sustainability incorporated into any other functional strategy that enhances its operationalization in manufacturing operations?
- How is sustainability integrated into daily structural and infrastructural manufacturing decisions?
- How can management systems be important enablers of operationalizing sustainability in day-to-day activities?

Regarding the relationships of the components based on Vickery's (1991) model, Studies 2 and 3 suggest that the process is not fully followed in the manufacturing companies. None of the papers reviewed in Study 1 has also addressed the full deployment process of sustainable manufacturing strategy. The companies in Studies 2 and 3 have not translated sustainability from the business strategy into the content of the functional manufacturing strategy in terms of a manufacturing objective. As mentioned earlier, neither has it been translated into the strategic decision areas. However, sustainability-oriented initiatives are still implemented in parallel and besides the existence of a formal manufacturing strategy and can support the intended one. The link that is supposed to feed sustainable performance indicators back to where the strategy formations happen does not exist, due to the absence of sustainability in the functional strategy. Therefore, since most sustainability initiatives are directly driven by the business strategy, this has caused sustainability

to follow a top-down approach; this process is illustrated in Figure 2. Thus, future research can examine these links and answer the question:

- How is a sustainable manufacturing strategy process deployed?

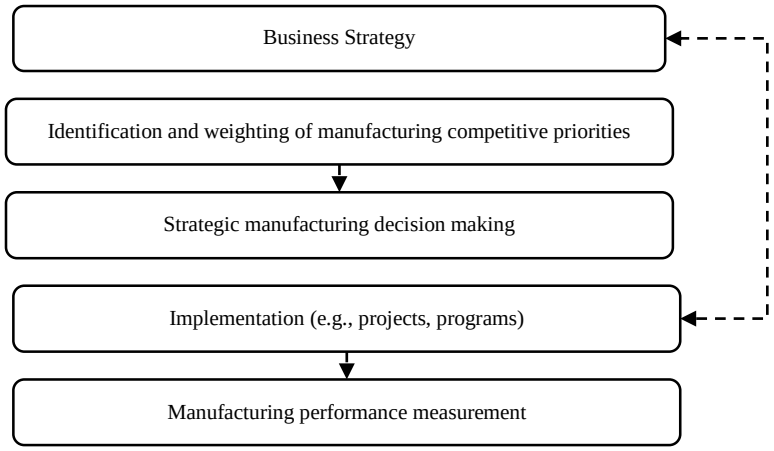

Figure 2. Process of sustainable manufacturing strategy in empirical cases

Other OM disciplines have attempted to consider the role of humans in achieving sustainability. Some scholars already pointed out the important function of human resources in the implementation and deployment of environmental initiatives (Angell and Klassen, 1999; Daily and Huang, 2001). Daily and Huang (2001) proposed empowerment, training, autonomy, decision making, employee involvement, rewards, and teamwork as key factors to involve employees in order to achieve environmental performance. Hanna et al. (2000) also focused on employee involvement to improve performance. More recently, Sarkis et al. (2010) emphasized the role of employee training as a means to overcome the organizational barriers to implementing environmental practices.

However, people as the main component of a firm has not been much researched in the field of manufacturing strategy and accordingly, sustainability in the operations strategy (Barnes, 2002) although operations capabilities are formulated through decision categories and by people, that is, operations managers, operators, and so on. The literature analysis in Study 1 shows the environmental pillar of sustainability as the dominant element of the research in the field; the focus on social issues, which are linked to people, is still rare. The social sustainability aspect has been widely acknowledged as the least developed of the three sustainability pillars (Omann and Spangenberg, 2002; Vallance et al., 2011). Previous studies on other disciplines, such as sustainable supply chain management, pointed out a similar observation (e.g., Seuring and Müller, 2008).

Thus, it would be beneficial for future research to include social aspects in its investigations. Employees have been identified as significant enablers to acquire operations competence in the sustainability context. Therefore, it would be interesting to conduct a more in-depth study on the employees involved in each step and to explore the following questions:

- How can operations managers impact the operationalization of sustainability through their decisions and actions?
- How can operational personnel impact the operationalization of sustainability through their decisions and actions?
- How can an integrated way of working between employees who manage sustainability issues and employees on the operational level enhance the operationalization of sustainability?

Over the past couple of years, the number of sustainable performance measures has tended to increase fast. Each of these measures needs resources and administrative work to collect, analyze, report, and present data. However, existing performance measurement systems are rarely enough to improve organizational performance (Searcy et al., 2008). Performance measures often encourage local optimization, focus mainly on economic performance, do not reflect corporate goals, and do not recognize the dynamic internal and external environments in which companies operate. Moreover, it is still unclear how these performance measures are linked back to related decisions and used to make new ones and how different decisions are reflected in performance measures' outcomes. The interactions among the different measures and how these interlinkages affect a company's total performance are often not studied, either. The lack of tradeoff understanding makes it difficult to understand the impact of one sustainable dimension on the others and their direct and indirect relationships, as well as system optimization (Rosenzweig and Easton, 2010; de Burgos Jiménez et al., 2013). Moreover, according to Johansson et al. (2012), despite the relatively broad knowledge base for measuring environmental aspects, knowledge is limited on how to measure and assess social aspects. This can be because social aspects are difficult to judge quantitatively and often involve challenging ethical considerations. This information leads to the following research questions:

- Which performance measures can help operations effectively manage their sustainability performance?
- How does the use of performance measures affect the effective decision making regarding sustainability?

