Friederike Neugebauer

The formation of sustainability strategies

An Action Research inquiry into sustainability strategy making in a corporate innovation project

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Abstract

The formation of sustainability strategies, i.e. the way in which they are made, is hardly ever addressed in sustainability research. Instead, it is often implicitly assumed that sustainability strategies are planned and implemented top-down. In contrast, the formation of strategies is a frequent topic of discussion in strategy research where a consensus has been established that strategy making resides on a continuum between planned and emergent. Sustainability strategy turns a blind eye on emergent strategy making pointing to a research gap regarding the formation of sustainability strategies.

This dissertation sets out to narrow this gap by investigating the formation of sustainability strategies from a theoretical and an empirical angle. The theoretical angle consists of a conceptual framework to help explain when planned and when emergent sustainability strategy making is more likely. As part of this, the nature of a problem is proposed to be connected to the kind of strategy making that is expected to address the problem. The empirical angle comes into play with the Action Research study that is conducted in cooperation with an innovation project at Robert Bosch GmbH over a period of 14 months. The goal of this cooperation was to set up a project-specific sustainability strategy. A sustainability understanding that is deduced from the natural sciences provides the starting point for the Action Research study.

This dissertation contributes to a better understanding of sustainability strategy making. The gap in sustainability research is addressed by suggesting a theoretical framework which stresses the impact of the nature of a problem on the strategy making process. The framework is supported by the Action Research study. In addition, the empirical research indicates that champions play a major role for emergent sustainability strategy making. The role of

champions is of practical relevance for companies aiming at advancing sustainability.

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Contents

List of Figures

List of Tables

List of Acronyms

The following acronyms are used for lengthy terms. When a term is used for the first time in this dissertation, the full term is provided followed by the acronym in parentheses. From then on, the acronym is used.

CFCs	Chlorofluorocarbons
DfE	Design for Environment
LCA	Life-Cycle Assessment
NGO	Non-Governmental Organization
PTO	Power Take-Off

Chapter 1

Introduction: The challenge of corporate sustainability

"The role of business is to provide practical solutions to create this sustainable world."
World Business Council for Sustainable Development

The concept of sustainability envisions society in balance. This balance concerns two levels: First, on the environmental level, a sustainable society lives within the boundaries that are set by the recovery rates of natural resources. Second, on the social level, sustainability means justice among all people at the present, as well as among current and future generations.

During the last decades, it has become more and more obvious that society is globally out of balance. For instance, evidence has been rising that the prevalent patterns of consumption and production have become a serious threat to the functioning of the global ecosystem on which the livelihood of humanity depends. Rockström et al. (2009) identify ten planetary boundaries of which three have already been surpassed, namely those concerning biodiversity loss, the nitrogen cycle, and climate change. To provide another example, global inequality is at extreme levels where the richest 20% of population own

83% of all income while the poorest 20% have only 1% of all income (Ortiz and Cummins, 2011). Although progress has been made, it has been a slow change – "we estimate that it would take more than 800 years for the bottom billion to achieve ten percent of global income under the current rate of change" (Ortiz and Cummins, 2011, p. vii).

To remedy such highly complex, global problems, various players are called to contribute their shares. For example, nation states are supposed to pass legislation that helps solve environmental and social problems at the national and international level, and individuals are called to make informed decisions and to reconsider their consumption patterns. An equally important player in this context is the private sector. Because companies are at the core of the economic development that causes those global problems and because they have resources and capacity to advance solutions for sustainability (Shrivastava, 1995), they are called to take on responsibility and contribute their share.

What does this mean for a company willing to address sustainability? Sustainability is a complex and long-term goal. Its complexity implies that a high corporate sustainability performance, e.g. zero negative environmental and social impacts, cannot be achieved easily. Indeed, enhancing the efficiency of business as usual is not sufficient (Dyllick and Hockerts, 2002; Young and Tilley, 2006). Instead, business as usual needs to be redefined. The long-term nature of sustainability makes it a strategic goal because it is the strategy of a company that defines the "long-term direction" in which it is going (Johnson et al., 2011, p. 3). It has therefore been argued that companies aiming at making a meaningful contribution towards sustainability need to fundamentally change their strategies (see, e.g., Cherp et al., 2007). The carpet company Interface serves as an example of such a fundamental change of strategy (Anderson, 1998). Interface went from a conventional carpet producer to an environmental frontrunner that aims at reducing its environmental impact to zero.

Hence, for companies that are willing to contribute to the attainment of sustainability at the global and societal level, the question is how they can make sustainability an integral part of their way of doing business.

Based on these remarks, two basic assumptions are made for this dissertation: First, it is supposed that companies have an important role to play in making the goal of sustainability attainable at the global level. Second,

in order to be able to play this role, it is assumed that companies need to fundamentally re-orient their strategies towards sustainability.

1.1 Research question

In current research, a plethora of sustainability definitions exist, including the Brundtland definition (WCED, 1987), the triple bottom line (Elkington, 1997), and the concept of carrying capacity (Daily and Ehrlich, 1992), to name just a few. At the same time, the term 'sustainability' is used in so many different contexts and for so many different purposes that its precise meaning becomes blurred. This situation makes it difficult for companies that aim at addressing sustainability in a strategic way to formulate a meaningful vision and goals. To address this problem, the sustainability understanding on which this work is based is deduced from a multidisciplinary literature review. This understanding is suggested as a starting point for corporate sustainability strategies.

One logical next step is to ask how companies can put this sustainability understanding into practice. Since sustainability is a strategic goal, this dissertation chooses the perspective of (sustainability) strategy making in order to address this question. It is argued that the prevalent understanding of sustainability strategy making in the sustainability literature is incomplete because it overlooks an important development that has been taking place in strategy research over the last decades. There, two dominant schools of thought debate whether strategies are planned in a systematic top-down process or rather emerge from practice in a bottom-up movement. A consensus has been reached that most strategy making likely contains both planned and emergent elements, thus residing on a continuum between the two extremes of purely planned and purely emergent strategy making. In order to explain when strategies are expected to be more planned or more emergent, a range of contingency factors are suggested.

Sustainability research ignores this development and largely assumes that sustainability strategies are made in a planned way. Purely planned strategy making is an extreme case that is unlikely to be found in practice (Mintzberg and McHugh, 1985). In the case of sustainability, it is argued to be even less

likely that strategies are made in a purely planned way because sustainability problems are often highly complex, so-called wicked problems with unforeseeable, long-term consequences. If strategies for this kind of problem were to be planned, it would be necessary to predict the developments of complex, poorly understood sustainability issues far into the future. By overlooking the possibility that sustainability strategies might well be made in an emergent way, sustainability research remains under-developed with regards to the process of strategy formation.

In order to contribute to filling this gap, this dissertation seeks to shed light on the formation of sustainability strategies at a company. Consequently, the research question addressed in this dissertation reads as follows: *How does the formation of sustainability strategies take place?* There is a continuum between planned and emergent strategy making and most strategies are assumed to be made in a mixed way. Therefore, the research questions is addressed in terms of the degree to which sustainability strategies are made in a planned or emergent way.

The research question is addressed from a theoretical and an empirical angle. Regarding the former, a conceptual framework of the formation of sustainability strategies is developed. It is suggested that sustainability strategy making can be explained by five contingency factors one of which is newly developed to consider the nature of the problem at hand. This new factor postulates that the degree of salience and wickedness of a sustainability problem affects the strategies that are made to address it. A two-factor matrix serves to explain the connection between the nature of the problem and sustainability strategy making. Regarding the latter, the empirical angle comes into play with the Action Research study that is conducted in cooperation with an innovation project at the company in which this researcher is situated as a PhD candidate. This cooperation aims at setting up a project-specific sustainability strategy in order to increase the sustainability performance of the product to be developed. By allowing the researcher insider insights in to the strategy making process during 14 months, the Action Research study serves as an ample example for the formation of a sustainability strategy.

This dissertation makes a range of contributions to research. First, the basic sustainability understanding for this dissertation is deduced from a natural science literature review, allowing insights into the views on sustainability in

the four selected sciences as well as offering a common-denominator definition of sustainability. Second, the gap in sustainability research with regards to strategy making is pointed out. The conceptual framework serves to illuminate the way in which sustainability strategies are made and is intended as a contribution to both, sustainability research and strategy research.

The Action Research study that is conducted in cooperation with an innovation project in the field of renewable energies serves as an example of how such a strategy making process can unfold at the innovation project level. It is argued that the innovation project is an interesting unit of analysis because change processes happening on higher levels might be mirrored at the project level and might take place faster. Furthermore, the innovation project is more accessible and allows for deeper insights than the top-management level. The results from this study lend tentative support to the conceptual framework and help refine it. Beyond the framework, insights are yielded regarding inter alia the importance of champions for sustainability strategy making.

1.2 The case company Robert Bosch GmbH

Robert Bosch GmbH is an international engineering company with a broad product portfolio. In 2013, Bosch had approximately 280,000 associates and generated 46.1 billion euros in sales. The sector of automotive technology is the oldest and largest corporate division of the company and generated 66% of total sales in 2013. Typical products include fuel-injection systems and powertrain control. Beyond that, Bosch offers industrial technology products (including, e.g., packaging machines and components for wind turbines), consumer goods (including, e.g., household appliances and electric tools), and energy and building technology (including, e.g., heating boilers and security cameras) (Bosch Group, 2013, 2014).

In this dissertation, an Action Research study was conducted with an innovation project that aims at developing a new technology for generating electricity from ocean waves. This project is located in the industrial technology division, precisely in the section Renewable Energy of the business unit Drive and Control Technology (this business unit Drive and Control Technology is

identical with the Bosch Rexroth AG which is owned 100% by Bosch). The innovation project reports to the board of Bosch Rexroth AG.

1.3 Structure of the dissertation

In the following, an overview of each chapter is provided, emphasizing its approach as well as the links between the chapters.

The theoretical groundwork on which this dissertation is based is laid in **chapter 2**. This chapter is dedicated to making clear how the term 'sustainability' is understood as a general concept and in the corporate context. For this purpose, four natural sciences are analyzed with regards to their understandings of sustainability, including physics, biology, chemistry, and engineering science. Since this dissertation is written not only for an academic purpose but also aims at improving corporate practice (this is elaborated in chapter 4), the underlying sustainability understanding is supposed to be applicable in the context of a large engineering company. The focus on the natural sciences is promising as the large majority of employees have a natural science background. Sustainability is found to be a topic of discussion in specific research streams of the four natural sciences: These are thermodynamics (physics), ecosystem research (biology), green chemistry (chemistry), and ecological engineering (engineering science). The deduced common-denominator understanding reads as: *Sustainability means (1) operating within the global system boundaries and (2) adopting a far-sighted orientation that considers both current and future generations.* The first element is based on the natural sciences and can be inferred from natural laws. Interestingly, the second element does not originate in the natural sciences but has been adopted from the humanities.

This sustainability understanding informs the theoretical framework of sustainability strategy making developed in chapter 3. Furthermore, the understanding was used as the starting point for discussion during the first meetings of the Action Research study with the innovation project. During these meetings, a common understanding of sustainability was worked out which informed the selection of the two focus topics (chapter 5). After the theoretical groundwork has been laid in this chapter, the question of the next chapter

is how sustainability can be translated into practice, i.e. how strategies for sustainability are made.

In **chapter 3**, sustainability strategy making is taken as the starting point to develop the theoretical mainstay of this dissertation. The sustainability understanding of chapter 2 is taken as the basis for defining sustainability strategies. It is shown that in strategy research, two dominant schools of thought debate whether corporate strategies are made in a systematic planning process and implemented top-down or rather in an emergent process in which strategy formulation and implementation are intertwined. A consensus has been established in strategy research that strategies usually contain both planned and emergent elements, thus residing on a continuum in between. In order to understand when strategy making tends to be more planned or more emergent, a range of contingency factors are suggested in current strategy research, including the company's ENVIRONMENT, the ORGANIZATION itself, DECISION MAKING, and 'top-management characteristics' (which later becomes the factor PEOPLE).

The literature on sustainability strategies, however, seems to overlook most of this development and assumes instead that sustainability strategies are made in a purely planned way. In addition to pointing out this bias, a new contingency factor is proposed that helps explain sustainability strategy making based on the nature of the problem addressed. The NATURE OF THE PROBLEM is described by a problem's salience and its wickedness. It is argued that a salient problem is more likely to be addressed by planned strategy making whereas a wicked problem is expected to elicit emergent strategies. This is illustrated by the salience-wickedness matrix which shows four problem types that are expected to be addressed by different kinds of strategy making.

The nature of this research field influences the methodological choice. Because the field of sustainability strategy making is still under-researched, an exploratory research setting is promising.

Chapter 4 serves to introduce the method of choice: Action Research. Action Research is based on a constructivist tradition. It does not aim at finding explanations but rather at understanding and interpreting meanings, particularly of processes of social or organizational change. The most important quality of Action Research is that it combines scientific research with practical problem solving and deliberately promotes the interaction of these

two spheres. This is also the major advantage of this method: Researchers can gain in-depth insights of their research topics because they participate in the practical work as well. Furthermore, Action Research allows researchers to use a wider range of information than more conventional research methods. For example, informal and subjective data can be considered.

Four characteristics are proposed to define Action Research: First, the research is based on theory; while second, it addresses a problem that is relevant for practice and aims at improving practice; third, the research process takes shape as a spiral of action and reflection; and fourth, the research is conducted in cooperation with a team of researchers and practitioners. These defining properties are the basis for the criteria of scientific rigor that are put forward in this chapter. The chapter is concluded with a mid-way reflection in which the fit of the research question and the method is discussed. It is argued that the research gap that this dissertation addresses and the situation of the researcher as an insider PhD candidate at a company match well with the exploratory method of Action Research.

In the rigor check in chapter 5, the rigor criteria developed in chapter 4 are used for an evaluation of the Action Research study that took place at the innovation project. Furthermore, the methodological discussion of Action Research is taken up in chapter 6 in the critical reflection of the methodological approach as well as in the implications for practice.

Chapter 5 describes the Action Research study that has been conducted in cooperation with an innovation project developing a technology for generating electricity from ocean wave energy. This chapter aims at providing a detailed documentation of the Action Research process in order to make this empirical piece of research transparent and intelligible.The purpose of the Action Research study is twofold: first, it aims at contributing to understanding sustainability strategy making by testing the theory-based conceptual framework developed with the help of an empirical study (the Action Research study). Second, it aims at helping the project staff develop an understanding of sustainability and get under way a project-specific sustainability strategy.

The study was structured in three phases: the orientation phase, the cooperation phase, and the evaluation phase. During the orientation phase, this researcher conducted two rounds of meetings with various managers and a range of heads of innovation projects in order to find a partner project for

the cooperation phase. The cooperation with the wave energy project was decided at the end of 2011. Subsequently, the cooperation phase began. During this active cooperation with the project staff and a network of other experts within and outside the company, two focus topics emerged. The first was a sustainability assessment of materials that were needed for a selection of alternative power take-off (PTO) concepts. The second topic was the potential negative impact on marine biodiversity that the technology might cause. The last phase was the evaluation phase. The data that had been generated during the cooperation phase were evaluated and interpreted with regards to the five contingency factors of the conceptual framework. Furthermore, multiple triangulation studies were conducted in order to test and validate the results.

After the three phases of the Action Research study are described, the last section of chapter 5 conducts a rigor check in which the Action Research study is evaluated based on the criteria of scientific rigor defined in chapter 4. The findings described in this chapter form the basis for the discussion of the Action Research study in the following chapter 6.

Chapter 6 brings together the different threads of the story that this dissertation tells. The goal of this chapter is to discuss the implications that the empirical part of the dissertation has for the theoretical framework of sustainability strategy making developed in chapter 3. For this purpose, the relevance and predictive power of each of the five contingency factors are elaborated in two steps. First, the manifestations of each contingency factor in the Action Research events are discussed. Second, the coverage of each contingency factor in current research is addressed. Based on these two analyses, the predictive power of each factor is appraised.

Furthermore, the chapter serves to highlight the contributions to research that this dissertation offers, as well as to critically reflect the use of the method and the limitations of the dissertation. Implications for practice and avenues for future research are pointed out in conclusion of this chapter.

This dissertation is concluded with **chapter 7**. The conceptual and methodological research process of this dissertation is reflected. The implications of this dissertation are taken up and their relevance for research and practice is emphasized. Finally, the prospects of sustainability strategy making are sketched out by offering a wider view on the topic.

Chapter 2

Laying the groundwork: What is sustainability?

"[T]here is a need for a shared vision in order to realise a sustainable development of companies."
Enroth, 2007, p. 107

This chapter lays the theoretical groundwork for this dissertation[1]. Since sustainability is a ubiquitous buzzword that is used in plenty of contexts, some have argued that it would be wise to abandon the term altogether (see, e.g. Glavic and Lukman, 2007). Yet, this is not helpful if there is not a better term to describe a future-oriented societal balance of the kind described by the term 'sustainability'. Furthermore, the term sustainability possesses a deep and utterly relevant meaning as this chapter aims to show.

It is of crucial importance to define sustainability in the beginning of any (scientific) undertaking for which sustainability plays a role in order to make transparent the sustainability understanding on which all arguments are based. Clarifying this for this dissertation is the purpose of this chapter. The chosen approach is a multidisciplinary literature review that analyzes the sustainability understandings in physics, biology, chemistry, and engineering science. In

[1]Earlier versions of chapter 2 were presented at the Corporate Responsibility Research Conference (CRRC) in Leeds, UK, in 2011, and at the International Sustainable Development Research (ISDR) Conference, Hull, UK, in 2012.

order to enable a shared understanding of sustainability, the deduced understanding is suggested as a common base for sustainability strategy making at an engineering company. Since most staff have natural science backgrounds which are likely to influence their views on sustainability, the focus on the natural sciences is promising. The goal is to understand what the sustainability interpretations of the natural sciences have in common, and to find a common denominator in the plethora of sustainability definitions in order to suggest an understanding that can become the commonly accepted view of sustainability.

The chapter is structured as follows. Section 2.1 applies the concept of frames of reference to the context of corporate sustainability in order to explain why a common understanding of sustainability is crucial for a large company. After that, the methodological background of the literature review conducted is briefly reflected. Section 2.2 presents the findings of the literature review, i.e. the views on sustainability that are prevalent in the four natural science research streams. In section 2.3, these sustainability understandings are discussed along four categories: their underlying value orientation, the sustainability approach, the target groups of the policy recommendations made in each stream, and the intersections with other disciplines. From this, a common-denominator sustainability understanding is deduced in section 2.4. Interestingly, the resulting sustainability understanding turns out to contain elements from both the natural science and the humanities. The final section 2.5 shows how the deduced understanding of sustainability can be useful for corporate strategic management and leads into the next chapter.

2.1 The framing of sustainability

Sustainability is a normative and a societal concept. It is normative because it prescribes desirable characteristics of development as is e.g. reflected in the Brundtland report which is usually cited as follows: sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). It is societal in that it requires going beyond the perspective of an individual and argues at the level of the whole society. Furthermore, sustainability is subjective, and how people understand it depends on their frames of reference.

These are the "cognitive maps and thinking frameworks of managers [people] in practice" (Porac and Thomas, 2006, p. 169). These frames are highly personal and might prevent decision makers from seeing the whole picture (Hodgkinson and Healey, 2008; Porac and Thomas, 2006; Sharma, 2000). Moreover, there are many different frames of reference within one company. Since an agreed-upon definition of sustainability does not exist, different interpretations of the concept can lead to misunderstandings. Even if on the face of it people talk about the same thing – "sustainability" – they might end up working on opposing agendas. Developing a common understanding of sustainability is therefore of great importance.

The literature on cognitive framing shows that the frames of reference that people have influence the way they understand things and act on problems (e.g. Walsh, 1995). Companies can be seen as interpretation systems (Porac and Thomas, 2006) that are embedded in certain industry belief systems. Sharma et al. (1999) found that while some managers saw environmental issues as strategic and thus steered their company to respond actively early on, others did not believe that environmental issues were of strategic relevance and were slow to react to environmental problems. But also within one company, many different frames of reference exist. To enable a common strategy, it is important to have a shared understanding of sustainability. Even though the natural sciences interpret sustainability in different ways, a common-denominator definition can be found. This definition can serve as the basis of a shared frame of reference with regards to sustainability to which all organizational members can relate.

2.2 A multidisciplinary review

In order to better understand the different sustainability perspectives in the natural sciences, a systematic literature review of the approaches to sustainability in the four natural sciences physics, biology, chemistry, and engineering science is conducted. They are supposed to represent the natural sciences, including engineering which reflects the educational background of many employees at companies today. This is a relevant context as this sustainability definition is ultimately applied in a corporate context. Other natural sciences

such as geology or astronomy appear less relevant in this context and are therefore omitted.

In contrast to a 'traditional review', a 'systematic literature review' follows a formal methodology and needs to be "systematic, explicit and reproducible" (Fink, 2010, p. 3). Since four completely distinct streams of research are reviewed no claims to completeness are raised (as implied in the term 'review', see Karatzoglou, 2013). Following the steps recommended by Jesson et al. (2011) for conducting a systematic literature review, a review plan was made as a first step, defining the research question, keywords for the comprehensive search, and exclusion criteria to select the sample literature (scoping review). Second, an internet search of articles was conducted using the keywords "sustainability and thermodynamics", "sustainability and biology", "sustainability and chemistry", and "sustainability and engineering" on a range of databases as recommended by Tranfield et al. (2003): IEEE Xplore, Google scholar, Science Direct Scopus, Springer Link, and Wiley (comprehensive search). Moreover, the bibliographies of seminal papers were scanned as well. Third, papers were selected to be in or out of the review based on criteria defined in the beginning, such as the criterion that papers had to contribute to the theoretical question, rather than developing technological details, for example (quality assessment). In the fourth step, the papers were summarized (data extraction). Analyzing these summaries resulted in clusters (synthesis) hat helped structure the content of the papers. These clusters covered 1) the historical development of each research stream, 2) the way in which sustainability is defined, including whether a focus on systems and/or resources constraints is given, 3) the policy recommendations and aspirations scholars have for their disciplines, and 4) the interdisciplinary overlaps with other research fields. A fifth cluster was the measuring of sustainability which revealed that each discipline uses its own metrics. This cluster was dropped because it did not yield any insights beyond the four, completely different, dominant metrics.

2.2.1 Sustainability in physics

Within physics, sustainability has been a continuous topic of discussion in two related research streams: research at the intersection of thermodynamics and economics, and ecological economics.

Historical developments. The implications of thermodynamic laws for economics, industry and society have been debated in economics and physics beginning with Nicholas Georgescu-Roegen's essays in the 1960s (Gowdy and Mesner, 1998), and his most influential book in the 1970s (Georgescu-Roegen, 1971). In the 1980s, ecological economics emerged as a school of thought (Røpke, 2004; Söllner, 1997). It argues that the interactions between different systems as well as inherent system constraints must be considered in economic theory (Gutowski et al., 2009; Ruth, 2005) which renders infinite economic growth impossible (Amir, 1994; Costanza and Daly, 1992; Georgescu-Roegen, 1986; Söllner, 1997).

Definition of sustainability. The Brundtland report is the point of departure for most articles in this field. Building on this anthropocentric value base, sustainability in physical research is approached from a thermodynamics view which makes clear that the resources on planet earth are strictly finite. The first thermodynamic law holds that energy can neither be consumed nor produced in a closed system; the second says that entropy increases with every process in a closed system, which means that the amount of available energy tends to decrease (Ayres, 1998; Kåberger and Månsson, 2001; Rifkin, 1980). With regards to matter, the planet is a closed system in the sense of the 'spaceship earth' (Boulding, 1993): both, the amount of available resources and the absorption capacities are fixed; neither is there an input of additional matter into the system, nor are there new sinks. With regards to energy, the earth is an open system exchanging radiation with its environment and, most importantly, receiving solar energy (Kåberger and Månsson, 2001). Understanding the world as consisting of systems is a basic element of thermodynamic theory. While the earth is a closed system, its sub-systems are open with regards to both matter and energy (Gutowski et al., 2009). For instance, ecosystems or industrial systems interact with each other and other (sub)systems.

Recommendations. Many scholars in this research stream hold that humanity must switch from exhaustible to renewable resources, i.e. ultimately base the economy on solar energy (e.g. Ayres, 1998; Kåberger and Månsson, 2001). This policy recommendation is roughly the same among many authors in this stream, regardless of their opinions on the relevance of the entropy law for economic theory.

Interdisciplinary overlaps. The discussions on thermodynamic implications for sustainability are clearly multidisciplinary since their core argument is that thermodynamic laws should be integrated in economic theory and policy. Many scholars discuss the overlap of thermodynamics with industrial ecology and ecological engineering (Connelly and Koshland, 2001a,b; Gutowski et al., 2009; Hammond, 2004). Industrial ecology suggests that industrial systems be modeled on ecosystems in order to realize closed-loop industries that rely solely on solar energy (e.g. Ehrenfeld, 2004; Erkman, 1997). Business is taken as the starting point, and the goal is to influence industrial design and processes (Tilley, 2003). Ecological engineering is discussed below.

2.2.2 Sustainability in biology

In biology, most sustainability-related research can be found in research streams addressing the ecosystem level, i.e. interactions within and between ecosystems.

Historical developments. Ecosystem theory has for a long time been concerned with resilience of ecosystems which may be understood as a kind of system sustainability. Research on resilience and biodiversity does not form a new research stream concerned with sustainability that emerges within an established discipline. To illustrate, the term 'ecosystem' came up in 1935 (Tansley, 1935). Even though this research field has a long tradition, some authors still stress how complex the subject is and how incomplete the scientific knowledge about topics such as interrelations or feedback loops (Kay et al., 1999; Nielsen, 2007). Some even wonder whether sustainability is not one "grand illusion" (Kibert, 1997).

Definition of sustainability. Sustainability is understood as the ability of ecosystems to remain productive over time (Hooper et al., 2005; Paoletti, 1999). A common theme is the role of resilience and vulnerability of ecosystems, often in relation to biodiversity. Resilience is defined as either the time an ecosystem needs to recover from a disturbance or the magnitude of disturbance necessary to alter the state of an ecosystem, and it is regarded as the ecological equivalent to sustainability (Perrings, 2006; van den Bergh and Gowdy, 2000). Ecosystems are understood as self-organizing holarchic open systems (Kay, 2000; Kay et al., 1999). Changes in ecosystems and their environments

happen in a non-directed way and cannot be forecasted easily (van den Bergh and Gowdy, 2000). Obviously, systemic thinking is at the core of ecosystem biology.

Recommendations. It is accepted if not common sense among biologists that human development critically depends on ecosystem services (Folke et al., 2002; Gowdy, 1995; Waltner-Toews and Kay, 2005). However, as Figge (2004) and Perrings (2006) point out, human development is not usually addressed as a problem of biodiversity although there is broad consensus that biodiversity and ecosystem functioning are positively related (Hooper et al., 2005; McDaniel and Gowdy, 1998; Naeem et al., 1994; Perrings, 2006; Scheffer et al., 2001; Tilman et al., 2006). The recognition that humanity depends on ecosystems and ecosystems depend on biodiversity leads authors to call on policy makers to take explicit account of diversity, ecosystem integrity, and the underlying structural processes (McDaniel and Gowdy, 1998; Perrings, 2006; Scheffer et al., 2001). This shows that this research stream has a more ecocentric orientation.

Interdisciplinary overlaps. Not many scholars call for multidisciplinary cooperation (one exception being Myers, 2002). Although intersections exist e.g. with ecological engineering (see below), multidisciplinary outreach seems rather uncommon in ecosystem biology. Examples for the few multidisciplinary endeavors include Nielsen (2007) who addresses the compatibility of ecosystem theory with economic theory, Figge (2004) who applies portfolio theory to biodiversity valuation and management, and Fraser et al. (2005) who assess the vulnerability of food systems with the help of economic, financial, and chemistry tools. However, these articles have not been published in biological journals but rather in those of economics and the social sciences.

2.2.3 Sustainability in chemistry

Within chemistry, discussions of sustainability can be found in the research field of green chemistry.

Historical developments. Green chemistry is a young movement and the youngest research area discussed here. “With all of the research successes realized in green chemistry over the past 15 years, it is necessary to recognize

and understand that the field is in a nascent stage", as Horváth and Anastas (2007, p. 2169) stress.

Definition of sustainability. Green chemistry is "the invention, design and application of chemical products and processes to reduce or to eliminate the use and generation of hazardous substances" (Anastas and Warner, 1998, p. 30). The 'Principles of Green Chemistry' include waste prevention, safer chemicals, catalysis, and design for degradation (Warner et al., 2004, for discussions see Centi and Perathoner, 2003; Tundo et al., 2000). In this research stream, the Brundtland definition is often referred to (Hasna, 2009; Horváth and Anastas, 2007; Kirchhoff, 2005; Winterton, 2003) which implies an anthropocentric world view. Systems thinking is not common but the finiteness of resources is sometimes explicitly discussed (Horváth and Anastas, 2007; Tundo et al., 2000) and often implicitly assumed, and it seems to be one of the main motivators for green chemistry.

Recommendations. Scholars of this field see chemistry as the key discipline for sustainability from which major contributions are to be expected (Clark, 2006; Collins, 2001; Horton, 1999; Kidwai, 2006; Kirchhoff, 2005; Kümmerer, 2007; Manley et al., 2008; Tundo et al., 2000; Winterton, 2003). Yet, it is also argued that the discipline of chemistry needs to be transformed in order to meet this expectation (Collins, 2001; Horváth and Anastas, 2007; Venselaar, 2003). Green chemistry has put forward its own business case: it is generally argued that integrating green chemistry is profitable and is therefore driven by industry without any regulatory pressure (Centi and Perathoner, 2003; Horton, 1999; Warner et al., 2004). It is remarkable that green chemistry largely argues in line with the ecological modernization school without ever referring to it explicitly. Green chemistry is also a lot closer to industry than the two disciplines discussed above which becomes obvious from the many examples of green chemistry principles being realized in products or production (see, e.g., Ishida and Haruta, 2007; Kaneda et al., 2006).

Interdisciplinary overlaps. The proponents of green chemistry argue that chemistry as a discipline needs to be transformed, e.g. by integrating sustainability in academic curricula (Collins, 2001; Horváth and Anastas, 2007; Manley et al., 2008). Chemistry is called to take on long-term goals aiming at a fundamental transformation of products, processes and ultimately society (Centi and Perathoner, 2003; Venselaar, 2003). In general, the recommen-

dations made by green chemistry are targeted at chemistry researchers and industry.

2.2.4 Sustainability in engineering

Sustainability is hardly addressed in mainstream engineering research (Gaul, 2011) but there are calls for integrating sustainability in engineering curricula (e.g. Hasna, 2010). In the hybrid discipline of ecological engineering however, sustainability is key.

Historical developments. Ecological engineering goes back to the work of the Odum brothers in the 1960s (Mitsch and Jørgensen, 2003; Odum and Odum, 2003). Yet, the basic idea of creating a "partnership with nature" is centuries old (Mitsch and Jørgensen, 2003, p. 365).

Definition of sustainability. Ecological engineering is "the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both" (Mitsch, 2003, p. 365) and combines ecology and engineering, aiming at reconciling ecosystems with industrial systems (Bergen et al., 2001; Gattie et al., 2003). Sustainability is defined according to its Latin root 'sustenare' as "keeping an existing system operational" (Sandborn and Myers, 2008, p. 81). An operational system is able to maintain its ability to fulfill current and future requirements (Sandborn and Myers, 2008). This wording of current and future requirements is reminiscent of the current and future generations the Brundtland report refers to which is indeed an oft-cited source for defining sustainability (see, e.g., Cabezas et al., 2003; Mitsch, 2003; Thompson et al., 2011). Ecological engineering aims at creating both "human and ecological value" (Mitsch and Jørgensen, 2004, p. 23) and starts from the premise that natural resources are limited (Bakshi and Fiksel, 2003; Vinodh, 2010). Intrinsic value is conceded to both, humans and ecosystems. Therefore, it is safe to say that the value orientation of ecological engineering is both, anthropocentric and ecocentric.

The units of interest in ecological engineering are ecosystems and industrial systems. The interacting ecological and industrial spheres are at the same time seen as parts of one overarching system (Odum, 1996). For ecological-industrial systems to perform best, ecosystems are left to self-organize (Odum and Odum, 2003). The sustainability of sub-systems is a necessary but not suf-

ficient condition for the superordinate systems to be sustainable as well (Bakshi and Fiksel, 2003; Cabezas et al., 2003; Mitsch, 2003). Others argue that the sustainability of the whole ecosystem does not mean that all its subsystems run sustainably as well (Gosselin, 2008), hence arguing that the sustainability of a sub-system is *not* a necessary condition for overall sustainability. In any case, ecological engineering is concerned with the interaction of systems and their environment and clearly shares the systemic approach that is found in physical and biological research as well.

Recommendations. Ecological engineering is put forward as a whole new engineering discipline that is scientifically based on ecology (Bergen et al., 2001; Gattie et al., 2003). Its proponents aspire to influence engineering science in general (Bergen et al., 2001; Mihelcic et al., 2003). Similar to the green chemistry scholars, the ecological engineers seem to be closer to industry than to politics. While a lot of research discusses best practice examples of ecological engineering (see, e.g., Harbottle et al., 2007; Odum and Odum, 2003), policy recommendations are largely absent.

Interdisciplinary overlaps. Ecological engineering is multidisciplinary by definition since it is informed by ecology and engineering in equal shares. Furthermore, many have suggested that ecological engineers should work together with industrial ecology to design technological-ecological synergy networks (Odum, 1996; Seliger, 2011; Urban et al., 2010). The major difference between ecological engineering and industrial ecology is that the former revolves around ecosystems whilst the main theme for industrial ecology is the design of industrial processes (Tilley, 2003).

2.3 Sustainability from a natural science view

In this section, the research streams are discussed along five categories that have developed out of the clusters of the literature analysis. The first category is discussed in section 2.3.1 and concerns their underlying value orientation, i.e. their basic normative motivation which is found to be either anthropocentric or mixed anthropocentric and ecocentric. This emerged out of the *definition of sustainability* cluster. The second category discusses the way the concept of sustainability is approached by each research stream, i.e. their

discipline-specific theoretical framings of the subject, partly covering the *definition of sustainability* cluster as well (section 2.3.2). The third category in section 2.3.3 focuses on the target groups that are addressed by policy recommendations, corresponding to *recommendations* cluster. The fourth category (section 2.3.4) looks at the intersections that each stream has with other disciplines, corresponding to the cluster *interdisciplinary overlaps*. Finally, in the last category in section 2.3.5, the research streams are compared with regards to their historical developments and their levels of maturity. Table 2.1 on page 24 provides an overview of the different approaches to sustainability in the four research streams.

2.3.1 Underlying value orientation

The physical and chemical streams base their research on a purely anthropocentric value orientation. They refer to the Brundtland report (WCED, 1987) to define sustainability and largely adopt the concept of intra- and intergenerational justice. With ecologists and ecological engineers, the picture is less homogenous as they take on either an anthropocentric or an ecocentric value orientation. Despite the apparent ecocentric orientation, many scholars in biology also stress the value that intact ecosystems have for humans (Gowdy, 1995; Paoletti, 1999). Where biology overlaps with economics, namely in the ecosystem services valuation literature, there is a clear anthropocentric orientation (e.g. Atkinson and Mourato, 2008). In ecological engineering, humanity and ecology are equally at the center. Overall, it can be said that an anthropocentric view exists in all four streams. It is particularly dominant in green chemistry and thermodynamics whereas in ecology and ecological engineering, ecocentric views are important as well.

2.3.2 Sustainability approach

Every research stream understands sustainability in its own terms and frames it from its own theoretical perspective. For thermodynamics and ecological economics researchers, the earth is a closed system with regards to material. However, it is an open system with regards to energy, and its subsystems are open in respect of both. The inevitable consequence for economic theory is, first, that resources should not be treated as externally given but as internal

and scarce, and second, that infinite quantitative growth is not possible. In biology, sustainability is understood in terms of ecosystems. Ecosystems are interdependent, they develop in a non-linear way, and they are not fully understood. A resilient, i.e. sustainable ecosystem is able to absorb external shocks and to remain productive in the long term. The limitedness of resources is not an issue in this stream of literature. Rather, the uniqueness of ecosystems and their importance for regional and global ecological stability are stressed. Green chemistry's sustainability understanding is largely adopted from the Brundtland definition and based on the recognition of resource limitations. The chemistry stream fails to develop a differentiated sustainability understanding but rather uses the term sustainable synonymously with green or eco-efficient. However, the depletion of resources is the main motivator for the green chemistry school. The sustainability approach in ecological engineering is based on a strong systems approach and aims at integrating industrial systems and ecosystems in new, symbiotic super-systems. This systems approach is similar to the one in biology.

One interesting aspect is that the thermodynamic and engineering literatures base their sustainability understandings on systems thinking as well as on the recognition of resource constraints. In contrast, the biological stream has a strong systems understanding but no concern for resource constraints, and the chemical research accepts the limitations of resources as a fundamental problem but does not frame sustainability in a systemic way.

2.3.3 Target groups of policy recommendations

The scholars of physics call on a target group outside their academic boundaries, namely society at large. Major change is expected to be attainable only if a societal transition occurs. For instance, many scholars recommend that humanity must switch from exhaustible to renewable resources. Similarly, policy recommendations in the biological stream also address an external target group, policy makers, to consider conservation and biodiversity issues. In contrast, green chemistry and ecological engineering view themselves as the providers of technological solutions as can be seen by the many examples of best practice in the literature. Rather than putting forward policy recommendations, these two disciplines call on their peer researchers as well as industry

to take on responsibility for sustainability. Hence, chemical and engineering research appear closer to industry while thermodynamic and biological research are more oriented towards society and policy makers.

2.3.4 Disciplinary intersections

The discussed research streams have a lot of intersections with each other and other areas of research. To illustrate, the implications of thermodynamic laws for economics, industry and society have been discussed in economics and physics. In addition, there are connections between thermodynamic research and ecological engineering (Gutowski et al., 2009; Hammond, 2004). The biological stream seems less inter-connected but there are exceptions. These exceptions, however, are not driven by biology scholars but rather by economists and social scientists who complement their own perspectives with a biological one. Ecological engineering is multidisciplinary by definition as a hybrid of engineering and ecology. Green chemistry is less multidisciplinary although a few exception exist.

A particular overlap exists between the industrial ecology school and both, green chemistry and ecological engineering. Green chemistry is closely connected to this research field as it aims at providing the tools for industrial ecology (Horton, 1999). Ecological engineering is close to industrial ecology as well since has the same vision, i.e. to balance humanity with nature (Tilley, 2003), and applies a similar approach, i.e. designing ecosystems and industrial systems together.

To sum up, thermodynamics and ecological engineering are particularly multidisciplinary. It might not be a coincidence that it is in these two streams where both a systemic approach and a strong recognition of the limitedness of resources are highly developed.

2.3.5 Levels of maturity

Of the four research fields, green chemistry is the newest; the other three fields date back at least 50 years. However, they do not seem to have been equally influential. The discussion of the implications of thermodynamics for economics and society has matured to an extent where its insights have even penetrated public opinion. The neoclassical axiom of infinite economic growth

being both possible and desirable is seriously questioned (see, e.g., Jackson, 2009). Ecosystem theory could be seen as most limited in scope since it does not address sustainability as a global problem but, foremost, as an ecosystem problem. Although ecosystem services and biodiversity are of crucial importance to global environmental sustainability, this relation is not addressed in depth by ecosystem biologists. Despite the newness of their discipline, green chemistry scholars are optimistic about the 'business case' for green chemistry and the future influence of their field on chemistry, sustainability science, and policy. This is especially striking in comparison with the rather cautious writers of ecosystem biology which is the oldest stream of research of the four. Ecological engineering has been around for a long time but its influence seems to be limited to the realm of ecosystem restoration. At least, it does not seem to have influenced engineering science at large, at least not yet (Gaul, 2011).

Table 2.1: Sustainability views of the natural science streams

Categories	**Thermodynamics, ecological economics**	**Ecosystems biology, ecology**	**Green chemistry**	**Ecological engineering**
Underlying value orientation	Anthropocentric	Anthropocentric and ecocentric	Anthropocentric	Anthropocentric and ecocentric
Sustainability approach	Spaceship earth is a materially closed system; thus, cannot steadily use resources faster than they grow back	A sustainable ecosystem remains intact over a long period of time	Mostly borrowed from Brundtland report; focus on eco-efficiency and on atom/molecular level	Symbiotic balance between industrial systems and ecosystems
- *Systems thinking*	x	x		x

Categories	**Thermo-dynamics, ecological economics**	**Ecosystems biology, ecology**	**Green chemistry**	**Ecological engineering**
- *Acceptance of finite resources*	x		x	x
Target groups of policy recommenda-tions	Society at large, economic research	Conservation policy makers	Industry, chemistry research	Industry, engineering research
Disciplinary intersections	Economics, ecological engineering	Economic/ financial theory (ecosystem services valuation)	industrial ecology, parallels with Ecological Moderniza-tion	Biology/ ecology, industrial ecology
Maturity	Long history, large influence	Long history, less visibility	Short history	Medium history, apparently not much influence

2.4 A common denominator for sustainability

The aim of this analysis has been to find a common denominator among the sustainability understandings of the four research streams representing a natural science frame of reference. This common denominator understanding is suggested as a common base for sustainability strategy making at Bosch where most people have natural science backgrounds. The above discussion shows that each stream has its own specific approach towards sustainability, and that some elements are shared while others are not. At the core of understanding sustainability in all four streams is a basic systemic understanding and/or the recognition that natural resources are limited. This is rooted in the natural

sciences themselves and established in natural laws. For instance, the systemic approach to sustainability in ecosystem biology builds on the understanding of ecosystems as interconnected and open systems. In the physics literature, the systems view originates from thermodynamic laws. Analogously, the limitedness of resources and the resulting limitations for quantitative growth are accepted because they result directly from these natural laws. Based on this, it is suggested that the common-denominator understanding should include that sustainability means 'operating within the global system boundaries'.

It might come as a surprise that the anthropocentric aspect of sustainability, i.e. intra- and intergenerational justice, is part of the sustainability understandings of three of the four research streams (thermodynamics, green chemistry, and ecological engineering). This is unexpected because this element cannot be deduced from natural laws. Instead, it is adopted from literature outside the natural science realm such as, in many cases, the Brundtland report (WCED, 1987) and Rawls' theory of justice (Rawls, 1999). Considering the interdisciplinary nature of the discussed research streams, it appears less surprising that a justice concept is transferred to natural sciences, particularly when a topic such as sustainability is discussed which is not only a scientific research object but also a political issue. Hence, the second element of the common-denominator understanding is suggested as follows: 'adopting a far-sighted orientation that considers both current and future generations'.