6 Conclusion

The importance and relevance of integrating and operationalizing sustainability in the manufacturing strategy have been proposed. However, few studies have addressed the issue. This thesis has aimed to investigate the integration and operationalization of environmental and social sustainability in the manufacturing strategy to obtain a holistic view and to shape an agenda for future research. This study contributes to the literature on sustainable manufacturing strategy by bringing together the current developments of the topic in existing literature and in practice. Generally, it attempts to extend the perspective to the area of sustainable manufacturing strategy and its operationalization.

Two RQs have been used to achieve this purpose. 1) How is environmental and social sustainability captured in the manufacturing strategy in theory and practice? This question has been answered by means of a literature review of sustainability in the manufacturing strategy, three case studies, and data analysis based on Vickery's (1991) proposed process model of manufacturing strategy. The findings identify some gaps in the theory and practice of sustainable manufacturing strategy and also show similarities and differences between how sustainability is addressed in the literature and in reality. 2) Which areas of sustainable manufacturing strategy are overlooked in the current body of knowledge? Based on the findings from RQ1, some areas to focus on for future research and further questions for research in the field have been proposed to answer RQ2.

This thesis is a starting point for studying the integration of environmental and social sustainability into manufacturing strategy content and process and its operationalization. The empirical data of this thesis is based on a limited number of interviews in several cases; therefore, no general conclusions can be drawn about how companies should implement sustainability in their operations. However, the findings make it possible to gain a more holistic perspective of sustainability in the manufacturing strategy and have been used to open up new opportunities and directions for future research.

Regarding future research, the descriptive analysis of the literature from Study 1 shows that almost all the papers are either literature reviews, conceptual types, or surveys. Only a few papers have used the case study as their main method of investigation. According to Flick (2014), the previous research provides a kind of "big narrative" for the area, but the field still offers a nascent theory for which there are insufficient firm constructs to address the "how and why" questions (Edmondson and McManus, 2007). As mentioned in the discussion on RQ1, the internal and external contexts, including industry, firm size, organizational structure, organizational culture, and so on, might have positive or negative effects on achieving environmental and social sustainability goals in the strategy. Therefore, further descriptive studies are required to capture how these contextual situations can hinder or enable the operationalization of sustainability. Moreover, almost all the

research questions and directions, as defined in the discussion on RQ2, call for more in-depth studies in various contexts. Therefore, a more explanatory, qualitative approach will be useful to answer the proposed questions.

7 References

Albino, V., Balice, A. and Dangelico, R. M. (2009), "Environmental strategies and green product development: an overview on sustainability-driven companies." *Business Strategy and the Environment*, Vol. 18**,** No. 2, pp. 83–96.

Almström, P., Andersson, C., Muhammad, A. and Winroth, M. (2011), Achieving sustainable production through increased utilization of production resources. Proceedings of the 4th Swedish Production Symposium, SPS11, Lund, May 3–5, 2011.

Alvesson, M. and Sandberg, J. (2011), "Generating research questions through problematization." *Academy of Management Review*, Vol. 36**,** No. 2, pp. 247–271.

Amoako-Gyampah, K. and Meredith, J. R. (1989), "The operations management research agenda: an update." *Journal of Operations Management*, Vol. 8**,** No. 3, pp. 250–262.

Anderson, J. C., Cleveland, G. and Schroeder, R. G. (1989), "Operations strategy: a literature review." *Journal of Operations Management*, Vol. 8**,** No. 2, pp. 133–158.

Angel del Brio, J., Junquera, B. and Ordiz, M. (2008), "Human resources in advanced environmental approaches – a case analysis." *International Journal of Production Research*, Vol. 46**,** No. 21, pp. 6029–6053.

Angell, L. C. and Klassen, R. D. (1999), "Integrating environmental issues into the mainstream: an agenda for research in operations management." *Journal of Operations Management*, Vol. 17**,** No. 5, pp. 575–598.

Anussornnitisarn, P., Phusavat, K., Jaiwong, P. and Pennanen, M. (2009), "Environmental consideration and small and medium enterprises' competitiveness improvement." *International Journal of Management and Enterprise Development*, Vol. 6**,** No. 1, pp. 18–37.

Avella, L. and Vázquez-Bustelo, D. (2010), "The multidimensional nature of production competence and additional evidence of its impact on business performance." *International Journal of Operations & Production Management*, Vol. 30**,** No. 6, pp. 548–583.

Avella, L., Vazquez-Bustelo, D. and Fernandez, E. (2011), "Cumulative manufacturing capabilities: an extended model and new empirical evidence." *International Journal of Production Research*, Vol. 49**,** No. 3, pp. 707–729.

Azzone, G., Bertelè, U. and Noci, G. (1997), "At last we are creating environmental strategies which work." *Long Range Planning*, Vol. 30**,** No. 4, pp. 478–571.

Azzone, G. and Noci, G. (1998), "Identifying effective PMSs for the deployment of "green" manufacturing strategies." *International Journal of Operations & Production Management*, Vol. 18**,** No. 4, pp. 308–335.

Baines, T., Brown, S., Benedettini, O. and Ball, P. (2012), "Examining green production and its role within the competitive strategy of manufacturers." *Journal of Industrial Engineering and Management*, Vol. 5**,** No. 1, pp. 53–87.

Bansal, P. and Roth, K. (2000), "Why companies go green: a model of ecological responsiveness." *Academy of Management Journal*, Vol. 43**,** No. 4, pp. 717–736.

Barnes, D. (2002), "The complexities of the manufacturing strategy formation process in practice." *International Journal of Operations & Production Management*, Vol. 22**,** No. 10, pp. 1090–1111.

Baumann, H., Boons, F., and Bragd, A. (2002), "Mapping the green product development field: engineering, policy and business perspectives." *Journal of Cleaner Production*, Vol, 10, pp. 409_425.

Baumgartner, R. J. (2014), "Managing corporate sustainability and CSR: a conceptual framework combining values, strategies and instruments contributing to sustainable development." *Corporate Social Responsibility and Environmental Management*, Vol. 21**,** No. 5, pp. 258–271.

Beder, S. (2002), Global spin: the corporate assault on environmentalism. Green Books Totnes, Devon.

Berchicci, L. and Bodewes, W. (2005), "Bridging environmental issues with new product development." *Business Strategy and the Environment*, Vol. 14**,** No. 5, pp. 272–285.

Berns, M., Townend, A., Khayat, Z., Balagopal, B., Reeves, M., Hopkins, M. S. and Kruschwitz, N. (2009), "The business of sustainability: what it means to managers now." *MIT Sloan Management Review*, Vol. 51**,** No. 1, pp. 20–26.

Bettley, A. and Burnley, S. (2008). "Towards sustainable operations management integrating sustainability management into operations management strategies and practices." In Handbook of performability engineering, pp. 875–904. Springer, London.

Boudreau, J. W. and Ramstad, P. M. (2005), "Talentship, talent segmentation, and sustainability: a new HR decision science paradigm for a new strategy definition." *Human Resource Management*, Vol. 44**,** No. 2, pp. 129–136.

Bouquet, C. and Birkinshaw, J. (2011), "How global strategies emerge: an attention perspective." *Global Strategy Journal*, Vol. 1**,** No. 3–4, pp. 243–262.

Boyer, K. K. and Lewis, M. W. (2002), "Competitive priorities: investigating the need for trade-offs in operations strategy." *Production and Operations Management*, Vol. 11**,** No. 1, pp. 9–20.

Brown, K. A. (1996), "Workplace safety: a call for research." *Journal of Operations Management*, Vol. 14**,** No. 2, pp. 157–171.

Brown, S., Squire, B. and Lewis, M. (2010), "The impact of inclusive and fragmented operations strategy processes on operational performance." *International Journal of Production Research*, Vol. 48**,** No. 14, pp. 4179–4198.

Brundtland, G. H. (1987), Report of the World Commission on Environment and Development: "Our common future." United Nations.

Bryman, A. and Bell, E. (2011), Business research methods, 3rd ed. Oxford University Press, Oxford, USA.

Cleveland, G., Schroeder, R. G. and Anderson, J. C. (1989), "A theory of production competence." *Decision Sciences*, Vol. 20**,** No. 4, pp. 655–668.

Corbett, C. J. and DeCroix, G. A. (2001), "Shared-savings contracts for indirect materials in supply chains: channel profits and environmental impacts." *Management Science*, Vol. 47**,** No. 7, pp. 881–893.

Corbett, C. J. and Klassen, R. D. (2006), "Extending the horizons: environmental excellence as key to improving operations." *Manufacturing & Service Operations Management*, Vol. 8**,** No. 1, pp. 5–22.

Croom, S. (2009), "Introduction to research methodology in operations management." *Researching Operations Management*, p. 43–83.

Crowe, D. and Brennan, L. (2007), "Environmental considerations within manufacturing strategy: an international study." *Business Strategy and the Environment*, Vol. 16**,** No. 4, pp. 266–289.

Da Silva, E., Jabbour, C. J. C. and Santos, F. C. A. (2009), "Integrating environmental management and manufacturing strategy: an emerging competitive priority." *International Journal of Environmental Technology and Management*, Vol. 10**,** No. 3, pp. 397–411.

Dahlsrud, A. (2008), "How corporate social responsibility is defined: an analysis of 37 definitions." *Corporate Social Responsibility and Environmental Management*, Vol. 15**,** No. 1, pp. 1_14.