The deduced common-denominator understanding reads as: *Sustainability means (1) operating within the global system boundaries and (2) adopting a far-sighted orientation that considers both current and future generations.*

2.5 The basis for sustainability strategy making at a company

This chapter has offered insights into the distinct sustainability approaches in four research streams of the natural sciences as well as common ground and differences between them. It also sheds light on the origins of different perspectives on sustainability that people may have. Based on this review, a common-denominator definition of sustainability has been developed. This sustainability understanding is suggested as a common base to enable a com-

monly accepted sustainability strategy at an engineering company where most people have natural science backgrounds which are likely to influence their frames of reference. If such a shared understanding of sustainability is in place, sustainability strategy making and implementation is likely to be successful (Enroth, 2007).

The understanding of sustainability as comprising two elements, the limitedness of natural resources and the consideration of both, current and future generations, is the basis which this dissertation builds on. The proposed understanding is believed to be at the core of sustainability which is definitely not void of meaning – this meaning only needs to be reflected upon and thoroughly developed. It is an interesting result that even in a strictly natural science review, the Brundtland definition of sustainability is ubiquitous. In this context, it is worth quoting this definition at its full length.

"*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:*

- *the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.*"
  (WCED, 1987, ch. 2)

When considering the entire Brundtland definition, not only the needs of present and future generations, which correspond to the anthropocentric interpretation of sustainability, are found but also the limitations of the environment's ability to meet these needs, i.e. the ecocentric view which can be derived from the natural sciences. That these limitations are part of the probably most-cited sustainability definition is often forgotten (Stappen, 2008) but it is a strong argument against those arguing that the term should be abandoned. The complete Brundtland definition as cited above is in line with the sustainability understanding deduced in this chapter. Even though the term sustainability is arguably overstretched (Esty, 2001), sustainability is an elaborated concept on whose two main components surprisingly little disagreement exists, at least in academic writing. Even the natural science research

streams considered here agree on these two elements although one of them is not deducible from natural laws.

Naturally, this review has a limited scope and could be extended in many directions, e.g. by considering other natural sciences or by adding social sciences and humanities. However, in the context of this dissertation, the focus on the natural sciences was deliberately chosen in order to develop a sustainability understanding that can be used as the common base for sustainability strategy making at an engineering company. Furthermore, it is possible that extending the scope of this review would not yield substantially new insights. Another important question is how exactly the suggested sustainability understanding can be applied to corporate practice. It is argued that the suggested definition offers several advantages for corporate (strategic) management. First, if this basic understanding of sustainability is implemented successfully in the sense that most employees share the same understanding, misunderstandings can be avoided and meaningful communication about sustainability becomes possible. Second, the company's credibility could be enhanced if its concept or a corporate vision of sustainability is clearly and precisely stipulated. Third, a common sustainability understanding might be the point of departure for corporate activities to enhance sustainability.

How exactly such sustainability activities come about is a question addressed in the following chapters. One obvious starting point for making general and long-term decisions about sustainability is corporate strategy making. After the basic sustainability understanding of this dissertation has been developed in this chapter, we move to the next step in order to further elaborate the research question of this dissertation: How are sustainability strategies made?

Chapter 3

Theoretical mainstay: Sustainability strategy making

"Sustainable development issues are typical 'strategic' challenges [...] in that they require comprehensive and radical transformations of complex social systems affected by multiple actors over long time periods."

Cherp et al., 2007, p. 638

This chapter provides the theoretical mainstay for this dissertation[2]. The conceptual framework developed in this chapter introduces a new contingency factor that helps explain sustainability strategy making. Two propositions and a two-factor matrix explain the link between the contingency factor and sustainability strategy making. The main theoretical contribution of the dissertation is contained in this chapter which addresses an important research gap. The propositions are later applied to the Action Research study (chapter 4, 5) and will be discussed in the empirical context again in chapter 6.

The second section 3.1 presents the state of the research on corporate strategy making where two main perspectives on the formation of strategies

[2] An early idea of this chapter was presented at the Group Researching Organizations and the Natural Environment (GRONEN) Conference, Saint Maximin la Sainte Baume, France, in 2012.

A slightly modified version has been accepted for publication by the journal Business Strategy and the Environment (Neugebauer et al., 2014).

exist: the first school understands strategy making as a planning task while the other argues that strategies are often unplannable but emerge from practice (e.g. Mintzberg and McHugh, 1985). By now, there is a consensus that strategy making resides on a continuum from planned to emergent strategy making where most strategies are made in a mixed way. Various sets of contingency factors have been suggested to explain the influences on the strategy making mode, i.e. on whether strategies are made in a more planned or a more emergent way.

Yet, as argued in section 3.2, in the corporate sustainability literature it is most commonly assumed that sustainability strategies are made in a planned way. Research on corporate sustainability seems to overlook the debate on different modes of strategy making as well as the idea of a continuum between planned and emergent strategy making. This is particularly remarkable because planned strategies are most appropriate for comparatively straightforward and controllable contexts (Hart, 1992; Regnér, 2003). However, many sustainability researchers agree that sustainability is a complex, if not 'wicked' problem (Frame, 2008), implying that controllable contexts are not overly likely. In addition, the nature of the problem that a strategy seeks to address is usually not taken into account as an influence factor on strategy making.

In order to fill these gaps, it is suggested in section 3.3 to conceptualize sustainability strategy making in the context of the planned-emergent continuum. Furthermore, the nature of the addressed problem is introduced as a new contingency factor to help explain sustainability strategy making. To illustrate this new contingency factor, strategy making for four types of sustainability problems is discussed. It is argued that planned strategy making is expected for salient and non-wicked problems while emergent strategy making is more likely for non-salient and wicked problems.

Finally, section 3.4 concludes the chapter by highlighting the theoretical contributions. The fact that sustainability research turns a blind eye to emergent strategy making hinders a better understanding of the strategy making processes as well as the successful implementation of more sustainable practices. While the focus on the nature of the problem as a novel contingency factor for strategy making might offer interesting insights for strategy research beyond the specific case of sustainability, the main contribution is to add to a better understanding of the role of different strategy making modes in the

context of corporate sustainability. The bias of the sustainability strategy literature towards planned approaches is alleviated and strategy making is discussed for different types of sustainability problems. Beyond this contribution to research, sustainability practice might be improved if emergent strategy making is facilitated in companies, in addition to the more traditional strategic planning.

3.1 Two opposed views of strategy making

According to Johnson et al. (2011, p. 3), strategy is "the long-term direction of an organisation". Mintzberg (1978) defines strategy as a "pattern in a stream of decisions" that consists of both planned and emergent elements. Both definitions are drawn on because it is important for the purpose of this research to keep in mind that strategy usually contains both, planned elements as well as unintended, emergent elements. Hence, strategy is understood as the long-term direction of an organization consisting of both planned and emergent elements.

Strategy research tends to focus on either strategy content or process (Rajagopalan et al., 1993). This research is positioned in the process camp because the goal is to better understand how sustainability strategies are made. Strategy making is the process through which a strategy develops, be it by planning or out of practice. The question how exactly strategies are made has been debated for decades in the literature by two main schools of thought: The planned and the emergent strategy making school. In the following, both approaches are outlined as well as the consensus that has been established and the contingency factors developed to explain when strategies are planned and when they are emergent.

The continuum of planned and emergent strategy making is discussed by emphasizing the two extremes: (purely) planned versus (purely) emergent strategy making. It is not implied that these extremes are likely manifestations of strategy making. Using the extremes illustrates the continuum in between, notwithstanding that the extremes are actually rather unlikely to occur.

3.1.1 Planned strategy making

The strategic planning literature has its roots in the work of Lewin who describes change processes in his three-step model as consisting of unfreezing, moving, and refreezing (Lewin, 1947). This rather static understanding of organizational change is still at the core of many more recent approaches (Burnes, 2004). Ansoff coined the term 'strategic planning' in the 1960s (Ansoff, 1965; Martinet, 2010). Based on observations of actual strategy making in leading big companies in the 1950s, Ansoff argues that strategic decisions are "made through an organization-wide systematic strategic planning process" (Ansoff, 1987, p. 505). Strategic planning is understood as a well-structured process consisting of two separate steps: first, goals are deduced from a vision and a strategy is planned; second, the strategy is implemented throughout the organization in order to reach these goals. The leadership of top management is crucial for strategic planning (Hart, 1992) because it is the top management's task to plan strategies and to implement them in a top-down manner.

The role of strategic planning in companies continues to be debated. Maritz et al. (2011) find that companies do still plan their futures which implies that strategic planning is still a relevant issue in management research (see also Tsai et al., 1991). On the other hand, it has been shown that strategic planning with its assumption of rational decision making is inconsistent with managerial reality and fails in practice (By, 2005; Herbert, 1999).

3.1.2 Emergent strategy making

One of the main critics of the planned approach to strategy making is Mintzberg who argues that strategy formulation cannot be separated from strategy implementation (Mintzberg, 1994; see also Mintzberg, 1978). He suggests that strategy making consists of both deliberate and emergent elements and that the purely planned strategy is the unlikely extreme of a wide continuum (Mintzberg and McHugh, 1985). The idea of emergent strategies is that within an organization, strategy emerges out of practice in a bottom-up or undirected way. Even though many attempts of emergent strategy making might fail, some are successful in changing the company's overall direction. Emergent strategy making is "most likely to emerge at a level where managers are directly in contact with new technological developments and changes in market

conditions, and have some budgetary discretion" (Burgelman, 1991, p. 246). In this view, strategic decision making is an ongoing and rather inductive change process (Hendry, 2000; Regnér, 2003). It can be rather incremental and path-dependent as strategies are continuously modified (Jarzabkowski, 2004; Whittington, 1996) and thereby become accepted within the organization (Lowe and Jones, 2004; Papagiannakis et al., 2013).

The emergent approach to strategy making is not without its critics either. For instance, Carter et al. (2008) argue that it is just as top-management oriented as the planned approach, and others criticize that it still lacks coherence (By, 2005; Idenburg, 1993). According to Idenburg (1993, p. 136), the emergent perspective on strategy "leaves the door wide open for all kinds of irrational mechanisms". As opposed to this, many scholars argue that the emergent approach is particularly relevant for practice (e.g. Hendry, 2000; Lowe and Jones, 2004; Maritz et al., 2011).

3.1.3 Contingency factors

It appears to be widely accepted that emergent and planned strategy making complement each other (Burgelman, 1983a,b, 1991; Chaffee, 1985). This implies that "superior emergent processes have some elements of deliberate strategy embedded in them" (Jett and George, 2005, p. 408), and vice versa. Many authors agree that strategy can be made in both a planned and an emergent way and that real-world strategies usually contain elements of both. For instance, Idenburg (1993) and Chaffee (1985) argue that the different styles of strategy making complement each other; and Lowe and Jones (2004) state that the outcomes of a strategy making process are a product of both conscious and unconscious decisions.

Hence, we proceed on the assumption of a continuum between planned and emergent strategy making modes. Different contingency factors have been suggested to explain when planned or emergent strategy making becomes more likely (Elbanna, 2011; Hart, 1992; Rajagopalan et al., 1993). The contingency factors established in the strategy literature can be grouped into four categories, namely the company's environment, the organization itself, decision-making aspects and management-specific aspects (table 3.1 on page 36 provides an overview).

Environment

The first set of factors covers the company's ENVIRONMENT, i.e. the market where the company sells its products, the industrial sector to which it belongs, and the institutional setting in the region where it operates. This environment is described on a continuum from stable (or simple) to turbulent (or complex), and from munificent to hostile (Barbuto, 2002; Elbanna, 2011; Hart, 1992; Hutzschenreuter, 2006; Papadakis et al., 1998; Rajagopalan et al., 1993). Planned strategies are expected in rather stable environments and emergent strategy types in turbulent environments (Barbuto, 2002; Hart, 1992). Companies in rather uncertain environments increase the decision-making speed (Hutzschenreuter, 2006), which might make planned strategy more likely. In a hostile environment, planned strategies might be more likely because they allow companies to react faster (Hart, 1992; see also Slawinski and Bansal, 2012), however, higher risks might also slow decision making down (Schilit and Paine, 1987). There has not been much research on the influence of munificence and hostility on strategy making (Elbanna and Child, 2007a; Rajagopalan et al., 1993) and the results are contradictory (Elbanna, 2011).

Organization

The second set of factors concerns the ORGANIZATION itself and includes factors such as the size of the company (e.g. Elbanna, 2011; Elbanna and Child, 2007a; Hart, 1992), its stage of development (e.g. Hart, 1992; Rajagopalan et al., 1993), the type of ownership (e.g. Elbanna, 2011; Li and Hu, 2008; Papadakis and Barwise, 1998), the availability of slack resources (Rajagopalan et al., 1993), present and past performance (e.g. Burgelman, 1991; Papagiannakis et al., 2013), and present and past strategy (e.g. Hart, 1992; Papagiannakis et al., 2013).

Size has been researched relatively well but results are contradictory: Some expect small companies to have planned strategies (Barbuto, 2002; Hart, 1992), some argue that larger organizations have a tendency to plan more Stone et al. (1999), and others suggest that size does not make a difference at all (Hickson et al., 1986; Li and Hu, 2008; Papadakis and Barwise, 1998). Mature companies tend to have less planned strategies than those in an early stage of development (Hart, 1992; Li and Hu, 2008). A more innovative business strategy is likely to

coincide with more emergent strategy making (Hart, 1992). If past strategies were unsuccessful, new alternatives are more likely to emerge (Papagiannakis et al., 2013), which might foster emergent strategy making. When performance declines, pressure grows and strategic renewal through emergent strategies is more likely (Burgelman, 1991). Specific aspects of a national culture, e.g. the importance of hierarchy, might be conducive to planned strategy making (Lok et al., 2010) but there are no conclusive results regarding tendencies toward planned or emergent strategies.

Further factors have been suggested although the exact nature of their influence remains unclear. These are for example the overall level of risk faced by the company and internal power structures (Rajagopalan et al., 1993), organizational culture, impact of upward influence, and employee involvement (Simons and Thompson, 1998).

Decision making

Third, DECISION-SPECIFIC FACTORS are suggested to be particularly important influences on the strategy making process (Papadakis et al., 1998). Commonly suggested factors are decision complexity, uncertainty, urgency, and the perception as threat or opportunity (Delmas and Toffel, 2004; Dutton, 1986; Elbanna, 2011; Papadakis and Barwise, 1998; Rajagopalan et al., 1993; Sharma, 2000; Simons and Thompson, 1998). Other factors include decision frequency and time required (Papadakis and Barwise, 1998; Rajagopalan et al., 1993; Simons and Thompson, 1998).

It has been argued that low decision complexity enhances decision making speed (Astley et al., 1982). Issues perceived as threats and unfamiliar problems are addressed more rationally, i.e. by more planned strategy making (Elbanna, 2011; Nooraie, 2011). These arguments suggest that both threatening and unfamiliar issues tend to lead to more planned strategies. Dutton (1986) argues that the more issues are perceived as threats, the more resources are devoted to their solution and the higher the centralization of control. Thus, perception as a threat might induce more planned strategy making. However, research addressing the influence of decision making on the strategy making process remains under-developed. While many authors argue for the relevance

of particular factors, a discussion of which factors enhance the probability of planned or emergent strategy, respectively, is largely absent.

Top-management characteristics

Fourth, TOP-MANAGEMENT CHARACTERISTICS (Hambrick and Mason, 1984) are suggested to play an important role for strategy making. The following three sets of factors are commonly suggested: First, demographics including managers' age, gender, educational background, tenure, and past experience (Elbanna, 2011; Hitt and Tyler, 1991; Papadakis and Barwise, 1998; Simons and Thompson, 1998); second, personality characteristics such as personal values, risk propensity, need for achievement, social conditioning, and aggressiveness (Elbanna, 2011; Papadakis et al., 1998; Papagiannakis et al., 2013; Simons and Thompson, 1998); and third, team characteristics including team heterogeneity and turnover rate of team members (Schwenk, 1984, 1995).

One implication of the research is that managers' tenure makes planned strategies more likely because managers with high tenure tend to be more conservative (Elbanna, 2011). Beyond tenure, there are few suggestions concerning whether other factors enhance or decrease the likelihood of planned or emergent strategy making,(Papadakis et al., 1998; Rajagopalan et al., 1993; Simons and Thompson, 1998), and existing studies have yielded mixed results (Elbanna, 2011; Papadakis and Barwise, 1998). Although the personal characteristics of managers are recognized and discussed a lot, it is unclear how they influence the likelihood of planned or emergent strategy making.

Table 3.1: Contingency factors explaining the strategy making mode

Contingency factors	**more planned if...**	**more emergent if...**	**References**
	ENVIRONMENT		
Market / industry / institutional setting	stable, certain, simple, hostile	turbulent, uncertain, complex, munificent	Barbuto (2002); Hart (1992); Hutzschenreuter (2006)

Contingency factors	**more planned if...**	**more emergent if...**	**References**
	Influence acknowledged, direction unclear		Simons and Thompson (1998)
National culture	*Influence acknowledged, direction unclear*		Papadakis and Barwise (1998); Schneider and Meyer (1991)
Location	Center (headquarters)	Periphery (divisions)	Regnér (2003)
Stakeholder power	High stakeholder power	Low stakeholder power	Elbanna (2011)
	ORGANIZATION		
Company size	Big	Small	Elbanna (2011); Elbanna and Child (2007b); Papadakis and Barwise (1998); Stone et al. (1999)
	Small	Big	Barbuto (2002); Hart (1992); Hutzschenreuter (2006); Stone et al. (1999)
	Influence acknowledged, direction unclear		Hickson et al. (1986); Li and Hu (2008); Papadakis and Barwise (1998); Rajagopalan et al. (1993)
Stage of development	*Influence acknowledged, direction unclear*		Hart (1992); Hutzschenreuter (2006); Li and Hu (2008); Rajagopalan et al. (1993)

Contingency factors	**more planned if...**	**more emergent if...**	**References**
Type of ownership	*Influence acknowledged, direction unclear*		Elbanna (2011); Li and Hu (2008); Papadakis and Barwise (1998); Papadakis et al. (1998); Simons and Thompson (1998)
Availability of organizational slack	Scarce	Abundant	Rajagopalan et al. (1993)
Past and current performance	High	Low	Burgelman (1991); Elbanna (2011); Elbanna and Child (2007b); Hutzschenreuter (2006); Papadakis and Barwise (1998); Papagiannakis et al. (2013); Rajagopalan et al. (1993)
Past and current business strategies	Successful	Unsuccessful (need for new strategies)	Papagiannakis et al. (2013)
	Traditional	Innovative	Hart (1992)
	Influence acknowledged, direction unclear		Hutzschenreuter (2006); Rajagopalan et al. (1993)
	DECISION MAKING		
Decision urgency and time required	*Influence acknowledged, direction unclear*		Rajagopalan et al. (1993); Simons and Thompson (1998)

Contingency factors	more planned if...	more emergent if...	References
Decision complexity and uncertainty	*Influence acknowledged, direction unclear*		Astley et al. (1982); Rajagopalan et al. (1993); Simons and Thompson (1998)
Political nature of decision: perception as threat or opportunity	Threat	Opportunity	Dutton (1986); Elbanna (2011); Papadakis and Barwise (1998); Schilit and Paine (1987); Simons and Thompson (1998)
TOP-MANAGEMENT CHARACTERISTICS			
Personal characteristics	*Influence acknowledged, direction unclear*		Elbanna (2011); Hambrick (2007); Papadakis and Barwise (1998); Papagiannakis et al. (2013); Simons and Thompson (1998)
Demographics	*Influence acknowledged, direction unclear*		Elbanna (2011); Papadakis and Barwise (1998); Simons and Thompson (1998)
Management team characteristics	*Influence acknowledged, direction unclear*		Schwenk (1984, 1995)

3.2 Strategy making for sustainability

After the contingency factors have been introduced, this section addresses the formation of sustainability strategies. Sustainability is understood as a societal problem that highlights ecological limitations as well as intra- and intergenerational justice (see chapter 2) and to which companies can contribute positively and negatively (Jennings and Zandbergen, 1995). Research on sustainability

strategy overlooks one of the most important developments in strategy research of the last decades, namely the discussion on whether and when strategies are made in a more planned or a more emergent way. In order to address this blind spot and to contribute to a better understanding of sustainability strategy making, the perspective of sustainability strategy research is suggested to be widened to the entire continuum from planned to emergent strategy making, rather than limiting itself to one extreme (Hendry, 2000; Maritz et al., 2011). The nature of the problem, in terms of the problem's wickedness and salience, is proposed as a new contingency factor to explain where sustainability strategy making is positioned on this continuum.

3.2.1 Sustainability strategy making: state of debate

Two of the most common topics in the literature on corporate sustainability strategy are the classification of sustainability strategies on a range from proactive to reactive (see, e.g., Baumgartner and Ebner, 2010; Hunt and Auster, 1990; Welford, 1998) and the identification of drivers of sustainability strategies (see, e.g., Enroth, 2007; Harris, 2007; Papagiannakis et al., 2013). However, the making of sustainability strategies is hardly ever addressed.

Instead, many authors implicitly assume that sustainability strategies are first planned and then implemented top-down. For instance, Roome refers to 'strategy formulation' and subsequent strategy implementation in his seminal articles on corporate environmental strategy (Roome, 1992, 1994). Banerjee (2002) states that sustainability strategies require the integration of sustainability targets into 'strategic planning', and also the frequent emphasis on top management (Harris, 2007; Kaldschmidt, 2011; Lee et al., 2003; Maritz et al., 2011; Prakash, 2001) suggests the same. Similarly, Cherp et al. (2007) argue that research on strategic environmental assessment (SEA) lags behind the developments in strategy research and is still largely influenced by the ideas of the planning school. Sustainability balanced scorecards (Figge et al., 2002) are another example of planned strategy making where sustainability strategies are derived and implemented in a top-down planning process (Dias-Sardinha et al., 2007; Hansen et al., 2010).

By contrast, emergent strategy making is advanced by organizational members initiating and shaping sustainable practices and projects rather than top

management (Sharp and Zaidman, 2010), which corresponds to a strategy-as-practice perspective (Jarzabkowski, 2004). The literature on sustainability champions also takes on such a more emergent perspective. In general, champions are individuals who are particularly committed to advocating and advancing a particular goal or project within their organization (Anderson and Bateman, 2000; Howell and Higgins, 1990; Markham, 1998; Noda and Bower, 1996). "[T]hey identify with the idea as their own, and with its promotion as a cause, to a degree that goes far beyond the requirements of their job" (Schön, 1963, p. 84). Noda and Bower (1996, p. 189) describe how "[e]ntrepreneurial managers can and actually do develop independent strategic premises based on their visions and intentions" and communicate them to top management in a bottom-up process. As champions aim at advancing strategic topics bottom-up, they might thereby create or advance emergent strategies.

In particular, sustainability champions are individuals who "believe that environmental issues are a top priority and who possess environmental knowledge and skills" (Anderson and Bateman, 2000, p. 549). They are found to play important roles in fostering sustainability strategies (Enroth, 2007; Harris, 2007; Prakash, 2001; Schaltegger and Wagner, 2011; Taylor et al., 2012). In his study of environmental championing in technological innovation projects in four firms, Markusson (2010) finds that private life environmental commitments and personal pro-environmental attitudes play an important role for individuals to promote and shape environmental aspects in their daily professional decision making. Firms sometimes seek to facilitate such bottom-up sustainability initiatives by creating spaces for employee-driven projects. For instance, so-called green teams are self-organized, grass-root and cross-functional teams where employees initiate sustainability projects in their organizations which in the cases of eBay or Intel have shaped the energy and carbon strategies of these firms (Fleischer, 2009). While these sparse examples from the literature tentatively cover the emergent perspective, they do not offer a comprehensive discussion of the making of sustainability strategies.

3.2.2 Nature of sustainability: salience and wickedness

Sustainability is a difficult problem for companies to address because the range of challenges arising from the goal of sustainability are very complex, has

societal impacts, and is of a long-term nature. If stakeholders successfully draw attention to particular sustainability problems, these problems become highly relevant for companies. It is expected that these characteristics of sustainability problems will play an important role for whether sustainability strategies are formulated in a planned or an emergent manner. Therefore, the contingency factor NATURE OF THE PROBLEM is developed as follows.

The concept of wicked problems is useful for describing sustainability (e.g. Frame, 2008). Following the definitions by Rittel and Webber (1973), wicked problems cannot be fully understood, potential solutions are unknown, and there is no right and wrong, but rather good and bad. Trying to solve a wicked problem changes it and can have unforeseen consequences. Furthermore, wicked problems are unique, i.e. experience from other problems does not help solve a wicked problem, and they are intertwined with other problems. Finally, wicked problems have social consequences that make those trying to solve them responsible for social impacts of attempted solutions. In addition, there is no way to find out in advance if a solution will work.

Three aspects of wickedness are highlighted for the case of sustainability: its complexity, its societal impacts, and its long-term nature. First, concerning complexity, most authors agree that sustainability is extremely complex. According to Anderson and Bateman (2000, p. 549), "[t]he widespread consequences of environmental issues may far exceed those of many other corporate issues". Second, with regards to societal impacts, Rotmans' description of such problems is used: They are "deeply rooted in our societal structures and institutions, and [...] closely interwoven with manifold societal processes, so that they cannot be solved in isolation" (Rotmans, 2006, p. 36). Furthermore, they are "caused by fundamental flaws in our societal systems" (Rotmans, 2005, p. 4). Third, due to its reference to future generations a long-term orientation is inherent to sustainability (WCED, 1987). Well-known studies such as the IPCC reports (IPCC, 2013) or the Stern Review (Stern, 2007) address very long periods of time, with scenarios often covering the next 100 years. These time periods are uncommonly long for strategic planners in the political and private sector (Burgelman and Grove, 1996; Chaffee, 1985; Slawinski and Bansal, 2012).

In addition to wickedness, salience is a helpful concept to better understand sustainability problems. Drawing on Mitchell et al. (1997), a sustainability

problem is salient if (1) powerful stakeholders are able to influence companies to address the problem; if (2) solving the problem is generally seen as desirable and in line with societal norms and values; and (3) if the problem requires immediate attention and is of critical importance to stakeholders. To illustrate, climate change as a sub-issue of sustainability is powerful because it has got influential stakeholders such as the UNFCCC, it is legitimate in that hardly anyone denies its importance, and it is urgent as acting late becomes more and more expensive (Stern, 2007). In contrast, overpopulation is an urgent problem because it accelerates the overexploitation of natural resources but measures to reduce population growth are often illegitimate because having (many) children is seen as desirable in most cultures. Furthermore, there are no powerful stakeholders pushing for a global reduction of birth rates.

In this context, it is important to emphasize the difference between the nature of the problem and other contingency factors, including the decision making and the environment. Decision processes might be simple although the underlying problems are complex. For example, as soon as child labor is generally considered unacceptable, decision making about child labor can be very simple even though it represents a complex problem. Similarly, even if a company's environment is complex the sustainability issue addressed might be simple. For instance, a company in a complex environment such as highly competitive energy markets under high regulatory uncertainty (Hoffmann et al., 2009), might still address a comparatively simple sustainability problem such as CO_2 reduction. Although some authors argue that problem-specific factors matter for strategy making (e.g. Boal and Meckler, 2010; Dutton, 1986; Eesley and Lenox, 2005) there has not been a systematic discussion of the influence that the nature of the problem might have on the strategy making mode.

To sum up, the NATURE OF THE PROBLEM that is to be addressed by a sustainability strategy is described by (1) the problem's wickedness, i.e. its complexity, its social relevance, and its long-term nature; and (2) its salience, i.e. its power, legitimacy, and urgency. It is argued that in addition to the contingency factors discussed above, the nature of the problem will influence strategy formation. More precisely, the extent of wickedness and salience is expected to affect whether strategies are more likely to be made in a planned or an emergent way.

3.2.3 Sustainability strategies on the continuum

Wicked sustainability problems tend to be addressed by emergent strategies for the following four reasons. First, planned approaches to strategy making are prevalent in stable environments, i.e. in comparatively straightforward and controllable contexts (Hart, 1992; Regnér, 2003). A wicked problem does not provide such a context but rather comes with a complexity that is difficult to manage with a planned approach. This is due to two cognitive biases in planned strategy making (Das and Teng, 1999). Strategic planners tend to have objectives when entering the strategy making process. These objectives are based on hypotheses of possible future developments and are likely to influence the strategy making. Thus, the manager risks not solving the problems at hand. Furthermore, strategic planning creates an illusion of manageability because the seemingly rational process makes managers believe that the risks are lower than they actually are (see also Mintzberg, 1994). If planned strategies for wicked problems are not successful in addressing these in the long run, they might become more unlikely.

Second, emergent strategy making enables organizational learning (Mintzberg and McHugh, 1985) which is likely to play an important role in the case of poorly understood, wicked problems.

Third, in order to better understand wicked problems and to better be able to address them, it might be necessary to go into more depth and consider details. Particularly social impacts often have local impacts and are easier to address if the strategy making happens close to where the impacts are felt (Mintzberg and McHugh, 1985), i.e. not at the center of the organization but at its periphery (Regnér, 2003).

Finally, because emergent strategy making is driven by internal motivation, e.g. by champions, rather than external pressure (Burgelman, 1991; Prakash, 2001), emergent strategy making is more likely in the case of wicked problems. For instance, a highly wicked sustainability problem of low salience such as biodiversity loss is very difficult to address with a planned strategy because of the high level of uncertainty – it is impossible to define corporate targets, not least because the unit of measurement is not clear, and they would be impossible to monitor as the factors involved in rendering species extinct are poorly understood. However, at a lower level, e.g. in the development of a

product for a particular market, it might be possible to consider particular ecosystems and the potential impacts of the product.

Proposition 1: The more wicked a sustainability problem, the more likely it is addressed by emergent strategy making.

Salient problems tend to be addressed by planned strategies since all three aspects of salience make planned strategies more likely. First, salient problems pose threats to companies because powerful stakeholders can put companies under pressure and force them to react (Aaltonen and Sivonen, 2009; Ackermann and Eden, 2011). In order to avoid damage from stakeholder activities like boycotts, companies engage with their stakeholders and integrate them into decision making processes (Morsing and Schultz, 2006; Wheeler and Sillanpää, 1998). For this purpose, coordinated activities such as lobbying, stakeholder forums, and the publishing of reports (Aaltonen and Sivonen, 2009; Roloff, 2008) are frequently used instruments. A problem with powerful stakeholders is more likely to be addressed by such planned strategies, rather than by emergent ones.

Second, the legitimacy of the problem is high if it is in line with societal norms and values. Again, in order to avoid reputational damage, companies engage with stakeholders by using tools of corporate communication (Bradford and Garrett, 1995). Additionally, as suggested by Chattopadhyay et al. (2001) and Staw et al. (1981), companies facing a threat tend to focus on controllable activities in order to regain control. Such activities include the issuing of press releases and entering into agreements such as the Global Compact, for example. Consequently, highly legitimate problems make planned strategies more likely as well.

Third, the urgency of the problem puts the company under pressure to react immediately and to communicate its activities to address the problem (Siomkos and Shrivastava, 1993). Here, planned strategy making is more likely, too, because planned strategies are developed more quickly than emergent strategies. For example, the strategic decision about signing a code of conduct can be made very quickly at the top management level and does not need time to emerge bottom-up.

In addition, Dutton (1986) argues that decision-making authority tends to be centralized to enable the company to better deal with salient issues. A centralized decision-making process relies on planned strategy making modes since emergent strategy are by definition "not driven by central intention" (Mintzberg, 1990b, p. 176). Furthermore, salient problems are addressed with more resources (Dutton, 1986; Lotila, 2010) which might enable a company to launch potentially costly stakeholder dialogues or communication campaigns, for instance.

To provide an example, the goal of increasing energy efficiency is often addressed by setting centralized goals and by planning and implementing a strategy top-down throughout the company. Companies aiming at improving energy efficiency have the clear goal of analyzing their energy consumption and finding ways to reduce it. Well-defined means and ends are good prerequisites for planned strategy making (Maritz et al., 2011), hence, a company dedicated to improving its energy efficiency would be expected to set a company-wide reduction target and implement this goal throughout all levels of the organization.

Proposition 2: The more salient a sustainability problem, the more likely it is addressed by planned strategy making.

3.3 The salience-wickedness matrix

As argued above, the two dimensions of the nature of a problem, wickedness and salience, influence the strategy making mode in opposite directions on the continuum between planned and emergent strategy making – wickedness enhances emergent strategy making while salience makes planned strategies more likely. Figure 3.1 shows four schematic types of sustainability problems. The yellow triangles symbolize that these four kinds of problems are extreme cases and that most real-world problems are likely to be situated somewhere in between.

In the following, problems that are both wicked and salient are brought into focus. The question what strategy making modes are likely under which circumstances is addressed first. Second, it is reflected on whether the most

likely strategy making mode is also the most appropriate one. Finally, it is suggested that wicked and salient problems are likely to be addressed by both kinds of strategy making, with the planned approach dominating.

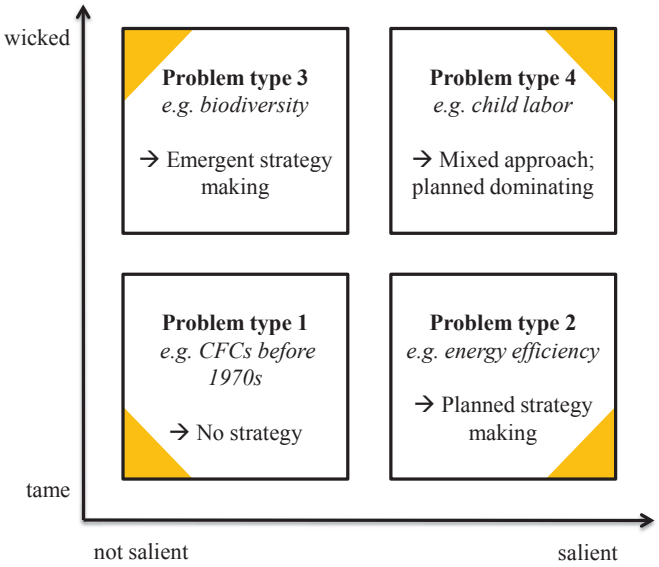

Figure 3.1: Strategy making for sustainability problems (salience-wickedness matrix)

Type 2 and type 3 problems have already been discussed above: Type 2 problems, i.e. salient non-wicked problems, are expected to be addressed by planned strategies while type 3 problems, i.e. wicked non-salient problems, are more likely to be addressed by emergent strategies. Since wickedness and salience have opposing impacts on the strategy making mode, the question is what strategy making would look like for problems that are both wicked and salient (type 4).

For such problems two competing tendencies are expected to be observed. On the one hand, mounting external pressure is likely to favor the development of planned strategies. On the other hand, emergent strategies are likely to come about as well because (highly wicked) sustainability problems motivate

champions to engage in emergent strategy making (Prakash, 2001). There is a high level of agreement that both forms of strategy making are usually present in companies, complementing each other (Jarzabkowski, 2004, 2008; Mintzberg and McHugh, 1985; Mintzberg and Waters, 1985). Hence, it is assumed that in the case of a wicked-and-salient sustainability problem, both strategy making modes are present.

In line with Mintzberg and McHugh (1985), top management is expected to plan an umbrella strategy in order to be able to communicate swiftly on the company's response to the problem (needed in particular for legitimate and urgent problems) and that sets limitations for emergent strategy making. Particularly if the problem is very urgent, planned strategy making is expected to dominate over emergent strategy making because emergent strategy making is unlikely to be fast enough to address the problem. In such cases, the development of a planned strategy might not leave much room for emergent strategy making at the same time. Planned strategy making might also crowd out emergent strategy making because it is pushed top-down throughout the hierarchy and is therefore backed up by formal power.

The recent scandal on labor conditions, including child labor, in Bangladesh is an example for a wicked and salient problem. It is wicked because the business model of the textile industry is built on low labor costs and cannot be changed easily but has complex social implications in the countries of production. It became salient when the companies that had been producing at the Rana Plaza building, which collapsed in April, 2013, were exposed in the press (Cooper, 2013; Kernaghan, 2013). Companies were quick to react to the criticism, trying to prevent further reputational damage, e.g. Gap by denial (Jamieson, 2013) and Joe Fresh by proactivity (CBC News, 2013). These reactions represent planned sustainability strategies, launched by the top managements of the affected companies. Any emergent strategy making happening at the same time would be expected to be pushed back by this rise of strategic planning.

Although both, planned strategy making and emergent processes contribute to the development of a sustainability strategy (Pestre et al., 2008) both kinds of strategy making may be problematic for wicked-and-salient problems. If a strategy for such a problem is planned it has a high likelihood of failure because the issue's complexity might not be adequately addressed. Yet,

if a strategy for such a problem is left to emerge, it might well take too long to address the problem in time and the strategy might be inadequate for communicating on the problem since emergent strategies are often only recognized as strategies in hindsight. Overall, as soon as strategic planning crowds out emergent strategies, the company runs the risk of the planned strategy failing to solve the problem which is not only a salient but also a wicked one. More problem-specific strategies are needed which are more likely to develop in an emergent way and locally. Therefore, it is argued that emergent strategy making has an important role to play in the case of type 4 problems. Planned strategies enable companies to react appropriately to a rise in salience but solely relying on planned strategies risks not addressing the problem. It is therefore proposed that sustainability problems that are both, wicked and salient are likely to be addressed by planned and emergent strategy making with planned strategy making dominating.

For type 1 problems, i.e. problems that are neither wicked nor salient, it is debatable if specific strategies will be observed. A simple problem that is not salient is more likely to be perceived as a non-problem for which strategy making is not necessary. The widespread use of chlorofluorocarbons (CFCs) before the 1970s serves as an example for a type 1 problem: it was neither a salient problem yet, nor was it wicked since the solution was relatively simple (Prins and Rayner, 2007; Sunstein, 2007). At that time, CFCs were a non-problem from a corporate perspective for which probably no strategy making happened.

To conclude this discussion, the limitations of the chapter are pointed out. While the nature of the problem has been introduced as a new influence factor on the mode of strategy making, it is expected that this factor will interact with the other factors discussed in the literature. Discussing these interactions is beyond the scope of this dissertation but represents promising areas for future research. For example, "an uncertain environment, which is also munificent (e.g. high growth industries in initial stages of industry evolution) is very different from an uncertain environment, which is far less munificent" (Elbanna, 2011, p. 21). This is an important point, implying that the nature of the problem alone cannot explain the strategy making mode used to address sustainability problems. Rather, it is proposed that the nature of the problem

complements other factors and should be considered in addition to the factors discussed above.

As another limitation, the time dimension is not considered. Sustainability strategy making is a dynamic process, hence, it is possible that planned strategy making becomes more emergent over time (Papagiannakis et al., 2013), or vice versa. It is also possible that some aspects of the strategy are more planned while others are more emergent at the same time (Slawinski and Bansal, 2012).

3.4 Theoretical contribution

In this chapter, two contributions are made. First, attention is drawn to an important gap in the sustainability strategy literature, namely the lack of consideration for the debate between the strategic planning school and the emergent strategy school. It is suggested that sustainability strategy research would benefit greatly if it recognized that sustainability strategies are not necessarily made in a planned way and that a more realistic understanding of sustainability strategy making can be obtained if the entire continuum from planned to emergent strategy making is taken into account.

Second, a new contingency factor is developed to explain how the nature of the problem influences the strategy making mode in the context of sustainability strategies. It is argued that in addition to the four sets of factors proposed by former studies, sustainability strategy making is affected by problem-specific factors, namely the wickedness and the salience of the sustainability problem to be addressed. While high levels of wickedness tend to elicit emergent strategies, high levels of salience increase the likelihood of planned strategy making.

The next chapter introduces the method of Action Research which is used in the empirical part of this dissertation. This method is particularly suitable for an exploratory research approach as the one needed in order to advance the understanding of strategy making in the sustainability research field. The new contingency factor that has been developed in this chapter is taken up again for the analysis of the Action Research study as described in chapter 5. Particularly, the implications of the empirical research for this new factor and for the theoretical propositions of this chapter are discussed in chapter 6.

Chapter 4

Action Research: A method of in-depth inquiry

"New theories, to influence practice, must be developed out of practice"
Westbrook, 1995, p. 13

In this thesis, Action Research is used as the main method of research which is introduced and discussed in this chapter (other methods, i.e. literature review and web survey, are discussed in the chapters in which they are used). Section 4.1 sketches out the epistemological underpinnings of Action Research by introducing the conventional, positivist approach to science and contrasting it with the constructivist point of view which forms the foundation of Action Research. The second section 4.2 provides a definition of Action Research and discusses its strengths and weaknesses. Section 4.3 is about conducting Action Research and introduces the particularities of the Action Research process, including the Action Research cycle and the dichotomy of goals, projects, and roles. One specific variant of Action Research, namely insider Action Research, is explained in more detail. In the fourth section 4.4, some general thoughts on the scientific rigor of Action Research are offered, followed by the development of the rigor criteria that are used in chapter 5 to assess the scientific rigor of the

Action Research study that has been conducted for this dissertation. Finally, section 4.5 offers a mid-way reflection about the match of the research question that is addressed by this dissertation and the choice of Action Research as a method.

4.1 Epistemological underpinnings

Action Research is discussed controversially because it is in stark contrast to the more conventional ways of doing research. The roots of this discussion lie in the divide between positivism on the one side and constructivism and Action Research on the other side with regards to their understanding of scientific knowledge (Susman and Evered, 1978). Even though Action Research fits the constructivist frame, it has been argued that it offers a new way of understanding knowledge creation that goes beyond both, positivism and constructivism (Reason and Torbert, 2001; Riordan, 1995). The two epistemologies are outlined and compared in the following.

4.1.1 The positivist perspective

The positivist understanding of research is based on a tradition that reaches back to pre-Socratic times (Checkland and Holwell, 1998). Checkland (1981) shows the basic principles of positivist science:

(1) *reductionism*: complex phenomena can be explained by simpler phenomena, i.e. by reducing them to their core content as far as possible;

(2) *repeatability*: studies must be repeatable without changes in results (quantitative measurement is preferred because quantitative results can be recorded and repeated more easily);

(3) *refutation*: scientific knowledge consists of all knowledge that has not yet been refuted.

Positivist science aims at finding objective, exact results and establishing universal laws that are valid independently of time, location, and the people involved in the research (Chandler and Torbert, 2003; Coghlan, 2011; Susman and Evered, 1978). By separating fact from value, science is supposed to become value-free (Riordan, 1995). For research to be objective, subjective and inter-subjective perspectives have to be excluded and researchers must be

neutral and detached observers. Positivist scientific knowledge is of a special quality because it is subject to public scrutiny in the sense that in principle, all results are testable and refutable by any other person who uses the same methods (Checkland, 1981). This is why this kind of scientific knowledge is regarded as the most valid and powerful knowledge (Checkland and Holwell, 1998).