Daily, B. F. and Huang, S.-C. (2001), "Achieving sustainability through attention to human resource factors in environmental management." *International Journal of Operations & Production Management*, Vol. 21**,** No. 12, pp. 1539–1552.

Dangayach, G. and Deshmukh, S. (2001), "Manufacturing strategy: literature review and some issues." *International Journal of Operations & Production Management*, Vol. 21**,** No. 7, pp. 884–932.

de Burgos Jiménez, J. and Lorente, J. J. C. (2001), "Environmental performance as an operations objective." *International Journal of Operations & Production Management*, Vol. 21**,** No. 12, pp. 1553–1572.

de Burgos Jiménez, J., Vázquez-Brust, D., Plaza-Úbeda, J. A. and Dijkshoorn, J. (2013), "Environmental protection and financial performance: an empirical analysis in Wales." *International Journal of Operations & Production Management*, Vol. 33**,** No. 8, pp. 981–1018.

Díaz-Garrido, E., Martín-Peña, M. L. and Sánchez-López, J. M. (2011), "Competitive priorities in operations: development of an indicator of strategic position." *CIRP Journal of Manufacturing Science and Technology*, Vol. 4**,** No. 1, pp. 118–125.

Drake, D. F. and Spinler, S. (2013), "OM forum – sustainable operations management: an enduring stream or a passing fancy?" *Manufacturing & Service Operations Management*, Vol. 15**,** No. 4, pp. 689–700.

Edmondson, A. C. and McManus, S. E. (2007), "Methodological fit in management field research." *Academy of Management Review*, Vol. 32**,** No. 4, pp. 1246–1264.

Eisenhardt, K. M. (1989), "Building theories from case study research." *Academy of Management Review*, Vol. 14**,** No. 4, pp. 532–550.

Elkington, J. (1994), "Towards the suitable corporation: win-win-win business strategies for sustainable development." *California Management Review*, Vol. 36**,** No. 2, pp. 90–100.

Elkington, J. (1997), Cannibals with forks: the triple bottom line of twenty-first century business. Capstone, Oxford.

Epstein, M. J. (2008), Making sustainability work. Greenleaf, Sheffield.

Epstein, M. J. and Buhovac, A. R. (2010), "Solving the sustainability implementation challenge." *Organizational Dynamics*, Vol. 39**,** No. 4, pp. 306–315.

EuroStat. (2012), "The EU in the world 2013: A statistical portrait." *Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-30-12-861/EN/KS-30-12-861-EN.PDF* , accessed on 2014-10-10

Evans, S., Gregory, M., Ryan, C., Bergendahl, M. N. and Tan, A. (2009), Towards a sustainable industrial system: with recommendations for education, research, industry and policy. University of Cambridge, Institute for Manufacturing, Cambridge, UK.

Fai Pun, K. (2006), "Determinants of environmentally responsible operations: a review." *International Journal of Quality & Reliability Management*, Vol. 23**,** No. 3, pp. 279–297.

Ferdows, K. and De Meyer, A. (1990), "Lasting improvements in manufacturing performance: in search of a new theory." *Journal of Operations Management*, Vol. 9**,** No. 2, pp. 168–184.

Ferrer, G. (2008), "Sustainability: what does it mean for the operations manager?" *Journal of Operations and Supply Chain Management, International Conference of the Production and Operations Management Society*, Vol. 1**,** No. 2, pp. 1–16.

Flick, U. (2014), An introduction to qualitative research. Sage Publication, London.

Florida, R. L. (1996), "Lean and green: the move to environmentally conscious manufacturing." *California Management Review*, Vol.39, No.1, pp. 80_105.

Flyvbjerg, B. (2006), "Five misunderstandings about case-study research." *Qualitative Inquiry*, Vol. 12**,** No. 2, pp. 219–245.

Garetti, M. and Taisch, M. (2012), "Sustainable manufacturing: trends and research challenges." *Production Planning & Control*, Vol. 23**,** No. 2–3, pp. 83–104.

Gerring, J. (2007), Case study research: principles and practices. Cambridge University Press, New York, USA.

Gimenez, C., Sierra, V. and Rodon, J. (2012), "Sustainable operations: their impact on the triple bottom line." *International Journal of Production Economics*, Vol. 140**,** No. 1, pp. 149–159.

Gunasekaran, A., Irani, Z. and Papadopoulos, T. (2013), "Modelling and analysis of sustainable operations management: certain investigations for research and applications." *Journal of the Operational Research Society*, Vol. 65**,** No. 6, pp. 806–823.

Gunasekaran, A. and Spalanzani, A. (2012), "Sustainability of manufacturing and services: investigations for research and applications." *International Journal of Production Economics*, Vol. 140**,** No. 1, pp. 35–47.

Gupta, M. C. (1995), "Environmental management and its impact on the operations function." *International Journal of Operations & Production Management*, Vol. 15**,** No. 8, pp. 34–51.

Gupta, M. and Sharma, K. (1996), "Environmental operations management: an opportunity for improvement." *Production and Inventory Management Journal*, Vol. 37**,** No.3, pp. 40–46.

Haanaes, K., Balagopal, B., Arthur, D., Kong, M. T., Velken, I., Kruschwitz, N. and Hopkins, M. S. (2011), "First look: the second annual sustainability & innovation survey." *MIT Sloan Management Review*, Vol. 52**,** No. 2, pp. 77–83.

Haapala, K. R., Zhao, F., Camelio, J., Sutherland, J. W., Skerlos, S. J., Dornfeld, D. A., Jawahir, I., Clarens, A. F. and Rickli, J. L. (2013), "A review of engineering research in sustainable manufacturing." *Journal of Manufacturing Science and Engineering*, Vol. 135**,** No. 4, pp. 1_16.

Halldorsson, A. and Aastrup, J. (2003), "Quality criteria for qualitative inquiries in logistics." *European Journal of Operational Research*, Vol. 144**,** No. 2, pp. 321–332.

Hanna, M. D., Newman, W. R. and Johnson, P. (2000), "Linking operational and environmental improvement through employee involvement." *International Journal of Operations & Production Management*, Vol. 20**,** No. 2, pp. 148–165.

Hayes, R. H. and Pisano, G.P. (1994), "Beyond world-class: the new manufacturing strategy." *Harvard Business Review*, pp. 77_86.

Hayes, R. H. and Wheelwright, S. C. (1979), "Link manufacturing process and product life cycles." *Harvard Business Review*, Vol. 57**,** No. 1, pp. 133–140.

Hayes, R. H. and Wheelwright, S. C. (1984), Restoring our competitive edge: competing through manufacturing. John Wiley & Sons, USA.

Hill, M. R. (2001), "Sustainability, greenhouse gas emissions and international operations management." *International Journal of Operations & Production Management*, Vol. 21**,** No. 12, pp. 1503–1520.

Hill, T. (1994), Manufacturing strategy: text and cases. Irwin/McGraw-Hill, Boston, Massachusetts, USA.

Hitomi, K. (1997), "Manufacturing strategy for future production moving toward manufacturing excellence." *International Journal of Technology Management*, Vol. 14**,** No. 6–8, pp. 701–711.

Hohenstein, N.-O., Feisel, E. and Hartmann, E. (2014), "Human resource management issues in supply chain management research: a systematic literature review from 1998 to 2014." *International Journal of Physical Distribution & Logistics Management*, Vol. 44**,** No. 6, pp. 434–463.

Hopkins, M. S. (2009), "8 reasons sustainability will change management (that you never thought of)." *MIT Sloan Management Review*, Vol. 51**,** No. 1, pp. 27.

Inman, R. A. (2002), "Implications of environmental management for operations management." *Production Planning & Control*, Vol. 13**,** No. 1, pp. 47–55.

Jabbour, C. J. C., Da Silva, E. M., Paiva, E. L. and Santos, F. C. A. (2012), "Environmental management in Brazil: is it a completely competitive priority?" *Journal of Cleaner Production*, Vol. 21**,** No. 1, pp. 11–22.

Jesson, J., Matheson, L. and Lacey, F. M. (2011), Doing your literature review: traditional and systematic techniques. SAGE Publications Limited, California, USA.

Johansson, G. and Winroth, M. (2010), "Introducing environmental concern in manufacturing strategies: implications for the decision criteria." *Management Research Review*, Vol. 33**,** No. 9, pp. 877–899.

Jovane, F., Yoshikawa, H., Alting, L., Boër, C., Westkamper, E., Williams, D., Tseng, M., Seliger, G. and Paci, A. (2008), "The incoming global technological and industrial revolution towards competitive sustainable manufacturing." *CIRP Annals-Manufacturing Technology*, Vol. 57**,** No. 2, pp. 641–659.

Kaebernick, H., Kara, S. and Sun, M. (2003), "Sustainable product development and manufacturing by considering environmental requirements." *Robotics and Computer-Integrated Manufacturing*, Vol. 19**,** No. 6, pp. 461–468.

Karlsson, C. (2008), Researching operations management. Routledge, New York, USA.

Kim, J. S. and Arnold, P. (1996), "Operationalizing manufacturing strategy: an exploratory study of constructs and linkage." *International Journal of Operations & Production Management*, Vol. 16**,** No. 12, pp. 45–73.

Kiron, D., Kruschwitz, N., Haanaes, K., Reeves, M. and Goh, E. (2013), "The innovation bottom line." *MIT Sloan Management Review*, Vol. 54**,** No. 3, pp. 69_73.

Klassen, R. D. (2001), "Plant-level environmental management orientation: the influence of management views and plant characteristics." *Production and Operations Management*, Vol. 10**,** No. 3, pp. 257–275.

Klassen, R. D. and Whybark, D. C. (1999), "The impact of environmental technologies on manufacturing performance." *Academy of Management Journal*, Vol. 42**,** No. 6, pp. 599–615.