Critics of positivist sciences argue that the separation of fact and value is an artificial one leading scientists to overlook "by far the greatest part of the variance in life" (Reason and Torbert, 2001, p. 3). Excluding subjective information and reducing complex systems to simpler sub-phenomena might be risky because potentially crucial data are disregarded. Indeed, the (positivist) social sciences struggle to generate universal laws and often fail to predict future developments (Riordan, 1995). Some even argue that the "positivist paradigm as a whole is misleading when applied to practice" (Reason and Torbert, 2001, p. 4).

Furthermore, the assumption that science can be independent of time, place, and people is challenged. Keynes is quoted saying that economics should not be treated as a "pseudo-natural science" because it is not "homogenous through time" (Checkland and Holwell, 1998, p. 11). Critics of positivism argue that this is true for all social sciences because they are *not* independent of time, place, and the researchers involved.

Additionally, positivist research is criticized for analyzing "particular predesignated questions" (Reason and Torbert, 2001, p. 6) out of academic curiosity rather than to help solve real-world problems, and for doing so in hindsight, i.e. after the activities under investigation have happened (Chandler and Torbert, 2003). The ability of such research to generate new insights is questioned.

Finally, it is argued that positivism is still largely unquestioned as the dominant paradigm. Hence, the majority of researchers follow the same logic which makes innovative, out-of-the-box insights rather unlikely, and might not yield results that are relevant for practice (Näslund, 2002).

4.1.2 Constructivism and Action Research

While positivist science seeks explanation, i.e. "to identify the relevant generalizations which cover the case to be explained" (Riordan, 1995, p. 7), construc-

tivist science aims at understanding and interpreting the meanings shared by a social group (Riordan, 1995). The core of constructivism is that reality is dependent on perception, hence researchers can only interpret it rather than unveil objective truths (Brannick and Coghlan, 2007). In this perspective on science, it is accepted that even a comment can be an intervention, contributing ideas and expectations into the processes under observation (Näslund, 2002; Riordan, 1995). Thus, researchers are not neutral but act as more or less active participants in the research they conduct.

The most common criticism of constructivism is that the research results it produces are rather arbitrary because they are difficult to repeat and thus hard to prove. However, constructivist researchers argue that their research does not aim at providing objective results and should therefore not be judged by positivist standards.

Action Research is based on constructivism and other philosophical foundations such as, inter alia, the Aristotelian concept of praxis, Hemeneutics, and critical theory (Coghlan, 2011; Susman and Evered, 1978). It attempts to bridge the gap between scientific theory and organizational practice by getting involved in both and contributing to both (Coghlan and Brannick, 2005). Action Research is not value-neutral but considers both, fact and value, together (Riordan, 1995). Indeed, action researchers pursue a normative claim by deliberately attempting to influence and change organizational practice for the better. Tensions that may arise in this balancing act are embraced and openly discussed.

In contrast to other epistemologies, Action Research explicitly acknowledges all kinds of knowledge, including tacit knowledge (Argyris, 1976; Ballantyne, 2004) and practical knowledge (Reason and Torbert, 2001; Susman and Evered, 1978) without judging one kind of knowledge as being more scientific or worthy of research than another. In this way, Action Research has a knowledge base that is much broader than that considered by other methods. Accordingly, Action Research aims at contributing not only to scientific but also to tacit and practical knowledge (Brannick and Coghlan, 2007; Coghlan, 2011; Eden and Huxham, 1996b; Reason and Torbert, 2001). Knowledge is generated from experience and through dialogue between researchers and practitioners (Ballantyne, 2004). In this process of knowledge generation, different kinds of learning play a role. Learning is understood as learning from

each other rather than learning from experts (Zuber-Skerritt, 2002b). Two kinds of learning are distinguished: the first is single-loop learning which does not question the goals and activities of the organization. Beyond that, Action Research aims at enabling double-loop learning where underlying assumptions are questioned (Argyris, 1976, 1995).

Finally, it might be interesting to note that Action Research studies often aim at empowering the participants by helping them gain access to knowledge and tools which they may keep using after the research project is finished.

What is described above as the epistemological basics of Action Research is "outside the paradigmatic scope of positivism that dominates much of the management sciences" (Ballantyne, 2004, p. 333). In fact, many scholars contrast Action Research with positivist science and suggest it as a future-oriented, collaborative, and situational alternative (Susman and Evered, 1978; see also Coghlan, 2011; Coughlan and Coghlan, 2002; Friedman and Rogers, 2009). The most important differences between the positivist paradigm and the Action Research paradigm are summarized in table 4.1.

4.2 Understanding Action Research

Action Research is a qualitative research method where the generation of scientific knowledge and the involvement in a social or organizational change process are of equal importance, and are pursued concurrently. Action Research was developed by Lewin who, after World War II, sought to democratize social science by emphasizing the involvement of all participants (Dickens and Watkins, 1999).

4.2.1 Definition and characteristics

Because of a growing gap between theory and practice, many scholars express concern that academic research does not provide the results needed to address the real-world problems faced by practitioners (Argyris and Schön, 1974; Schultz and Hatch, 2005; Susman and Evered, 1978; Westbrook, 1995). Reason and Torbert (2001) argue for an 'action turn' in science that enhances the value of practical knowledge. Research after such an action turn "aims

Table 4.1: Contrasting Action Research and positivism (based on Chandler and Torbert, 2003; Coghlan, 2011; Dickens and Watkins, 1999; Susman and Evered, 1978)

Unit of comparison	**Positivism**	**Action Research**
Aim of research	Studies few specific variables	Considers entire system in its natural environment
Type of knowledge acquired	Universal law	Particular, situational knowledge
Time perspective	Analysis of mostly past events	Aims at considering past, present, and future
Nature of data	Quantitative or qualitative	Qualitative
Validation	Logical consistency, prediction, control	Evaluate whether actions produce intended consequences
Role of researcher	Detached, neutral observer	Involved participant
Relationship with setting	Participants are subject to study	Participants are co-researchers
Language	Third person, objective	First, second, and third person, ranging from personal to impersonal

at timely, voluntary, mutual, validity-testing, transformative action at all moments of living" (Reason and Torbert, 2001, p. 6). Similarly, Schultz and Hatch (2005) call for a 'shift in logic': instead of building management practice from theory, management theory should be built from practice. The logic behind this is that human systems can only be understood if one is involved (Coghlan, 2011). Accordingly, researchers who want to understand how organizations work need to spend time within these organizations in order to gain an insider perspective of what is really happening in practice (Friedman and Rogers, 2009; Näslund, 2002). Action Research is suggested as an appropriate method to do exactly that.

One of the most frequently quoted definitions of Action Research reads as follows: "Action research aims to contribute *both* to the practical concerns of people in an immediate problematic situation and to the goals of social

science by joint collaboration within a mutually acceptable ethical framework" (Rapoport, 1970, p. 499, emphasis in original). The strength of this definition is the emphasis on the co-existence of the two equally important goals of Action Research, action and research. Another definition is suggested by Coughlan and Coghlan who state that Action Research is: "research *in* action rather than *about* action, participative, concurrent with action, a sequence of events and an approach to problem solving" (Coughlan and Coghlan, 2002, p. 222, emphasis in original). Finally, it is also worth noting that "Action research in all its forms is a long-term, evolutionary, emergent form of inquiry" (Bradbury and Reason, 2001, p. 453). Based on these definitions and on other research (including Coghlan and Brannick, 2005; Eden and Huxham, 1996b; Friedman and Rogers, 2009; Herr and Anderson, 2005; Susman and Evered, 1978), Action Research shall be understood for the purposes of this dissertation as comprising the four elements listed in table 4.2.

Table 4.2: Action Research definition

Theory	The research is based on and contributes to theory.
Action	The research project addresses a problem that is relevant for practice and aims at creating enduring organizational change.
Method	The research process takes shape as a spiral of Action Research cycles.
Team work	A team of practitioners and researchers works on the research project collaboratively.

The first element of the Action Research definition is theory. It is chosen as the first element in order to counter-act the common criticism that Action Research does not sufficiently contribute to theory and in order to emphasize the scientific nature of Action Research. Hence, good Action Research is grounded in scientific theory, i.e. the research question it addresses stems from theory and is of interest to theory. Furthermore, Action Research must contribute to scientific theory by creating theoretical knowledge that advances the state of the research.

Second, Action Research requires an action component where the researcher is actively involved in the change process under investigation as a participant

who deliberately influences this process. This implies that the results of the Action Research are relevant to the context of the involved practitioners; the project aims at creating enduring organizational change; and it contributes to the empowerment of participants by providing them with tools to analyze the current situation in its context and to bring about the desired change.

Third, Action Research is conducted on a currently ongoing change process and it does not follow a linear path but moves back and forth between action and reflection in a cyclical process. This process is called the Action Research cycle with its five steps problem definition and planning, data gathering and project work, data analysis, taking action, and evaluation and reflection (described in more detail in section 4.3.1). Research teams go through various Action Research cycles which is often illustrated by a spiral of one cycle feeding into the next.

Fourth, Action Research means team work. An action researcher is not a neutral observer, but rather an active participant who deliberately influences the activities of the group in which he or she is involved (Avison et al., 1999; Eden and Huxham, 1996b; Westbrook, 1995). This group is called the Action Research team and consists of researchers and practitioners who work on the project collaboratively. Action Research enables all those involved in it to learn from each other and to develop further their own and the organizational knowledge (Chandler and Torbert, 2003; Zuber-Skerritt, 2002b). The most important defining aspect of Action Research, which also sets it apart from most other research methods, is that Action Research consists of two parts and pursues two equally important goals at once. This implies that the first and the second element of this definition are inextricably linked and, indeed, mutually dependent: theory is created from practice, and practice is influenced by theoretical knowledge.

The main goal of Action Research is to provide "accessible and useful tools for practitioners, academics, and other participants in action research" (Friedman and Rogers, 2009, p. 32). Indeed, the goals pursued by Action Research are always twofold, on the one hand advancing an (organizational) change process, on the other hand contributing to scientific theory.

A variety of Action Research approaches exists, including insider Action Research (see section 4.3.2 on page 62), participatory Action Research (see, e.g., Whyte, 1991), action science (see, e.g., Argyris and Schön, 1974, 1991;

Riordan, 1995), and action learning (see, e.g., Argyris, 1976; Zuber-Skerritt, 2002b). For an overview of various types of action-oriented research, see Coghlan (2011); Coghlan and Brannick (2005); Dick (2002) or Dickens and Watkins (1999).

4.2.2 Advantages and drawbacks of Action Research

Action Research is a promising method to address social science research questions that require an understanding of practical contexts and that address organizational or social change (Friedman and Rogers, 2009). The main advantage of Action Research is that it enables researchers to gain in-depth insights into organizational processes that cannot be understood this deeply with other methods such as case studies or interviews where the interaction with practitioners is limited to a few hours. In Action Research, a broader range of information are covered, including subjective data such as personal opinions or data about relationships between participants, and sensitive data such as information on informal processes. Some conclude that Action Research meets the criteria of scientific rigor better than other social sciences because, first, it is able to timely test the generated knowledge in action (Brydon-Miller et al., 2003; Coghlan, 2011) and, second, the people doing the tests are interested in the outcomes and might therefore be more dedicated to relevance, social change, and validity (Brydon-Miller et al., 2003). Action Research sets out to offer solutions to practical and theoretical problems. Beyond that, it might bring a solution to the stalemate in the debate between positivists and constructivists by offering a new way of doing science which accounts for fact and value equally (Riordan, 1995).

However, Action Research is not always an appropriate method. Because Action Research generates subjective knowledge that is, by definition, not generalizable, thorough documentation and in-advance explanation of epistemology and methodology are required in order to make it at least 'recoverable' (Checkland and Holwell, 1998). Furthermore, to gain the insider insights that Action Research promises, researchers need to spend a considerable amount of time in the organization under investigation. These two points lead to Action Research studies being more time-consuming than most other methods. When the time frame of a research project is very limited, e.g. in research projects of

a few months' duration, Action Research is probably not a good choice. Another aspect is that Action Research is very localist and often struggles to deal with larger-scale change processes (Brydon-Miller et al., 2003). This makes it inappropriate for questions addressing large units of analysis or broad trends. And of course, positivist and quantitative questions where social relations or emerging trends are not relevant might not have much to gain from Action Research either.

4.3 Doing Action Research

Putting Action Research into practice is a process of interest itself to action researchers, and differs from putting into practice other qualitative methods because participants are involved from the very beginning. Researchers need to carefully plan their Action Research study in order to make the process as transparent as possible and need to keep reflecting the process while it is happening to be able to make changes if needed.

4.3.1 The Action Research process

Lewin defines cycles of action and reflection through which researchers should go in a "spiral of steps, each of which is composed of a circle of planning, action and fact-finding about the result of the action" (Lewin 1997, p. 146, as cited by Coghlan, 2011, p. 61). For this dissertation, Action Research cycles are defined as comprising the following five steps:

1) problem definition and planning, i.e. choosing and planning the goal and direction of the Action Research cycle at hand by defining questions to be answered (reflection);

2) data gathering and project work, i.e. working with the team on the defined questions (action);

3) data analysis, i.e. desk analysis of the collected data, and action planning, i.e. preparing for the implementation in practice (reflection);

4) taking action, i.e. putting into practice the results of the previous steps (action); and

5) evaluation, i.e. evaluating data and action in context (reflection) which eventually leads into the next cycle.

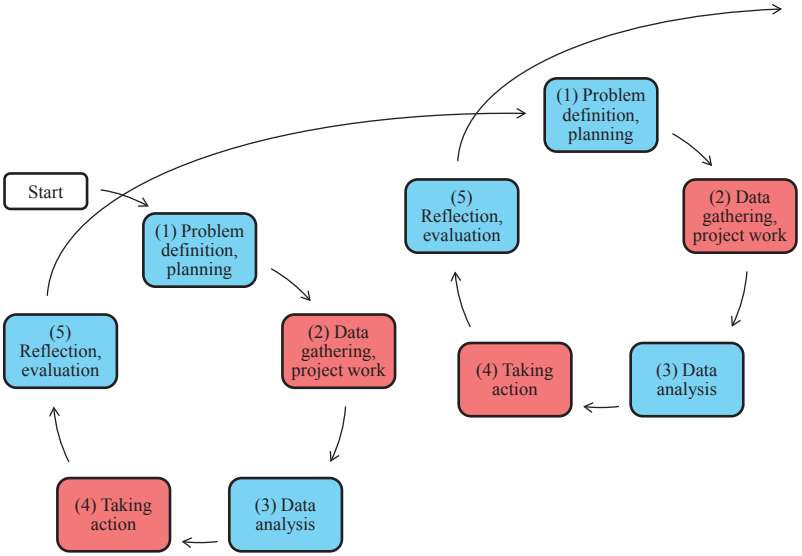

Figure 4.1: The spiral of Action Research cycles, inspired by Zuber-Skerritt (2001) and Coughlan and Coghlan (2002)

Going through Action Research cycles is a process that is often illustrated by a spiral where one Action Research cycle feeds into the next as illustrated in figure 4.1 (in the figure, blue indicates steps of reflection while red marks the steps of action). In the AR cycle, action and reflection take turns which shows that researchers move back and forth between analyzing at their desks (reflection) and actively collaborating with the team members (action). In this way, input from practice can be used for theory building, and theory can be developed, used, and tested in practice. Such a cyclical process allows for adaptation and flexibility, i.e. for re-assessing the data and re-formulating the problem several times if needed (Dickens and Watkins, 1999).

As noted before, Action Research is shaped by the dichotomy of action and research. Because Action Research pursues two goals at once, namely creating scientific knowledge and engaging in a change process, action researchers move

back and forth between these two when going through the Action Research cycle. Furthermore, action researchers have two parallel projects: the core Action Research study which is of interest to the organization, and the thesis project which is of interest to academia (Coughlan and Coghlan, 2002). The core project consists of the active collaboration with practitioners which is mainly motivated by practical needs. The thesis project is about writing down and disseminating the results of the Action Research to the academic audience and is motivated by scientific interest. In order to avoid getting trapped in a conflict of interest, these two projects need to be distinguished. It is recommended to communicate clearly that the "thematic concern", i.e. the goal or focus of the one project might not be the same as that of the other project (Zuber-Skerritt and Perry, 2002).

4.3.2 Insider Action Research

Because insider Action Research is the chosen method for this dissertation, it is discussed in more detail here. Insider Action Research is a variant of Action Research defined as "research by complete members of organizational systems and communities in and on their own organizations" (Brannick and Coghlan, 2007, p. 59). Insider action researchers are not only actively involved in the organizational change process, they are also full members of the organization under investigation. In addition, insider researchers are also *researchers* of change processes happening in their organizations (Coghlan and Brannick, 2005; Herr and Anderson, 2005). Insider Action Research enables a close and longitudinal cooperation between the project team and the researcher in which he or she accompanies an ongoing change process over a certain period of time. Insider Action Research offers particular advantages and suffers from specific drawbacks that are distinct from the general strengths and weaknesses of Action Research.

The most obvious advantage that is even more true of insider Action Research than of general Action Research is the depth of understanding that can be obtained and that is "denied to more objective methods" (Westbrook, 1995, p. 9). By being full members of the organization, researchers speak the same language as their colleagues and are likely to enjoy a higher level of trust than outsider researchers (Ballantyne, 2004). Insider Action Research allows

a researcher to be "significantly less intrusive on practitioners than with most other research approaches because the researcher has a legitimate reason for being involved that is independent of the immediate research aims" (Huxham and Vangen, 2003, p. 395).

Yet, conducting insider Action Research can present researchers with various challenges. First, insider researchers have a pre-understanding that might get in the way of a more neutral perception – they are too close to be objective. Whether such a pre-understanding is an advantage or a problem is debated. Brannick and Coghlan (2007) emphasize the advantages of 'going native' as allowing researchers to fully understand the perspective of the organizational members. In contrast, Johnson et al. (1999) argue that researchers can get under pressure to be useful to the organization and might thus be forced to give up their outsider understanding of the situation that might well differ from that of the organizational members. Because insider Action Research should be conducted in close cooperation with a team that regularly gets together in seminars, workshops, or team meetings over an extended period of time (Schultz and Hatch, 2005), a certain extent of 'going native' is unavoidable and might even be necessary. Ideally, insider researchers combine the advantages of both, the neutral outsider's perspective and the insights of the involved insider (Roth et al., 2007).

The second, related, problem is that tension is likely to arise between the two roles of the researcher (researcher versus insider) (Brannick and Coghlan, 2007; Coghlan and Brannick, 2005; Roth et al., 2007; Westbrook, 1995). Researchers need to be able to enter into the value systems of the organization and at the same time challenge organizational goals (Riordan, 1995). Not reflecting the role of the researcher means implicitly assuming that he or she is a neutral observer (Johnson et al., 1999) which fits a positivist approach but not a constructivist or Action Research perspective. Beyond that, there is an imbalance between these two roles: the quality of the research depends on the quality of the action whereas the action is relatively independent of the research agenda (Huxham and Vangen, 2003).

A first step in dealing with this problem of role duality is to make it explicit through transparent documentation of the research project. In addition to such self-reflectivity, validation meetings with research participants and discussions

with critical friends are good ways to address role duality, and more generally the problem of bias (Herr and Anderson, 2005; McNiff and Whitehead, 2009).

Third, tensions between researchers and practitioners can arise in insider Action Research because practitioners need to react to problems immediately whereas researchers wait for data interpretation to be complete (Chavis et al., 1983). Five problem areas are defined as being particularly critical, these are: (1) differences in values; (2) availability of resources and skills to cooperate with practitioners; (3) the need for the researcher to give up control to practitioners who participate in the research; (4) political aspects that researchers as outsiders do not understand; and (5) academic rewards and costs of collaborating with practitioners who are not interested in the academic but only in the practical outcomes (Chavis et al., 1983). Israel et al. (1992) show how they address each of these problem areas in their Action Research study by actively involving the practitioners who participate in their research.

Finally, insider researchers need to deal with organizational politics to a greater extent than outsider researchers. These internal politics need to be understood, considered, and managed because they might have tremendous influence on the success or failure of the research project (Brannick and Coghlan, 2007; Coghlan, 2011; Roth et al., 2007).

4.4 The scientific rigor of Action Research

Why are action researchers under such pressure to justify their method? The main reason is that it is difficult for Action Research to comply with common rigor criteria. Since Action Research does not fulfill the requirements of the mainstream social sciences, it has "been at pains to insist on the scientific nature of its own endeavours" (Riordan, 1995, p. 11). The concept of rigor has its roots in the natural sciences and hence in a positivist tradition. It has been adapted to qualitative methods where criteria of scientific rigor have been established as well but there are no equivalent, commonly accepted criteria for Action Research. They are sorely missed because neither quantitative nor qualitative quality criteria are helpful for judging the scientific rigor of Action Research (Koplin, 2006).

4.4.1 General thoughts on rigor in Action Research

Common criteria for scientific rigor in qualitative research include construct validity (using the correct measures), internal validity (establishing a causal relationship), external validity (generalizability), and reliability (the study can be repeated by other researchers) (Stuart et al., 2002). These criteria are most helpful for assessing the scientific rigor of many types of social science studies, especially if they are based on a positivist perspective. They are less helpful for assessing Action Research which is per definitionem neither generalizable nor repeatable, and does not aim at establishing universally valid causal relationships. The topics of social or organizational change addressed by Action Research are subject to change induced by time, place, and the involved researchers. "[S]ince social phenomena are mental abstractions at a meta-level to their manifestations, even thinking and arguing about them can change them!" (Checkland and Holwell, 1998, p. 11). Thus, conventional criteria of scientific rigor do not apply to Action Research.

Action Research analyzes events currently happening in real organizations which leaves researchers with little control over the situation. The result is "an unfolding story [that is] not possible to control or predict" (Coghlan, 2011, p. 54). Rather, researchers "may be privileged to share the journey" (Grant, 2007, p. 268). Action researchers do not aim at explaining phenomena but at understanding meaning (Coghlan, 2011; Friedman and Rogers, 2009) which is an important distinction with regards to the researchers' roles: they are not to impose their interpretations on their subjects of study but rather attempt to enable a collaborative learning experience for all involved. In line with Stuart et al. (2002), the method of using singular cases as it is done in Action Research "is often chosen to identify a relationship or effect, not to describe an average effect; hence cases often are not aimed at being representative, but rather exemplary" (Stuart et al., 2002, p. 426).

In Action Research, generating value for practitioners is part of the research activity. The oft-cited Lewin quote might be worth repeating here: "If social scientists truly wish to understand certain phenomena, they should try to change them. Creating, not predicting, is the most robust test of validity-actionability" (cited in Kaplan, 1998, p. 89). This is the logic behind Action

Research which helps understand the way in which action researchers make their contributions to knowledge.

In the words of Eden and Huxham (1996a, p. 76), "good action research will be good science though not in a way which depends necessarily on meeting all the tenets of traditional scientific method". Many have argued therefore that action researchers need to develop their own criteria of judgment that fit their individual pieces of research (Bradbury and Reason, 2001; Connelly and Clandinin, 1990).

4.4.2 Rigor criteria for Action Research

The remainder of this section is dedicated to developing the criteria that are used to evaluate the rigor of the Action Research presented here. Many authors have proposed frameworks and checklists to guide action researchers. Two of these propositions are briefly summarized as examples for two perspectives on rigor in Action Research.

Two exemplary frameworks

Chandler and Torbert (2003) define a three-dimensional matrix to describe the reality that research can investigate. The first axis is the time axis on which three modes are situated: research addressing the past, the present, and the future. The second axis has three kinds of voice, namely the researcher's own subjective voice (first person), an inter-subjective voice involving other research participants (second person), and the anonymous and impersonal voice of the third person which is usually used in scientific writing. On the third axis, research can cover first-, second-, and third-person practice. First-person practice means the activities of the researcher, second-person practice is the interaction between participants, and third-person practice describes the activities of various, potentially unrelated people. Chandler and Torbert (2003) point out that conventional positivist-empiricist research barely covers two of these 27 modes: events that happened in the past, and research conducted in a third-person voice. The practice dimension is not covered at all. In contract, Action Research is principally capable of covering all research modes and its quality can be assessed based on the degree to which it succeeds in addressing a variety of modes.

A second framework is put forward by Bradbury and Reason (2001) who suggest five choice points that can help assess the quality of Action Research. These concern: 1) the quality of relationships, i.e. the degree to which everyone involved is free to participate; 2) the practical outcomes, i.e. the contribution of the Action Research to improving practice; 3) extended ways of knowing, i.e. reasonable choice of theory, various ways of communicating research results, and engaging with others to discuss and question the results; 4) purpose, i.e. reflecting on what makes the research question worthwhile; and 5) enduring consequence, i.e. the emergence of new and enduring routines. Although Bradbury and Reason (2001) and Coghlan and Brannick (2005) stress that these choice points are not comprehensive and should not be understood as a list of criteria that every Action Research study needs to fulfill, they explicitly invite PhD students to use them to assess the strengths and weaknesses of their research. Therefore, the criteria developed below are informed by these two frameworks, inter alia.

Criteria deduced from definition

Recall the four elements of Action Research (see table 4.2 on page 57): 1) Theory: the research is based on and contributes to theory; 2) Action: The research project addresses a problem that is relevant for practice and aims at creating enduring organizational change; 3) Method: the research process takes shape as a spiral of Action Research cycles; 4) Team work: A team of practitioners and researchers works on the research project collaboratively. The rigor of an Action Research study can be assessed by asking whether or not it fulfills the expectations raised by this definition, i.e. whether or not it is theoretical, actionable, methodical, and team-oriented.

Theory. An Action Research study is theoretical, i.e. fulfills the first criterion 'Theory', if first, it is based on theory (Bradbury and Reason, 2001; Eden and Huxham, 1996a,b). This implies that the research question addressed in the thesis project is taken from scientific theory and not from the needs of the practitioners involved and is of interest to the field of research. Second, answering the research question must be a relevant contribution to theory and enhance the state of the art in this research field (Coghlan and Brannick, 2005; Eden and Huxham, 1996a,b; Friedman and Rogers, 2009; Herr and Anderson,

2005; Huxham and Vangen, 2003; Schultz and Hatch, 2005; Westbrook, 1995; Whitehead and McNiff, 2006).

Action. The second criterion includes that, first, the core project addresses a question that is relevant for the practitioners involved (Brydon-Miller et al., 2003; Herr and Anderson, 2005). Second, it needs to contribute to improving practice and empowering the practitioners by providing them with knowledge or tools that they can use after the project is finished (Friedman and Rogers, 2009; Herr and Anderson, 2005; Reason and Torbert, 2001). Hence, the Action Research should aim at creating long-term improvements or enduring organizational change (Bradbury and Reason, 2001; Coghlan and Brannick, 2005).

Method. The third criterion requires that, not least for justifying its scientific nature, the Action Research study needs to be carried out in a systematic and logical way so that the steps that are taken can be understood by people outside the project (Eden and Huxham, 1996b; Herr and Anderson, 2005). This requires thorough documentation and appropriate communication in order to make the research accessible to the relevant research field, to the practitioners involved, and to all other parties that might be interested in the outcomes (Bradbury and Reason, 2001; Eden and Huxham, 1996b; Whitehead and McNiff, 2006). Furthermore, the basic epistemological assumptions of the research must be disclosed (Checkland and Holwell, 1998). This requires considering different viewpoints and positioning one's own research. Third, the research team should go through a spiral of several Action Research cycles (Coghlan, 2011; Coghlan and Brannick, 2005; Eden and Huxham, 1996b). The amount of cycles research teams go through is not set but it should be a sufficient number to enable a hermeneutic spiral. Fourth, the project must be reflective, i.e. challenge opinions held by those involved (Bradbury and Reason, 2001; Coghlan and Brannick, 2005; Friedman and Rogers, 2009; Johnson et al., 1999). One way of doing this is involving different people with potentially contradicting perspectives to critically engage with each other. Beyond that, reflectivity requires considering first-, second-, and third-person research, i.e. the personal reflections of the researcher, inter-subjective exchanges between participants and the researcher, and more distanced descriptions of actions taken by various people involved in the research (Chandler and Torbert, 2003; Reason and Torbert, 2001). Furthermore, a "plurality of knowing" is embraced in the sense that different kinds of knowledge are acknowledged and explicitly

taken into account (Bradbury and Reason, 2001). Finally, the research project should be sensitive to time, i.e. consider the past, present, and future context of the practitioners involved (Chandler and Torbert, 2003; Eden and Huxham, 1996b; Susman and Evered, 1978).

Team work. Action Research studies involve a considerable amount of team work which is accounted for by the fourth criterion. This can be tested by asking whether the researcher is actively engaged in the organizational change process taking place (Avison et al., 1999; Eden and Huxham, 1996b; Westbrook, 1995). Second, also all other team members should actively participate in all phases of the project (Bradbury and Reason, 2001; Eden and Huxham, 1996b).

Table 4.3: Rigor criteria for Action Research

Criterion	#	**Rigor question**	**References**
Theory	1.1	Is the Action Research study grounded in scientific theory?	Bradbury and Reason (2001); Eden and Huxham (1996a,b)
	1.2	Does it contribute to theory?	Coghlan and Brannick (2005); Eden and Huxham (1996a,b); Friedman and Rogers (2009); Herr and Anderson (2005); Huxham and Vangen (2003); Schultz and Hatch (2005); Westbrook (1995); Whitehead and McNiff (2006)
Action	2.1	Are the results of the Action Research study relevant to the context of the involved practitioners?	Brydon-Miller et al. (2003); Herr and Anderson (2005)

Criterion	#	Rigor question	References
	2.2	Does the Action Research study contribute to improving practice and to enduring organizational change?	Bradbury and Reason (2001); Coghlan and Brannick (2005); Friedman and Rogers (2009); Herr and Anderson (2005); Reason and Torbert (2001)
Method	3.1	Is the methodological approach systematic and well documented?	Bradbury and Reason (2001); Eden and Huxham (1996b); Herr and Anderson (2005); Whitehead and McNiff (2006)
	3.2	Are the epistemological underpinnings clear?	Checkland and Holwell (1998)
	3.3	Did the research team go through a spiral of Action Research cycles?	Coghlan (2011); Coghlan and Brannick (2005); Eden and Huxham (1996b)
	3.4	Is the project reflective?	Bradbury and Reason (2001); Chandler and Torbert (2003); Coghlan and Brannick (2005); Eden and Huxham (1996b); Friedman and Rogers (2009); Johnson et al. (1999); Reason and Torbert (2001); Susman and Evered (1978)
Team work	4.1	Is the researcher actively involved in the change process?	Avison et al. (1999); Eden and Huxham (1996b); Westbrook (1995)

Criterion	#	Rigor question	References
	4.2	Are all members of the Action Research team actively involved in all phases of the Action Research study?	Bradbury and Reason (2001); Eden and Huxham (1996b)

If the research project is rigorous, the responses to the four sets of questions displayed in table 4.3 on page 69 should be precise and understandable. This does not mean that all questions need to be answered in the positive, indeed this might be impossible. Instead, the researcher must show that he or she has paid due attention to each rigor question and explain why some criteria might not be fulfilled. Assessing the rigor of one's own study requires comprehensive documentation of the research process. Also the process of assessing the research should be documented in order to make the study transparent and intelligible. Thereby, a critical reflection on whether the criterion could have been fulfilled if the research project had been carried out differently and whether this would have resulted in a better research outcome is called for.

In section 5.4 on page 117, this is done for the Action Research study that has been conducted in the context of this dissertation.

First-voice comment[3]**:** In the beginning of the Action Research study in 2011, I defined four criteria of scientific rigor based on a literature review. They were 'being based in theory', 'action orientation', 'systematic methodology', and 'active involvement of the entire team'.
In the process of writing this chapter, I realized that the most plausible way of generating project-specific rigor criteria would be to ground them in the Action Research definition because this would ensure that the research project fulfills the expectations that it raises, i.e. it is case-specific. After many changes, the criteria started to resemble the old criteria and finally turned out quite similar to those developed in the beginning. I take this as an encouragement in the sense that my final set of validity criteria is in line with the validity criteria suggested by many other and more experienced action researchers.

[3]First-voice comments are used in this dissertation to allow a few glimpses into the first-person research that has not been the research focus but which definitely took place as well. Since many authors stress the importance of accounting for first-person research (Chandler and Torbert, 2003; Coghlan, 2011; Fisher and Phelps, 2006; Reason and Torbert, 2001), these

4.5 Mid-way reflection

Chapters 2 and 3 have provided the theoretical foundation for addressing the research question of this dissertation, and chapter 4 has discussed the chosen methodological approach. In the middle of the document, a moment is taken to pause and reflect on the match of the research question and the method.

The research question of this dissertation addresses an organizational change process: the formation of sustainability strategies. Since sustainability is a complex issue on which, as argued in chapter 2, various views can exist within one organization, sustainability strategy making is expected to be a very complex and long-term process. As shown in chapter 3, scientific knowledge about how sustainability strategies are made in companies is limited as it is widely assumed that such strategies are exclusively planned and implemented top-down.

In the beginning of the research, cases inside the company were sought for the empirical study of sustainability strategy making. As no ongoing processes of sustainability strategy making were detected it seemed a promising approach to not only observe but also to initiate and support such a process. The one research method not only allowing but explicitly requiring an active involvement of the researcher is Action Research. Like no other method, Action Research enables this researcher to take full advantage of the situation of being an industry-sponsored PhD candidate with an insider understanding and the same access rights as any other employee.

Furthermore, Action Research is very well-suited to address the research question and the research setting of this dissertation for the following three reasons. First, it allows addressing research questions in great depth and with a longitudinal research design because the researcher is an active participant of a team collaborating on the issue at hand. Therefore, he or she can spend far more time on the empirical investigation than other methods would permit. Furthermore, he or she can consider a wide range of different kinds of information, including subjective and sensitive data, which can enable a more comprehensive view. This is particularly useful for the complex and long-term organizational phenomenon of strategy making that is under investigation here.

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short comments are used as a way of integrating the first voice as a deliberately subjective, personal note.

Second, Action Research is an exploratory method that does not aim at measuring pre-defined constructs but rather at understanding practice inductively. Action Research serves to find patterns of people's actions and interactions over time in an unobtrusive way. This makes it appropriate for a research question on which knowledge is still largely amiss as is the case for the subject area of sustainability strategy making.

Finally, Action Research enables the researcher to advance both, theoretical knowledge and corporate practice, and therefore to complement his or her scientific understanding of the problem with a well-grounded empirical view. This is advantageous for a topic such as corporate sustainability strategy making which is, first and foremost, an empirical phenomenon.

At the end of this mid-way reflection, it is argued that Action Research is a very good methodological fit for the research question and the setting of the dissertation project. The following chapters present the Action Research study that has been conducted for this dissertation (chapter 5) and discuss its implications for both, theory and practice (chapter 6). The main points and implications as well as next steps for research and practice are taken up in the conclusion (chapter 7).

Chapter 5

Research findings: Sustainability strategy making in action

"Fruitful interaction between research and practice requires a longitudinal relationship to experience first-hand the shifts and ongoing dynamics."
Schultz and Hatch, 2005, p. 344

This chapter presents the findings from the Action Research study that has been conducted between 2011 and 2014. The first three sections describe the three phases through which this study has gone: the orientation, cooperation, and evaluation phase. The orientation phase (section 5.1) served to define the research goals and to prepare for the cooperation phase which is the core of the Action Research study. During the orientation phase, it became clear that the empirical part of this dissertation would address strategy making at an innovation project. In order to find a partner project at the company, a range of discussions took place with managers at Bosch who recommended 11 projects (project search). A second round of meetings took place with the heads of these projects (project selection) which was concluded with the decision for one innovation project. Section 5.1 describes the purpose of the study, the unit of analysis, ethical considerations, and a detailed description of the sequence of events that took place during this phase.

The core of the Action Research study was the cooperation phase (section 5.2) in which the researcher worked in cooperation with the partner project on a project-specific sustainability strategy. During this phase, two focus topics emerged on which the team decided to focus the sustainability strategy making efforts. These were a sustainability assessment of materials to be used (topic I) and the potential negative impacts on biodiversity (topic II). The events that took place for each focus topic and the patterns of these strategy making processes are described in section 5.2.

Finally, the evaluation phase is described in section 5.3. During this phase, there was sporadic contact between the innovation project team and the researcher. The researcher analyzed the data that had been generated during the cooperation phase and linked it back to the theoretical foundation of chapter 3. In section 5.3, the approach and method of data analysis is described as well as the triangulation efforts that were made in this phase. The results and interpretations of the data analysis follows in chapter 6.

After the three phases of the Action Research study have been described in detail, section 5.4 performs a rigor check of the Action Research study and shows that all of the criteria of scientific rigor defined in chapter 4 are addressed.

5.1 The orientation phase

This section covers the beginning of the Action Research study, i.e. the orientation phase. The orientation phase of the Action Research study included the search for partner projects at the company and the selection of one innovation project. It contained several meetings that took place between April and December, 2011.

Before the orientation phase, the idea to research strategy making at the project level and to conduct an Action Research study was inspired by two PhD seminars at Queen's University Belfast in December, 2010, and February, 2011. In spring 2011, the orientation phase began with the search for an appropriate partner project within the company. As a first step, ten meetings took place with different people who were assumed to have an overview of the innovation projects running at the company (project search). As a second

step, 20 interviews took place with nine of the eleven recommended projects (project selection). With the help of these meetings, a final decision for one innovation project was reached by the end of the year 2011.

5.1.1 Research design and purpose of the study

Drawing on Huxham and Vangen (2003), three choices can be made for the research design regarding overtness, visibility of data collection, and risk level. First, this Action Research has been very overt in the sense that the research agenda has been communicated overtly with the participants and it has been made clear that the researcher has a personal interest in the Action Research study as it is part of her PhD.

Second, data collection throughout the cooperation phase has been practically invisible since the data set is drawn from protocols, event- or project-related files such as presentations that were used during meetings, general notes, entries in the reflective diary, calendar items, and e-mails. No intrusive methods of data collection (e.g. video taping) were used, hence there should not have been any negative impacts on participation from the visibility of data collection.

Third, the risk of failure has been larger for the project than for the dissertation. To explain this, the purpose of the study is defined a little more elaborately, drawing on the distinction between the core project and the thesis project (Coughlan and Coghlan, 2002; Zuber-Skerritt and Perry, 2002). In both the core and the thesis work, candidates are involved in groups of either co-workers or researchers but the "thematic concern" (Zuber-Skerritt, 2002a) can be different in the two projects. This has been the case here: The core project, i.e. the Action Research study that was carried out in cooperation with practitioners, aimed at helping the project members develop an understanding of sustainability and to get under way a project-specific sustainability strategy. In contrast, the thesis project, i.e. the dissertation presented here, has aimed at contributing to understanding sustainability strategy making with the help of a theory-based conceptual approach (see chapters 3 and 6) as well as an empirical approach (the Action Research study). Thus, the purpose of the Action Research study is to advance both, the core and the thesis project, by improving corporate practice with regards to sustainability and by creating relevant

knowledge on the formation of corporate sustainability strategies. While the goal of the core project, i.e. developing a lasting sustainability strategy for the partner project, might have been missed, the goal of the thesis project, i.e. observing how a sustainability strategy might (or might not) have come about, could still be achieved. This explains why the level of risk associated with the core project was higher than that of the thesis project.

5.1.2 The Action Research study put in context

This section serves as a short reflection about the context in which the innovation project was embedded. Naturally, the cooperation phase covered only a fraction of the life time of the innovation project which takes several years (from the idea via the so-called 'research process' through to the end of the 'development process'). Although 14 months is a rather long period to be researched by a PhD dissertation, this means that the results of the analysis only represent this specific period and cannot be generalized to other stages of the project.

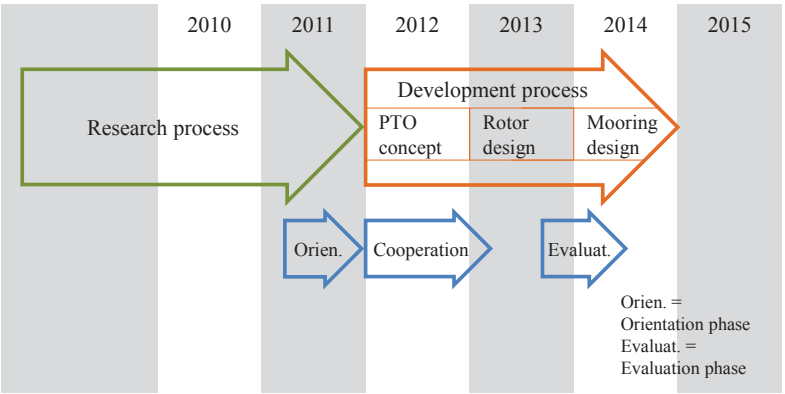

Figure 5.1: The project time line

In parallel with the cooperation phase, other processes have been taking place and sometimes overlapped with it. Most importantly, the project has been going through the company-specific innovation process, consisting of the 'research process' which focuses on the theoretical proof of concept and the

'development process' which aims at making the product ready for the market. At the beginning of the cooperation phase of the Action Research study, the innovation project had just entered the development process.

The project time line is visualized in figure 5.1. The green arrow symbolizes the research process which the innovation project was about to complete during the orientation phase of the Acton Research study. The orange arrow stands for the development process that had started at the same time as the cooperation phase. The major focus of the project during the development process has been the technological concept. Figure 5.1 shows that the project was focused on developing a PTO concept during cooperation phase of the Action Research study. During the evaluation phase, the focus had slightly shifted towards the design of the prototype.

However, it should be borne in mind that an innovation process is not as neat and linear as figure 5.1 suggests. Instead, the key words in the orange arrow (PTO concept, rotor design, mooring design) represent some of the major tasks that have been more or less prevalent during the entire development process.

During the cooperation phase, the project team developed the technological concept for their power converter. Developing a technological for an innovation project is a rather internal process in the sense that it is usually not subject to many external influences. This implies that during this stage of the development process, the project was focused on technological aspect of the product and not, for example, on its market potential or on regulatory requirements. Influences of the external environment are therefore expected to be low at this stage where internal influences are likely to prevail. In contrast, the analysis of market potential in the beginning of the development process, i.e. around 2009, might have been a lot more influenced by external factors such as developments in the target markets, and the same might be true for the last phase of the development process which is to prepare the start of production for 2018.

5.1.3 Unit of analysis

One point that has to be emphasized before the contents of the strategy making are described in detail is the choice of the unit of analysis. The unit of analysis

of this dissertation is an innovation project, i.e. strategy making is investigated as an activity happening at the project level.

In the literature, corporate strategy is usually understood as the strategy of the company, decided upon at the highest level (see, e.g., Ansoff, 1987, and chapter 3 of this dissertation). Yet, it has been pointed out that strategy making might happen at lower levels of a company as well, e.g. by particularly dedicated individuals engaging in "autonomous strategic behavior" (Burgelman, 1983a). In addition, the emphasis on emergent strategy making put forward in chapter 3 suggests as well that strategies do not necessarily originate at the top management level.

Moreover, analyzing strategy at a lower level of the organizational structure offers a range of advantages. First, in a smaller unit, change happens at a faster pace and is thus easier to observe in a study with a limited time frame and a small team of researchers. Second, the developments at the corporate level might be mirrored by innovation projects where at a lower level, similar developments happen, only faster. It is safe to assume that this is particularly true if innovation projects are used as a playing field to test new strategic directions before they are implemented in the entire organization. Third, smaller units such as innovation projects are more easily accessible for a researcher than the board of management level. In this context, accessibility is not only about the formal step of being allowed to participate in meetings but also about the degree of openness that the other participants can be expected to have towards the researcher, and vice versa.

By focusing on one innovation project, the Action Research study is also a single-case study. Single cases can serve as powerful examples if they illustrate and make plausible a conceptual framework (Siggelkow, 2007). Particularly if single cases are "revelatory" or "longitudinal" they might offer valuable insights (Yin, 2009, p. 47-49). The present case is revelatory in the sense that this project would usually not have been available for researchers. It is accessible for this researcher because she is a member of the same organization. The case is also a longitudinal case since the research was conducted over a period of 14 months. Along these lines, the innovation project is a comprehensive single case which allows for rich data generation and in-depth investigation.

5.1.4 Ethical considerations

Ethics are an important issue to consider for all research studies, particularly if people are directly involved and affected by the research. Furthermore, the researcher might be trapped in a conflict of interest which cannot always be avoided but in any case must be made transparent.

Conflicts of interest are the most relevant ethical issue in Action Research since action researchers closely collaborate with practitioners and are likely to get personally involved in practice, particularly if they are insider-researchers. A conflict of interest can arise between the researcher role and the practitioner role when one role demands something that contradicts the requirements of the other role. For example, researchers can get under pressure to contribute to the aims of the organization even though their role as researchers might require them to question these aims (Johnson et al., 1999).

First-voice comment: In the Action Research study presented here, conflicts of interest have fortunately been rare. Two attempts were made by team members to instrumentalize the research for their own goals but both were easy to dismiss and did not turn into problems for the research. Indeed, both people later became active supporters of the Action Research and sustainability agenda.

In addition to avoiding conflicts of interest, ethical requirements for Action Research include that participants should not suffer disadvantages from participating in the research, that confidentiality and anonymity are protected, and that the participants know what to expect in advance and agree to these terms (Burn, 2006, p. 107-108). These requirements are met in the Action Research conducted here. The participants were encouraged to participate in the sustainability discussions and did not suffer any reprisals. Confidentiality and anonymity have not been problematic during the course of the project but in order to protect the privacy of every participant, the names of all persons involved and the project name are anonymized. The participants were informed of the goal and research method of the dissertation in the beginning of the cooperation phase. In fact, the goals and methods of the cooperation phase were only decided upon in collaboration with the participants during the course of the study.

A further point raised by Burn (2006) is that researchers should make sure that participants do not rely on the researcher for understanding the data. Instead, data must be self-explanatory and accessible. In the present project, the only data that did not originate from the project were the protocols and literature reviews conducted by the researcher. These were referred to often and participants were encouraged to use them as well. During the cooperation and evaluation phase, all working documents and other data were stored on a shared network drive which every project member could access.

Finally, the research model needs to be appropriate to the context of the practitioners (Burn, 2006). Since the used methods and the entire research approach were always discussed and decided upon with the project team, the research model should have remained appropriate throughout in this study.

Although action researchers must pay attention to these ethical concerns, it has also been argued that it is the voluntary cooperation with practitioners that enables Action Research to accommodate ethical requirements very well, potentially better than other methods (Coghlan, 2011). This supports the author's confidence that this research has not been compromised by ethical problems.

5.1.5 The sequence of events

After the fundamental assumptions and prerequisites of this Action Research study have been clarified in the last sections, this section is now moving on to the contents of the orientation phase. As argued in section 5.1.2, the phases of the Action Research study are embedded in the context of the innovation project which went through the company-specific innovation process. This context is illustrated again in figure 5.2 which highlights the position and the contents of the orientation phase.

The orientation phase was the first phase of the Action Research study and ran in parallel to the last months of the project's research process, as figure 5.2 shows. At the top, a small version of figure 5.1 is shown in order to locate the orientation phase in the context of the other processes. Following the same logic, figure 5.3 on page 87 and figure 5.7 on page 106 zoom into the project timeline in order to locate the cooperation and the evaluation phase in this context as well.

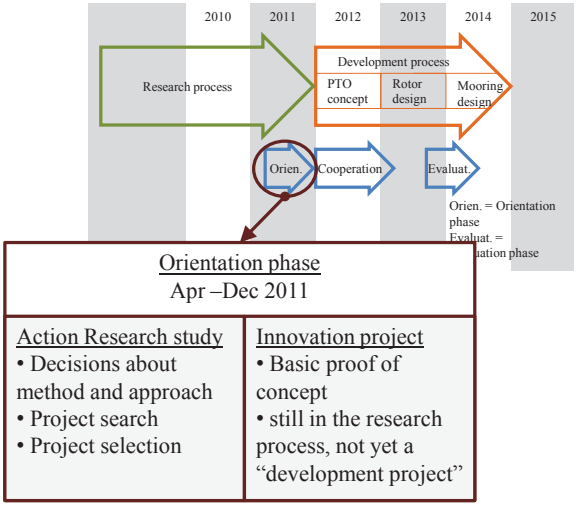

Figure 5.2: The orientation phase

In the following, the sequence of the events in the orientation phase is described in order to make understandable what exactly happened during this phase and how the insider-researcher approached the start of the Action Research study. After a pre-phase in which it was decided to pursue an Action Research approach, the orientation phase began, consisting of project search and project selection. During the first part of the orientation phase, the project search, ten meetings took place with managers who were recommended as having a good overview of the innovation projects running within the organization based on their experience and/or their position. For example, a due diligence coordinator was approached since he knew about merger and acquisition (M&A) projects, and a Design for Environment (DfE) coordinator was interviewed because he was aware of DfE-related projects. A total of 13 discussion partners suggested 11 innovation projects as potential partner projects.

The search was explicitly *not* limited to projects dealing with sustainability-related issues, yet most of the projects that came up in the discussions develop products in the fields of renewable energy and alternative fuels. As was ar-

gued by many of the interview partners, these projects were expected to be inclined to work on a sustainability strategy which was the explicit goal of the planned cooperation. An overview of the meetings that took place from April to September, 2011, is shown in table 5.1.

Table 5.1: Orientation phase: Project search

Date	**People involved**	**Suggested projects**
29/04/2011	Due diligence coordinator (corporate environment department)	no. 1; 2
04/05/2011	DfE coordinator (corporate environment department)	no. 3
12/05/2011	Head of the corporate research office; head of innovation management	no. 4; 5
27/05/2011	Head of corporate strategy department	no. 6
27/05/2011	Head of corporate sustainability office	no. 1; 2
14/06/2011	DfE coordinator of a business unit	no. 7; 8
08/06/2011	DfE coordinator of another business unit	no. 2; 9
18/07/2011	Head of project no. 4	no. 10
05/08/2011	Head of business unit; assistant; head of services	no. 11
23/09/2011	Head of corporate research unit	none

The recommendations from these meetings were used as door openers to contact the 11 innovation projects in the second part of the orientation phase, the project selection phase. A total of 20 meetings took place with nine of the eleven recommended projects between May and November, 2011.

As can be seen from table 5.2, talks with some projects were more intensive than with others. No contact could be established with projects no. 1 and 2. Step by step, projects that were not a good fit for a cooperation on sustainability strategy were excluded. For example, project no. 8 was still in a very early stage of development whereas project no. 5 was in a very mature stage of development. In the case of the former, uncertainty about the project was still high; in the case of the latter, most sustainability-related decisions

had already been made. In both cases, there did not seem to be much room for developing a project-specific sustainability strategy.

In fall 2011, a short list of four projects remained, including projects no. 3, 6, 10, and 11. At the end of the year, the decision was made for project no. 6 because the project leaders appeared intrinsically motivated to address sustainability in depth, the project seemed well-organized and in a good stage of development in the sense that the uncertainty of a brand new project had already been left behind while market pressure and path dependencies had not yet gained too much influence.

Table 5.2: Orientation phase: Project selection

Date	**Project no.**	**People involved**
31/05/2011	5	Head of project no. 5; head of innovation management; PhD student of project no. 5
14/06/2011	7; 8	Environmental coordinator of a business unit
20/06/2011	5	Head of project no. 5; PhD student in project no. 5; head of one sub-project
18/07/2011	4	Head of project no. 4; former head of the project
20/07/2011	8	Head of project no. 8
20/07/2011	9	Member of project no. 9
21/07/2011	9	Head of project no. 9; innovation manager; team leader; environmental manager
25/07/2011	6; 11	Head of business unit
29/07/2011	9	Head of project no. 9
01/08/2011	5	Head of project no. 5; two project members
03/08/2011	4	Head of project no. 4
05/08/2011	11	Head of business unit; executive assistant; head of customer service
08/08/2011	6	Both heads of project no. 6

Date	Project no.	People involved
30/08/2011	3	Head of project no. 3
06/09/2011	3	Head of project no. 3; member of project no. 3
18/09/2011	4	Head of project no. 4; member of project no. 4
18/10/2011	11	Business development manager of project no. 11
26/10/2011	10	Head of project no. 10
07/11/2011	3	Head of project no. 3; member of project no. 3
08/11/2011	6	Both heads of project no. 6

First-voice comment: At first, innovation project no. 3 seemed a great fit with the research goals of this dissertation: It addressed an interesting subject, it was fast emerging, and it had an open-minded head of project who was motivated to pursue a sustainability agenda in the project. However, we finally decided not to cooperate because this project was under such pressure to perform that it had been difficult to even schedule the first meetings.
I realized that for projects to address sustainability, a certain degree of both, time and freedom, is necessary. This is an important point which will become relevant later, referring to the idea of 'leeway' that sustainability champions need.

5.2 The cooperation phase

After the orientation phase had been concluded with the decision to partner with project no. 6, the cooperation phase started in January, 2012. This was the active, cooperating phase of the Action Research study and is addressed in this section. It ran until February, 2013, which is in line with the rule of thumb defined by Zuber-Skerritt and Perry (2002) recommending that about a third of the time of an Action Research PhD should be spent on the core project.

At the beginning of this section, the research setting is described (section 5.2.1). This includes tow parts: First, an introduction of the partner innovation project no. 6 and the initial motivation of the project leaders to participate

in a study on sustainability are provided. Second, the research participants are presented, allocated to eight different groups, and shown in the context of the entire network of participants. In section 5.2.2, the contents of the strategy making process is described. The activities for topic I and topic II are presented in detail whereby the strategy making process for topic I is described first and summarized in table 5.3 on page 98. After that, the strategy making process for topic II is elaborated, also followed by a table which summarizes the main events (table 5.5 on page 103).

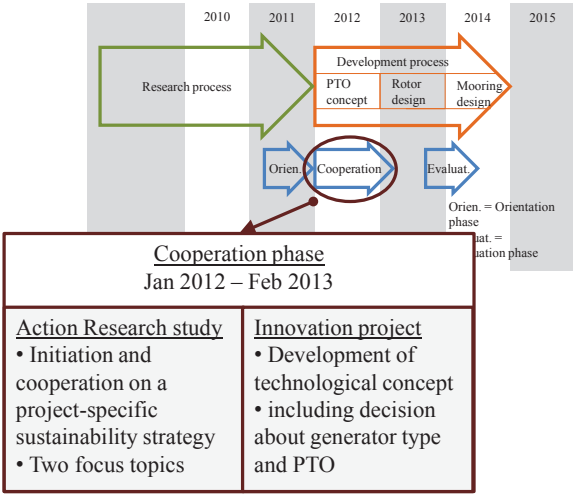

Figure 5.3: The cooperation phase

Figure 5.3 serves to illustrate the context in which the cooperation phase was embedded. It shows that the cooperation phase ran in parallel with the development process. At the time, the innovation project focused on its technological concept, including the PTO concept and the generator selection.

5.2.1 The setting

This section details the research setting of the Action Research study by introducing the innovation project and the 57 research participants.

The innovation project

The research partner project no. 6 is an innovation project that aims at developing a new way of generating electricity from ocean energy. The idea is that a rotor with blades is excited by the revolving movement of the water under the surface of a wave. An artist's impression of a potential final product is shown in figure 5.4.

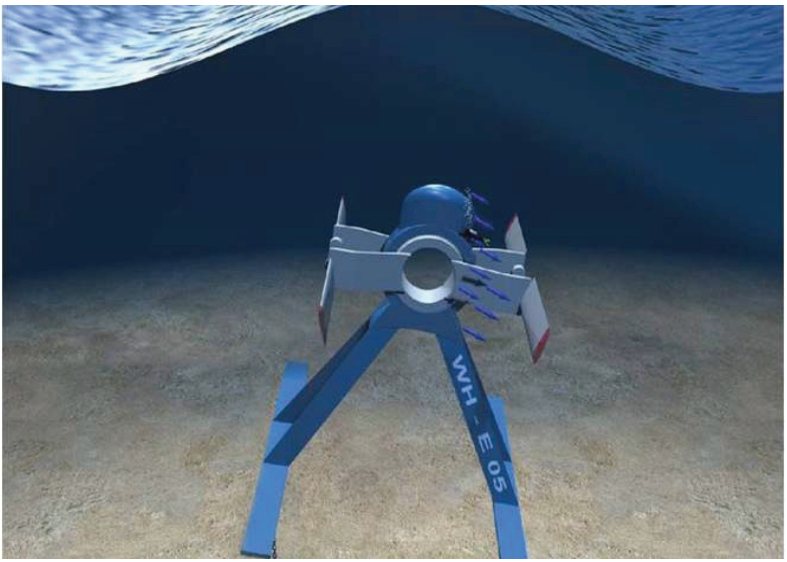

Figure 5.4: An artist's impression of the wave energy converter

Located within a big multinational engineering company, the innovation pro-ject enjoys the advantages of a start-up firm that is encouraged to explore the technological possibilities of its innovation while at the same time being shielded from external pressures. Because the project is still at an early stage of development, many questions that are relevant for sustainability are yet to be answered, such as the materials that will be used or the way different components will be constructed. At this stage, the project leaders had been asking themselves how to ensure that the product that they were developing was compatible with their understanding of sustainability. Since they wished

to target the renewable energy sector with a *truly* sustainable technology, developing a project-specific sustainability strategy was a matter of consistency. This was driven by the project leaders' personal intrinsic motivation but also by economic considerations of the reputational damage that could be caused if they failed to fulfill the promise of providing a sustainable technology. This is why the offer to foster and support the development of a sustainability strategy by conducting an Action Research study fell on sympathetic ears when the heads of the project were first contacted in August 2011.

As a first step, the Action Research core team was set up. This core team consisted of four permanent and two temporary members, namely the two heads of project, one DfE coordinator of the corporate environment department, the insider-researcher, and two graduate students in succession. This team agreed to meet regularly in order to work together on the sustainability issues to be addressed. The insider-researcher was in charge of organizing and documenting meetings, but all protocols and documents were made available on a shared network drive and were open to discussion with all Action Research participants also beyond the core team during the cooperation and the evaluation phase. The composition of the core team remained the same throughout the cooperation phase.

The participants

Networks are becoming increasingly important for Action Research (Chisholm and Elden, 1993; Foth, 2006): Because practitioners as well as academics are becoming more and more inter-connected, action researchers are advised to consider and use these networks. Collaborating with various networks comprising a large number of different people can be a challenge. The first step of managing this challenge is to make visible the network of participants and to analyze which groups play which roles. In the Action Research study presented here, eight groups of people have been involved as shown in figure 5.5. These groups are introduced in the following.

The *core team* includes the two heads of the project (T1; T2), one DfE coordinator of the corporate environment department (T3), two graduate students who wrote their theses in cooperation with the corporate environment department in 2012 (T4; T5), and the PhD candidate (also referred to as the

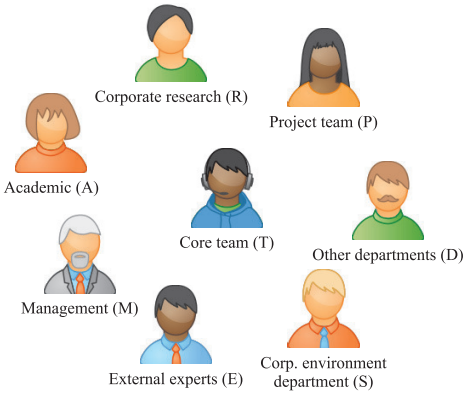

Figure 5.5: The participant groups *(figure created with yEd Graph Editor, yWorks, 2014)*

insider-researcher; T6). The *project team* includes all members of the innovation project as of 2012, including colleagues working on the PTO (P1; P2; P8), construction (P3; P4), simulation (P6; P7; P9), and control engineering (P5; P10). The *corporate research team* includes participants of the Action Research study who were not affiliated with the innovation project but with corporate research departments working on metals and composites engineering (R1; R2; R3, R5), surface coating (R4), plastics engineering (R6; R7; R8), and methods and moderation (R9). The *academic group* includes the PhD supervisor (A1), the second assessor (A2), fellow PhD students (A4; A7; A8), a range of other academics who took part in conferences and seminars in which T6 also participated (A3; A5; A6; A9), as well as T5's thesis supervisor (A10). The *management group* includes two executives from the board of the business unit to which the innovation project belongs (M1; M2), the head of the corporate environment department (M3), and the head of the corporate strategy department (M4). The *external experts* are two researchers from a partner university project on critical resources (E1; E2), three external service providers under contract with the organization (E3; E4; E5), one person from a research institute (E6), and one from an environmental non-governmental organization (NGO) (E7). Three members of the sustainability group of the

corporate environment department have been involved in the research, i.e. two DfE coordinators (S1, S2), and the head of the sustainability group (S3). Finally, six people from *other departments* participated as well, including five colleagues of the central purchasing department (D1; D2; D3; D4; D6), and one from the norms and standards unit (D5).

Naturally, the groups overlap as there are several people fitting into more than one group. For instance, T3 and T6 work at the corporate environment department and could therefore also be allocated to the S group. Depending on what their most important role has been, the participants are assigned to one particular group.

Figure 5.6 shows the network of all participants. The lines between the participants symbolize that these people have attended the same meetings at least once, i.e. they show who worked together. Furthermore, the size of the icons indicates the extent to which each person was involved. The more a participant collaborated with others in events, the bigger he or she appears.

The six members of the core team (T1-T6) are shown in the center since they are the most connected with all other participants. The academic group (A1-A10) is shown in the right bottom, connected to each other but hardly any other participant except T6. The members of other departments (D1-D6) are shown on the lower right side. They are mostly connected with T1 and T6. Above the other-departments group, the members of the sustainability group of the corporate environment department are shown (S1-S3). They are mostly connected with the core team but a few connections with the project team (P) exist as well. On the upper right side, the management group (M1-M4) is shown, connected with the core team (T) and the corporate environment department (S). The external experts (E1-E7) are allocated in the upper right corner, connected to the core team (T) and the innovation project team (P). On the upper left side of the figure, the project team is depicted (P1-P10), evidently a lot more connected between themselves than the other groups. The project team is also closely connected with the core team and parts of the corporate research team. The corporate research group (R1-R11) on the left side of the figure is connected with the project and the core team.

What figure 5.6 illustrates is that a network of 57 different people has contributed to the strategy making process that took place during the cooperation phase. Although it is obvious that some people were more actively involved

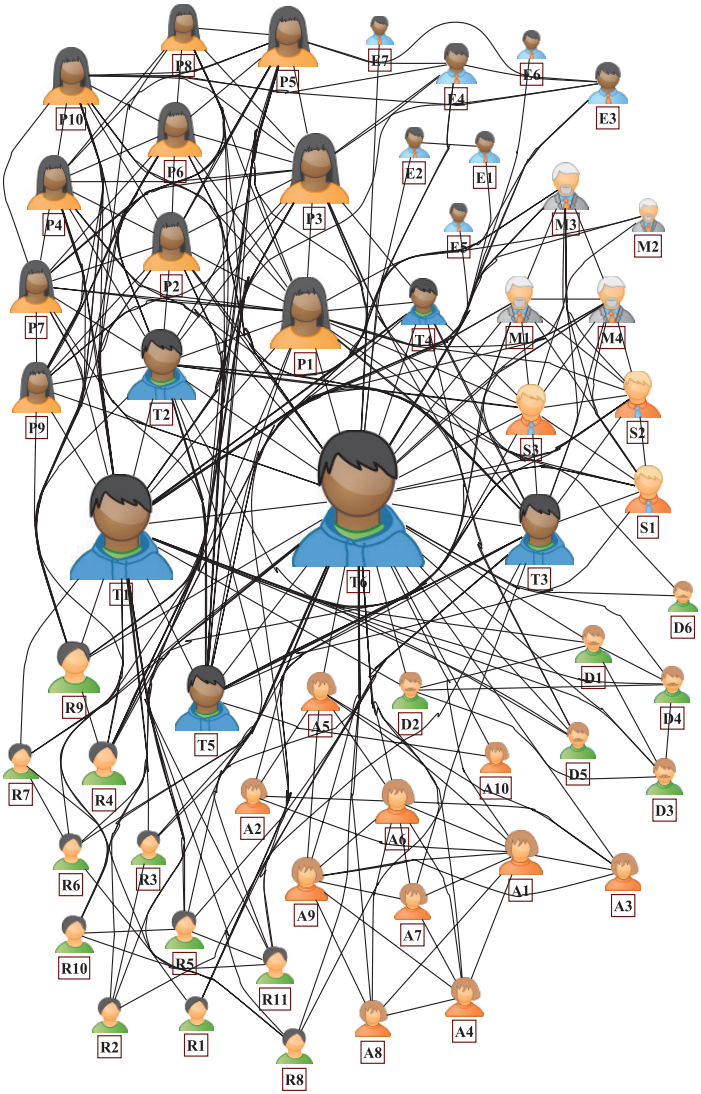

Figure 5.6: The network of participants *(figure created with yEd Graph Editor, yWorks, 2014)*

than others, this suggests that strategy making for such topics as the ones chosen here required support from various experts of multiple fields.

5.2.2 The making of a sustainability strategy

In the following, the work on the project-specific sustainability strategy and its content are described in order to make transparent how the strategy making processes proceeded over time. Two topics became the focus areas of the sustainability strategy: The sustainability assessment of the material selection based on a life-cycle view and the potential negative impacts on marine biodiversity. These two strategic focus areas were not pre-defined but instead were left to emerge from practice during the cooperation phase. Topic I was decided upon at the beginning of January, 2012, and topic II emerged in mid-February, 2012. The strategy formation is described separately for both topics and is based on the most important events. In total, 111 events took place which have been clustered as

- team meetings, i.e. meetings within the groups T and P;
- student meetings, i.e. meetings between T6 and T4 or T5;
- expert consultations, i.e. meetings with experts within the organization but outside the innovation project;
- management meetings, i.e. meetings with members of the board of the business unit and the heads of two corporate departments; and
- academic meetings, i.e. PhD seminars, conferences, and meetings with the PhD adviser.

A selection of the most important events is provided in table 5.3 on page 98 for topic I and in table 5.5 on page 103 for topic II. For the complete list of all events, refer to appendix A.

Based on the Action Research cycle (see figure 4.1 on page 61), the strategy making processes for topic I and topic II, respectively, are structured along five steps:

1) the beginning (problem definition and planning);
2) first patterns (data gathering, project work);

3) mid-course reflection (data analysis);

4) progress of strategy (taking action); and

5) results (reflection, evaluation).

This implies that the entire cooperation phase can be understood as one big superordinate Action Research cycle, consisting of two parts addressing topic I and II, respectively. However, several Action Research cycles have taken place for each topic as well as is shown in section 5.4 on page 117. The development of the focus topics is described in chronological order in the following. For each of the five steps, the questions that were addressed, participants that were particularly involved, and results and observations are presented.

Topic I: Comparative sustainability assessment of materials

The beginning. In the very first team meeting on January 10, 2012 (event no. 18 in table 5.3 on page 98), the focus on materials was suggested by T3 who kept supporting this topic from then onward. In addition, T1 embraced this focus area and supported it throughout the entire cooperation phase. The question that was asked was: What is the most sustainable material selection for the product to use? After a few weeks, it had boiled down to: Which generator type would be the most sustainable one based on the sustainability impacts of the materials it consists of? This question was decided to be addressed taking a life cycle perspective. In the corporate research section of the company, many departments are dedicated to materials science. It was therefore agreed to make use of the internal know-how and to conduct workshops with experts of the relevant materials. These workshops were initiated and planned by T6.

In parallel to the sustainability assessment, a technological assessment of potential generator types was conducted (mainly by P1 and P2). While the sustainability assessment was based on ecological, social, and long-term economic criteria, the technological assessment aimed at maximizing energy conversion efficiency while keeping costs low. The technology assessment was very helpful for the sustainability assessment because it served as a source of information, e.g. about the generator types that were technically feasible.

These generator types were taken as the starting point of the sustainability assessment.

First patterns. During the first months of the cooperation phase, expert consultations were the most common event type due to many meetings and workshops that took place with colleagues from the corporate research section and other departments (events no. 131; 36; 39; 41; 47; 48). These meetings helped gain a better understanding of the sustainability aspects of the various materials. A model of all materials (basically a list of materials and their shares of the total generator mass) that were likely to be used for each kind of generator was compiled and further developed in team meetings that took place in turns with the expert consultations (events no. 19; 32; 43; 56).

From November 15, 2011, through March 31, 2012, T4 wrote her Master's thesis on the systematic assessment of materials along their life cycle, using the example of Neodymium Iron Boron magnets (Peiffer, 2012). Her thesis helped develop the methodological approach for the sustainability assessment and laid the groundwork for the simplified, or streamlined, life-cycle assessment (LCA) that was conducted later (for the streamlining of LCAs, see Graedel, 1996; Rebitzer et al., 2004). Furthermore, the thesis shed light on the particular sustainability issues of rare earth metals in the early stages of the life cycle (mining and processing).

Mid-course reflection. After roughly a quarter of the cooperation phase, a review meeting took place in which the first results of the expert consultations were discussed (event no. 43). After these workshops were completed in late May, a period of reflection began in which the state of the materials model was refined and interpreted. At this stage, T5 started writing his diploma thesis (May 1 until November 30, 2012) by using the insights of the cooperation so far, aiming at developing weighting criteria for the materials and assess their relative sustainability performance (Dreusicke, 2012).

Progress of strategy. After the reflection phase, team meetings became the dominant event type again. They served to refine and specify the materials model (events no. 79; 102; 105; 106; 110; 113). Particularly P1 and P2 became actively involved in the sustainability assessment (events no. 79; 82; 102; 106; 109; 110; 113). At that point, topic I was not only supported by T1, T3, and T6, but had gained three more supporters, namely T5, P1, and P2.

T5 was mainly developing the method for comparing the generator types with regards to sustainability criteria and was becoming an important player for the work on topic I. He was the only participant who worked on topic I full-time which made him a knowledgeable and dedicated topic I champion. T5's insights and the ranking of generator types that was based on his work became an integral part of the final recommendations for the generator selection (Dreusicke, 2012). P1 and P2 provided support for the sustainability assessment by helping T5 and T6 understand the technological concept and by delivering the numbers needed for the mini LCA conducted by T5.

At this stage of the cooperation phase, the core team also started integrating some of the sustainability requirements into project processes. For example, the recyclability of materials was taken up as a requirement in one of the project management tools (event no. 109).

Results and observations. At the Action Research review session of topic I on January 8, 2013 (event no. 105), a sustainability ranking of the generator types was presented and discussed. One of the most important criteria had been that the generator did not contain rare earth magnets because these were seen as particularly problematic with regards to all three, ecological, social, and long-term economic aspects (for details, see Dreusicke, 2012).

During the cooperation phase, a paradigm change had occurred: While permanently excited generator types (which contain rare earth magnets) were seen as a promising option in the beginning, skepticism grew as many participants (T3; T4; T5; T6; R1; D6) stressed the ecological, social, and economic risks. At the end of the cooperation phase, also the technological assessment required that the machine should not rely on a rare earth magnet for excitation. The ranking from more to less sustainable generator types was almost identical with the ranking provided by the technological assessment team. The sustainability ranking and the technologically informed selection of PTOs had been run in parallel and had apparently informed each other.

First-voice comment: During the year after the cooperation phase, 2013, the shift of paradigm seemed to have reversed as permanently excited generators had found their way back into contention. Top-down pressure seemed to have played an important role (based on personal communication with one of the team members in October, 2013 and March, 2014), but technical reasons had been in place as well (according to results of the web survey, cf. section 5.3.2 on page 111).

Not only had topic I become a more regular subject of discussion, also the researcher, T6, had become more integrated into the project team and had participated more and more in general project meetings that did not primarily have to do with the sustainability assessment (events no. 57; 62; 67; 76; 82; 109). Also, there was a trend away from expert consultations to team meetings and from T6 organizing meetings to her being invited to meetings.

Some observations can be made regarding the developments during the cooperation phase. First, the work on topic I relied heavily on internal knowledge and on many internal meetings with experts (within and outside of the innovation project).

Second, P1 and P2 became more involved in the sustainability assessment over time. While in the beginning, neither of them seemed overly interested and there were misunderstandings as to what the goals of the Action Research was, both of them became tremendously helpful supporters during the latter half of the cooperation phase. This close cooperation was certainly an important reason for the alignment of the technological and the sustainability assessment. In addition to P1 and P2, T5 started to play an important role and greatly advanced the research progress.

Third, sustainability awareness among project members (P1-P10; T1; T2) seemed to have risen during the cooperation phase. From the course of several discussions (as reported in the event protocols) it becomes clear that over time, people started to consider sustainability-related questions relevant for their work. A few examples support this impression, such as event no. 83 when P2 stated that he considered some sustainability goals important parts of the technological assessment and the final review (event no. 105). In this event, it was also discussed how the recommendations would be implemented in the project in the future. In line with this general raise of awareness, sustainability requirements were partially integrated in the project. The most important contribution was the sustainability ranking of generator types which was also communicated to the management (event no. 108).

To conclude the description of the strategy making process for topic I, an overview of the most important events is given in table 5.3. After that, the strategy making for topic II is described in detail as well, also followed by a table containing the most important events.

Table 5.3: Most important topic I events

#	Date	Event type	Participants	Content
18	10/01/2012	Start of cooperation	T1; T2; T3; T4; T6	Start of cooperation; decision about topic I
19	16/01/2012	Expert consultation	T1; T3; T4; T6; R1	Workshop on sustainability aspects of rare earth metals
32	21/02/2012	Expert consultation	T1; T2; T3; T4; T6; P1; P3	First compilation of a list of relevant materials
36	02/03/2012	Expert consultation	T4; T6; D6	Workshop on sustainability aspects in the life cycle of rare earth metals
39	06/03/2012	Expert consultation	T1; T3; T6; R3	Workshop on sustainability aspects of selected metals
41	12/03/2012	Team meeting	T1; T3; T4; T6; P2; R5	Discussion of materials list
43	14/03/2012	Team meeting	T1; T2; T6	Discussion of progress of the cooperation so far
47	21/03/2012	Expert consultation	T1; T6; D1; D2; D3; D4	Workshop on the materials list from a purchasing perspective
48	22/03/2012	Expert consultation	T1; T6; R6; R7; R8	Workshop on sustainability aspects of plastic materials
56	24/05/2012	Expert consultation	T6; P2	Discussion about alternative PTOs
57	29/05/2012	Team meeting	T1; T2; T6; P1; P2; P3; P4; P5; P6; P8	Workshop on prototype

#	**Date**	**Event type**	**Participants**	**Content**
62	14/06/2012	Team meeting	T1; T2; T6; P5; P7	Workshop on long-term requirements the machine must meet
67	17/07/2012	Team meeting	T1; T2; T5; T6; P1; P2; P3; P4; P5; P6; P8	Workshop on technological specifications
76	20/08/2012	Team meeting	T1; T2; T6; P1; P3; D5	Workshop on standards
79	23/08/2012	Team meeting	T5; T6; P1; P2	Discussion of materials list
82	10/09/2012	Team meeting	T1; T5; T6; P1; P2	Workshop on the model of materials
83	10/09/2012	Team meeting	T1; T2; P1; P2; P3; P4	Workshop on construction and design
102	19/12/2012	Expert consultation	T6; P2	Discussion of the model of materials
105	08/01/2013	Team meeting	T1; T2; P1; P2; P3; P7	Final review of topic I results
106	11/01/2013	Team meeting	T6; P1; P2	Follow up on materials model
108	21/01/2013	Management meeting	T1; T2; T6; M2	Presentation of results at strategic review meeting
109	28/01/2013	Team meeting	T1; T2; T6; P1; P2; P3; P4; P5; P6; P7; P9; P10; R9	Workshop on generator options
110	29/01/2013	Expert consultation	T6; P2	Follow up on workshop

#	Date	Event type	Participants	Content
113	27/02/2013	Team meeting	T6; P1; P2	Discussion about generator options

Topic II: Potential impacts on marine biodiversity

In the following, the strategy making process for topic II is described in detail, also along the five steps that were already used for topic I. Again, the questions that were addressed during each step, the participants that were involved, as well as results and observations are presented. The section is concluded with a table of the most important topic II events (table 5.5 on page 103).

The beginning. Topic II came up a few weeks into the cooperation phase at the team meeting on February 14, 2012 (event no. 29). T2 brought up for discussion what could be done to avoid the reputational and environmental damage that he expected in case of the machine causing damage to sea animals, e.g. by collision. It was agreed at this meeting that negative impacts on marine biodiversity would be addressed as a second focus topic in addition to the material assessment. T2 supported the work on topic II throughout the cooperation phase. It became clear early on that biodiversity was an issue about which knowledge within the company was limited. Therefore, the approach to topic II was different from that of topic I. On the one hand, it was based on a literature review, on the other hand, external partners were sought with whom the team could work out a biodiversity strategy.

First patterns. The question addressed was refined during the first weeks and was finally agreed to be: What are potential negative impacts on marine biodiversity that could be caused by the technology? It was agreed that a literature review would be conducted by T6 as a first step. Once a basic understanding would have been obtained, T2 and T6 planned to reach out to external experts in order to find the expertise that was lacking inside the company (event no. 43).

Based on the literature review, four main potential negative impacts that ocean energy converters can have on marine biodiversity were identified as relevant for the project. These were collision, chemical emissions, noise, and electromagnetic fields. In the early stages of the cooperation phase, not much

interaction took place on these issues between T6 and T2 and the rest of the team. A summary of the literature review can be found in appendix B.

Mid-course reflection. Once a preliminary understanding of the potential impacts on biodiversity was established, the search for an external partner was taken up (after event no. 117). The literature research was still conducted in parallel in order to improve the theoretical understanding of the issue. However, the literature study thus far had also made clear that external expertise and testing of particular locations where the energy converter would potentially be installed was needed in order to move beyond generic recommendations.

Progress of strategy. During this step, the goal was to find an external partner who could build upon the literature review and conduct an in-depth study of the marine biodiversity at potential sites and provide more specific recommendations. In total, 11 experts of organizations addressing the environmental impacts of ocean energy were contacted by T2 and T6, including the project Streamlining of Ocean Wave Farms Impact Assessment (SOWFIA), the European Ocean Energy Association (EU-OEA), the World Wide Fund for Nature (WWF), the International Union for Conservation of Nature (IUCN), the German Federal Agency for Nature Conservation (BfN), and various European ocean research institutes and conservation consulting firms.

> **First-voice comment**: The search for an external partner proved extremely difficult. In many cases, our inquiries were left unanswered for which an explanation is still lacking. The search for an external partner therefore took much longer than had been anticipated.

Within the company, more people became involved in the biodiversity issue over time. In the beginning, it was mostly T2 and T6 who worked on topic II, but later on, P2, P4, P7, R4, and S2 participated in meetings on potential negative impacts and how they could be measured and avoided (events no. 57; 62; 69; 70; 84; 85; 86; 104; 107). Although a few informal discussions took place concerning how collision could be avoided by design, most team meetings dealt with chemical emissions, noise and electromagnetic fields. This was due to the fact that, first, external experts were involved who offered their professional opinions on chemical emissions (events no. 58; 117; 71). Second,

noise and electromagnetic fields were already a minor technological concern in the development process and could therefore relatively easily be strengthened as project development requirements (events no. 70; 84; 85; 104). Thresholds were discussed in the later meetings and it was decided to establish project-internal thresholds because regulation or guidelines were not in place (events no. 62; 69).

Results and observations. Based on the literature review, general recommendations for avoiding negative impacts on marine biodiversity were made at the end of the cooperation phase. It should be noted however that the scientific understanding of the causes of biodiversity loss is still in its infancy and legally binding thresholds are largely amiss. The recommendations for the project to address topic II in the future are summarized in table 5.4.

Table 5.4: Recommendations to avoid negative impacts on biodiversity

Impact	**Recommendations**
Collision	Avoid migration routes and seasons
	Establish exclusion zones where navigation is banned around the area in which converters are situated
Chemical emissions	Use vegetable-based hydraulic fluids wherever possible; in any case avoid biocide coating
Noise	Refrain from pile driving
	Use acoustic and visual deterring devices
	Use soft starts in the commissioning phase, i.e. a slow beginning of noisy activities
Electromagnetic fields	Use cable jackets to shield electromagnetic fields
	Bury cables in the seabed
	where feasible: use so-called Faraday cages
General recommendation	Monitor each location in order to learn about effects on biodiversity

The literature review, which was the first part of the work on topic II, was successful in that a reasonable understanding of the potential impacts on biodiversity could be obtained. Also, thresholds had been discussed and agreed upon for each impact. Regarding the second part, i.e. continuing this work

with the help of an in-depth study on biodiversity issues at a selection of potential sites, two research institutes finally made offers to conduct such studies. However, T2 decided in February, 2013, to postpone the contract award to the second half of 2013 (event no. 112).

The first observation with regards to topic II concerns the event types. The first half of the cooperation phase was dominated by the literature study, thus the events were mostly discussions between T2 and T6. In contrast, the second half saw more collaboration both within and outside of the company, thus more expert consultations and team meetings with higher participation. However, the work on biodiversity impacts suffered from the general lack of knowledge both within the company and in science. The innovation project was at a too early stage of development to know the locations where the energy converter would most likely be installed eventually. This ruled out investigating specific biodiversity impacts and limited the team to discussing and deciding about general impacts only. Furthermore, contacts with external people were more common than in the work on topic I, while there were in total by far less internal meetings addressing topic II than addressing topic I.

In the following table 5.5, the most relevant events that addressed topic II are listed. This concludes this section about the cooperation phase and leads into the next section in which the evaluation phase is presented.

Table 5.5: Most important topic II events

#[4]	**Date**	**Event type**	**Participants**	**Content**
29	14/02/2012	Team meeting	T1; T2; T6	Discussion of research method of cooperation; decision about topic II
43	14/03/2012	Team meeting	T1; T2; T6	Discussion of progress of the cooperation so far
57	29/05/2012	Team meeting	T1; T2; T6; P1; P2; P3; P4; P5; P6; P8	Workshop on prototype

[4]The numbering of events is not simply consecutive because of changes that were made during the evaluation phase. In order to make sure that events are not confused with each other, the numbering has been left in this order. The events are listed chronologically.

#	Date	Event type	Participants	Content
58	29/05/2012	Expert consultation	T6; E3	Discussion about various assessment methods for biodiversity impacts
62	14/06/2012	Team meeting	T1; T2; T6; P5; P7	Workshop on long-term requirements the machine must meet
117	15/07/2012	Expert consultation	T6; E7	Discussion of potential negative impacts on biodiversity
69	19/07/2012	Team meeting	T1; T2; T6; P2; P3; P4; P5; R9	Workshop on prototype
70	19/07/2012	Team meeting	T6; P2; P4	Discussion of noise and electromagnetic fields
71	26-27/07/2012	Expert consultation	T1; T6; P3; P5; P10; E3; E4	Visit of experimental sites
84	12/09/2012	Expert consultation	T1; T2; P3; R4; R9; R10; R11	Maritime coatings workshop
85	20/09/2012	Team meeting	T6; P7	Discussion of noise and chemical emissions
86	20/09/2012	Expert consultation	T6; S2	Discussion of the impacts of electromagnetic fields under water
100	10/12/2012	Team meeting	T2; T6	Definition of requirements for a biodiversity study
104	08/01/2013	Team meeting	T1; T2; T3; T6; P1; P7	Final review of topic II results

#	Date	Event type	Participants	Content
107	18/01/2013	Expert consultation	T6; S2	Discussion of impacts of electromagnetic fields under water
112	21/02/2013	Team meeting	T2; T6	Decision to postpone contract award for biodiversity study

First-voice comment: After the wrap up of the cooperation phase and the two reviews, I was absent for four months of maternity leave. I started working part-time after that (working on my theoretical contribution) and only took up the Action Research evaluation when I was back full-time in October, 2013. Hence, there was a period during which the research activities were on hold while daily life in the innovation project went on.
This explains the gap between the cooperation and the evaluation phase in figure 5.1 on page 78. This also provides the background to T2 expressing in January, 2014, that the continuation of the sustainability work had suffered from the (sudden) lack of a sustainability champion (see section 5.3.2).

5.3 The evaluation phase

This section describes the evaluation phase, i.e. the activities that were undertaken in order to evaluate and interpret the data generated during the cooperation phase (section 5.3.1). It took place from September, 2013 until June, 2014 and consisted of multiple rounds of gathering, structuring and analyzing the data. Section 5.3.2 describes how for triangulation purposes, a web survey was conducted in January, 2014. In this survey, the project members were asked to evaluate a set of statements deduced from the data analysis (the questionnaire can be found in appendix C). In addition, an interview-based research project was conducted by a student who analyzed the role of sustainability issues in 21 other innovation projects at the company. Finally, section 5.3.3 offers a short review of the sequence of events that took place during the evaluation phase.

During the evaluation phase, the innovation project was working on the prototype and on design questions. It also neared completion of the development process, as can be seen in figure 5.7.