Kleindorfer, P. R., Singhal, K. and Wassenhove, L. N. (2005), "Sustainable operations management." *Production and Operations Management*, Vol. 14**,** No. 4, pp. 482–492.

Lawn, P. (2004), "To operate sustainably or not to operate sustainability?—That is the long-run question." *Futures*, Vol. 36**,** No. 1, pp. 1–22.

Leong, G. K., Snyder, D. and Ward, P. T. (1990), "Research in the process and content of manufacturing strategy." *Omega*, Vol. 18**,** No. 2, pp. 109–122.

Li, C., Liu, F. and Wang, Q. (2010), "Planning and implementing the green manufacturing strategy: evidences from western China." *Journal of Science and Technology Policy in China*, Vol. 1**,** No. 2, pp. 148–162.

Longoni, A., Golini, R. and Cagliano, R. (2014), "The role of new forms of work organization in developing sustainability strategies in operations." *International Journal of Production Economics*, Vol. 147**,** pp. 147–160.

Lovins, L. H. (2008), "Rethinking production." *State of the World*,

Lubin, D. A. and Esty, D. C. (2010), "The sustainability imperative." *Harvard Business Review*, Vol. 88**,** No. 5, pp. 42–50.

Lubin, D. A. and Esty, D. C. (2014), Bridging the sustainability gap. Sloan Management Review Association, Cambridge, USA.

Marshall, C. and Rossman, G. B. (2014), Designing qualitative research. Sage Publications.

Martín-Peña, M. L. and Díaz-Garrido, E. (2008), "Typologies and taxonomies of operations strategy: a literature review." *Management Research News*, Vol. 31**,** No. 3, pp. 200–218.

Marucheck, A., Pannesi, R. and Anderson, C. (1990), "An exploratory study of the manufacturing strategy process in practice." *Journal of Operations Management*, Vol. 9**,** No. 1, pp. 101–123.

Maxwell, J. A. (2012), Qualitative research design: an interactive approach. Sage Publications, USA.

McDonough, W. and Braungart, M. (2002), "Design for the triple top line: new tools for sustainable commerce." *Corporate Environmental Strategy*, Vol. 9**,** No. 3, pp. 251–258.

Merriam, S. B. (1998), Qualitative research and case study applications in education. Jossey-Bass Publishers, San Francisco.

Miemczyk, J., Johnsen, T. E. and Macquet, M. (2012), "Sustainable purchasing and supply management: a structured literature review of definitions and measures at the dyad, chain and network levels." *Supply Chain Management: An International Journal*, Vol. 17**,** No. 5, pp. 478–496.

Mills, J., Platts, K. and Gregory, M. (1995), "A framework for the design of manufacturing strategy processes: a contingency approach." *International Journal of Operations & Production Management*, Vol. 15**,** No. 4, pp. 17–49.

Miltenburg, J. (2005), Manufacturing strategy: how to formulate and implement a winning plan. Productivity Press, USA.

Minarro-Viseras, E., Baines, T. and Sweeney, M. (2005), "Key success factors when implementing strategic manufacturing initiatives." *International Journal of Operations & Production Management*, Vol. 25**,** No. 2, pp. 151–179.

Mintzberg, H. (1995), "Musings on management. Ten ideas designed to rile everyone who cares about management." *Harvard Business Review*, Vol. 74**,** No. 4, pp. 61–67.

Mintzberg, H. and Lampel, J. (2012), "Reflecting on the strategy process." *MIT Sloan Management Review*.

Mirvis, P., Googins, B. and Kinnicutt, S. (2010), "Vision, mission, values: guideposts to sustainability." *Organizational Dynamics*, Vol. 39**,** No. 4, pp. 316–324.

Mohanty, R. and Deshmukh, S. (1999), "Managing green productivity: a case study." *Work Study*, Vol. 48**,** No. 5, pp. 165–169.

Moore, S. B. and Manring, S. L. (2009), "Strategy development in small and medium sized enterprises for sustainability and increased value creation." *Journal of Cleaner Production*, Vol. 17**,** No. 2, pp. 276–282.

Narasimhan, R., Swink, M. and Wook Kim, S. (2005), "An exploratory study of manufacturing practice and performance interrelationships: implications for capability progression." *International Journal of Operations & Production Management*, Vol. 25**,** No. 10, pp. 1013–1033.

Newman, W. R. and Hanna, M. D. (1996), "An empirical exploration of the relationship between manufacturing strategy and environmental management: two complementary models." *International Journal of Operations & Production Management*, Vol. 16**,** No. 4, pp. 69–87.

O'Brien, C. (1999), "Sustainable production – a new paradigm for a new millennium." *International Journal of Production Economics*, Vol. 60**,** pp. 1–7.

Omann, I. and Spangenberg, J. H. (2002), Assessing social sustainability. Biennial Conference of The International Society for Ecological Economics.