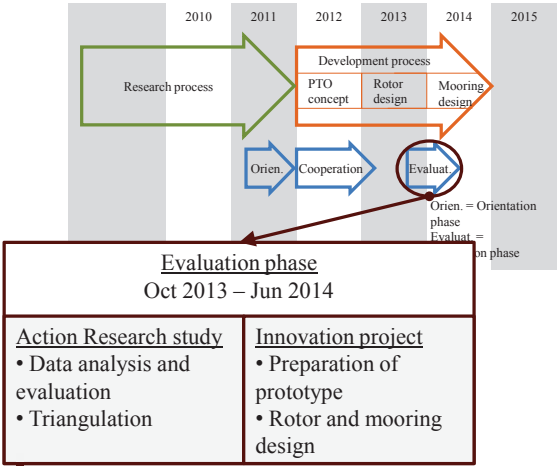

Figure 5.7: The evaluation phase

5.3.1 Data evaluation

The data set to be evaluated consists of protocols, event- or project-related files such as presentations that were used during meetings, general notes, entries in the reflective diary, calendar items, and e-mails. While the protocols, project documents and files were available to all project members, calendar items were available only to the core team members, and the diary notes and e-mails were only available to T6.

First-voice comment: Action researchers are encouraged to write reflective diaries (Coghlan and Brannick, 2005; Coughlan and Coghlan, 2002) in order to keep a high level of self-awareness. With this advice in mind, I started a reflective diary in late 2011 and kept entering more personal entries or reflection processes that I wanted to clarify for myself. These entries have been helpful for analyzing the different roles played by the contingency factors, especially the influence that specific people had and how this influence developed over time.

The data analysis was carried out in four steps: describing and categorizing data, inductive analysis of content, linking first insights back to theory, and quantitative and qualitative evaluation (inspired by the steps for generating evidence suggested by Whitehead and McNiff, 2006). It should be noted that these steps were not taken as linearly as this list might suggest. Rather, the researcher went back and forth between them and often worked on more than one step simultaneously.

Describing and categorizing data. All events were logged in a spreadsheet in chronological order. They were numbered and described, including details such as the date, a one-sentence summary, the organizer and the participants, and the respective protocols and files. In addition, a comprehensive archive of all protocols, event- or project-related files, general notes, entries in the reflective diary, calendar items, and e-mails was put together to allow the researcher an overview and quick access to the details of each event. Several categories were developed to cluster the events, including the event type (team meetings, student meetings, expert consultations, management meetings, and academic meetings) and whether the event addressed topic I, topic II, both, or none.

Inductive analysis of content. The content of the events was analyzed repeatedly. In the first round, the events were summarized and the most important details were highlighted. In the following rounds, the content was analyzed with regards to manifestations of the five contingency factors ENVIRONMENT, ORGANIZATION, DECISION-MAKING PROCESS, PEOPLE, and NATURE OF THE PROBLEM. The kind of influence or its direction was not specified at that stage. After a few rounds of analysis, sub-factors emerged. They were informed by sub-factors suggested in the literature on contingency factors of strategy making (see chapter 3) but were not limited to these. This approach of letting factors emerge inductively from the data analysis resembles the open coding methods described by Kim and Andersen (2012) and Robson (2002) where the content of the analyzed text is labeled based on themes that are found in the data. These inductively generated sub-factors were refined in the following rounds of scanning the data. This refinement was done similarly to the method of 'memoing' where the modeler writes down his or her thoughts during coding (Luna-Reyes and Andersen, 2003). In this case, the reflective diary was used for reflection, or memoing, about the factors as they developed.

Linking insights back to theory. Going back to the literature review of contingency factors, sub-factors were defined that lead to either planned or emergent strategy making. These sub-factors were generated inductively and often took shape as contrastive pairs. In addition, the sub-factors were compared to the contingency factors from the literature. Some sub-factors are addressed in the literature, e.g. the influence of decision complexity, while others are not, e.g. the current economic situation of the company. Particularly, the direction of these sub-factors is often not addressed by existing research. For instance, whether strong internal processes make planned or rather emergent strategy making more likely is not discussed in strategy research. In the following, the sub-factors that are used for the contingency factor analysis are explained. The direction of their influence, i.e. whether they are expected to elicit planned or emergent strategy making, is addressed in particular. The resulting sub-factors are listed in table 5.6 on page 110.

ENVIRONMENT. The only manifestations of influences stemming from outside the company that were found in the data were high and low external pressure. High external pressure was taken for a factor making planned strategies more likely because companies under pressure from their environment are likely to aim at offering a fast response to this pressure. As opposed to this, emergent strategy making was assumed to be more likely if external pressure was low.

ORGANIZATION. The following four sub-factors of ORGANIZATION were expected to make planned strategy making more likely. First, *internal processes* are relatively rigid corporate guidelines that are decided upon at top management levels and were therefore seen as part of planned strategy making. Second, in companies that are in a *negative economic situation* it was assumed that employees enjoyed less leeway to develop strategies in an emergent way. Third, *internal dissemination*, e.g. meetings to inform a wider audience about strategic activities, was expected to make the strategy-making process more official and to foster management attention. Fourth, *top-down pressure* implies that the project needs to fulfill requests from above which was interpreted as a more planned way of strategy making. In contrast, the sub-factors that were expected to make emergent strategy making more likely are *friendly, cooperative culture* as employees working together are more likely to create an emerging strategy and *positive economic situation* because it was assumed that

a company with enough resources allows employees the leeway that is needed for emergent strategy making.

DECISION-MAKING PROCESS. Because issues that are perceived as threats are addressed more rationally and with higher levels of resource input and centralization (Dutton, 1986), the sub-factor of DECISION MAKING expected to be conducive to planned strategy making was *perception as threat*. The two sub-factors driving emergent strategy making were *decision complexity* because more complex decision processes are difficult to address with strategic planning, and *perception as opportunity* because people working on emergent strategies are likely to be given more leeway if the decision is perceived as an opportunity rather than a threat.

PEOPLE. The three sub-factors supporting planned strategy making were the following. First, the sub-factor *top-management involved* was assumed to indicate planned strategy making, similar to, second, *middle management implementing rules top-down*. Third, *people following rules* was interpreted as an indicator of planned strategy making as well. On the side of emergent strategy making, four sub-factors were developed. First, if participants became actively involved beyond and supported the sustainability efforts with their expertise (*participants actively involved*) this was expected to contribute to an emergent strategy making process. Second, *middle management actively involved* is a similar sub-factor only for middle management, i.e. the heads of the project who also became actively engaged in the strategy making process. Third, because it was expected that sustainability champions would be strong drivers of emergent strategy making, *participants (except T6) acting as champions* became a sub-factor covering all participants except T6. The fourth sub-factor *researcher (T6) acting as champion* served to subtract out the influence of the insider-researcher who was acting as a champion as well.

During the sub-factor generation, it became clear that the original fourth contingency factor 'top-management characteristics' [5] did not suffice to adequately capture the influence that specific people had exerted during the cooperation phase. This contingency factor was therefore renamed 'PEOPLE' and extended to include the influence of people on all hierarchy levels, particularly people acting as sustainability champions. Other sub-factors that

[5] This factor represents the fourth set of contingency factors discussed in chapter 3.

are discussed in theory, such as a volatile market as a sub-factor of the company's environment, never manifested itself in the data and were therefore not included as a sub-factor.

In addition to the analysis of the inductively generated sub-factors described above, the data set was also scanned for manifestations of strategy making modes. This analysis ran in parallel to the contingency factor analysis and was kept separate as far as possible. It is described in more detail in section 6.6.2.

Table 5.6: Inductively generated sub-factors

Contingency factors	**Sub-factors associated with planned strategy making**	**Sub-factors associated with emergent strategy making**
Environment	High external pressure	Low external pressure
Organization	Internal processes	Friendly, cooperative culture
	Negative economic situation	Positive economic situation
	Internal dissemination	
	Top-down pressure	
Decision-specific factors	Perception as threat	Decision complexity
		Perception as opportunity
People	Influence of top management	Participants actively involved
	Middle management implementing rules top-down	Middle management actively involved
	People following rules	Participants (except T6) acting as champions
		Researcher (T6) acting as champion
Nature of problem	High salience	High wickedness

Quantitative and qualitative evaluation. Based on the spreadsheet list of all events, a semi-quantitative analysis was conducted. This analysis is called semi-quantitative because it is obvious that the kind of data that this study relies on is too small for a statistical analysis. However, correlations

and patterns can be detected by comparing the numbers of meetings in which contingency factors have had an influence. In order to normalize for the fact that there had been more meetings addressing topic I, the resulting numbers were divided by the total numbers of events that had taken place for each topic, respectively.

Topic I and topic II meetings were compared with regards to the following questions:

1) How did patterns change over time, e.g. the involvement of sustainability champions or the dominance of certain event types?
2) How did participants interact and who acted as a champion? (This was also used as a basis for the network graph in figure 5.6 on page 92)
3) How did the two topics evolve over time with regards to characteristics of strategy making?

This section has explained the approach to data evaluation that was chosen in order to analyze the data set that had resulted from the active cooperation with the innovation project. The results and interpretations of this analysis are discussed in chapter 6.

5.3.2 Triangulation

The primary method of data analysis has been explained above. This section focuses on additional analyses that were conducted for the purpose of triangulation.

Triangulation means "observation of the research issue from (at least) two different points" (Flick, 2004). The basic idea of triangulation is that the weaknesses of one perspective could be compensated by the strengths of another (Jick, 1979). In this research, triangulation is used to balance the deep but narrow perspective of the Action Research study which has investigated one particular project in great depth but has neglected, for instance, other projects within the company, projects outside the company, and other units of analysis. The goal of triangulation is to enhance the scientific rigor of a research study. Beyond that, it enables researchers to learn more about their research subjects and to analyze their research questions from various angles (Flick, 2004; Guion et al., 2011; Olsen, 2004).

Several variants of triangulation exist, among them

- data triangulation, i.e. using different data sources;
- theory triangulation, i.e. using different disciplinary viewpoints or different theories;
- investigator triangulation, i.e. using a research team or different investigators;
- methodological triangulation, i.e. combining different methods such as case studies and surveys; and
- environmental triangulation, i.e. changing locations or settings that might influence the results (Flick, 2004; Guion et al., 2011; Meijer et al., 2002).

Furthermore, triangulation can be done with the same cases or with different data sets (Flick, 2004). In social research, it is particularly promising to combine interactive and non-interactive methods (Flick, 2004). An additional kind of triangulation is "within-method triangulation" (Denzin, 1978, p. 301) which is achieved by using different techniques within the same method to increase internal consistency (Jick, 1979).

In this dissertation, triangulation has assumed various forms. First, data triangulation is part of the Action Research approach since different kinds of data sources were used, including interactive sources such as team meetings and non-interactive sources such as project documents. Second, the web survey has served to triangulate with regards to method, and has done so on the same case since the respondents were almost identical with the Action Research study team. It was also an non-interactive study, in contrast to the highly interactive Action Research study before. Third, the latest student thesis (Kärsten, 2014) has performed triangulation of data, theory, investigator, and method. It was also a case of triangulation of data sets since the interviews of this thesis were conducted with 21 innovation projects at the company, excluding the partner project with which the Action Research study was done.

The former two theses can also be argued to have been investigator triangulations although it should be noted that only Kärsten (2014) investigated a similar set of research questions. In contrast, Dreusicke (2012) and Peiffer (2012) addressed particular questions related to topic I. They were therefore

more relevant to the empirical part of this dissertation and to the innovation project than to answering the overall research question of this dissertation.

In the following, the two main triangulation studies that were used to test and enhance the scientific rigor of this dissertation are described, i.e. the web survey and the third student thesis.

Web survey

An anonymous web survey was conducted from January 24–30, 2014. All Action Research study participants affiliated with the innovation project were asked by e-mail to participate[6]. Participants were asked to express the extent to which they agreed or disagreed with a range of statements concerning sustainability strategy making during the cooperation phase. The number of participants was small (n = 15) which rules out quantitative analysis. Furthermore, the respondents were able skip part 2 if they were not involved in work on topic I and part 3 if they had not had to do with topic II. Out of the 16 people who were contacted by e-mail, 15 responded to the questionnaire which is a high response rate.

The complete questionnaire can be found in appendix C. It was organized in four main parts: The first part presented six general questions in order to assess people's views on sustainability as a corporate or project goal. It revealed a very positive understanding of sustainability. For example, 13 out of 15 respondents agreed with the statement that sustainability was one of the most important goals that companies had to address. Potentially, this positive view may have resulted from the Action Research cooperation in which sustainability had been a frequent topic of discussion. Of course, it could also be due to researcher bias which cannot be ruled out since it is impossible to guarantee that every respondents remains anonymous if the number of respondents is low.

The second part consisted of questions related to topic I, the sustainability assessment of materials. The respondents stated that topic I was a very wicked and somewhat salient problem. To some extent, topic I seemed to have become a relevant issue in some project-internal decision-making processes.

[6] In addition to the ten members of the project team, two members of the core team, three of the corporate research group, and one new employee of the innovation project were contacted. Cf. section 5.2.1 on page 87.

Furthermore, the respondents found the work on topic I a more emergent than planned process. They also made clear that drivers such as regulation, customer requirements, internal targets and a sustainability champion would be needed in order to strengthen the relevance of topic I for the project.

The third part of the survey contained a similar set of questions covering topic II, the potential impacts on biodiversity. Here, respondents stated that topic II had only to a small degree become a part of the decision-making processes within the team. All respondents except one found biodiversity an extremely wicked problem and rather salient as well. Particularly, the influence of external stakeholders was seen as relevant for topic II. However, the respondents said that no strategy for topic II was in place. If at all, strategy making had been emergent. Finally, respondents saw a sustainability champion as the second most important driver that was needed to foster topic II at the project. Only regulation was regarded as more important.

The fourth part contained questions comparing strategy making for the two topics. It showed that the respondents thought that more know-how existed on topic I, that topic I had become further integrated than topic II, and that topic II was more wicked.

By and large, the results of the web survey show the following: Strategy making had been been perceived as more emergent than planned for topic I. Regarding topic II, the respondents did not see any strategy in place; if at all, strategy making had been emergent. Topic I had been integrated to some extent into the mainstream requirements that the project aimed to fulfill. In contrast, less integration had happened for topic II contents. For topic I and particularly for topic II, a sustainability champion was named as a necessary driver for sustainability although for both topics, regulation was estimated to be the most powerful driver.

The web survey yielded two unexpected insights as well: The first concerned the perception of salience and wickedness but was partially resolved in the discussions at the team meeting in January, 2014. According to the web survey, both topics were seen as quite salient. The discussion at the team meeting helped clarify that the respondents saw biodiversity as a salient problem for society in general with powerful stakeholders pushing for consideration of biodiversity. Yet, it became clear that topic II was seen as less salient *for*

the innovation project and the company. Furthermore, topic I was perceived as a very wicked problem as well, although a little less wicked than topic II.

Second, most respondents stated that regulation was the missing driver for sustainability strategy making which suggests that they valued external pressure such as regulation as the most important driver. In contrast, the contingency factor ENVIRONMENT had hardly played a role in the cooperation phase. This is probably explained by the fact that sufficiently influential regulation is not in place for either topic.

In addition, the web survey enabled a hindsight perspective on the cooperation phase. At a monthly team meeting of the project team at the end of January 2014, which eight of the innovation project members attended, the researcher presented the preliminary results of the web survey. Some of the questions were discussed in detail, as well as the current stage of the sustainability strategy one year after the cooperation phase had ended. In one of these discussions, T2 stated that in his opinion, the lack of sustainability activities after the cooperation phase was not due to the economic situation but first and foremost to the leaving of the sustainability champion, referring to T6, to which the other project members agreed. This supports the emphasis of this dissertation on the importance of champions for sustainability.

Interview-based student thesis

In order to complement the deep but narrow perspective of the Action Research study which focused on one project, a student thesis investigated the making of sustainability strategies in 21 other Bosch innovation projects from January to August, 2014 (Kärsten, 2014). Because most innovation projects were expected to have no explicit sustainability strategy, the research question was phrased as follows: How do sustainability issues become integrated in innovation projects and what are the main drivers for this integration? The thesis was based on existing research on sustainability innovations (Fichter and Arnold, 2003; Lehmann-Waffenschmidt, 2007) and drivers for sustainability (Hart and Milstein, 2003; Schrettle et al., 2014), while particularly focusing on one internal driver of corporate sustainability, namely corporate culture (Schein, 2010). Problem-based interviews were conducted with 23 individuals of 21 projects working on sustainability-related topics, representing 9% of all 229 innovation

projects that were running as of February, 2014. These projects were classified as *enthusiasts*, *smart movers*, *compliance followers*, and *why mes* depending on the levels of intrinsic motivation and individual initiative of the interviewees.

The thesis found that external sustainability drivers were a necessary but not sufficient condition for the integration of sustainability, particularly for generating sustainability innovations, i.e. activities that aim at creating completely new products rather than incremental developments for ensuring compliance or increasing efficiency. For such sustainability innovations, internal drivers are needed, most importantly corporate culture and bottom-up movements by sustainability champions. Beyond that, Kärsten (2014) argued that a gap exists at the company between formal sustainability communication and implementation of sustainability issues at the innovation project level. Since most interviewees were motivated to advance sustainability integration in their projects but wished for more top-down support, the thesis identified potential for bridging this gap if project members were given a certain leeway to implement their sustainability ideas.

These results support the emphasis that is put on champions in this dissertation. Sustainability champions (here: *enthusiasts*) are shown to be a critical condition for sustainability activities that go beyond the necessary within an innovation project. For two more detailed insights of this study, see appendix D.

5.3.3 The sequence of events

The evaluation phase is a reflective phase by definition and it is not surprising that the level of cooperation was low compared to the preceding two phases. Most of the evaluation phase was dedicated to desk-based data analysis and interpretation. Therefore, the events of the evaluation phase are not listed in a table but are briefly summarized as follows.

The events that took place during the evaluation phase were focused on triangulation, including the discussion of the web survey with the project team (one two-day team meeting in January, 2014) and meetings with the graduate student (22 meetings between January and August, 2014). Academic meetings took place as well, i.e. meetings with the PhD adviser and the second assessor (four meetings between October, 2013, and July, 2014), meetings with the

supervisor of the corporate environment department (16 meetings between September, 2013, and August, 2014), PhD seminars (two meetings between September, 2013, and February, 2014). Finally, the researcher gave a presentation of the Action Research results and its implications for the organization to an extended audience of the corporate environment department and Action Research participants who were involved in the cooperation phase (July, 2014).

5.4 Rigor check

In the following, the rigor of the conducted Action Research study is tested based on the criteria of scientific rigor defined in chapter 4 (see table 4.3 on page 69). At the end of this section, a summary of the rigor test can be found in table 5.9 on page 130.

5.4.1 Theory

The theory criterion is addressed by two questions (cf. Coughlan and Coghlan, 2002; Friedman and Rogers, 2009; Rapoport, 1970): Is the Action Research study grounded in scientific theory (question 1.1) and does it contribute to theory (question 1.2)?

Regarding **question 1.1**, it is argued that the present Action Research study is well grounded in scientific theory since the question addressed by it is based on the theoretical framework developed in chapter 3. Precisely, the research question how corporate sustainability strategies are made and which contingencies influence the strategy making mode towards more emergent or more planned strategy making which is addressed in theory in chapter 3, is investigated in practice by the Action Research study presented here. In particular, the application of the new and the existing contingency factors to the data, the inductive development of sub-factors, and the feeding back of these sub-factors to the theory show that the Action Research study is not only based on but critically engaged with theory.

Question 1.2 is answered in the positive as well since the project has contributed to theory in more than one way. First, it has applied four existing and one new contingency factor to practice. Second, the relative importance of the five contingency factors is evaluated which lends support to some existing

research, e.g. on the role of sustainability champions (e.g., Enroth, 2007) but does not confirm other theoretical propositions, including e.g. those emphasizing the role of external pressure such as regulation for sustainability strategy making (e.g., Newton and Harte, 1997; Rugman and Verbeke, 1998). The interview-based thesis that was conducted additionally during the evaluation phase as well as the web survey help back up these contributions. For more details on the scientific contributions that this dissertation has made, see section 6.7.

5.4.2 Action

The action criterion is assessed with the help of two questions (cf. Argyris and Schön, 1974; Schultz and Hatch, 2005; Susman and Evered, 1978): Are the results of the Action Research study relevant to the context of the involved practitioners (question 2.1)? And does the Action Research study contribute to improving practice and to enduring organizational change (question 2.2)?

The statements by the two heads of the innovation project during both the orientation and the cooperation phase, in which they explained their sustainability motivations, prompt an affirmative answer to **question 2.1**. First of all, their interest and active involvement in the Action Research cooperation indicates that they considered sustainability an issue important enough to invest time and resources in a 14 months cooperation project. Furthermore, their dual motivation makes clear that sustainability is a relevant problem: First, from a risk management point of view, the cooperation on sustainability issues was expected to minimize reputational risks, and second, from a marketing or maybe personal perspective, the Action Research study was expected to help ensure that the promise which the project aimed to fulfill, namely offering a new way of sustainable energy generation, could be kept. Not only the project heads but the entire core team saw sustainability as a relevant issue as became obvious from conversations with T3, T4, and T5 as well as the responses to the web survey. Furthermore, some of the team members, most notably P1 and P2, bought into the idea of integrating sustainability requirements into the project development, and started advancing this goal during the cooperation phase.

Question 2.2 is only partially confirmed. Whether or not the Action Research study has contributed to an improvement of practice is judged by the degree of integration that has been achieved with regards to the two sustainability focus topics. Figure 5.8 shows the number of manifestations of such an integration with regards to topic I and II. For this purpose, the content of the events was scanned for integration efforts. In one event, for example, a recycling quota was set and integrated into the list of requirements the project aimed at fulfilling. This event counted as a manifestation of 'integration'. The total number of manifestations is rather small, particularly when spread over 14 months. However, figure 5.8 indicates that both topics may have become further integrated into the project mainstream decision processes over time. Hence, it is tentatively concluded that the Action Research study contributed to an improvement of practice.

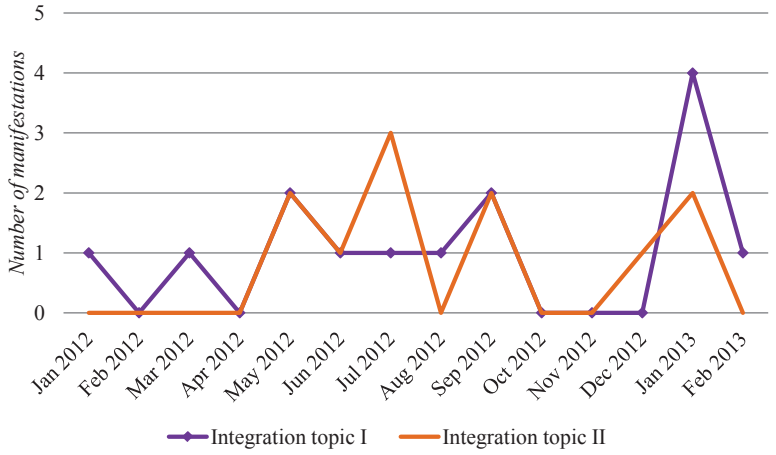

Figure 5.8: The integration of the two topics

The second part of question 2.2 is more ambiguous. The contribution of the research project to enduring organizational change is judged by the degree to which topic I and II are still integrated in the daily project routines one year after the cooperation phase ended. The web survey conducted in January, 2014 contained three questions about the role that the two focus areas still played in the project at the time of the survey (questions 2.17; 3.17; 4.3; see appendix

C). The answers indicate that topic I was still present in the beginning of 2014 while topic II had practically disappeared. Therefore, it is concluded that the Action Research study has contributed to enduring organizational change with regards to topic I, but probably not with regards to topic II.

5.4.3 Method

The method criterion is tested by four questions (cf. Coughlan and Coghlan, 2002; Dickens and Watkins, 1999; Zuber-Skerritt, 2001): Is the methodological approach systematic and well documented (question 3.1)? Are the epistemological underpinnings clear (question 3.2)? Has the research team gone through a spiral of Action Research cycles (question 3.3)? Is the project reflective (question 3.4)?

This Action Research study was systematically planned and stringently documented which is presented in this chapter and appendices A and C. **Question 3.1** is answered in the positive based on the structured approach to the Action Research study in three phases (orientation, cooperation, evaluation) and the thorough documentation of each phase with regards to developments on the content level (i.e. the topic I and II content of the events) as well as the meta level (e.g. patterns of change regarding event types, participant involvement, etc.). Furthermore, the engagement with the Action Research literature in chapter 4 based on which the conducted Action Research study was planned and the application of this literature to the evaluation of the project shows that the method was used systematically.

The epistemological underpinnings asked for by **question 3.2** are elaborated in section 4.1 on page 52. There, different epistemologies are presented in order to make clear the historical and philosophical background of Action Research. Furthermore, Action Research is carefully defined drawing on various existing definitions, and its advantages and drawbacks are clearly presented. The question how another epistemology would have enabled and called for a different kind of empirical study is addressed in section 6.8.

In order to answer **question 3.3**, a more detailed justification is needed. The following paragraphs show how the team went through two parallel sets of Action Research cycles during the 14 months of the cooperation phase: seven

cycles with topic I and four cycles with topic II. As a reminder, the steps of the Action Research cycle are the following (see also figure 4.1 on page 61):

1) problem definition and planning (reflection);

2) data gathering and project work (action);

3) data analysis (reflection);

4) taking action (action); and

5) evaluation (reflection).

Table 5.7 on page 122 and table 5.8 on page 126 show the Action Research cycles for topic I and II, respectively (the events referred to in the right columns of these tables can be found in completeness in appendix A). These two sets of Action Research cycles are briefly summarized as follows.

Topic I. The work on the sustainability assessment of materials started at the same time as the cooperation phase since it was suggested as a focus topic in the very first meeting. The *first Action Research cycle* took less than three weeks and consisted of a couple of preparatory meetings (reflection), but also included one decisive workshop on rare earth metals (event no. 19) (action).

The *second cycle* started with the official launch of the cooperation phase, i.e. a team meeting which most of the innovation project members attended (reflection). Several expert consultations took place (action) and the idea of conducting a workshop series in order to benefit from the company-internal wealth of knowledge on material science took shape (reflection).

During the *third cycle*, the list of materials that would later develop into the materials model was compiled in a range of team meetings (action). Additionally, a couple of reflective meetings took place in which the insights from the workshops were integrated into the materials list (reflection). This cycle included also the final presentation of T4 which served as a discussion forum for members of the project team and the corporate environment department (action).

The *fourth cycle* contained a further set of workshops and expert consultations but now also team meetings in which the materials model was developed with the support of a couple of members of the project team, most notably P1 and P2 (action). Indeed, these two participants became active supporters

of the sustainability assessment during this time. Discussions of the way forwards as well as T5's mid-way research project presentation took place as well (reflection).

The *fifth cycle* forwent the first step of problem definition and planning and continued with a couple of expert consultations and a range of team workshops to refine the materials model and develop a ranking of the generator types (action). In this cycle, the work of T5 became more and more influential and was a major driver for both, the sustainability assessment in general and the comparative analysis of generator types in particular. Many student meetings also shaped this cycle since T5 was in the final phase of his thesis (reflection). Furthermore, the first results of the cooperation were reported at two management meetings (action).

Also the *sixth cycle* continued the work on topic I without another step of problem definition and planning. Instead, T5 finalized his work and gave his final presentation which again offered room for discussions between project members and the corporate environment department (reflection). The work on topic I had also gained attention at the corporate environment department which may have been one reason for the opportunity for T5 and T6 to participate in an LCA training (action). After T5's final presentation, this cycle ended with the final review of topic I where the results were presented and discussed among the active topic I participants (reflection). This review marked the official end of the cooperation phase. However, an *after-cycle* followed which shows that the work on topic I had really gained momentum. P1 and P2 were again actively involved and aimed at taking over the responsibility for the further development of the sustainability assessment in the materials selection. This is an incomplete cycle though, consisting only of the action-focused steps.

Table 5.7: The Action Research cycles in topic I

Cycle and duration	**Step**	**Content**	**Events**
1st cycle 04/01–24/01/2012	(1) Problem definition, planning	Planning the start of cooperation with T3 and T4	127; 20

Cycle and duration	Step	Content	Events
	(2) Data gathering, project work	Start of cooperation	18
	(3) Data analysis	Data analysis and reflection in cooperation with T4	15; 16; 17; 22
	(4) Taking action	Expert consultations	19; 21
	(5) Evaluation	Discussions with T1	23
2nd cycle 25/01–20/02/2012	(1) Problem definition, planning	Official start of cooperation	116
	(2) Data gathering, project work	Technical meetings and team discussions	120; 26
	(3) Data analysis	Discussions with T1; T2; T3; T4	25; 27; 29; 30
	(4) Taking action	Expert consultation	131
	(5) Evaluation	Preparations of workshop series	29; 31
3rd cycle 21/02-14/03/2012	(1) Problem definition, planning	Discussion of goals of workshop series	34
	(2) Data gathering, project work	Collection of data for the materials list; expert consultations	32; 125; 36; 39; 41
	(3) Data analysis	Reflections on workshops; discussions of the first results	33; 35; 38; 42; 43
	(4) Taking action	*n/a*	*n/a*

Cycle and duration	Step	Content	Events
	(5) Evaluation	Final presentation T4	37
4th cycle 15/03–11/07/2012	(1) Problem definition, planning	Planning further workshops with T1	34
	(2) Data gathering, project work	Workshops; expert consultations	46; 47; 48; 56; 59
	(3) Data analysis	Discussions with T1 and T4	52; 60
	(4) Taking action	Team workshops	57; 61
	(5) Evaluation	Mid-way presentation of T5	64
5th cycle 12/07–22/10/2012	(1) Problem definition, planning	*n/a*	*n/a*
	(2) Data gathering, project work	Expert consultation; team workshop on standards	65; 76
	(3) Data analysis	Discussions with T5	72; 74; 81; 88; 92
	(4) Taking action	Team workshops on materials model; management meetings	67; 79; 129; 82; 83; 91
	(5) Evaluation	Exchange meetings with T1; future outlook	77; 87
6th cycle 24/10/2012–08/01/2013	(1) Problem definition, planning	*n/a*	*n/a*

Cycle and duration	Step	Content	Events
	(2) Data gathering, project work	LCA training	94
	(3) Data analysis	Discussions with T5	95; 96; 98
	(4) Taking action	Team workshop on materials model	102
	(5) Evaluation	Final presentation T5; topic I review	99; 105
After-cycle 11/01–27/02/2013	(1) Problem definition, planning	*n/a*	*n/a*
	(2) Data gathering, project work	Team workshops on materials model	109; 110; 113; 115
	(3) Data analysis	*n/a*	*n/a*
	(4) Taking action	Team meeting discussing materials model; management meeting	106; 108
	(5) Evaluation	*n/a*	*n/a*

Topic II. In the same manner as for topic I, the Action Research cycles for topic II are shown as follows and illustrated in table 5.8.

The work on biodiversity started later than topic I as it only emerged as a topic at a team meeting in mid-February. In general, one can say that compared to topic I, action and reflection took slower turns. For instance, the work on topic II started with a rather long period of reflection-based activity (1st cycle), followed by a rather long period of action-oriented events (second cycle). The *first cycle* is an incomplete Action Research cycle consisting of reflection-based steps in which the approach to topic II was discussed.

During the *second cycle*, the issue of biodiversity became visible for many project members. Several consultations of internal and external experts took place as well as events in which biodiversity impacts started to be discussed as new requirements for the project development. Several participants became involved. In particular, P1 and P4 played a part in discussions on noise and electromagnetic fields, R4, E3, and E4 helped address the issue of chemical emissions, and S2 gave support concerning the calculations of electromagnetic fields. During the course of this cycle, T6 started to work on the literature review on potential impacts on marine biodiversity.

The *third cycle* consisted of expert consultations and a team workshop. The first insights from the literature review and its implications for the project were discussed within the project team as well as at a management meeting. One further project member, P7, became an active supporter of topic II, most notably for the issue of noise, during this cycle. Furthermore, first efforts were made to integrate into the project processes some of the requirements defined in the literature-based study.

During the *fourth cycle*, the focus was on the theoretical evaluation of the literature review and on defining the requirements for a follow-up study that was to be conducted by an external research institute on the biodiversity implications of a selection of potential locations. The official end of the cooperation phase was marked by the topic II review but as with topic I, the work continued for a bit longer. A couple of meetings concerning the specifications for the biodiversity study took place as well as two management meetings in which the final results of the cooperation phase with regards to both, topic I and II were presented. The fourth cycle was concluded by the decision by T2 to postpone the contract award to the latter half of 2013.

Table 5.8: The Action Research cycles in topic II

Cycle and duration	**Step**	**Content**	**Events**
1st cycle 14/02-14/03	(1) Problem definition, planning	Emergence of topic II	29

Cycle and duration	Step	Content	Events
	(2) Data gathering, project work	*n/a*	*n/a*
	(3) Data analysis	Discussion with T2	140
	(4) Taking action	*n/a*	*n/a*
	(5) Evaluation	*n/a*	*n/a*
2nd cycle 15/03-21/08	(1) Problem definition, planning	Discussions with T2	45; 53
	(2) Data gathering, project work	Expert consultations	58; 70; 71; 117
	(3) Data analysis	Literature review by T6	*n/a*
	(4) Taking action	Events discussing the integration of topic II; information of M3 for NGO meeting	57; 62; 66; 69; 71
	(5) Evaluation	Status-quo analysis with T2	78
3rd cycle 22/08-28/09	(1) Problem definition, planning	*n/a*	*n/a*
	(2) Data gathering, project work	Team workshop on coatings; expert consultations; tentative integration of biodiversity requirements into project requirements	84; 85; 86
	(3) Data analysis	*n/a*	*n/a*

Cycle and duration	Step	Content	Events
	(4) Taking action	Management meeting	129
	(5) Evaluation	Future outlook	87
4th cycle 29/09-21/02	(1) Problem definition, planning	Discussion with T2	89
	(2) Data gathering, project work	Expert consultation	107
	(3) Data analysis	Discussion about specifications for biodiversity study	100; 101; 103
	(4) Taking action	Management meetings	90; 108
	(5) Evaluation	Topic II review; decision about external study	104; 112

To conclude, question 3.3 is answered in the positive since the team has evidently gone through multiple Action Research cycles during the cooperation phase.

Turning to the last **question 3.4** of the method criterion, the reflectivity of the Action Research study is justified on the following grounds. First, a network of 57 people with very different qualifications, both from inside and outside the organization, and from various hierarchy levels, has been involved in the project. These people critically engaged with each other and many of them in more than one meeting during the cooperation and evaluation phase. With regards to first-, second-, and third-person research, the presented dissertation clearly focuses on the latter. Although alternative ways of presenting theses are intriguing (Davis, 2007; Fisher and Phelps, 2006), this research had no difficulty to accommodate a conventional writing style consistently throughout the document. Since this document is intended for an academic audience, it is likely to be easier to read and understand in this way. However, the reflec-

tive first-voice comments that appear from time to time throughout chapters 4 and 5 are supposed to account for first-voice research, i.e. to present the personal insider perspective of this researcher. Furthermore, the third-person account of the cooperation phase is based on the longitudinal second-person research conducted as Action Research. The equal consideration of both scientific and tacit knowledge, the latter in the form of meta-information about the way in which strategic decisions are made, may have contributed to a "plurality of knowing". Finally, the project accounts for the past, present, and future context of the project by considering the longer-term processes in which it is embedded, most notably the research and development processes.

5.4.4 Team work

The two team work questions (cf. Avison et al., 1999; Eden and Huxham, 1996a; Westbrook, 1995) are whether the researcher is actively involved in the change process (question 4.1) and whether all members of the Action Research team are actively involved in all phases of the Action Research study (question 4.2).

Question 4.1 is clearly confirmed, as T6 participated in all but one events and was usually the person who organized, prepared, and evaluated the meetings. Indeed, T6 moved far beyond the role of an observing researcher by becoming a critical sustainability champion pushing forward both topic I and topic II.

Question 4.2 can be answered in the positive as well. The entire core team was actively involved in all three Action Research phases with the only exception of the two students who were only temporary members of the organization and T1 who left the company in March, 2014. T3 actively supported the research even before the orientation phase and after the evaluation phase.

5.4.5 Conclusion

To sum up, the Action Research study conducted with the innovation project addresses all of the defined criteria of scientific rigor. It is particularly strong regarding the theory, method, and team work criteria. The project's main weakness is in the creation of enduring organizational change which is one part of the action criterion. Even though the strategy started to emerge during the

cooperation phase, decisions outside the Action Research study have had a major influence on the durability of this strategy. The economic situation of the business unit, the decision against hiring a person in charge of continuing the sustainability strategy, as well as the decision against awarding a contract for a biodiversity study were beyond the scope of influence of this researcher. Thus, it is argued that the Action Research study addressed the rigor criteria and has aimed at incorporating them. Therefore, it is presented as a piece of rigorous research.

Table 5.9: Rigor check

#	**Rigor question**	**Fulfilled in Action Research?**
1.1	Is the Action Research study grounded in scientific theory?	Yes. The research question of the Action Research study was derived from conceptual analysis and deductive theorizing (see chapter 3). Furthermore, the project has critically engaged with existing theory.
1.2	Does it contribute to theory?	Yes. The Action Research study has tested the five contingency factors in practice and has assessed the relative influence of these factors. Further support for these results was provided by two triangulation studies.
2.1	Are the results of the Action Research study relevant to the context of the involved practitioners?	Yes. Advancing sustainability was seen as a relevant problem for the project by both heads of project as well as the other core team members. Also many of the participants outside the core team found sustainability an important factor that should be addressed in their daily work.
2.2	Does the Action Research study contribute to improving practice and to enduring organizational change?	Partially. The project contributed to improved practice as can be seen by the degree to which the two topics became integrated in the project work. However, creating enduring organizational change may have been beyond the scope of the Action Research study as this change was hampered by strong influences outside the project.

#	**Rigor question**	**Fulfilled in Action Research?**
3.1	Is the methodological approach systematic and well documented?	Yes. The approach of the research project has been systematic and well structured. It has also been extensively documented of which only parts are presented in the limited scope of this chapter.
3.2	Are the epistemological underpinnings clear?	Yes. The epistemological underpinnings of this Action Research study have been elaborated in chapter 4.
3.3	Has the research team gone through a spiral of Action Research cycles?	Yes. The research team followed two sets of Action Research cycles, seven cycles for topic I and four cycles for topic II.
3.4	Is the project reflective?	Yes. A diverse network of people has contributed to the project; first-, second-, and third-person research is considered albeit the latter is dominant; a "plurality of knowing" has been sought; and the past, present, and future context of the project has been taken into account.
4.1	Is the researcher actively involved in the change process?	Yes. T6 participated in all but one events and even became an important sustainability champion pushing forward both topic I and II.
4.2	Are all members of the Action Research team actively involved in all phases of the Action Research study?	Yes. The entire core team (except T4 and T5 who had temporary contracts) has been actively engaged in the Action Research study throughout all three phases.

Chapter 6

Discussion: The formation of sustainability strategies

"The human resource function is crucial to organisational change for sustainability."
Benn et al., 2006, p. 159

This chapter serves to discuss the predictive power of the conceptual framework developed in chapters 2 and 3 and the implications of the Action Research study that was conducted as part of this dissertation (chapters 4 and 5). The approach to the data analysis has been described in section 5.3.1 on page 106. In this chapter, the implications of this analysis are discussed.

Section 6.1 provides a general overview of the occurrence of the five contingency factors in the Action Research events as a starting point for the following sections. It is shown that not all five factors have played an equally prominent role in the strategy making process.

Sections 6.2, 6.3, 6.4, and 6.5 serve to evaluate the predictive power of the four contingency factors ENVIRONMENT, ORGANIZATION, DECISION MAKING, and PEOPLE and follow the same structure. They discuss these contingency factors with regards to their manifestations in the Action Research study. In a second step, the predictive power of the sub-factors of each contingency factor are evaluated based in their coverage in current research. On the basis of this

empirical analysis and this literature-based discussion, the predictive power of each contingency factor is evaluated in a third step.

Section 6.6 discusses the new contingency factor NATURE OF THE PROBLEM and follows a similar structure as the previous sections. The first step is the contingency factor analysis. Because the new factor has not been addressed in strategy research thus far, the second step presents an analysis of the characteristics of the two strategy making processes instead of a literature analysis of the sub-factors. In the third step, the results of the two analyses are brought together to evaluate the predictive power of the contingency factor NATURE OF THE PROBLEM.

Section 6.7 highlights the main contributions that this dissertation makes to theory as well as its implications for practice. The limitations of this dissertation with regards to method, theory, and practice are discussed in section 6.8. This includes a critical reflection of the application of the chosen method. Section 6.9 highlights the implications of this dissertation to practice. Finally, a future outlook is offered in section 6.10.

6.1 Overview of contingency factors

This section serves to provide a first overview of the frequency of occurrence of the five contingency factors in the events of the cooperation phase. They are the four contingency factors that were deduced from the literature (ENVIRONMENT, ORGANIZATION, DECISION-MAKING PROCESS, and PEOPLE) and the newly developed factor NATURE OF THE PROBLEM. In a first step, the manifestations of all contingency factors in the Action Research events are counted. Because some contingency factors have more sub-factors than others, it is counted as a manifestation if at least one of the sub-factors played a role in an event. The first insight is that not all contingency factors were equally prevalent in the events of the Action Research study.

As figure 6.1 shows, PEOPLE was the most frequent contingency factor, followed by the factor ORGANIZATION. The NATURE OF THE PROBLEM was less common but still found in many events. Finally, the company's ENVIRONMENT and DECISION MAKING processes were found to play a role only rarely.

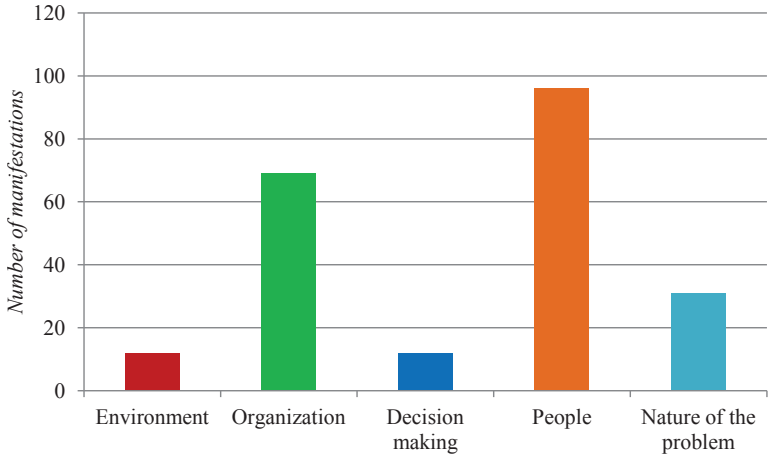

Figure 6.1: Distribution of contingency factor manifestations

The next question is to which degree these factors explain planned and emergent strategy making. Based on the inductively generated sub-factors explained above (see section 5.3.1), the manifestations are separated with regards to the direction of their influence on strategy making. For example, the manifestations of the NATURE OF THE PROBLEM are separated into those that are due to the sub-factor *salience* which contributes to planned strategy making, and those that are due to the sub-factor *wickedness* making emergent strategy making more likely. As above, if *at least* one sub-factor is found to have influenced an event, it is counted as one manifestation in order to normalize for the amount of sub-factors of each contingency factor.