Pagell, M. and Gobeli, D. (2009), "How plant managers' experiences and attitudes toward sustainability relate to operational performance." *Production and Operations Management*, Vol. 18**,** No. 3, pp. 278–299.

Pagell, M. and Handfield, R. (2000), "The impact of unions on operations strategy." *Production and Operations Management*, Vol. 9**,** No. 2, pp. 141–157.

Pagell, M. and Shevchenko, A. (2014), "Why research in sustainable supply chain management should have no future." *Journal of Supply Chain Management*, Vol. 50**,** No. 1, pp. 44–55.

Pettigrew, A. M. (1992), "The character and significance of strategy process research." *Strategic Management Journal*, Vol. 13**,** No. S2, pp. 5–16.

Pilkington, A. and Meredith, J. (2009), "The evolution of the intellectual structure of operations management—1980–2006: a citation/co-citation analysis." *Journal of Operations Management*, Vol. 27**,** No. 3, pp. 185–202.

Platts, K., Mills, J., Bourne, M., Neely, A., Richards, A. and Gregory, M. (1998), "Testing manufacturing strategy formulation processes." *International Journal of Production Economics*, Vol. 56**,** p. 517–523.

Porter, M. (1996), America's green strategy. Business and the environment. Earthscan Publications, London.

Porter, M. E. and Kramer, M. R. (2006), "The link between competitive advantage and corporate social responsibility." *Harvard Business Review*, Vol. 12**,** pp. 78–92.

Quental, N., Lourenço, J. M. and da Silva, F. N. (2011), "Sustainable development policy: goals, targets and political cycles." *Sustainable Development*, Vol. 19**,** No. 1, pp. 15–29.

Quinn, M. M., Kriebel, D., Geiser, K. and Moure-Eraso, R. (1998), "Sustainable production: a proposed strategy for the work environment." *American Journal of Industrial Medicine*, Vol. 34**,** No. 4, pp. 297–304.

Rosén, M. (2011), The practice of strategy formation – opening the green box. Bokförlaget BAS, School of Business, Economics and Law, University of Gothenburg, Sweden.

Rosenzweig, E. D. and Easton, G. S. (2010), "Tradeoffs in manufacturing? A meta-analysis and critique of the literature." *Production and Operations Management*, Vol. 19**,** No. 2, pp. 127–141.

Rosenzweig, E. D. and Roth, A. V. (2004), "Towards a theory of competitive progression: evidence from high-tech manufacturing." *Production and Operations Management*, Vol. 13**,** No. 4, pp. 354–368.

Rudberg, M. and Olhager, J. (2003), "Manufacturing networks and supply chains: an operations strategy perspective." *Omega*, Vol. 31**,** No. 1, pp. 29–39.

Rusinko, C. A. (2007), "Green manufacturing: an evaluation of environmentally sustainable manufacturing practices and their impact on competitive outcomes." *Engineering Management, IEEE Transactionsn*, Vol. 54**,** No. 3, pp. 445–454.

Rytter, N. G., Boer, H. and Koch, C. (2007), "Conceptualizing operations strategy processes." *International Journal of Operations & Production Management*, Vol. 27**,** No. 10, pp. 1093–1114.

Sarkis, J. (1995), "Manufacturing strategy and environmental consciousness." *Technovation*, Vol. 15**,** No. 2, pp. 79–97.

Sarkis, J. (2001), "Manufacturing's role in corporate environmental sustainability – concerns for the new millennium." *International Journal of Operations & Production Management*, Vol. 21**,** No. 5/6, pp. 666–686.

Sarkis, J., Gonzalez-Torre, P. and Adenso-Diaz, B. (2010), "Stakeholder pressure and the adoption of environmental practices: the mediating effect of training." *Journal of Operations Management*, Vol. 28**,** No. 2, pp. 163–176.

Schmenner, R. W. and Swink, M. L. (1998), "On theory in operations management." *Journal of Operations Management*, Vol. 17**,** No. 1, pp. 97–113.

Schoenherr, T. (2012), "The role of environmental management in sustainable business development: a multi-country investigation." *International Journal of Production Economics*, Vol. 140**,** No. 1, pp. 116–128.

Schoenherr, T. and Talluri, S. (2013), "Environmental sustainability initiatives: a comparative analysis of plant efficiencies in Europe and the US." *Engineering Management, IEEE Transactions* , Vol. 60**,** No. 2, pp. 353–365.

Schrettle, S., Hinz, A., Scherrer-Rathje, M. and Friedli, T. (2014), "Turning sustainability into action: explaining firms' sustainability efforts and their impact on firm performance." *International Journal of Production Economics*, Vol. 147**,** pp. 73–84.

Searcy, C., Karapetrovic, S. and McCartney, D. (2008), "Application of a systems approach to sustainable development performance measurement." *International Journal of Productivity and Performance Management*, Vol. 57**,** No. 2, pp. 182–197.

Seuring, S. and Müller, M. (2008), "From a literature review to a conceptual framework for sustainable supply chain management." *Journal of Cleaner Production*, Vol. 16**,** No. 15, pp. 1699–1710.

Sharma, S. (2000), "Managerial interpretations and organizational context as predictors of corporate choice of environmental strategy." *Academy of Management Journal*, Vol. 43**,** No. 4, pp. 681–697.

Singh, R. K., Murty, H., Gupta, S. and Dikshit, A. (2009), "An overview of sustainability assessment methodologies." *Ecological Indicators*, Vol. 9**,** No. 2, pp. 189–212.

Skinner, W. (1969), "Manufacturing – missing link in corporate strategy." *Harvard Business Review*, Vol. 47**,** No. 3, pp. 136–145.

Skinner, W. (1974), "The focused factory." *Harvard Business Review*, Vol. 52**,** No. 3, pp. 113–121.

Skinner, W. (2007), "Manufacturing strategy: the story of its evolution." *Journal of Operations Management*, Vol. 25**,** No. 2, pp. 328–335.

Slack, N. (2005), "Operations strategy: will it ever realize its potential?" *Gestão & Produção*, Vol. 12**,** No. 3, pp. 323–332.

Slack, N., Chambers, S. and Johnston, R. (2010), Operations management. Pearson Education, UK.

Slack, N. and Lewis, M. (2011), Operations strategy. Financial Times/Prentice Hall.

Slack, N., Lewis, M. and Bates, H. (2004), "The two worlds of operations management research and practice: can they meet, should they meet?" *International Journal of Operations & Production Management*, Vol. 24**,** No. 4, pp. 372–387.

Starkey, K. and Madan, P. (2001), "Bridging the relevance gap: aligning stakeholders in the future of management research." *British Journal of Management*, Vol. 12**,** No. S1, pp. S3–S26.

Swamidass, P. M. and Newell, W. T. (1987), "Manufacturing strategy, environmental uncertainty and performance: a path analytic model." *Management Science*, Vol. 33**,** No. 4, pp. 509–524.

Taylor, A. and Taylor, M. (2009), "Operations management research: contemporary themes, trends and potential future directions." *International Journal of Operations & Production Management*, Vol. 29**,** No. 12, pp. 1316–1340.

Thürer, M., Godinho Filho, M., Stevenson, M. and Fredendall, L. D. (2013), "Competitive priorities of small manufacturers in Brazil." *Industrial Management & Data Systems*, Vol. 113**,** No. 6, pp. 856–874.

United Nations. (1992). Rio declaration on environment and development.

United Nations Environment Programme. (2011), "Towards a green economy: pathways to sustainable development and poverty eradiction." *Available at:* *www.unep.org/greeneconomy*, accessed on 2015-06-05

Vallance, S., Perkins, H. C. and Dixon, J. E. (2011), "What is social sustainability? A clarification of concepts." *Geoforum*, Vol. 42**,** No. 3, pp. 342–348.

Van Marrewijk, M. (2003), "Concepts and definitions of CSR and corporate sustainability: between agency and communion." *Journal of Business Ethics*, Vol. 44**,** No. 2–3, pp. 95–105.

Van Weenen, J. (1995), "Towards sustainable product development." *Journal of Cleaner Production*, Vol. 3**,** No. 1, pp. 95–100.

Veleva, V. and Ellenbecker, M. (2001), "Indicators of sustainable production: framework and methodology." *Journal of Cleaner Production*, Vol. 9**,** No. 6, pp. 519–549.

Vickery, S. K. (1991), "A theory of production competence revisited." *Decision Sciences*, Vol. 22**,** No. 3, pp. 635–643.

Vickery, S. K., Droge, C. and Markland, R. E. (1994), "Strategic production competence: convergent, discriminant, and predictive validity." *Production and Operations Management*, Vol. 3**,** No. 4, pp. 308–318.

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002), "Case research in operations management." *International Journal of Operations & Production Management*, Vol. 22**,** No. 2, pp. 195–219.

Wheelwright, S. C. and Hayes, R. H. (1985), "Competing through manufacturing." *Harvard Business Review*, Vol. 63**,** No. 1, pp. 99–109.

Wilkinson, A., Hill, M. and Gollan, P. (2001), "The sustainability debate." *International Journal of Operations & Production Management*, Vol. 21**,** No. 12, pp. 1492–1502.

Winroth, M., Almström, P. and Andersson, C. (2014), Indicators of sustainable production – a survey among Swedish manufacturing industry. Proceedings of the 1st EurOMA Sustainable OM & SCM Forum.

World Economic Forum (2012), "The future of manufacturing opportunities to drive economic growth." *Available at:* *http://www3.weforum.org/docs/WEF_MOB_FutureManufacturing_Report_2012.pdf*. Accessed on 2015-07-28

Yin, R. K. (2009), Case study research: design and methods. Sage, USA.

Young, W., Hwang, K., McDonald, S. and Oates, C. J. (2010), "Sustainable consumption: green consumer behaviour when purchasing products." *Sustainable Development*, Vol. 18**,** No. 1, pp. 20–31.