The left side of figure 6.2 shows the share of events in which the five contingency factors had an influence towards *planned* strategy making. Clearly, the most influential factor driving planned strategy making was the ORGANIZATION itself, followed by the NATURE OF THE PROBLEM and PEOPLE. The external ENVIRONMENT and DECISION-MAKING PROCESSES were rare influences towards planned strategy making. The right side of the figure shows the manifestation of the contingency factors towards *emergent* strategy making. It can be seen that PEOPLE was by far the most influential factor for emergent strategy making. By a large distance, the factor ORGANIZATION follows,

and after that in descending order the NATURE OF THE PROBLEM, DECISION MAKING, and ENVIRONMENT.

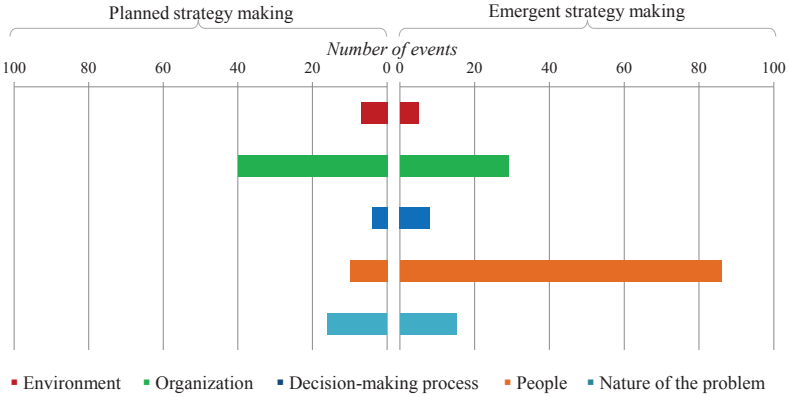

Figure 6.2: The prevalence of contingency factors

This figure yields three insights. First, it becomes clear that there were more manifestations of contingency factors conducive to emergent strategy making than of factors driving planned strategy making. If the inductively generated sub-factors are correctly allocated to planned or emergent strategy making modes, this indicates that overall, the strategy making process happening during the cooperation phase was more an emergent process than a planned one. Second, it is ORGANIZATION that explains most of the planned strategy making. Even though ORGANIZATION had a large impact towards emergent strategy making as well, its most important influence was towards planned strategy making. Third, PEOPLE is by far the most prevalent factor influencing emergent strategy making and also the strongest contingency factor altogether. PEOPLE is also the most unambiguous factor in the sense that its influence was largely in the emergent direction and only rarely in a planned direction. In the following sections, each of the five contingency factors is discussed in detail.

6.2 Environment

The figures showing the development of each contingency factor over time in this and the following sections illustrate the manifestations of each contingency factor during the 14 months of the cooperation phase. They offer visualizations of potential patterns in the occurrence of manifestations. They do *not* represent precise statistical analyses of a large data set. Instead, they are understood as supporting illustrations of the time line, showing when contingency factors played a role. As shown in the previous section, the contingency factor ENVIRONMENT played a role in very few events.

6.2.1 Contingency factor analysis

Two sub-factors of the contingency factor ENVIRONMENT are defined as: *high external pressure* which is expected to drive planned strategy making, and *low external pressure* which is expected to lead to emergent strategy making. The sub-factor *high external pressure* was found e.g. in the meetings on rare earth magnets in March, 2012, in which price and political pressures were often discussed. *Low external pressure* played a role when it became clear in a meeting that hardly any external pressure existed, e.g. to address marine biodiversity issues.

In order to recognize potential patterns in the factor's occurrence, the manifestations of its sub-factors are counted in each month of the cooperation phase. Figure 6.3 shows how the manifestations of the sub-factors of ENVIRONMENT developed over time. The teal-colored line indicates the amount of manifestations of *high external pressure*. The green line represents the sub-factor *low external pressure*. There was a small peak in March, 2012, which is due to the meetings in which rare earth metals were discussed as well as the workshop with colleagues of the corporate purchasing department. In these meetings, external influences such as price developments were a topic of discussion. In very few other events, *high* or *low external pressure* were discussed. Overall, few manifestation of the factor ENVIRONMENT are found in the data.

The fact that the company's ENVIRONMENT played an infrequent role may be explained by the following reason. As pointed out in section 5.1.2 on page 78, the cooperation phase only covered one phase of the innovation project

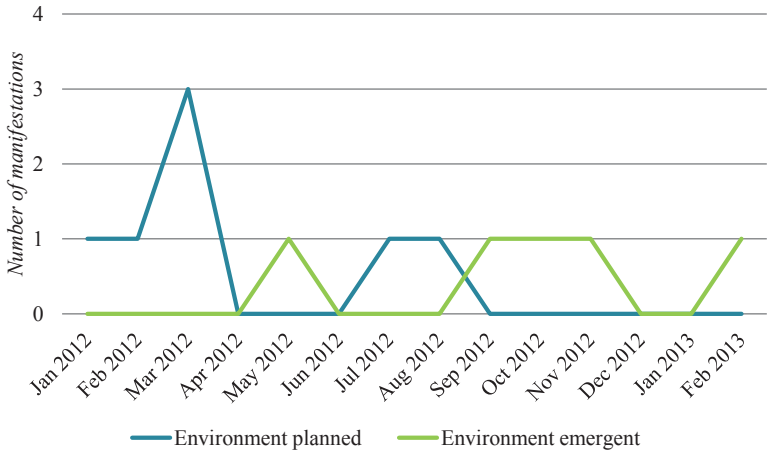

Figure 6.3: Manifestations of ENVIRONMENT over time

which was mostly concerned with developing the technological concept. This was a period in which the work of the team was based mostly on internal competencies in order to solve the basic technological questions. Questions such as economic ones that would have required considering the company's competitive, political, or regulatory environment, were not relevant at that point in time. From this perspective, it is less surprising that the factor ENVIRONMENT has played a minor role. This interpretation is supported by conversations between T6 and the project staff at the team meeting of January, 2014 where the web survey was discussed (see section 5.3.2 on page 111). There may well have been more external pressure in the beginning of the project phase, i.e. before the innovation project was launched, and there may well be more external pressure again towards the start of production. During the cooperation phase of the Action Research study, however, the external ENVIRONMENT did not have an important influence on the project. Therefore, the predictive power of this factor with regards to the strategy making processes at the innovation project is inferred to be low.

6.2.2 Coverage in current research

The sub-factors *high* and *low external pressure* are not addressed in the strategy literature. Of the sub-factors suggested in the literature, the factors hostility and munificence (low hostility) of a company's environment come closest to these sub-factors. The direction of strategy making resulting from hostility and munificence is not entirely clear. Some authors argue that companies in hostile environments are forced to react fast and are thus more likely to plan their strategies (Hart, 1992; Slawinski and Bansal, 2012). However, high levels of risk are likely in hostile environments which might slow down decision making (Schilit and Paine, 1987) and might make emergent strategy making more likely. In total, there has not been much research addressing the influence of hostility and munificence on strategy making (Elbanna and Child, 2007a; Rajagopalan et al., 1993) and results are contradictory (Elbanna, 2011). The predictive power of the contingency factor ENVIRONMENT is infered to be low since the sub-factors *high* and *low external pressure* are not covered in the literature while similar factors, i.e. hostility and munificence, are not yet fully understood.

6.2.3 Predictive power of the factor ENVIRONMENT

To conclude, the sub-factors of the contingency factor ENVIRONMENT are found to have played a role only rarely in the Action Research events. Based on current contingency factor research, their predictive power is minor. Hence, this dissertation cannot contribute to explaining better the link between the factor ENVIRONMENT and the strategy making mode.

6.3 Organization

The second contingency factor, the ORGANIZATION itself, was frequently found for both planned and emergent strategy making, as has been shown in section 6.1.

6.3.1 Contingency factor analysis

The manifestations of the sub-factors of this contingency factor are counted in the Action Research events of each month. The sub-factors of ORGANIZATION conducive to planned strategy making are inductively generated to be *internal processes*, *negative economic situation*, *internal dissemination*, and *top-down pressure*. *Internal processes* played a role fairly often when processes such as prescribed project routines or corporate regulations had an influence on the strategy making work. *Internal dissemination* was an even more common sub-factor which was always found to play a role when results were communicated to a wider audience. For example, the final presentations of T4 and T5 were events which served to discuss their respective topics with a large number of interested colleagues and to thereby inform also more remotely affiliated people about the work. The two remaining sub-factors *negative economic situation* and *top-down pressure* are hardly found to have played a role.

The sub-factors driving emergent strategy making are *friendly, cooperative culture* and *positive economic situation*. The former was regularly found whenever colleagues went out of their way to help the core team on its strategy making work. For example, in the second half of the cooperation phase, P7 took up the issue of noise and started to integrate the thresholds in his own work. The latter was found seldom and did not seem to have a relevant influence on strategy making. Hence, the strong influence of the ORGANIZATION towards emergent strategy making is almost exclusively due to the helpful mentality that most staff showed, i.e. the *friendly, cooperative culture*.

The occurrence of the factor ORGANIZATION fluctuated over time as can be seen in figure 6.4. The teal-colored line shows the sub-factors of ORGANIZATION that made planned strategy making more likely while the green line shows the sub-factors driving emergent strategy making. Overall, the factor ORGANIZATION was a frequent influence in the first three months of the cooperation phase. After that, manifestations are less and less frequent until they reach a sudden second peak in January, 2013.

This trend is explained by the fact that *internal dissemination* activities, i.e. information events addressing an audience beyond the core team, were more common in the beginning of the cooperation phase and served to inform the participants of the planned research and to gain support for the sustainability

Figure 6.4: Manifestations of ORGANIZATION over time

work, and towards the end of the cooperation phase when the results were communicated. Furthermore, efforts were made to integrate sustainability considerations into processes within the project so that these requirements would remain in place even after the cooperation phase. These integration efforts also help explain the prevalence of the sub-factor *internal processes*. Overall, the contingency factor ORGANIZATION played an important role in the beginning and at the end of the cooperation phase. In between, there were scattered manifestations of mostly those sub-factors supporting planned strategy making.

6.3.2 Coverage in current research

The sub-factors of ORGANIZATION are not among the most discussed factors in the related literature. Rajagopalan et al. (1993) mention internal power structures which might be related to the sub-factors *top-down pressure* and *friendly, cooperative culture*. Furthermore, organizational culture is suggested by Simons and Thompson (1998). However, it is not clear in which direction these factors would be expected to influence the strategy-making process. Therefore, the predictive power of the sub-factors of ORGANIZATION is hardly

backed by existing research which is too sparse and hardly addresses the sub-factors used here.

6.3.3 Predictive power of the factor ORGANIZATION

In conclusion, the contingency factor ORGANIZATION played an important role for the strategy making process of the Action Research study. In particular, the sub-factors *internal processes*, *internal dissemination*, and *friendly, co-operative culture* frequently played a role. However, the predictive power of these sub-factors is hardly supported by existing strategy research. Therefore, the factor ORGANIZATION is tentatively supported by this dissertation but further research is needed in order to better understand this factor's influence on strategy making.

6.4 Decision making

As section 6.1 has already illustrated, the contingency factor DECISION MAKING was an infrequent influence on the strategy making activities at the innovation project.

6.4.1 Contingency factor analysis

Counting the manifestations of this factor's sub-factors over the 14 months of the cooperation phase shows no particular pattern, except a small peak in January, 2013. The contingency factor has one sub-factor that is expected to support planned strategy making, namely *perception as threat*. This sub-factor is found a few times in those events in which people stated that they perceived the risks associated with the sustainability issues as threats. The sub-factors driving emergent strategy making are *decision complexity* and *perception as opportunity*. Both these factors are hardly found to have played a role for the strategy making process.

It is therefore safe to infer that DECISION-MAKING PROCESSES within the innovation project hardly had an influence on strategy making. In the few instances this factor was observed, it was either in situations of complicated decision making, e.g. on LCA tools, or in meetings where sustainability issues

were perceived either as threats (e.g. by top manager M2 in the discussions about reputational risk associated with damage to biodiversity) or as opportunities (e.g. by project leader T2 in discussions about benefits of considering biodiversity issues early on).

The negligible influence of DECISION-MAKING PROCESSES is explained by two aspects. First, this contingency factor is difficult to observe because people might not always express or even be aware of themselves being influenced by particular decision-making processes. Second, decision-making processes may not have played a role simply because there were not many decisions to be made that were relevant to the Action Research study. After the cooperation had been decided upon at the end of the orientation phase, the emphasis of the cooperation phase was to develop a sustainability strategy, rather than to make new decisions about it.

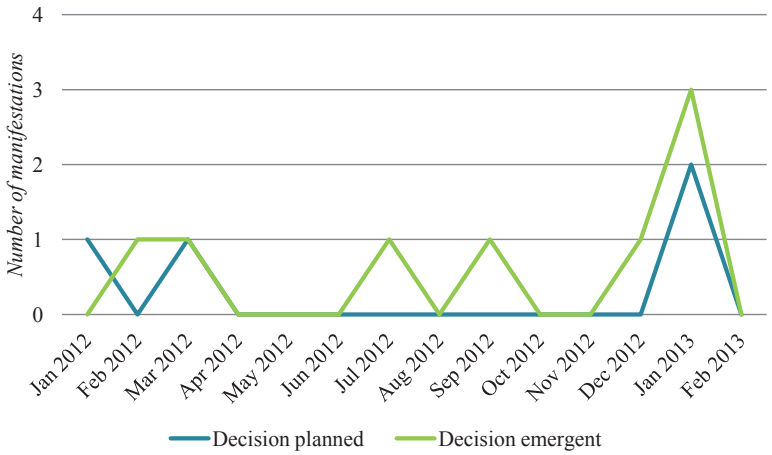

Figure 6.5: Manifestations of DECISION MAKING over time

Figure 6.5 shows the manifestations of sub-factors likely to lead to planned strategy as a teal-colored line, and those related to emergent strategy making as green line. On a low level throughout, the contingency factor DECISION MAKING has a small peak of relevance in January, 2013. This is due to the wrap-up events at the end of the active cooperation phase in which the fo-

cus topics were discussed with particular emphasis on future developments. In these events, the focus topics were sometimes framed as either threats or opportunities.

6.4.2 Coverage in current research

The perception of a decision as a threat or opportunity is discussed extensively by Dutton (1986) who argues that issues that are perceived as threats are addressed by more centrally steered activities than those perceived as opportunities. This backs up the relevance of the two sub-factors *perception as threat* and *perception as opportunity*. *Decision complexity* has been suggested as an important factor influencing strategy making although the direction of this influence remains unclear: Low decision complexity might make planned strategy making more likely because it enables fast decision making (Astley et al., 1982). However, it is also argued that complex decision-making processes might require planned strategy making (Elbanna, 2011; Nooraie, 2011). In total, these studies suggests that predictive power of the contingency factor DECISION MAKING is higher than that of ENVIRONMENT and ORGANIZATION, but it is still limited with regards to the sub-factor *decision complexity*.

6.4.3 Predictive power of the factor DECISION MAKING

To conclude, the contingency factor DECISION MAKING appears to be largely irrelevant for the strategy making process that took place at the innovation project. Yet, the predictive power of the sub-factors that are used is partially backed up by current research. However, this dissertation cannot add to a better understanding of the link between the factor DECISION MAKING and the kind of strategy making that is expected.

6.5 People

As elaborated in section 5.3.1 on page 106, the factor PEOPLE is developed out of the factor 'top-management characteristics' that is often referred to in strategy research. It is widened here in order to account for all Action Research participants. This extension is based on the insight that championing

activities of specific people were crucial for advancing sustainability at the innovation project, no matter whether it was top management, the innovation project heads, or other participants who became active. The contingency factor PEOPLE was the most frequent influence on the strategy making process of the Action Research study (see section 6.1).

6.5.1 Contingency factor analysis

As with the previous contingency factors, the manifestations of the sub-factors of the contingency factor PEOPLE that occurred during the Action Research study are counted. The contingency factor PEOPLE has three inductively generated sub-factors conducive to planned strategy making, namely *influence of top management*, *middle management implementing rules top-down*, and *people following rules*. None of these three played a major role although it can be said that the first two were a little more frequent. In general, pressure passed down from higher hierarchy levels was not a strong influence factor even when it occurred. For instance, the interest of M2 in biodiversity and his encouragement to keep working on this topic was perceived as top-down pressure but more in the sense of management attention than pressure to deliver a fast solution.

The sub-factors driving emergent strategies are *participants actively involved*, *middle management actively involved*, *participants (except T6) acting as champions*, and *researcher (T6) acting as champion*. All four sub-factors were quite common as can be seen in figure 6.6. This figure shows that the sub-factors related to planned strategy making were infrequent whereas those conducive to emergent strategies were on a high level all the time, albeit fluctuating.

Above all, *participants actively involved* is found in a large number of events, describing situations where participants contributed to the question at hand on their own initiative. Similarly, the initiative of *middle management* is frequently found in events in which the heads of project became actively involved, suggesting new ideas or otherwise supporting the strategy work. These first two sub-factors represent the active involvement of participants who made an effort to help the core team advance the sustainability strategy making process. These actively involved people were not primarily motivated to advance

Figure 6.6: Manifestations of PEOPLE over time

the sustainability agenda. Rather, they were collegial participants making an extra effort to support the team with their expert knowledge.

Beyond this active involvement, championing activities are also observed. Two sub-factors account for championing, namely *participants acting as champions* which includes championing activities of every participant (also middle management) except the insider-researcher T6, and the complementing factor *researcher (T6) acting as champion*. In order to separate the championing activities of the insider-researcher (T6) who had an additional motivation to keep the sustainability strategy making process going since it was part of her PhD, the fourth sub-factor *researcher (T6) acting as champion* was factored out for the calculations on which figure 6.8 on page 148 is based. Various incidents were observed when people started pushing for sustainability goals proactively. These championing activities were less frequent than the first two sub-factors of active involvement which is intuitive since championing is understood as one step beyond active involvement. Championing is an activity with which the champion aims at advancing sustainability as a worthy goal in itself because he or she is convinced of its importance.

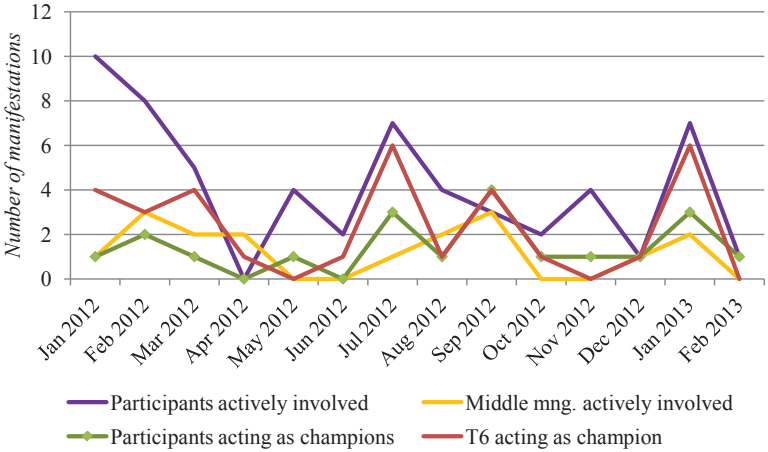

Figure 6.7: Degrees of involvement and championing over time

Figure 6.7 shows the developments of each of the four sub-factors driving emergent strategies over time. Evidently, manifestations of *participants acting as champions* became a bit more frequent over time. Reading this graph is a bit tricky since it has a zigzagging shape. In order to show how the degree of active involvement and championing activities changed over time, an aggregated illustration is helpful. Adding up the first two sub-factors *participants actively involved* and *middle management actively involved* to an overall indicator of 'active involvement' and adding up the latter two sub-factors *participants (except T6) acting as champions* and *researcher (T6) acting as champion* to an overall indicator of 'championing' helps illustrate the development over time.

As figure 6.8 shows, the level of active involvement was high in the beginning when many people got involved in the new sustainability study. During this period, the amount of championing was comparatively low because most champions were not active yet. The championing activities that were already in place go back to T6 as well as T3 who was an early supporter on behalf of the corporate environment department. In July and September, 2012 there were more championing activities than active involvement activities, and towards the end of the cooperation phase, the two were at the same level. Another look at figure 6.7 shows that the peak in September was mainly due to partic-

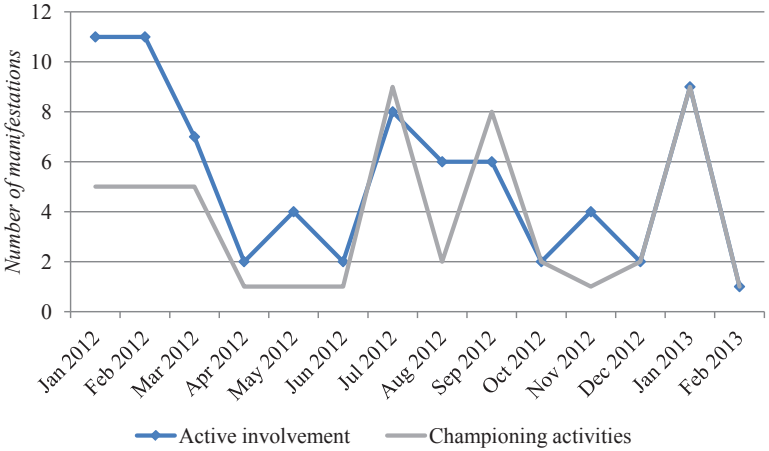

Figure 6.8: Active involvement and championing activities

ipants other than T6 taking the initiative. In July, 2012, and January, 2013, active involvement of participants as well as championing activities by T6 were frequent.

6.5.2 Coverage in current research

The top-management part of PEOPLE is stressed in the literature as an important influence on strategy making (see, e.g., Elbanna, 2011; Hambrick and Mason, 1984). Yet, whether this influence makes planned or emergent strategy making more likely is not resolved. With regards to the champions part of PEOPLE, the literature addressing contingency factors for strategy making is mostly blank. One exception are Simons and Thompson (1998) who suggest that upward influence and employee involvement have an impact, without however specifying the direction of this impact. In other research streams, champions are a common theme. For example, streams within the fields of organizational studies (e.g., Wright et al., 2012) and corporate sustainability (e.g., Anderson and Bateman, 2000; Taylor et al., 2012) suggest that champions are important drivers of emerging strategic change (see also section 3.2.1 of this dissertation).

6.5.3 Predictive power of the factor PEOPLE

To summarize, the analysis of the contingency factor manifestations indicates that the contingency factor PEOPLE was the most prevalent factor for emergent strategy making in the Action Research study. Its contribution to explaining planned strategy making was a lot smaller. Based on current research, the predictive power of the factor PEOPLE is high for the aspect of championing but rather low concerning the role played by top management. As a result, the predictive power of the factor PEOPLE is inferred to be high in the context of emergent strategy making by champions. The contingency factor is less powerful in explaining planned strategy making and the impact of top management.

6.6 Nature of the problem

Section 6.1 has shown that the prevalence of the contingency factor NATURE OF THE PROBLEM was moderate compared to the former four contingency factors. In this section, the newly developed contingency factor NATURE OF THE PROBLEM is discussed in three steps. In the first step (section 6.6.1), it is suggested that topic I fits the definition of a type 2 problem, i.e. a problem that is salient but not wicked, whereas topic II corresponds to a type 3 problem, i.e. a wicked but not salient problem. This is based on the manifestations of the contingency factor NATURE OF THE PROBLEM in the events of the cooperation phase.

Since current research on contingency factors does not address the factor NATURE OF THE PROBLEM, the second step (section 6.6.2) does not address the coverage in current research. Instead, the strategy making processes that took place for the two focus topics are compared and it is found that strategy making for topic I shows more characteristics of a planned process while strategy making for topic II is shaped by more emergent characteristics. This comparison is based on a direct analysis of the events for characteristics of strategy making, *not* on the analysis of the contingency factor NATURE OF THE PROBLEM.

In the third step (section 6.6.3), the analysis of the strategy making characteristics and the contingency factor analysis of NATURE OF THE PROBLEM

are brought together. It is shown that the two analyses arrive at the same result: The more salient problem, topic I, was addressed by more planned strategy making whilst the more wicked problem, topic II, was addressed by more emergent strategy making. This supports the predictive power of the new contingency factor NATURE OF THE PROBLEM.

The analysis of characteristics complements the search for sub-factor manifestations since it investigates the strategy making that took place with a different, additional approach. The evaluation of the influence that the contingency factor NATURE OF THE PROBLEM had on strategy making is therefore based on two building blocks: first, the analysis of the events for manifestations of the contingency factor NATURE OF THE PROBLEM, and second, the evaluation of the events for manifestations of strategy making characteristics. By combining two different approaches within one method, within-method triangulation is realized (Denzin, 1978; see also section 5.3.2 on page 111).

6.6.1 Contingency factor analysis

The propositions in chapter 3 have suggested that the strategy making mode depends on the nature of the problem addressed. While salient problems are expected to be addressed by planned strategy making, wicked problems are more likely to be addressed by emergent strategy making. With the help of the salience-wickedness matrix (cf. figure 3.1 on page 47), problems can be classified as different types. The focus topics of the sustainability strategy making process, i.e. the materials assessment (topic I) and the impacts on biodiversity (topic II), are analyzed with regards to their salience and wickedness and are classified as different problem types in the following.

Figure 6.9 shows the share of events for each topic in which manifestations of the two sub-factors of the NATURE OF THE PROBLEM, *salience* and *wickedness* were found. The *salience* of topic I was directly or indirectly discussed in 19% of the topic I meetings compared to 11% of the topic II meetings. The *wickedness* of topic I was an issue in 11% of the topic I meetings compared to 25% of the topic II meetings. While topic I was perceived as salient more often than as wicked, it was the other way around in the case of topic II. This can be explained by factors within the organization. First, the higher salience of topic I is explained by the fact that resource management has been institu-

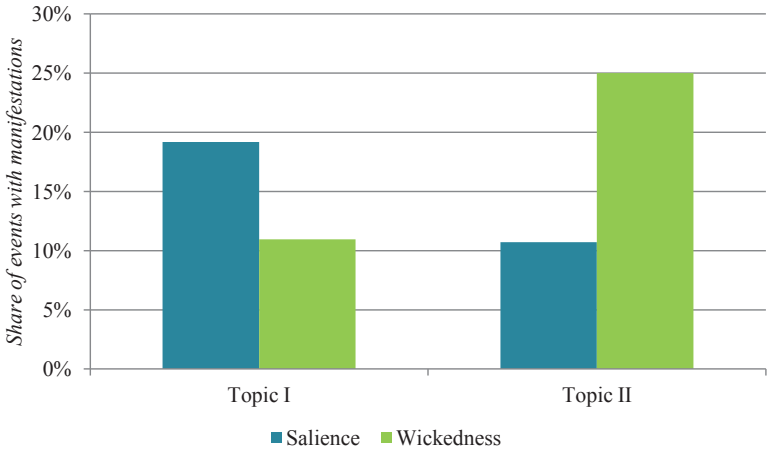

Figure 6.9: The nature of the two topics

tionalized at the company, particularly after external pressure had risen due to political developments such as the price fluctuations of rare earth metals. In this setting, it comes as no surprise that the sustainability of the material selection is seen as a salient issue, particularity by those who work with resource management in their daily jobs. In contrast, there is no institutionalization of biodiversity, indeed there is hardly any expertise on this topic at the company. Biodiversity loss is rarely perceived as a relevant problem for the company.

Second, it is safe to assume that topic II is seen as the more wicked problem due to the lack of internal expertise on biodiversity. Even the scientific research addressing questions of biodiversity only offers tentative explanations of cause and effect (see appendix B) and it seems that biodiversity is in fact a typical wicked problem as defined by Rittel and Webber (1973). In contrast, the level of expertise is high for topic I. Material science is part of most engineering curricula which suggests that the vast majority of employees have at least a basic understanding. Beyond this basic knowledge, various specialized departments exist within the corporate research section that work on materials questions exclusively. Hence, the level of internal expertise available for topic

I is a lot higher than for topic II which is likely to make topic I a more tangible and thus less wicked problem for most research participants.

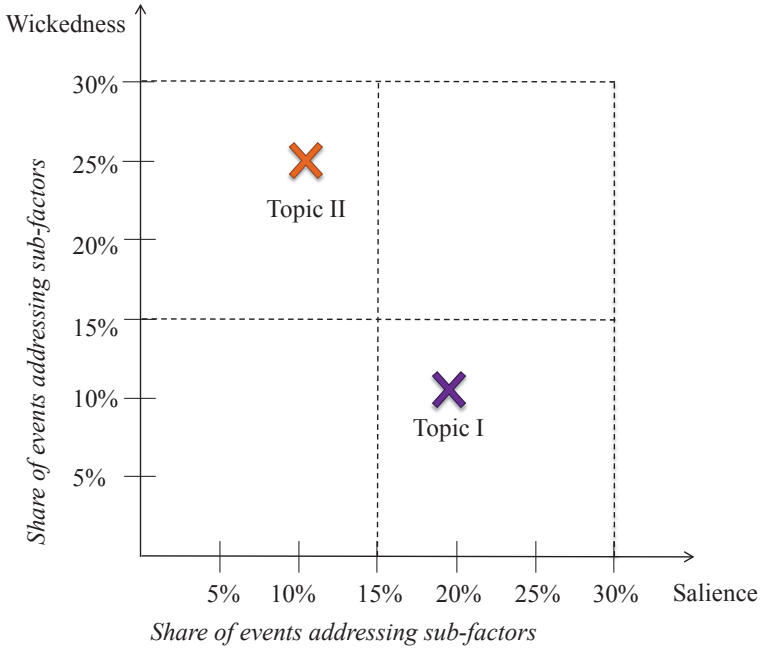

Figure 6.10: Topic I and II in the salience-wickedness matrix

In order to link back to the theory, the salience-wickedness matrix (figure 3.1 on page 47) is taken up again. In figure 6.10, the x-axis shows a salience scale and the y-axis a wickedness scale. Based on the share of events in which manifestations of the contingency factor NATURE OF THE PROBLEM were found, topic I was perceived as low to medium on the *wickedness* scale and as medium to high on the *salience* scale. In contrast, topic II was perceived as low to medium on the *salience* scale but as rather high on the *wickedness* scale. This places topic I in the lower right quadrant of problem type 2 (problems which are salient but not wicked) and topic II in the upper left quadrant of type 3 problems (those problems that are wicked but not salient). Even though neither topic I nor topic II are extreme cases as those discussed in

chapter 3, they are expected to be sufficiently different to be addressed by different strategy making modes.

The classification of topic I as a type 2 problem (a salient and not wicked problem) and topic II as a type 3 problem (a wicked but not salient problem) might require further explanation. It could be argued that both topics are better classified as type 1 problems, i.e. problem which are neither wicked nor salient, since both topics never reached more than 25% on the scale of events with manifestations (see figure 6.10 on page 152). If the scale was set from 0% to 100%, both topics would indeed end up in the lower left quadrant of type 1 problems. Three arguments justify the classification of the topics as it was done on a scale from 0% to 30%. First, the scales and the percentage shares should not be over-interpreted. Although they are backed up by hard numbers, these numbers rely on a data set that is too small to allow for statistical analysis. Instead, the numbers are used to show patterns and directions – they do not imply the shares to which the topics were perceived as salient or wicked by the research participants. In this sense, the shares of events between 11% and 25% define the continuum on which salience and wickedness are situated in the context of the Action Research study. Second, classifying topic II (negative impacts on biodiversity) as a wicked problem is justified by the state of the research on biodiversity. As the literature review, which was conducted as part of the strategy making process for topic II, shows, the problem of biodiversity loss is complex and far from being well understood (cf. chapter 5 and appendix B). If topic II is therefore accepted to be a type 2 problem, then topic I, which is less wicked but more salient than topic II, might well be a type 3 problem. Finally, since strategy making took place for both topics, neither of the topics is likely to be a type 1 problem for which no strategy making occurred. Thus, the scales from 0% to 30% show sufficiently well that the two topics differ with regards to both, salience and wickedness, so that different kinds of strategy making are expected.

6.6.2 Modes of sustainability strategy making

This section describes the second step of the evaluation of the predictive power of the contingency factor NATURE OF THE PROBLEM. Because there is no existing research on the NATURE OF THE PROBLEM as a contingency factor

for strategy making, this section uses a different approach than the previous sections 6.2.2, 6.3.2, 6.4.2, and 6.5.2, as explained in the following: Because topic I and II are located in different quadrants of the salience-wickedness matrix, it is expected that the strategy making modes by which they were addressed differ as well. In order to see which strategy making mode prevailed for each topic, manifestations of the characteristics are counted in each event directly, without referring to contingency factors. This analysis is done in parallel to the search for manifestations of contingency factors and their sub-factors. In the following, the characteristics of strategy making are defined based on research that describes possible strategy making modes. They are listed in table 6.1.

Table 6.1: Characteristics of planned and emergent strategy making

Planned strategy making	**Emergent strategy making**
Good understanding of the problem	Poor understanding of the problem
Formality	Informality
Official strategy	No strategy in place
Top-down movement	Bottom-up movement

Planned strategy making is characterized by a good understanding of the problem since it is assumed that only problems that are well understood can be addressed with strategic planning (Hart, 1992; Mintzberg et al., 1998). The formal strategic planning process that is established and being implemented is the second characteristic of planned strategy making (see, e.g., Ansoff, 1987; Mintzberg et al., 1998). Furthermore, if the strategy is a planned strategy, it is expected to be referred to as the official strategy since it will be communicated and implemented throughout the company. Finally, the overall movement of such a strategy making process is expected to be top-down (see, e.g., Hart, 1992; Mintzberg et al., 1998).

In contrast, an emergent strategy making process is expected to be shaped by poor understanding of the problem because poorly understood problems are more likely to be addressed by unplanned activities by those people who are affected by them rather than by central strategic planning (Burgelman, 1991). This poor understanding also implies that emergent strategy making allows

more for learning (Mintzberg and Waters, 1985). The interactions that are part of the emergent strategy making process are informal and spontaneous as they are not steered by a central authority (Idenburg, 1993; Mintzberg, 1990a). Furthermore, involved practitioners are expected to perceive that no strategy exists since an emergent strategy is often only recognized in hindsight (Idenburg, 1993; Mintzberg, 1990a). Finally, the overall direction of the strategy making is bottom-up (see, e.g., Mintzberg et al., 1998).

As noted before, these two strategy making modes represent the extremes of a continuum of strategy making modes. They are used to illustrate the continuum in between, notwithstanding that these extremes are improbable manifestations of strategy making in reality.

For this analysis, the Action Research events are examined with regards to manifestations of the eight characteristics of strategy making. The number of manifestations is counted for topic I and topic II events separately. The characteristics form four contrastive pairs which is why an event could only be assigned to one characteristic of each pair. For example, if one event was classified as formal, it could not be classified as informal as well.

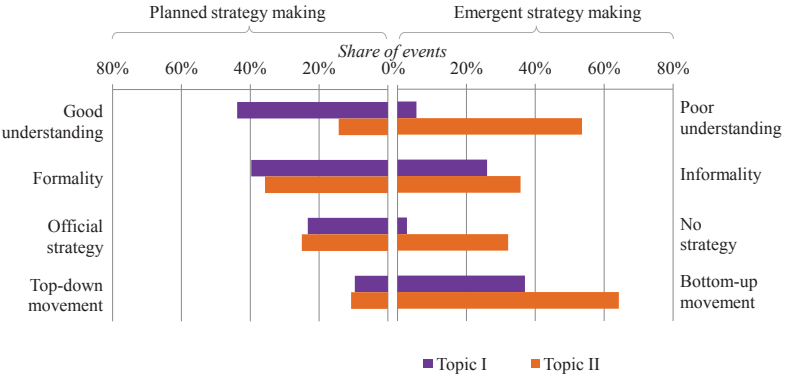

Figure 6.11: Characteristics of strategy making for the two topics

Figure 6.11 shows the manifestations of strategy making characteristics for topic I (represented by the purple bars) and topic II (represented by the orange bars). The numbers on which figure 6.11 is based are normalized with regards to the number of events that had taken place for each topic. The characteristics

of planned strategy making are shown on the left axis and the percentage share of events in which they played a role are marked by the bars facing to the left. On the right axis, the characteristics of emergent strategy making are shown in the same way. Note that not every event was assigned to one or many of the characteristics, some events did not fit any of them. This is why the total amount of manifestations of the characteristics within a contrastive pair is always below a total of 100% for each topic. The manifestations of the characteristics of strategy making are discussed for each topic as follows.

Level of understanding. Meetings in which participants discussed a topic at a high level of their expertise were counted as manifestations of *good understanding*. These were more frequent among topic I events due to the fact that a range of material experts were consulted during the workshops series. Furthermore, topic I was generally closer to the technological and material scientific expertise of the participants than topic II. Another reason is that during the cooperation phase, two graduate students contributed to a deeper understanding of topic I.

In contrast, events in which direct or indirect reference was made to a lack of understanding were assigned to *poor understanding*. It might be a psychological pattern that people tend to emphasize poor understanding more than good understanding. This would explain why there were more manifestations of poor understanding in total. With regards to strategy making for topic II, it should be noted that there were not any biodiversity experts or biologists at the core team or the innovation project. Essentially, topic II was outside the subject areas of all Action Research participants.

Formality and informality. Events that had a rather formal character are counted as manifestations of *formality*, including management meetings, milestone events such as the kick-off workshop at the beginning of the cooperation, and larger workshops with more than two participants, particularly those events that were officially organized by someone else than T6. Formal events were almost as frequent among topic I events as among topic II events. In the case of topic I, they were largely due to the officially planned and announced series of expert workshops with the corporate research section and the purchasing section. In contrast, the formality of topic II events stems from the mainly technological team meetings to which T6 was invited and a larger share of management meetings than in topic I events.

On the opposite end of the formality continuum, *informal* events are spontaneous discussions at the office or during a coffee break, for instance. These meetings also include meeting preparations and shorter one-to-one discussions. These were common in both topics but even more so in topic II events since most events in the beginning were discussions between T2 and T6. Formal topic II events became more common during the latter half of the cooperation phase when efforts were made to integrate sustainability targets into project goals and management was informed about the work on biodiversity for the innovation project. In contrast, there were many formal topic I events in the first half of the cooperation phase due to the workshop series with the material experts. In the latter half, there were more informal discussions about the model of materials and only a few more workshops with the innovation project staff.

Perception of strategy. Whenever event participants referred to official strategies in a way that was relevant to the strategy making work, e.g. by directly naming a strategic goal or by indirectly mentioning internal institutions or rules, this event is counted as a manifestation of the factor *official strategy*. To be precise, participants were often not referring to the process of sustainability strategy making as an official strategy but rather referred to an existing resource strategy outside the research project. This existing strategy had an influence towards planned strategy making in the sense that existing rules or goals could be adapted to the innovation project context. Also events in which long-term, strategic decisions concerning the innovation project's future were made or discussed are counted as manifestations of *official strategy*. This includes instances in which the official project planning process was adhered to and shaped the work on the focus topics and decisions about the future approach to sustainability at the project. This happened occasionally in both, topic I and topic II events. However, the strategically relevant content of topic I events tended to concern the corporate strategy with regards to resources whereas in topic II events, the subject of discussion was more frequently the future approach to biodiversity of the innovation project.

Events in which people discussed the lack of a strategy counted as *no strategy* manifestations. This was very rare in topic I meetings but happened regularly in topic II meetings which is intuitive because parts of topic I were already integrated at the company, e.g. through internal institutions and ex-

ternal partnerships. As opposed to this, biodiversity was not a part of any corporate-level strategy. This situation explains why the orange bar extends in both directions whereas the purple bar only extends to the left. In topic II meetings, the lack of strategic direction was discussed as well as the official *future* strategy that the project staff were about to develop. In the comparatively clear strategic setting of topic I, a lack of strategy was a rare topic of discussion.

Direction of movement. When top-down movements were noticed during events, e.g. when rules were implemented top-down, these events were counted as manifestations of the characteristic *top-down movement*. Top-down movements were an exception for both topics.

In contrast, events in which people tried to integrate topic I or II into processes or when long-term decisions in favor of topic I or II were made without any top-down pressure, these events are counted as *bottom-up movements*. *Bottom-up movements* are found frequently for both topics, although the share of topic II events influenced by bottom-up movements is far greater. *Bottom-up movements* are observed in a range of topic I meetings in which participants became actively involved or even started championing. This happened in topic II events as well which contributes to the higher share of bottom-up movement in topic II events. This higher share is furthermore explained by two additional reasons: First, since biodiversity is a topic that is not commonly discussed, let alone integrated into decision making at the company, much more pioneering work was done by T6 in order to convince the participants to take on the issue. These efforts are counted as bottom-up championing activities. Second, topic II consists of four sub-topics which were often discussed in separate meetings and for which separate *bottom-up movements* developed. These separate movements together account for the large share of *bottom-up movements* among topic II events.

To sum up, this section makes clear that the strategy making processes were quite different between topic I and topic II. On the one hand, the amount of manifestations of planned strategy making is similar for both topics except for the level of understanding. Here, topic I shows a much larger share of *good understanding* compared to topic II which has a markedly higher share of *poor understanding*. One the other hand, topic II had the large majority of manifestations of emergent strategy making characteristics. However,

also topic I events yielded several manifestations of *informality* and *bottom-up movements*. This shows that the strategy making process for topic I does not classify as purely planned but had elements of emergent strategy making as well. Compared to the work on topic II, it is merely the *more planned* process. In order to compare the nature of the two strategy making processes, the manifestations of the characteristics of planned and emergent strategy making are added up for each topic.

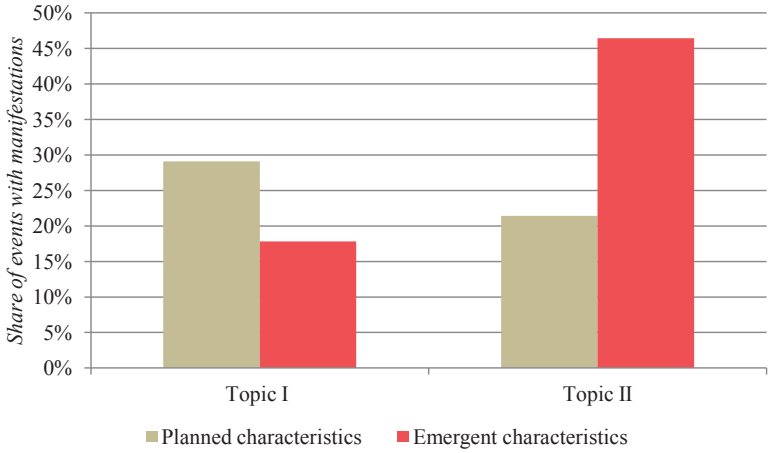

Figure 6.12: Summarized characteristics for the two topics

Figure 6.12 shows that topic I has more characteristics of planned strategy making while topic II is clearly dominated by characteristics of emergent strategy making. Just as the two topics are not extreme examples of salient and wicked problems, the respective strategy making processes were not extreme either. Instead, both topics were addressed by mixed strategy making processes whereby topic I was addressed in a more planned way and topic II in a more emergent way.

6.6.3 Predictive power of the NATURE OF THE PROBLEM

The fact that figure 6.12 looks similar to figure 6.9 on page 151 is no coincidence. Although based on different data, both figures serve to illustrate an

answer to the same question. Bringing together the results of the contingency factor analysis and the characteristics analysis, i.e. the insights of the two preceding sections 6.6.1 and 6.6.2, the predictive power of the newly suggested contingency factor NATURE OF THE PROBLEM is assessed from two angles.

The analysis of the events with regards to manifestations of the contingency factor NATURE OF THE PROBLEM shows that topic I was seen as the more salient and topic II as the more wicked problem. The complementary analysis of the strategy making characteristics indicates that topic I was addressed by more planned elements of strategy making while topic II was addressed in a more emergent way. Bringing together these two results, it is concluded that the more salient problem tended to be addressed with a more planned strategy making process while the more wicked problem was dealt with in a more emergent way.

Both analyses together therefore lend support to the assumption that a relation exists between the contingency factor NATURE OF THE PROBLEM and the strategy making mode. In so doing, they support the propositions put forward in chapter 3. The first proposition suggests that more wicked problems are addressed by more emergent strategy making, the second proposition holds that more salient problems are expected to be addressed by more planned strategy making. This is exactly what the two analyses discussed above suggest: The contingency factor NATURE OF THE PROBLEM has rightly proposed the type 2 problem (topic I) to be addressed by a (rather) planned strategy and the type 3 problem (topic II) by a (mostly) emergent strategy.

6.7 Contributions to research

In the following, seven contributions that this dissertation makes to research are discussed. The first three contributions stem from the theoretical part of the dissertation, the following three from the application of the theoretical framework to the empirical data. The last contribution is relevant to the methodological research on Action Research as well as to management research in general. At the end of this section, table 6.2 offers an overview of the

contributions and the research streams to which they are suggested to be relevant.

The theoretical groundwork of this dissertation is the sustainability understanding that has been deduced from four natural science research streams in chapter 2. Physics, biology, chemistry, and engineering science have been analyzed for their approaches to sustainability. The common-denominator definition of sustainability reads as follows: *Sustainability means (1) operating within the global system boundaries and (2) adopting a far-sighted orientation that considers both current and future generations.* While the first aspect stems from the natural sciences themselves, the second aspect has been adopted from the humanities. This understanding has served as a basis for both the conceptual work (see chapter 3) and the empirical work (see chapter 5 and 6). Sustainability has been discussed from multidisciplinary angles before (Cabezas et al., 2003; Geels, 2010; Gutowski, 2011) but not with a focus on the natural sciences. The natural-science based multidisciplinary review is argued to be particularly relevant to the context of sustainability in manufacturing companies. Furthermore, it demonstrates that even in the natural sciences, the justice element of sustainability is referred to although it cannot be deduced from the natural sciences themselves. This might be interpreted to show that the concept of sustainability has been spread widely and is understood in comparable ways across the sciences.

In chapter 3, it has been argued that the current understanding of sustainability strategy making is under-developed because it assumes that these strategies are exclusively planned (e.g. Banerjee, 2002; Roome, 1992). In doing so, sustainability overlooks the likely possibility that they are made in an emergent way. Attention has been drawn to this gap and it has been suggested that sustainability strategy research would benefit greatly if it recognized that sustainability strategies are not necessarily made in a planned way. A more realistic understanding of sustainability strategy making can be obtained if the entire continuum from planned to emergent strategy making is taken into account.

Furthermore, it is argued that in addition to the four sets of factors proposed by former studies, sustainability strategy making is affected by problem-specific factors, namely the wickedness and the salience of the sustainability problem to be addressed (e.g. Mitchell et al., 1997; Rittel and Webber, 1973;

Rotmans, 2006). A new contingency factor is put forward to explain how the NATURE OF THE PROBLEM influences the strategy making mode in the context of sustainability strategies (chapter 3). While high levels of wickedness tend to elicit emergent strategies, high levels of salience increase the likelihood of planned strategy making. The contingency factor NATURE OF THE PROBLEM is suggested as particularly useful for understanding the making of sustainability strategies because sustainability issues can be very salient and very wicked. This factor is suggested as a contribution to sustainability research. Moreover, it might be relevant beyond the sustainability realm. Other strategic problems might also be more or less salient and more or less wicked. The new contingency factor might help understand whether such problems are therefore more likely to be addressed with a more planned or more emergent strategy. In this way, this factor is suggested to be a helpful contribution to the research on strategy formation as well.

The analysis of contingency factors has been an integral part of this dissertation. Applying the insights of this analysis to practice generates further contributions. Four sets of contingency factors were identified in the current strategy literature, i.e. the company's ENVIRONMENT, the ORGANIZATION itself, DECISION MAKING processes, and 'top-management characteristics' (inter alia, Dutton, 1986; Elbanna, 2011; Elbanna and Child, 2007a; Hart, 1992; Rajagopalan et al., 1993). The latter is found to be incomplete since it can only explain planned strategy making. In order to account for emergent strategy making as well, this factor is extended by the influence of champions which have been extensively discussed in management and organizational research but not yet as a contingency factor for strategy making (chapter 5). The amended contingency factor PEOPLE includes sub-factors that make either planned or emergent strategy making more likely and is suggested to be a more significant factor than 'top-management characteristics' alone. This amended factor is suggested to be relevant for research on sustainability strategies and also for strategy research in which the impact of champions has not been recognized as a potentially crucial contingency factor.

The predictive power of all five contingency factors has been evaluated based on current research in chapter 3. In addition, the inductively generated sub-factors of each contingency factor have been evaluated based on the literature as well as with regards to their relevance in the Action Research

study (chapter 6). The sub-factors of ENVIRONMENT and ORGANIZATION are hardly covered by current strategy research. A few similar factors are identified but their influence on strategy making is also far from established (e.g. Hart, 1992; Rajagopalan et al., 1993; Schilit and Paine, 1987; Simons and Thompson, 1998; Slawinski and Bansal, 2012). The sub-factors of DECISION MAKING and PEOPLE are partially addressed in current research (e.g. Anderson and Bateman, 2000; Dutton, 1986; Elbanna, 2011; Enroth, 2007; Simons and Thompson, 1998). Therefore, some research has been conducted to support their predictive power which is therefore likely to be higher than that of the former two factors. In the Action Research study, the factors ENVIRONMENT and DECISION MAKING had a negligible influence on the two strategy making processes. In contrast, the ORGANIZATION and PEOPLE dominated. Hence, this dissertation lends strong support to the relevance that the contingency factor PEOPLE has, and some support to the relevance that the factor ORGANIZATION has for strategy making processes. It does not offer implications about the factors ENVIRONMENT and DECISION MAKING since these are hardly found to have played a role in the empirical part. In addition, the predictive power of the newly suggested factor NATURE OF THE PROBLEM is evaluated as well (chapter 6). Since there is not yet any existing research on the influence of this factor on strategy making modes, its predictive power cannot be analyzed in the same way as that of the other four factors. Instead, the two strategy making processes (for topic I and II) are analyzed based on eight characteristics describing planned and emergent strategy making. The analysis of the contingency factor's relevance to the Action Research study is conducted in the same way as for the established contingency factors. Based on these two analyses, the predictive power of the factor NATURE OF THE PROBLEM is tentatively suggested to be high. However, future research needs to verify the relevance of this new contingency factor. To sum up, this contribution consists in having evaluated the existing four and the new contingency factor based on existing research as well as on the role that they played in the Action Research study. This might provide interesting insights for strategy research as well as for sustainability research about these factors' strengths and weaknesses. For example, the importance of the factor ORGANIZATION found in the empirical data is not matched by the coverage of the applied sub-factors in current research. Hence, this dissertation suggests that this factor might play

a role based on an inductive finding which would be interesting to evaluate by further research.

As a further contribution to research, this dissertation suggests that the making of sustainability strategies critically depends on sustainability champions (cf. Anderson and Bateman, 2000; Enroth, 2007; Markusson, 2010; Prakash, 2001; Taylor et al., 2012) which appears to be a far more important factor than, for example, the economic situation of the company or pressure by external stakeholders (chapter 6). Although the results of this dissertation cannot be generalized, it presents an unambiguous case in which the personal commitment of individual people is the most important strategic factor. Particularly in the context of wicked problems for which top-management attention and centrally planned actions are missing, the starting point of a sustainability strategy is most likely to be found at the micro level of strategy making, i.e. in the activities of individual people, regardless of their hierarchical position. These insights are strongly supported by the triangulation student thesis (Kärsten, 2014). Hence, this dissertation indicates that sustainability champions might be important prerequisites for the formation of corporate sustainability strategies.

Finally, this dissertation offers a contribution to methodological research as well. Action Research is still an unconventional methodological choice in the research field of management (e.g. Coughlan and Coghlan, 2002; Näslund, 2002). This dissertation provides one example of a longitudinal study that has successfully been conducted within a company. It demonstrates that Action Research is a suitable methodological fit for insider-researchers investigating complex organizational change processes such as sustainability strategy making. This aims at contributing to enhancing the reputation and recognition of Action Research as a valid method which may offer insights to the research field of management that go beyond those acquired with conventional methods.

In table 6.2, the contributions of this dissertation to different fields of research are summarized.

Table 6.2: The contributions to research

Contributions	Relevant for...
The sustainability understanding developed in chapter 2 is suggested as a common denominator on which corporate sustainability strategy making can be based.	Corporate sustainability research
The gap in current sustainability research which overlooks emergent strategy making is pointed out (chapter 3).	Corporate sustainability research
The NATURE OF THE PROBLEM is suggested as a new contingency to influence strategy making modes (chapter 3).	Corporate sustainability research; strategic management research
The existing contingency factor 'top-management characteristics' is extended by the championing aspect in order to account not only for planned but also for emergent strategy making (chapter 5).	Corporate sustainability research; strategic management research
The predictive powers of both the existing four contingency factors and the newly suggested one are evaluated based on strategy research as well with regards to their relevance to the empirical part of this dissertation (chapter 6).	Corporate sustainability research; strategic management research
Champions are suggested to be a decisive factor for emergent corporate sustainability strategy making (chapter 6).	Corporate sustainability research
Action Research is argued to be a useful method for management research, particularly for insider-researchers (chapters 4, 5, and 6).	Action Research; management research

6.8 Limitations

This section addresses the theoretical, methodological, and practical limitations of this dissertation, including a critical reflection of the way in which the method was used for the empirical part of the dissertation.

Theoretical limitations. The issue of sustainability strategy making could have been addressed from a different theoretical angle. Even though various perspectives on sustainability and sustainability strategy making have been taken on throughout this dissertation, many more have been neglected. For example, in lieu of the contingency factors of strategy making the analysis

could have targeted internal and external sustainability drivers or could have analyzed other units of analysis, such as the top management level. One particularly promising perspective could have been the resource-based view which addresses organizational change processes as a question of available resources, including inter alia human resources (Barney, 1991; Wernerfelt, 1984). Sustainability strategy making could have been analyzed as a question of appropriate resources which may have yielded further insights into champions and knowledge. Also the idea of dynamic capabilities may have offered worthwhile routes of research. Dynamic capabilities are "high-level routines" (Winter, 2003, p. 991) that shape a company's internal change processes and strategy making (Eisenhardt and Martin, 2000). From this perspective, sustainability strategy making might be understood as a potential dynamic capability which is to be developed in order to substitute ad-hoc strategic responses to sustainability challenges.

Within the chosen theoretical framework, the interconnections between all five contingency factors could have been an interesting question for examination. While the contingency factors were addressed in isolation in this dissertation, it is more than likely that they interact and depend on each other. For example, the factor PEOPLE, including both champions and top management, is expected to affect the organizational context, i.e. the contingency factor ORGANIZATION, in which sustainability strategy may or may not take place.

Methodological limitations. Action Research is the chosen method of this dissertation because it allows for investigating a complex organizational change process such as the formation of a sustainability strategy in great depth. By choosing Action Research, the drawbacks that this method brings with it are accepted. These include the individual research design which makes it impossible to repeat the study, as well as the personal involvement of the insider-researcher which requires extensive documentation in order to make the study's results accessible for a wider audience.

Action Research was used as a method for analyzing the formation of a potential sustainability strategy at an innovation project. This unit of analysis was chosen mainly for two reasons: First, innovation projects might be used for trying out new strategic directions and might in this way mirror strategic developments at higher levels of the company. Second, they are more accessible for researchers than the top management level. Yet, it could be pointed

out that strategy is usually understood as corporate strategy, i.e. the overall strategy decided by top management. This level is indeed not covered by choosing an innovation project as the unit of analysis. However, the view that strategies are necessarily 'corporate' strategies is challenged in this dissertation. The likely possibility that strategies are also made in an emergent way at lower levels implies that strategies can be context-specific, i.e. valid for lower levels of the company such as business units, departments, or innovation projects.

Overall, Action Research was used successfully in the sense that both, theoretical contributions and an improvement of practice could be obtained. A network of various people participated in the study, the researcher gained an insider understanding of the innovation project context, and a few people even became actively involved as sustainability champions. However, the use of Action Research only partially succeeded in creating "enduring organizational change" (see chapter 4). Despite external influences such as budget constraints and changed targets that were implemented top-down and beyond the influence of the researcher and the team, the study may have been more successful at creating enduring change if the number of researchers involved had been higher. The core and project team together counted 16 people of which only one (the researcher) was engaged in the research part of Action Research. This induced an imbalance between the research goals and the action goals and between the innovation project goals and the sustainability goals.

An alternative to Action Research may have been a case study approach which would have required the researcher to stay detached as an observer. This method could have been advantageous to investigate and compare strategy making at multiple innovation projects. However, it would not have allowed for the same depth of understanding of the individual contingencies of strategy-making processes at each project. Moreover, a case study approach would have required ongoing strategy making processes at multiple projects without the researcher initiating them. In the orientation phase, a range of sustainability-relevant projects were sought – however, none of them already addressed sustainability as a strategic issue. Hence, this limitation is more a theoretical one because in reality, a case study approach would not have been feasible to address the research question at hand. Furthermore, the focus on

one innovation project has been balanced by the triangulation efforts described in section 5.3.2.

Finally, a comprehensive understanding of sustainability as brought forward in chapter 2 includes social aspects and is not limited to environmental topics only. In this sense, sustainability has not been addressed in its entirety in the empirical part of this dissertation. The core team decided to focus on ecological sustainability issues which appeared more relevant to the innovation project at the time. Letting the participants decide is part of Action Research even if it means that sustainability cannot not addressed comprehensively. Apart from that, researchers addressing corporate sustainability can hardly ever raise claims to completeness as sustainability includes far more issues than can be addressed by empirical studies.

6.9 Implications for practice

Companies that aim at strengthening their overall sustainability performance can benefit from several insights of this dissertation. In order to obtain sustainability strategies that address sustainability holistically, including salient and wicked problems, this dissertation suggests that both, planned and emergent strategy making are needed. For top management, planned sustainability strategy making is likely to be a more or less familiar task whereas encouraging emergent strategy making might represent a challenge. It should be noted that the contributions to research and the implications for practice overlap to some degree. Since in this dissertation, action and research have been pursued simultaneously, the theoretical work has been informed by the empirical experiences and vice versa. The following five implications are suggested to be relevant for practice.

As a first implication, the sustainability understanding put forward in chapter 2 is argued to be particularly applicable to engineering companies in which the majority of staff have a natural-science or engineering background. Such a commonly agreed upon understanding is argued to be a necessary starting point for both, the successful implementation of planned sustainability strategies and the successful formation of emergent sustainability strategies. The Action Research study conducted in this dissertation has shown that provid-

ing such a starting point enables a common understanding of sustainability within a team and enables discussions that can lead to some people taking on a championing role. Although it is impossible to measure the exact influence that the sustainability understanding had on the participants, it clearly served as a basis for discussion and helped get everyone on board.

This dissertation has demonstrated the use of Action Research for advancing sustainability at an innovation project. Potentially, Action Research might be a useful method for sustainability champions if they have a research interest in addition to their interest in advancing sustainability. Particularly when an innovation project starts working on its sustainability strategy, a champion acting as an action researcher might be able to stimulate the strategy making process if he or she engages in research and reflection as well. The example of the strategy making work on topic II suggests that a researcher providing a background study can contribute to a better understanding of wicked problems of the Action Research team.

The analysis of the Action Research study has made clear that the championing sub-factors of the contingency factor PEOPLE were the single most important influence in the sustainability strategy making process. This has been supported by both triangulation studies, the web survey and the student thesis (Kärsten, 2014). This dissertation suggests that the formation of emergent sustainability strategies imperatively requires motivated and proactive sustainability champions in order to gain momentum. This is a main implication for which a lot of evidence was found. It is therefore elaborated in more detail as follows.

The experience of this dissertation suggests two particular aspects. One is that a sustainability champion should remain independent of the project goals in order to avoid conflicts of interest. Most likely, sustainability goals compete with other goals in an innovation project, particularly with time, cost, and customer requirements. It is therefore important that champions find a way of aligning these competing goals by framing their issues as advantages (Markusson, 2010). The other aspect is that champions are most likely to be successful if they accompany their project(s)[7] over a long period of time.

[7] Based on the Action Research study that was conducted, innovation projects are suggested as a starting point for a network of champions to address. This is not to say however that other units could not equally benefit from working with sustainability champions. For

Their goal should be to advance and to assess the sustainability contribution of each project specifically. For instance, projects addressing renewable energy generation are likely to face different sustainability challenges than projects developing a robotics software.

The question arises if companies can encourage championing which is by definition an activity that happens independently of top-down control. Top management might be interested in supporting emergent strategy making because it enables sustainability strategies that cannot be planned, such as strategies to address wicked problems. In the words of Mintzberg and Waters (1985, p. 271), top management is encouraged "to surrender control to those who have the information".

The first step in supporting championing is identifying the champions. As a reminder, champions are defined as people who "identify with the idea as their own, and with its promotion as a cause, to a degree that goes far beyond the requirements of their job" (Schön, 1963, p. 84) and they "can and actually do develop independent strategic premises based on their visions and intentions" (Noda and Bower, 1996, p. 189). Since the championing activities go beyond what is required by someone's job description, champions cannot be identified by searching for formal criteria such as their official positions. In contrast to "formal leaders" who have management positions, champions are "emergent leaders" who have not been assigned an official leadership position for their championing activity (Howell and Higgins, 1990; Taylor et al., 2012). Therefore, they are likely to be known for their engagement in their specific environment and are more likely to be found by asking around.

Supporting champions can be a balancing act for top and middle management. On the one hand, champions are likely to require a certain level of authority to be able to assert the relevance of the sustainability goals. On the other hand, over-institutionalizing champions is likely to be counter-productive (Howell and Higgins, 1990). To illustrate, if champions start to assume responsibility for sustainability goals that are defined by top management rather than remaining the project-specific strategy makers on site, they become part of planned strategy making. It is therefore crucial to concede champions a high degree of discretion and leeway to enable them to find context-specific

example, champions could also help advance sustainability in the company's supply chain or its production sites.

strategic solutions for sustainability problems which cannot be addressed by planned strategy making.

Continuing to the next implication for practice, it is argued that a lack of knowledge might hamper strategy making altogether. If a problem is too wicked and therefore too poorly understood, it might become a non-problem for which no strategy will form. The example of topic II (biodiversity loss) during the Action Research study illustrates that addressing a topic for which hardly any expertise is available is a lot more difficult than addressing a topic that is reasonably well understood (such as topic I). The lack of knowledge concerning biodiversity at the company explains why the strategy making process for topic II took off slower. To prevent important but complicated sustainability challenges from disappearing into thin air, multidisciplinary exchange with experts within and/or outside the company is needed. If knowledge can be created this opportunity should be used in addition. For example, the planned study on biodiversity impacts of the wave energy converter that was to be conducted by an external institute on particular locations would have created new knowledge about the impacts of energy parks on marine biodiversity. For champions, this implies that they should be organized in networks. The Action Research study suggests that champions work effectively if they are part of a multidisciplinary internal and external network. In the case of the strategy making process at the innovation project, the network extended well beyond the boundaries of the core team and the innovation project. This implies that sustainability champions should not be left to work in isolation but should be encouraged to cooperate with each other. This also indicates that when hiring sustainability champions, people from a wide range of different subject areas should be pursued in order to cover as many sustainability topics, i.e. ecological, social, and long-term economic ones, as possible. In this way, the lack of knowledge that is likely to exist concerning many sustainability problems, particularly the more wicked ones, might be alleviated.

Finally, the researcher has gained a certain degree of insider understanding concerning the innovation project and its approach to sustainability. Since action researchers are explicitly encouraged to use unconventional forms of knowledge, the following implications are suggested based on this insider understanding. Based on the web survey as well as many oral statements by participants during the cooperation phase, the sustainability performance of the

company would benefit greatly if sustainability criteria were made a mandatory requirement of the pre-defined project milestones in the innovation and development processes. If sustainability targets played a similar role for the success or failure of an innovation project as conventional criteria such as cost and time requirements, the sustainability performance of the company would likely increase significantly. Furthermore, linking middle management remuneration to the attainment of sustainability goals is also seen as an effective way of strengthening sustainability. While a vision exists at the symbolic, top management level of the company and sustainability champions either exist or can be motivated, middle management is in between. Many of the interviewees taking part in the study by Kärsten (2014) suggested that middle management often did not support sustainability ideas unless they offered short-term economic benefits as well.

To sum up, this dissertation has five main implications for practice which are relevant for sustainability officers, for sustainability champions at all levels of the hierarchy, and for top and middle management. Table 6.3 provides an overview.

6.10 Future outlook

Several questions have remained open or have been uncovered in this research. The following list is not meant to be complete but aims at highlighting exemplary questions that might be particularly interesting for future research.

First, the four contingency factors that were identified as established in current strategy research are largely under-specified. Particularly, their influence on whether planned or emergent strategy making is more likely is still unclear in most cases. This is true for both, the contingency factors as well as their sub-factors, including the inductively generated sub-factors that have been used in this research. Further research is needed in order to help better understand the role that each contingency factor plays for strategy making.

Second, the new contingency factor NATURE OF THE PROBLEM is based on a conceptual framework and has been applied to theory and practice in the context of this dissertation. In order to evaluate its relevance, future research could advance this framework and could apply it to different empirical con-

Table 6.3: The main implications for practice

Implications	**Relevant for...**
The sustainability understanding defined in chapter 2 is proposed as a starting point for sustainability strategy making.	All company staff; actors of planned and emergent strategy making
Action Research might be a useful method for independent sustainability champions if they combine a research interest with their sustainability mandate (chapter 4)	Champions; middle management
Champions are one, potentially the most important factor driving sustainability strategy making. Ideally, they work independently of the unit of analysis for which the sustainability strategy is made but accompany this unit throughout its life time. Champions should be provided with both, leeway and authority (chapters 3 and 6).	Top and middle management; Human Resources
A lack of knowledge might hamper sustainability strategy making; therefore, sustainability champions are most successful if they are part of a multidisciplinary network.	Top and middle management
A promising measure to strengthen planned sustainability strategy making would be to integrate sustainability targets into pre-defined project milestones and to couple middle management remuneration with sustainability targets (chapters 5 and 6).	Top management

texts. Also, the contingency factor might be relevant beyond the sustainability realm. Future research could investigate whether the salience and wickedness of a problem is relevant for the making of other kinds of strategies.

Third, investigating strategy making for a type 4 problem, i.e. a problem that is both, highly salient and highly wicked offers another interesting route for future research. In order to shed light on the relationship between salience and wickedness and to test the hypothesis that planned strategies will dominate in the case of a type 4 problem (see chapter 3), further research is necessary.

Fourth, it is safe to assume that the different contingency factors interact with each other. Notwithstanding that considering all these interactions and

mediating effects would be a very ambitious project, studies considering at least some of them would greatly improve the scientific understanding of what influences strategy making.

Fifth, the insights of this dissertation regarding corporate sustainability strategy making need to be tested in different contexts, including e.g. other units of analysis and other organizations. Particularly, the contingency factors ORGANIZATION and PEOPLE are expected to vary if different organizations are considered.

Sixth, the exploratory research conducted in the context of this dissertation could be developed further from a different methodological perspective. For example, either a qualitative study investigating a large number of innovation projects or a quantitative study addressing a large sample could offer additional insights. The latter could be particularly useful in order to shed more light on the interconnections between the contingency factors.

Finally, further Action Research studies could provide additional examples of strategy making processes. If multiple Action Research studies were conducted on the formation of corporate sustainability strategies this would yield in-depth insights into multiple (sustainability) strategy making processes which would then be comparable to each other. As Herr and Anderson (2005, p. 128) argue, if Action Research studies are conducted more widely, they have the potential to "inform the knowledge bases of our fields of study".

Chapter 7

Conclusion: The prospects of sustainability strategy making

"Unless we change direction, we are likely to end up where we are going."
Chinese proverb

The main insights of this dissertation are resumed in this chapter, particularly highlighting the approach of the dissertation and the relevance of its implications for theory and practice. To conclude, attention is drawn to the future prospects of sustainability strategy making.

This dissertation has argued that the prevalent understanding of sustainability strategy making in the sustainability literature is incomplete because it overlooks the state of the art in strategy research. There, a consensus has been established that strategy making is made neither in a purely planned nor in a purely emergent way but is likely to reside on a continuum between these two extremes. A range of contingency factors are suggested to explain when planned and when emergent strategy making is more likely. Yet, sustainability research hardly addresses the *formation* of sustainability strategies and tends to assume that they are made in a purely planned way. In this dissertation, it is argued that purely planned strategies are particularly unlikely in the case of sustainability because it represents a highly complex and long-term issue. The goal of the dissertation is to contribute to filling this gap.

7.1 Research process of the dissertation

In the following, the approach taken to investigate sustainability strategy making is summarized. As a first step, a sustainability understanding was deduced from four natural science streams in order to provide a starting point for sustainability strategy making. The focus on the natural sciences is promising because most staff at Bosch, the company in which the empirical part of this dissertation was conducted, have natural science backgrounds. Therefore, a sustainability understanding that is compatible with the natural science education of most people at the company is likely to prevail. Such a shared understanding is seen as a prerequisite for the successful formation of a sustainability strategy.

In order to address the gap in sustainability research regarding the formation of sustainability strategies, a theoretical framework was suggested to analyze when more planned or more emergent sustainability strategies are to be expected. This framework builds on five contingency factors. Four of these were found in current strategy research. They are the company's ENVIRONMENT, the ORGANIZATION itself, the DECISION MAKING processes that take place in parallel, and PEOPLE. The factor PEOPLE was inspired by current research but amended to fit the context of this dissertation. Furthermore, the NATURE OF THE PROBLEM was suggested as a new contingency factor describing the salience and wickedness of a problem. While salient problems are argued to be more likely addressed by planned strategy making, wicked problems are expected to elicit emergent strategy making. Problems that are both, highly salient and highly wicked, are expected to be addressed by both strategy making modes with planned dominating. For example, reducing CO_2 emissions is argued to be a salient but not wicked problem for which planned strategy making is appropriate. Setting a corporate reduction target and implementing it throughout the company is feasible. In contrast, a wicked but not salient problem such as biodiversity loss is suggested to be more likely addressed by emergent strategy making at the local level. For instance, rather than setting up a planned strategy to address biodiversity loss (which this dissertation argues is hardly possible), the impacts of a particular product on biodiversity at a particular location can be addressed by context-specific emergent strategy making.

In addition to the theoretical and conceptual work, the process of sustainability strategy making was investigated empirically. Because sustainability strategy making is a complex organizational change process about which not much prior knowledge exists, an exploratory method was chosen. Action Research is such an exploratory method which allows the researcher to gain insights of great depth because he or she is part of the change process under investigation over a longer period of time. The main feature of Action Research is that it aims at making two contributions at the same time: one to scientific knowledge and one to practice. In the Action Research study that was conducted in cooperation with an innovation project at Robert Bosch GmbH, the researcher accompanied a sustainability strategy making process over a period of active cooperation of 14 months. The sustainability understanding defined at the beginning of this dissertation was used as the starting point for this strategy making process.

The data set generated from the Action Research study (consisting of protocols, event- or project-related files such as presentations that were used during meetings, general notes, entries in the reflective diary, calendar items, and e-mails) was evaluated with regards to the influence that the five contingency factors had on the process. The events and contents of the orientation phase, the cooperation phase, and the evaluation phase of the Action Research study were documented in detail in order to make the empirical part of this dissertation transparent and easily accessible.

The strategy making process at the innovation project was influenced by the five contingency factors, albeit not by all to the same extent. The factors ENVIRONMENT and DECISION MAKING were hardly ever observed in the Action Research events. The newly suggested factor NATURE OF THE PROBLEM played a moderate role, and PEOPLE and ORGANIZATION were the most prevalent factors. The factor ORGANIZATION explained mostly planned strategy making whereas the factor PEOPLE was the most influential for emergent strategy making. The NATURE OF THE PROBLEM was found to have played a moderate role but its predictions were supported by the data analysis of the Action Research study.

7.2 Implications and relevance

The implications of this dissertation stem from three different stages of the dissertation: the involvement with theory, the application of theory to practice, and the empirical experiences. Their relevance is highlighted in the following.

Involvement with theory. This dissertation has made a range of theoretical contributions, starting with the multidisciplinary review of sustainability understandings in the natural sciences. This common-denominator definition of sustainability sheds light on the way the natural sciences approach sustainability and offers a starting point for research on corporate sustainability as well as for sustainability strategy making in corporate practice.

Furthermore, a conceptual framework of sustainability strategy making was proposed as a contribution towards narrowing the research gap in sustainability research which hardly addresses the formation of sustainability strategies. Part of this framework is the newly suggested contingency factor NATURE OF THE PROBLEM, proposing a link between the nature of the problem which is addressed by a strategy, and the strategy making mode. It was argued that salient problems are more likely to be addressed by planned strategy making whereas wicked problems are expected to be addressed by emergent strategy making. This framework represents a contribution to both, sustainability and strategy research. For sustainability research, it sheds light on the formation of sustainability strategies which is an under-represented topic thus far. The newly suggested contingency factor might be relevant beyond the case of sustainability as well. It is therefore also a contribution to strategy research. Furthermore, the framework is relevant to corporate practice because it might enable a better understanding of strategy making processes for sustainability. A better understanding of these processes might enable management to address sustainability as a topic for which planned and emergent strategy making are needed and might serve to encourage champions to initiate emergent strategies.

Application of theory to practice. The conceptual framework was used to analyze the Action Research events with a contingency factor analysis. The empirical data way analyzed with respect to all five contingency factors, including the four established ones and the newly suggested one. In this way, the predictive power of each contingency factor for the innovation project's

strategy making process was analyzed. Of the five contingency factors, three were found to be influential: the NATURE OF THE PROBLEM, the ORGANIZATION, and PEOPLE. Hence, the application of the conceptual framework to the empirical data lends support to the link between these three factors and the kind of strategy making that is expected.

Applying the conceptual framework to practice showed that the contingency factor 'top-management characteristics' is not sufficient to explain most of the influence that participants have on the strategy making process. Because champions appeared to be such an important factor for sustainability strategy making, the contingency factor 'top-management characteristics' that is common in strategy research was amended in order to include the influence of people on lower ranks of the hierarchy as well. Based on this insight that was acquired inductively from empirical evidence, the factor was renamed PEOPLE and was suggested as a more comprehensive factor than 'top-management characteristics'. The influence of champions has been discussed in sustainability research and other research fields, but not as a factor that influences how sustainability strategies are made. It also has not been discussed as a contingency factor explaining strategy making in general. This amended contingency factor was therefore put forward as a contribution to both, sustainability research and strategy research. In addition, the role of champions is highly relevant for corporate practice: Strengthening champions who drive emergent strategy making was argued to be an integral part of sustainability strategy making at the corporate level.

Empirical evidence. The theoretical framework puts forward that wicked problems tend to be addressed by emergent strategy making. However, the empirical evidence of the Action Research study suggested that if a problem is too wicked and therefore poorly understood, strategy making in general might be hampered. For sustainability and strategy research, this implies that the lack of available knowledge might be a helpful factor particularly for understanding the *absence* of (sustainability) strategy making. In corporate practice, the lack of knowledge can be alleviated by exchanging knowledge in multidisciplinary teams and collaborating with external research institutions. However, this becomes difficult if knowledge about an issue is sparse in practice *and* science, as is arguably the case with biodiversity.

For practice, the Action Research study yields several additional insights that are part of the insider understanding that the researcher has gained. Because Action Research explicitly includes unconventional forms of knowledge and aims at considering insights from practice, they are presented as additional implications for practice as follows. First, in order to support emergent strategy making, champions should accompany projects (or other units) for a long time, e.g. during the duration of the innovation process while remaining independent of the project's goals. Furthermore, they should be provided with leeway as well as authority. Second, the method of Action Research might be useful for sustainability champions if they have a research interest in addition to their sustainability goals. Conducting Action Research studies might help them achieve the previous points: to accompany a project over a longer period of time, independently of the project goals, and with enough leeway to push sustainability forward. Third, making sustainability requirements a part of the pre-defined project milestones in the development processes is expected to prioritize sustainability goals and to speed up their implementation. Fourth, integrating sustainability goals into the performance-based remuneration of all top and middle management in charge of innovation projects is also seen as an effective way of ensuring the implementation of sustainability requirements.

7.3 The prospects of sustainability strategy making

In this dissertation, extremes have been used to illustrate continua. The strategy making continuum extends between the extreme cases of purely planned and purely emergent strategy making. The four schematic problem types identified for sustainability problems range between the extreme cases of problems that are either perfectly wicked or not wicked at all and/or perfectly salient or not salient at all.

In reality, planned and emergent strategy making are extreme cases that are utterly unlikely to be found at a company. Instead, the majority of strategies are probably mixed forms, shaped by top-down influences as well as bottom-up movements. In reality, influences from the top and the bottom of the hierarchy might also come into conflict with each other. For instance, champions working

on an emergent strategy may be obliged to fulfill goals of a planned strategy which may or may not support their championing activities. These conflicts are an interesting research topic beyond the scope of this dissertation but likely of high relevance to practice. Addressing the tension between different levels of strategy making promises a better understanding of the process of sustainability strategy making at companies. Mixed forms of strategy making are not only the most likely but also the most promising for advancing the overall contribution that a company makes to sustainability on a societal level.

Similarly, problems are probably never purely salient and not wicked at all, nor are they likely to be extremely wicked and of no salience whatsoever. Again, these are extreme examples in order to illustrate the continuum in between. However, sustainability is a societal goal that requires addressing all ecological and social challenges of which only a few examples have been named in this dissertation. This overall goal of sustainability is an excessively wicked problem which is also becoming more and more salient for society.

A point made in chapter 2 is taken up now. There, it has been argued that sustainability is often understood from a systems perspective. If global society is understood as a system, containing sub-systems such as individuals, institutions, companies, nation states, and many more, it becomes clear that companies are sub-systems of a larger system while having their own sub-systems as well. In the context of sustainability, this raises the question how these systems interact. The sustainability of one sub-system might be a necessary condition for the sustainability of the overall system but it is certainly not a sufficient condition. For the overall system, i.e. society, to be sustainable, all or most of its sub-systems need to contribute to this goal. This means that not only companies but, for example, also individuals and nation states are called upon.

Champions have been argued to play a crucial role for corporate strategy making. Champions might be decisive sustainability drivers in the process of passing legislation or for awareness building about ethical consumerism as well. But where do champions come from? How can society (or one of its sub-systems) support sustainability championing?

Supporting champions at companies is a somewhat paradoxical task. On the one hand, they are supposed to advance sustainability without any top-down pressure to do so. On the other hand, it is argued in this dissertation

that they should be given leeway and authority in order to take over some of the strategy making which cannot be done at the top management level, for example addressing wicked problems. So, how to plan not to plan a strategy? The management of this paradox also has to do with recognizing the potential tensions between planned and emergent strategy making described above. It requires an integrated style of management that goes beyond command and control but rather aims at integrating activities across different hierarchical levels. At the top management level, protagonists are needed who are willing to hand over control to those having specific knowledge so that emergent strategies are enabled.

Furthermore, even the clear affiliation of top management with planned strategy making is questionable. There are examples of CEOs who decided to change their companies in direction of sustainability. In order to do so, they started championing activities in order to convince their boards of management, their supervisory councils, and their shareholders. This challenges the common wisdom that top management can only make planned strategies and suggests that championing might be an activity that enables top management to generate emergent strategies as well.

The insights of this dissertation offer implications beyond the corporate realm as well. Parts of the solution for the paradox of enabling champions, i.e. to motivate people to advance on sustainability issues independently of external motivation, might come from other sub-systems of society than the private sector. Champions are intrinsically motivated to solve problems which they personally perceive to be unacceptable. They are likely to be well educated in the subject area of the problem they are addressing. In order to support the emergence of champions and to strengthen existing champions, education might be an important enabling factor. The empirical part of this dissertation has shown that people with an engineering background became sustainability champions after they had learned about the relevance of sustainability for their work. The discussions about the sustainability understanding in the first events of the Action Research study, and the subsequent discussions about how sustainability could become a more important part of the project development, apparently motivated some participants to become active supporters of the topic themselves.

To avoid that a lack of knowledge prevents sustainability strategies from emerging, education is key. Here, various sub-systems of society, including families, schools, universities, and maybe also companies, are called upon to contribute to raising awareness of sustainability by providing education. For instance, engineering and natural science curricula could include sustainability contents rather than exclusively focusing on technological questions. In this way, future engineers would be enabled to consider the societal and ecological effects of technological development and to make this understanding of the greater picture part of their decision making.

In conclusion, the prospects of sustainability strategy making hinge on a better understanding of the complex, intertwined processes happening at multiple levels in multiple systems within and outside a company. Sustainability as a societal goal poses a wicked problem which can only be solved if its complexity is addressed and better understood. As part of this, it needs to be recognized that sustainability strategy making is a complex process as well – which can never be fully addressed in an exclusively planned way.

Appendix A

The complete sequence of cooperation phase events

#	Topic	Date	Event type	Participants	Content
15	I	04/01/2012	Student meeting	T4; T6	Discussion of the research question addressed by the Master thesis
16	I	05/01/2012	Student meeting	T4; T6	Discussion of the thesis' contribution to the Action Research project
17	I	09/01/2012	Student meeting	T4; T6	Discussion of first chapters
18	I	10/01/2012	Start of cooperation	T1; T2; T3; T4; T6	Start of cooperation; decision about topic I

#	Topic	Date	Event type	Participants	Content
127	I	12/01/2012	Team meeting	T3; T4; T6	Preparations for the first workshop (event no. 19)
20	I	12/01/2012	Student meeting	T4; T6	Preparations for event no. 21
19	I	16/01/2012	Expert consultation	T1; T3; T4; T6; R1	Workshop on sustainability aspects of rare earth metals
21	I	19/01/2012	Expert consultation	E1; E2; T6	Discussion of sustainability aspects of specific materials
23	I	25/01/2012	Expert consultation	T1; T6	Discussion of PTO options
22	I	24/01/2012	Student meeting	T4; T6	Regular meeting
120	I	25/01/2012	Expert consultation	P1; T6	Discussion of PTO options
116	I	25/01/2012	Official launch of cooperation	T1; T2; T3; T4; T6	Presentation of dissertation goals (T6), planning of cooperation
25	I	30/01/2012	Student meeting	T4; T6	Regular meeting
124	-	31/01/2012	Academic meeting	T6; A1	Meeting with PhD adviser
121	I	01/02/2012	Job interview	T5; T6; S3	Job interview with second graduate student

#	Topic	Date	Event type	Participants	Content
131	I	06/02/2012	Expert consultation	T6; D6	Discussion of economic and ecological risks of rare earth magnets
26	I	07/02/2012	Expert consultation	T6; P1	Discussion of possible PTO technologies
27	I	08/02/2012	Student meeting	T4; T6	Regular meeting
28	-	09/02/2012	Academic meeting	T6; A1; A3; A4; A7; A8; A9	Presentation of state of the Action Research study
29	I, II	14/02/2012	Team meeting	T1; T2; T6	Discussion of research method of cooperation; decision about topic II
30	I	16/02/2012	Student meeting	T4; T6	Regular meeting
31	I	17/02/2012	Team meeting	T3; T6	Discussion and preparation of planned meetings
32	I	21/02/2012	Expert consultation	T1; T2; T3; T4; T6; P1; P3	First compilation of a list of relevant materials
33	I	22/02/2012	Student meeting	T4; T6	Regular meeting
34	I	27/02/2012	Team meeting	T1; T6	Preparation of events no. 36; 39
35	I	28/02/2012	Student meeting	T4; T6	Regular meeting

#	Topic	Date	Event type	Participants	Content
125	I	29/02/2012	Expert consultation	T6; S1	LCA discussion
36	I	02/03/2012	Expert consultation	T4; T6; D6	Workshop on sustainability aspects in the life cycle of rare earth metals
37	I	05/03/2012	Academic meeting	T1; T2; T3; T4; T5; T6; S1; S1; S2; S3	Final Master thesis presentation
38	I	05/03/2012	Student meeting	T4; T6	Regular meeting
39	I	06/03/2012	Expert consultation	T1; T3; T6; R3	Workshop on sustainability aspects of selected metals
41	I	12/03/2012	Team meeting	T1; T3; T4; T6; P2; R5	Discussion of materials list
42	I	12/03/2012	Student meeting	T4; T6	Regular meeting
43	I, II	14/03/2012	Team meeting	T1; T2; T6	Discussion of progress of the cooperation so far
44	I	15/03/2012	Team meeting	T1; T6	Discussion of method for topic I
45	II	20/03/2012	Team meeting	T2; T6	Discussion of method for topic II
46	I	21/03/2012	Expert consultation	P1; T6	Discussion of materials list

#	Topic	Date	Event type	Participants	Content
47	I	21/03/2012	Expert consultation	T1; T6; D1; D2; D3; D4	Workshop on the materials list from a purchasing perspective
48	I	22/03/2012	Expert consultation	T1; T6; R6; R7; R8	Workshop on sustainability aspects of plastic materials
115	I	01/04/2012	Expert consultation	T6; E5	Discussion of materials from a supplier perspective
122	-	03/04/2012	Academic meeting	T6; A1; A2	Meeting with PhD adviser and colleague
123	-	13/04/2012	Academic meeting	T6; A1; A2	Meeting with PhD adviser and colleague
52	I	17/04/2012	Team meeting	T1; T6	Discussion about the state of topic I and next steps
53	II	17/04/2012	Team meeting	T2; T6	Discussion about method for topic II
54	I	23/05/2012	Student meeting	T5; T6	Thesis planning
55	-	23/05/2012	Team meeting	T2; T6	Discussion of internal project development process
56	I	24/05/2012	Expert consultation	T6; P2	Discussion about alternative PTOs

#	Topic	Date	Event type	Participants	Content
57	I, II	29/05/2012	Team meeting	T1; T2; T6; P1; P2; P3; P4; P5; P6; P8	Workshop on prototype
58	II	29/05/2012	Expert consultation	T6; E3	Discussion about various assessment methods for biodiversity impacts
59	I	31/05/2012	Expert consultation	T6; P2	Discussion of PTO ranking
126	-	31/05/2012	Academic meeting	T3; T6	Preparation of PhD presentation (event no. 132)
60	I	04/06/2012	Student meeting	T5; T6	Regular meeting
61	I	05/06/2012	Team meeting	T1; T2; T5; T6	Introduction of T5
132	-	12/06/2012	Academic meeting	T1; T2; T3; T5; T6; P1; P2; P4; P10; M3; M4; S1; S2; S3	PhD presentation
62	II	14/06/2012	Team meeting	T1; T2; T6; P5; P7	Workshop on long-term requirements the machine must meet
132	-	15/06/2012	Academic meeting	T1; T3; T5; T6; P1; S1; S2; S3; M1; M3; M4	Mid-way presentation PhD dissertation

#	Topic	Date	Event type	Participants	Content
63	-	19/06/2012	Academic meeting	T5; T6; A10	Discussion with diploma thesis supervisor
141	-	24-26/06/2012	Academic meeting	T6; A2	International Sustainable Development Research Conference (ISDRC)
142	-	26-29/06/2012	Academic meeting	T6; A1; A3	Group for Research on Organizations and the Natural Environment Conference (GRONEN)
64	I	11/07/2012	Academic meeting	T1; T3; T5; T6; S1; S1; S2; S3	Presentation of T5's research project
117	II	15/07/2012	Expert consultation	T6; E7	Discussion of potential negative impacts on biodiversity
65	I	16/07/2012	Expert consultation	T5; T6; S1	Discussion of LCA method
66	II	16/07/2012	Management meeting	T5; T6; M3	Information on sustainability activities for NGO meeting
67	I	17/07/2012	Team meeting	T1; T2; T5; T6; P1; P2; P3; P4; P5; P6; P8	Workshop on technological specifications

#	Topic	Date	Event type	Participants	Content
68	-	18/07/2012	Team meeting	T6; P1; P3	Informal dinner
69	II	19/07/2012	Team meeting	T1; T2; T6; P2; P3; P4; P5; R9	Workshop on prototype
70	II	19/07/2012	Team meeting	T6; P2; P4	Discussion of noise and electromagnetic fields
71	II	26-27/07/2012	Expert consultation	T1; T6; P3; P5; P10; E3; E4	Visit of experimental sites
72	I	31/07/2012	Student meeting	T5; T6	Regular meeting
73	I	10/08/2012	Expert consultation	T6; E6	Discussion of a method for assessing hot spot impacts
74	I	13/08/2012	Student meeting	T5; T6	Regular meeting
75	-	15/08/2012	Academic meeting	T5; A10	Meeting with diploma thesis supervisor
76	I, II	20/08/2012	Team meeting	T1; T2; T6; P1; P3; D5	Workshop on standards
77	I	21/08/2012	Team meeting	T1; T5; T6	Exchange about materials assessment
78	II	21/08/2012	Team meeting	T2; T6	Discussion of current stage of work on topic II
79	I	23/08/2012	Team meeting	T5; T6; P1; P2	Discussion of materials list

#	Topic	Date	Event type	Participants	Content
80	-	27/08/2012	Academic meeting	T6; A1; A2	Meeting with PhD advisers
81	I	29/08/2012	Student meeting	T5; T6	Regular meeting
129	I, II	03/09/2012	Management meeting	M1; T6	Information about Action Research project
82	I	10/09/2012	Team meeting	T1; T5; T6; P1; P2	Workshop on the model of materials
83	I	10/09/2012	Team meeting	T1; T2; P1; P2; P3; P4	Workshop on construction and design
84	II	12/09/2012	Expert consultation	T1; T2; P3; R4; R9; R10; R11	Maritime coatings workshop
85	II	20/09/2012	Team meeting	T6; P7	Discussion of noise and chemical emissions
86	II	20/09/2012	Expert consultation	T6; S2	Discussion of the impacts of electromagnetic fields under water
87	I, II	28/09/2012	Team meeting	T1; T2; T6	Discussion of continuation of the sustainability work after the Action Research study
88	I	10/10/2012	Student meeting	T5; T6	Regular meeting

#	Topic	Date	Event type	Participants	Content
89	II	12/10/2012	Team meeting	T2; T6	Discussion about external contacts for research study on biodiversity
90	II	15/10/2012	Management meeting	T6; M2	Information about biodiversity impacts and possibilities for mitigation
91	I	18/10/2012	Team meeting	T1; T2; T6; P1; P2; P3; P4; P5; P6; P7; P10	Regular team meeting
92	I	22/10/2012	Student meeting	T5; T6	Regular meeting
93	-	23/10/2012	Academic meeting	T5; T6; A10	Meeting with diploma thesis supervisor
94	I	24-25/10/2012	Training	T3; T6; S1; S2; S3	LCA training
95	I	07/11/2012	Student meeting	T5; T6	Regular meeting
96	I	12/11/2012	Student meeting	T5; T6	Final discussion of diploma thesis
97	I, II	15/11/2012	Team meeting	T1; T6	Preparation of wrap-up and hand-over
98	I	19/11/2012	Student meeting	T5; T6	Preparation of final presentation
99	I	29/11/2012	Academic meeting	T1; T3; T5; T6; S1; S1; S2; S3	Final presentation of diploma thesis

#	Topic	Date	Event type	Participants	Content
100	II	10/12/2012	Team meeting	T2; T6	Definition of requirements for a biodiversity study
101	II	13/12/2012	Team meeting	T2; T6	Discussion of the planned external study
102	I	19/12/2012	Expert consultation	T6; P2	Discussion of the model of materials
103	II	04/01/2013	Team meeting	T2; T6	Discussion of potential impacts on biodiversity; preparation of event no. 104
104	II	08/01/2013	Team meeting	T1; T2; T3; T6; P1; P7	Final review of topic II results
105	I	08/01/2013	Team meeting	T1; T2; P1; P2; P3; P7	Final review of topic I results
106	I	11/01/2013	Team meeting	T6; P1; P2	Follow up on materials model
107	II	18/01/2013	Expert consultation	T6; S2	Discussion of impacts of electromagnetic fields under water
108	I, II	21/01/2013	Management meeting	T1; T2; T6; M2	Presentation of results at strategic review meeting
109	I	28/01/2013	Team meeting	T1; T2; T6; P1; P2; P3; P4; P5; P6; P7; P9; P10; R9	Workshop on generator options

#	Topic	Date	Event type	Participants	Content
110	I	29/01/2013	Expert consultation	T6; P2	Follow up on workshop
111	-	07/02/2013	Academic meeting	T6; A1; A3; A6; A7; A9	Presentation of Action Research progress
112	II	21/02/2013	Team meeting	T2; T6	Decision to postpone contract award for biodiversity study
113	I	27/02/2013	Team meeting	T6; P1; P2	Discussion about generator options

Appendix *B*

Summary of the biodiversity literature review

The goal of the following literature review has been to identify the most relevant potential negative impacts that the wave energy converter that is developed by the innovation project could cause in marine biodiversity. These impacts include impacts on flora and fauna at the location where a park of devices is to be installed as well as impacts that might come to bear at other locations. The latter becomes relevant when, for example, small amounts of substances that have leaked over a long period of time accumulate at another location causing harm to the ecosystem there.

In order to conduct a systemic literature review in the sense of Fink (2010), publications addressing the impact of wave energy devices or similar technologies on marine ecosystems were searched for with the help of the common databases, including Google scholar, Science direct, Scopus, Springer Link, and Wiley. As a first insight, it was found that the understanding of biodiversity and the causes of its loss is still rather scrappy and clear cause-effect relations have not been established. A consensus exists about the definition of marine biodiversity as the variety of all sea life, both within species and across ecosystems (Sala and Knowlton, 2006). However, "the total number of marine species is not known to even an order of magnitude, with estimates ranging

from 178,000 species [...] to more than 10 million species" (Sala and Knowlton, 2006, p. 96). In addition, many researchers agree that biodiversity loss leads to exponential loss of ecosystem functioning and efficiency (Danovaro et al., 2008) although the extent of environmental effects is not quantified (Simas et al., 2009). This situation confronts developers of marine energy technology with the problem that on the one hand, they need to test their technologies in order to develop it further, on the other hand, doing so risks environmental damage that cannot be foreseen because the scientific basis is still lacking (Bell and Side, 2011; Frid et al., 2012; Inger et al., 2009; Jacobson, 2011; Lohse et al., 2008).

However, ocean energy technology might also offer several environmental advantages. For instance, the greenhouse gas emissions over the life cycle of an ocean energy converter are expected to be low even compared to other renewable energies (Parker et al., 2007; Pehnt, 2006; Raventós et al., 2010). Furthermore, wave energy devices might have positive impacts on local biodiversity if they act as artificial reefs and fish-aggregating devices and if exclusion zones are created in order to keep navigation at a distance (AWATEA, 2008; Inger et al., 2009).

From seminal studies such those conducted by Inger et al. (2009) and Frid et al. (2012), four main impacts that marine energy converters may cause are identified: collision, chemical emissions, noise, and electromagnetic fields. One further impact is the potential change in sediments which is not addressed in this review because the knowledge base is found to be yet too sparse. This is not to say that a study addressing environmental impacts at a specific location should not cover this issue. The four potential impacts and suggestions for avoiding them are summarized in the following.

Collision

Collision is the risk of an animal being harmed by a device or its pressure field (Wilson et al., 2007). Also the mooring lines can cause entanglement (McMurray, 2007). The likelihood of a collision depends on the animal's detection ability, its attraction to the device, its size, its habitat use, its evasion behavior, and whether it can get trapped (Wilson et al., 2007). Some studies argue

that the risk of sea animals colliding with energy converters is low (Copping et al., 2011, 2012; Huckerby, 2009).

Several measures are recommended in order to prevent collision between sea animals and wave energy converters. These include acoustic or visual deterring devices, design for minimal impact, and avoidance of sensitive areas and times (e.g. migration seasons) (Compton et al., 2008; Isaacman and Lee, 2009; Russell et al., 2001). Furthermore, it is recommended that exclusion zones are established around parks of ocean energy devices where navigation is banned. This might even have positive impacts on biodiversity if these zones become de-facto protected areas (AWATEA, 2008; Inger et al., 2009).

Chemical emissions

Chemical emissions are leakages of substances that are used in or on the device, e.g. hydraulic fluids or anti-fouling paint. Even though quantities are expected to be low, the impacts of emitted chemicals might still be significant locally (Isaacman and Lee, 2009; Simas et al., 2009). Small amounts leaking from many devices over a long period of time also have the potential to add up to significant amounts, particularly if they accumulate in one place, e.g. in underwater sand dunes.

Two types of chemical emissions are considered: those consisting of fluids that permeate to the outside from inside the machine and those that are designed to rub off over time, namely the surface coatings of the machine. Regarding the former, it is very difficult to make a machine perfectly leak-proof, particularly in salt water which accelerates corrosion. Assuming that a certain degree of leakage is unavoidable, conventional lubricants and hydraulic fluids should be substituted for by vegetable-based fluids (McMurray, 2007, see also Luther, 2011). Regarding the latter, biocide coatings should be avoided, also because they are already banned by US and European law (Isaacman and Lee, 2009). Although the ecological impacts of non-stick coatings, which contain silicone oil, are debated (Watermann et al., 2005), they are recommended over biocidal anti-fouling coatings.

Noise

Noise is a complicated issue to deal with for ocean energy developers because its intensity depends on the frequency, the water depth, the seafloor and surface, as well as temperature layers and salinity (Nehls and Betke, 2011). Furthermore, the duration of the noise is likely to make a difference (Isaacman and Lee, 2009) and different animals are able to perceive different frequencies (Nehls and Betke, 2011). Sources of noise include boat traffic, dredging, drilling, pile driving, and cable placement (Isaacman and Lee, 2009). The most disruptive noise is likely to be caused during commissioning and decommissioning (Edenhofer et al., 2012), most damagingly by pile driving (Bell and Side, 2011; Frid et al., 2012; Isaacman and Lee, 2009; Witt et al., 2012).

Quantitative thresholds have been established, e.g. 180 dB by the U.S. National Marine Fisheries Service (Bell and Side, 2011) and 160 dB at a distance of 750m from the site by the German Umweltbundesamt (Diederichs et al., 2010; Nehls and Betke, 2011). However, other relevant pieces of information, such as the frequency of a noise or its duration, are often not defined which limits the usefulness of these thresholds (Nehls and Betke, 2011).

Since reliable thresholds are not yet established and are likely to differ between locations, mitigation measures are recommended in order to keep noise levels low and to limit their impact. Many authors suggest seal scarers and pingers, i.e. acoustic deterring devices (Brandt et al., 2012; Compton et al., 2008; Diederichs et al., 2009, 2010, 2009). Furthermore, a soft start, i.e. slow beginning of noisy activities (Compton et al., 2008), and bubble curtains or noise insulation tubes (Isaacman and Lee, 2009; Nehls and Betke, 2011) are recommended.

Electromagnetic fields

The understanding of the impacts of electromagnetic fields on marine biodiversity is still sparse and largely based on laboratory data (Isaacman and Lee, 2009; Simas et al., 2009). Yet, it is an important issue for wave energy developers because wave energy farms are likely to need great concentrations of cables, and because they rely on coil and magnet technology (Witt et al., 2012). Electromagnetic fields might cause disorientation in migrating species (Frid et al., 2012; Isaacman and Lee, 2009). Particularly sharks, rays, skates,

and turtles might be affected by electromagnetic fields (Edenhofer et al., 2012; Simas et al., 2009). Furthermore, they might interfere with some animals' ability to detect prey or avoid predators and with feeding or mating behavior, and they might have indirect effects on growth or reproduction (Ward et al., 2010).

Although no thresholds have been established so far, it is known that elasmobranchs tend to avoid electric fields of 100 µV/m or greater (Isaacman and Lee, 2009), and sharks respond to magnetic fields of 25-100 µT (Frid et al., 2012). Therefore, using cable jackets in order to shield electromagnetic fields, burying cables in the seabed, or using Faraday cages is recommended (Langhamer et al., 2010; McMurray, 2007).

Conclusion

Avoiding negative impacts on marine biodiversity is a challenge for the developers of wave energy converters. The scientific basis to enable informed decisions about environmental impacts is largely amiss (Frid et al., 2012). Furthermore, because the technology of wave energy conversion is still at an early stage of development, empirical evidence of environmental effects is lacking (Bell and Side, 2011). This situation is exacerbated by the fact that the relationship between the process of commissioning and running a park of wave energy devices and the responses of the ecosystems around it are expected to be non-linear and very complex (Lohse et al., 2008). Therefore, "predicting the magnitude of ecological change is difficult yet critical" (Lohse et al., 2008, p. 83). In this situation, developers face a dilemma between engineering issues that can only be solved by in-situ testing and environmental precaution.

Yet, the issue of negative impacts on biodiversity needs to be addressed. The minimum requirement is conducting an environmental impact assessment (EIA) which is required by law for energy parks of a certain size. Beyond this, ocean energy developers are well advised to account for the four sets of negative impacts described above already at the design stage. Decisions about all four impacts are already made years before an EIA must be conducted. For example, the decision about the PTO has an influence on the kind of fluids that are needed and is therefore also a decision about the chemical emissions

that are caused. Similarly, the decision about the kind of mooring is also a decision about whether pile driving is needed for commissioning.

Considering the generic recommendations that are deduced from this literature review (table 5.4 on page 102) is therefore suggested as a first step towards alleviating potential negative impacts on biodiversity. The next step must be to specify the potential negative impacts for each location in which an energy park is supposed to be installed and to take location-specific measures to avoid them. In this way, wave energy parks might eventually really succeed in having a positive environmental impact.

Appendix C

The web survey questionnaire

Umfrage zum Thema Nachhaltigkeit bei Wave Harrow

Promotionsvorhaben Friederike Neugebauer, C/PSS

Herzlich willkommen und vielen Dank für Ihre Teilnahme an dieser Umfrage!

Mit dieser Umfrage sollen die Ergebnisse aus der Kooperation zwischen dem Projekt Wave Harrow und mir, die im Jahr 2012 stattfand, validiert werden. Das Ziel meiner Dissertation ist es, die Entstehung von Nachhaltigkeitsstrategien besser zu verstehen.

Die Umfrage gliedert sich in vier kurze Teile:

1) allgemeine Fragen zu Nachhaltigkeit
2) Fragen zum Thema nachhaltige Werkstoffauswahl
3) Fragen zum Thema Artenvielfalt
4) Fragen zum Vergleich der beiden Themen

Regeln:

- Die Teilnahme ist anonym.
- Wer auf der letzten Seite ankommt, hat die Umfrage beendet und kann sie nicht mehr verändern.

- Ich bitte darum, dass alle bis zum Teammeeting am 29.1. teilgenommen haben, damit wir die Ergebnisse diskutieren können.

Bitte beantworten Sie zuerst eine allgemeine Frage: Arbeiten Sie zu 100% im Projekt DC/PJ-WH?

☐ ja
☐ nein

Teil 1: Nachhaltigkeit allgemein

1.1 Nachhaltigkeit ist für mich eines der drei wichtigsten Probleme, um die Unter-nehmen sich heute kümmern müssen.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

1.2 Nachhaltigkeit ist "nice to have", sollte aber kein vorrangiges Ziel sein.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

1.3 Ich finde, dass Nachhaltigkeit in manchen Situationen Vorrang vor finanziellen Zielen haben kann.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

1.4 Ich denke, dass es sich auch finanziell lohnt, wenn ein Unternehmen nachhaltiger wird.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

1.5 Es ist mir persönlich wichtig, dass Bosch bzw. Wave Harrow nachhaltiger wird.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

1.6 Was sind Ihrer Meinung nach die drei wichtigsten Gründe, Nachhaltigkeit zu berücksichtigen?
bitte max. drei ankreuzen

- ☐ Wenn man Nachhaltigkeit frühzeitig berücksichtigt, ist man auf künftige Regulierungen besser vorbereitet.
- ☐ Negative Schlagzeilen können vermieden werden.
- ☐ Für Nachhaltigkeitsaktivitäten kann man positive Publicity bekommen.
- ☐ Nachhaltigkeit zu berücksichtigen hilft uns, das Richtige zu tun.
- ☐ Nachhaltige Unternehmen sind wettbewerbsfähiger.
- ☐ andere, nämlich:
- ☐ keins davon

Teil 2: Nachhaltigkeit in der Werkstoffauswahl (Thema I)

Die Werkstoffauswahl war eines der beiden Nachhaltigkeits-Themen, an denen wir 2012 gearbeitet haben. Es ging darum ein Nachhaltigkeits-Ranking der

Generatoren zu erstellen, basierend auf den Werkstoffen, die in verschiedenen Generatortypen enthalten sein würden. Die Werkstoffe wurden bezüglich ihrer Umweltauswirkungen, ihrer sozialen Auswirkungen und ihrer langfristigen Ver-fügbarkeit analysiert. Dabei wurde der gesamte Lebensweg von Abbau bis Ent-sorgung berücksichtigt.

Bitte beantworten Sie zunächst die folgende Frage:

2.1 Waren Sie 2012 (oder danach) an der Arbeit zum Thema nachhaltige Werkstoffauswahl beteiligt?
Wenn nicht, klicken Sie auf "nein" und ganz unten auf der Seite auf "weiter". Dann werden Sie direkt zu Teil 3 weitergeleitet.[8]

☐ ja
☐ nein
☐ teilweise

Organisationsspezifische Fragen

Stimmen Sie den folgenden Aussagen zu?

2.2 Die wirtschaftliche Situation 2012 hatte einen großen Einfluss auf unsere Aktivitäten zum Thema "nachhaltige Werkstoffauswahl".

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

2.3 Es gab Druck von höheren Hierarchieebenen die Nachhaltigkeit der Werkstoffauswahl zu verbessern.

[8] In the web survey shown here, all five contingency factors were investigated for manifestations of topic I and II, respectively. Later on, this was given up in the case of the four established contingency factors. The distinction was only kept for the newly suggested contingency factor NATURE OF THE PROBLEM. In the survey interpretation, the responses for topic I and II were added up again so that the results were unaffected by this change.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

Fragen zum Entscheidungsprozess

Stimmen Sie den folgenden Aussagen zu?

2.4 Im Jahr 2012 gab es einen Konsens, dass Generatoren mit Seltenerd-Magneten möglichst vermieden werden sollten.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

2.5 Aus heutiger Sicht ist ein permanenterregter Generator mit Seltenerd-Magnet in der finalen Maschine wahrscheinlich.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

...zu 2.5: (nur falls ja oder eher ja)
Für den Generator mit Seltenerd-Magnet sprechen...

- ☐ wirtschaftliche Gründe
- ☐ technische Gründe
- ☐ ökologische Gründe
- ☐ Wunsch der Projektleitung
- ☐ Wunsch “von oben”

☐ andere Gründe:

2.6 Welcher Aussage stimmen Sie eher zu?

☐ Nachhaltigere Werkstoffe auszuwählen kann Risiken für das Projekt minimieren.
☐ Nachhaltigere Werkstoffe auszuwählen eröffnet Chancen für das Projekt.
☐ weiß nicht

Einfluss der Projektbereiche

2.7 Welche Bereiche des Projekts waren/sind beim Thema "nachhaltige Werkstoffauswahl" besonders einflussreich?
bitte max. fünf ankreuzen

☐ Projektleitung
☐ Projekt-Review
☐ Team Triebstrang
☐ Team Mooring
☐ Team Konstruktion
☐ Team Regelung
☐ Team Modellierung
☐ Team Biofouling
☐ Promotion und Abschlussarbeiten bei C/PS
☐ andere, nämlich:
☐ weiß nicht

Art des Problems

Stimmen Sie den folgenden Aussagen zu?

2.8 Das Problem der Nachhaltigkeit in der Werkstoffauswahl ist sehr komplex.

☐ ja
☐ eher ja
☐ eher nein

☐ nein
☐ weiß nicht

2.9 Wir brauchen quantitative Ziele um unsere Werkstoffauswahl nachhaltiger machen zu können.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

2.10 Es gibt einflussreiche Gruppen außerhalb der Firma, die sich für nachhaltigere Werkstoffe einsetzen.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

2.11 Die Nachhaltigkeit der Werkstoffauswahl ist bei Bosch ein anerkanntes Ziel.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

2.12 Das Problem der nachhaltigen Werkstoffauswahl muss dringend angegangen werden.

☐ ja
☐ eher ja
☐ eher nein
☐ nein

☐ weiß nicht

Fragen zur Strategie

Stimmen Sie den folgenden Aussagen zu?

2.13 Beim Thema "Nachhaltigkeit in der Werkstoffauswahl" wissen wir, was wir erreichen wollen.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

2.14 Wir haben eine Strategie für eine nachhaltige Werkstoffauswahl.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

2.15 Die Nachhaltigkeit der Werkstoffe wird bei Entscheidungen berücksichtigt.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

2.16 Die Nachhaltigkeit der Werkstoffauswahl wurde in unsere Prozesse integriert.

☐ ja
☐ eher ja
☐ eher nein

☐ nein

☐ weiß nicht

2.17 Wir haben uns auch nach 2012 mit Nachhaltigkeit in der Werkstoffauswahl be-schäftigt.

☐ ja

☐ eher ja

☐ eher nein

☐ nein

☐ weiß nicht

2.18 Welcher Aussage stimmen Sie eher zu?

☐ Unsere Aktivitäten für eine nachhaltigere Werkstoffauswahl beruhen vor allem auf Vorgaben.

☐ Unser Vorgehen zum Thema nachhaltige Werkstoffauswahl haben wir selbst entwickelt.

☐ beides gleichermaßen

☐ weiß nicht

2.19 Was macht es Ihrer Meinung nach wahrscheinlicher, dass das Thema Nachhaltigkeit in der Werkstoffauswahl bei Wave Harrow (mehr) Berücksichtigung findet?
bitte max. fünf ankreuzen

☐ ausreichende finanzielle Ressourcen

☐ eine Person, die das Thema treibt

☐ Vorgaben von oben, die Werkstoffauswahl nachhaltiger zu machen

☐ Verankerung eines Ziels für die Werkstoffauswahl bei Bosch

☐ Verankerung eines Ziels für die Werkstoffauswahl bei Wave Harrow

☐ Nachhaltigkeits-Anforderungen der Kunden

☐ gesetzliche Vorgaben

☐ Druck von NGOs, Medien

☐ etwas anderes, nämlich:

Teil 3: Artenvielfalt (Thema II)

Das zweite Thema, an dem 2012 gearbeitet wurde, war das Thema Artenvielfalt. Dabei ging es um den Schutz der Artenvielfalt an dem Standort im Meer, wo die Maschine eines Tages stehen soll. Vier potentiell negative Auswirkungen wurden berücksichtigt:

- ☐ Die Gefahr einer Kollision zwischen der Maschine und Meerestieren
- ☐ Lärm der Maschine im Aufbau, Abbau und im Betrieb
- ☐ Elektromagnetische Felder
- ☐ Chemische Emissionen aus der Maschine, wie z.B. Schmierstoffe oder Abrieb von Lackierungen

Zunächst beantworten Sie bitte die folgende Frage:

3.1 Haben Sie 2012 (oder danach) an den Themen Kollision, Lärm, elektromagnetische Felder oder chemische Emissionen mitgearbeitet?
Wenn nicht, klicken Sie auf "nein" und ganz unten auf der Seite auf "weiter". Sie werden dann direkt zu Teil 4 weitergeleitet.

- ☐ ja
- ☐ nein
- ☐ teilweise

Fragen zu den vier Unterthemen der Artenvielfalt

Stimmen Sie den folgenden Aussagen zu?

3.2 Wir haben im Projekt selbstständig Vorgehensweisen entwickelt, wie wir mit dem Thema ... umgehen.

	ja	eher ja	eher nein	weiß nicht
Kollision	☐	☐	☐	☐
Lärm	☐	☐	☐	☐
Elektromagnetische Felder	☐	☐	☐	☐

Chemische Emissionen	☐	☐	☐	☐

3.3 Es gibt Vorgaben, wie mit dem Thema ... umzugehen ist.

	ja	eher ja	eher nein	weiß nicht
Kollision	☐	☐	☐	☐
Lärm	☐	☐	☐	☐
Elektromagnetische Felder	☐	☐	☐	☐
Chemische Emissionen	☐	☐	☐	☐

3.4 Wir berücksichtigen das Thema ... in unseren Entscheidungen.

	ja	eher ja	eher nein	weiß nicht
Kollision	☐	☐	☐	☐
Lärm	☐	☐	☐	☐
Elektromagnetische Felder	☐	☐	☐	☐
Chemische Emissionen	☐	☐	☐	☐

3.5 In welchem Bereich wird das Thema ... bearbeitet?

	ja	eher ja	eher nein	weiß nicht
Projektleitung	☐	☐	☐	☐
Triebstrang	☐	☐	☐	☐
Mooring	☐	☐	☐	☐
Konstruktion	☐	☐	☐	☐
Regelung	☐	☐	☐	☐

Biofouling	☐	☐	☐	☐
weiß nicht	☐	☐	☐	☐
andere, nämlich:	☐	☐	☐	☐

Organisationsspezifische Fragen

Stimmen Sie den folgenden Aussagen zu?

3.6 Die wirtschaftliche Situation 2012 hatte einen großen Einfluss auf unsere Aktivitäten zum Thema Artenvielfalt.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

3.7 Es gab Druck von höheren Hierarchieebenen das Thema Artenvielfalt zu bearbeiten.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

Fragen zum Entscheidungsprozess

3.8 Welcher Aussage stimmen Sie eher zu?

- ☐ Artenvielfalt zu berücksichtigen hilft, Risiken für das Projekt zu vermeiden.
- ☐ Artenvielfalt zu berücksichtigen eröffnet neue Chancen für das Projekt.
- ☐ weiß nicht

Einfluss bestimmter Projektbereiche

3.9 Welche Bereiche des Projekts waren/sind beim Thema Artenvielfalt (Kollision, Lärm, elektromagnetische Felder, Emissionen) besonders einflussreich? *bis zu fünf ankreuzbar*

- ☐ Projektleitung
- ☐ Projekt-Review
- ☐ Team Triebstrang
- ☐ Team Mooring
- ☐ Team Konstruktion
- ☐ Team Regelung
- ☐ Team Modellierung
- ☐ Team Biofouling
- ☐ Promotion und Abschlussarbeiten bei C/PS
- ☐ andere, nämlich:
- ☐ weiß nicht

Art des Problems

Stimmen Sie den folgenden Aussagen zu?

3.10 Artenvielfalt ist ein sehr komplexes Problem.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

3.11 Wir brauchen quantitative Ziele um Artenvielfalt in unserer Arbeit berücksichtigen zu können.

- ☐ ja
- ☐ eher ja

☐ eher nein
☐ nein
☐ weiß nicht

3.12 Es gibt einflussreiche Gruppen außerhalb der Firma, die sich für Artenvielfalt einsetzen.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

3.13 Der Schutz der Artenvielfalt ist bei Bosch ein anerkanntes Ziel.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

3.14 Der Verlust von Artenvielfalt ist ein Problem, das dringend angegangen werden muss.

☐ ja
☐ eher ja
☐ eher nein
☐ nein
☐ weiß nicht

Fragen zur Strategie

Stimmen Sie den folgenden Aussagen zu?

3.15 Bei den Themen der Artenvielfalt (Kollision, Lärm, elektromagnetische Fel-der, Emissionen) wissen wir, was wir erreichen wollen.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

3.16 Wir haben eine Strategie für Artenvielfalt.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

3.17 Das Thema Artenvielfalt wird bei Entscheidungen berücksichtigt.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

3.18 Die vier Themen der Artenvielfalt wurden in unsere Prozesse integriert.

- ☐ ja
- ☐ eher ja
- ☐ eher nein
- ☐ nein
- ☐ weiß nicht

3.19 Welcher Aussage stimmen Sie eher zu?

- ☐ Unser Vorgehen beim Thema Artenvielfalt beruht vor allem auf Vorgaben.
- ☐ Unser Vorgehen zum Thema Artenvielfalt haben wir selbst entwickelt.
- ☐ beides gleichermaßen

☐ weiß nicht

3.20 Was macht es Ihrer Meinung nach wahrscheinlicher, dass das Thema Artenvielfalt, d.h. Kollision, Lärm, elektromagnetische Felder und/oder chemische Emissionen, bei Wave Harrow (mehr) Berücksichtigung findet?
bitte max. fünf ankreuzen

☐ ausreichende finanzielle Ressourcen
☐ eine Person, die das Thema treibt
☐ Vorgaben von oben, Artenvielfalt zu berücksichtigen
☐ Verankerung eines Ziels für Artenvielfalt bei Bosch
☐ Verankerung eines Ziels für Artenvielfalt bei Wave Harrow
☐ Nachhaltigkeits-Anforderungen der Kunden
☐ gesetzliche Vorgaben
☐ Druck von NGOs, Medien
☐ etwas anderes, nämlich:

Teil 4: Der Vergleich der beiden Themen

4.1 Für welches Thema gibt es bei Bosch mehr know-how?

☐ Nachhaltigkeit in der Werkstoffauswahl
☐ Artenvielfalt (Kollision, Lärm, elektromagnetische Felder, Emissionen)
☐ beide gleich
☐ weiß nicht

4.2 Welches Thema wurde bei Wave Harrow besser integriert?

☐ Nachhaltigkeit in der Werkstoffauswahl
☐ Artenvielfalt (Kollision, Lärm, elektromagnetische Felder, Emissionen)
☐ beide gleich
☐ keins wurde integriert
☐ weiß nicht

4.3 Welches der beiden Themen spielt *heute* im Projekt eine größere Rolle?

☐ Nachhaltigkeit in der Werkstoffauswahl

☐ Artenvielfalt (Kollision, Lärm, elektromagnetische Felder, Emissionen)
☐ beide gleich
☐ keins mehr
☐ weiß nicht

4.4 Welches der beiden Themen finden Sie komplexer?

☐ Nachhaltigkeit in der Werkstoffauswahl
☐ Artenvielfalt (Kollision, Lärm, elektromagnetische Felder, Emissionen)
☐ beide gleich
☐ weiß nicht

4.5 Welches der beiden Themen finden Sie dringlicher?

☐ Nachhaltigkeit in der Werkstoffauswahl
☐ Artenvielfalt (Kollision, Lärm, elektromagnetische Felder, Emissionen)
☐ beide gleich
☐ weiß nicht

Wenn Sie auf *weiter* klicken, ist die Umfrage beendet. Ihre Antworten werden gespeichert und können nicht mehr geändert werden.

Sie sind am Ende der Umfrage angekommen.

Vielen Dank für Ihre und eure Unterstützung!!

Falls Sie noch einen Kommentar jeglicher Art haben, ist hier dafür Platz:

Appendix D

Two details of Kärsten (2014)

One part of the triangulation for the Action Research study was an interview-based Bachelor thesis which was written between January and August, 2014. For this thesis, 23 problem-focused interviews were conducted with heads and staff of 21 innovation projects at the company, excluding the wave energy project with whom the Action Research study was conducted. In order to provide more background details of the findings of Kärsten (2014), two of her main insights are briefly summarized as follows.

The relation between project goal and championing

Figure D.1 is taken from Kärsten (2014) and shows the 21 interviewed innovation projects mapped on a matrix with two axes. This matrix is based on the sustainable value framework by Hart and Milstein (2003) but has been adapted for the purposes of the thesis.

The vertical axis ranges from today to tomorrow to distinguish projects that serve present customers from projects serving anticipated future customers. The horizontal axis indicates whether the projects were more influenced by internal or external drivers. This figure shows clearly that the more future-oriented projects tended to have a strongly motivated and active sustainability champion. These projects are shown in the upper left corner.

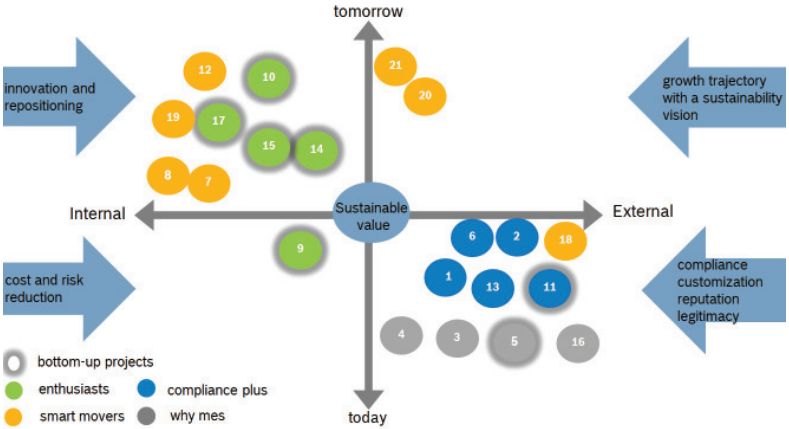

Figure D.1: The innovation projects map, taken from Kärsten (2014)

In contrast, the projects serving existing markets or mainly driven by compliance targets are shown in the lower right quadrant: These projects are largely driven by external factors.

The relation between external and internal drivers

One further insight of Kärsten (2014) has been a differentiation of the relationship between external sustainability drivers, such as regulation, customer requirements, and societal values, and internal drivers, such as personal drivers (awareness of sustainability issues and individual initiative) and corporate culture.

As illustrated in figure D.2, external drivers are a necessary condition for sustainability aspects to be integrated in innovation projects. If in addition, internal drivers are in place as well, e.g. sustainability champions, then it becomes more likely that the project makes a future-oriented sustainability contribution. If no internal drivers are in place, the sustainability contribution that the innovation project is likely to make is limited to compliance issues, cost reduction, and the like. This implies that the vertical axis in figure D.1 actually ranges from 'external and internal drivers' to 'external drivers only'.

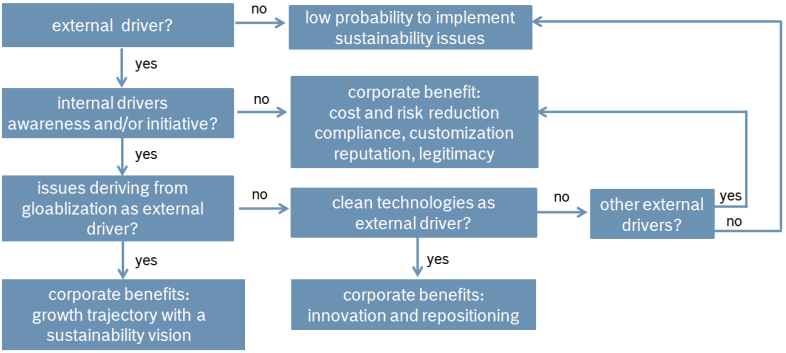

Figure D.2: The relationship between sustainability drivers, taken from Kärsten (2014)

For the context of this dissertation, these results offer the following advantages: First, the thesis adds an additional 21 innovation projects in which sustainability topics are debated and, to a greater or lesser extent, advanced in the projects. In this way, the limitations of the method of Action Research are somewhat compensated. Second, the empirical part of the dissertation suggests that champions are crucial players for the making of emergent sustainability strategies. This suggestion is supported by the Bachelor thesis which argues that for future-oriented sustainability innovations to emerge, intrinsically motivated and proactive champions are prerequisite. This line of argument runs parallel to the point made in the dissertation: Seriously integrating sustainability into product development which could be argued to be an emergent, project-specific sustainability strategy, requires people who go out of their way in order to advance the sustainability of their projects.

Bibliography

Aaltonen, K. and R. Sivonen (2009). Response strategies to stakeholder pressures in global projects. *International Journal of Project Management 27*(2), 131–141.

Ackermann, F. and C. Eden (2011). Strategic management of stakeholders: Theory and practice. *Long range planning 44*(3), 179–196.

Amir, S. (1994). The role of thermodynamics in the study of economic and ecological systems. *Ecological Economics 10*(2), 125–142.

Anastas, P. T. and J. C. Warner (1998). *Green Chemistry: Theory and Practice*. Oxford.: Oxford University Press.

Anderson, L. M. and T. S. Bateman (2000). Individual environmental initiative: Championing natural environmental issues in US business organizations. *Academy of Management Journal 43*(4), 548–570.

Anderson, R. (1998). *Mid-course correction: Toward a sustainable enterprise: the Interface model*. Chelsea Green Pub Co.

Ansoff, H. I. (1965). *Corporate strategy: An analytic approach to business policy for growth and expansion*. McGraw-Hill New York.

Ansoff, H. I. (1987). The emerging paradigm of strategic behavior. *Strategic Management Journal 8*(6), 501–515.

Argyris, C. (1976). Single-loop and double-loop models in research on decision making. *Administrative Science Quarterly 21*(3), 363–375.

Argyris, C. (1995). Action science and organizational learning. *Journal of Managerial Psychology 10*(6), 20–26.

Argyris, C. and D. A. Schön (1974). *Theory in practice: Increasing professional effectiveness*. San Francisco: Jossey-Bass.

Argyris, C. and D. A. Schön (1991). Participatory action research and action science compared: a commentary. In W. Whyte (Ed.), *Participatory Action Research*, pp. 85–96. London: Sage Publications.

Astley, W. G., R. Axelsson, R. J. Butler, D. J. Hickson, and D. C. Wilson (1982). Complexity and Cleavage: Dual Explanations of Strategic Decision-Making. *Journal of Management Studies 19*(4), 357–375.

Atkinson, G. and S. Mourato (2008). Environmental Cost-Benefit Analysis. *Annual Review of Environment and Resources 33*(1), 317–344.

Avison, D. E., F. Lau, M. D. Myers, and P. A. Nielsen (1999). Action research. *Communications of the ACM 42*(1), 94–97.

AWATEA (2008). Environmental Impacts of Marine Energy Converters. `http://www.mfe.govt.nz/rma/central/nps/generation/submissions/116-attachment.pdf`. 04/07/2014.

Ayres, R. U. (1998). Eco-thermodynamics: economics and the second law. *Ecological Economics 26*(2), 189–209.

Bakshi, B. R. and J. Fiksel (2003). The Quest for Sustainability: Challenges for Process Systems Engineering. *AIChE Journal 49*(6), 1350–1358.

Ballantyne, D. (2004). Action research reviewed: a market-oriented approach. *European Journal of Marketing 38*(3/4), 321–337.

Banerjee, S. B. (2002). Corporate environmentalism: the construct and its measurement. *Journal of Business Research 55*(3), 177–191.

Barbuto, J. E. (2002). How is strategy formed in organizations? A multi-disciplinary taxonomy of strategy-making approaches. *Journal of Behavioral and Applied Management 3*(1), 64–73.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management 17*(1), 99–120.

Baumgartner, R. J. and D. Ebner (2010). Corporate sustainability strategies: Sustainability profiles and maturity levels. *Sustainable Development 18*(2), 76–89.

Bell, M. and J. Side (2011). Tidal Technology Development and Deployment in the UK: Tidal Technologies: Key issues across planning and development for environmental regulators: Background Report on Task 2 of Sniffer ER20: Environmental impacts of tidal and wave power developments and key issues for consideration by environment agencies.

Benn, S., D. Dunphy, and A. Griffiths (2006). Enabling change for corporate sustainability: An integrated perspective. *Australasian Journal of Environmental Management 13*(3), 156–165.

Bergen, S. D., S. M. Bolton, and J. L. Fridley (2001). Design principles for ecological engineering. *Ecological Engineering 18*(2), 201–210.

Boal, K. and M. Meckler (2010). Decision Errors of the 4th, 5th, and 6th Kind: Chapter 12. In P. C. Nutt and D. C. Wilson (Eds.), *Handbook of decision making*, Volume 6, pp. 327–348. Chichester [Sussex]: Wiley-Blackwell.

Bosch Group (2013). Bosch Annual Report 2013. `http://www.bosch.com/content2/publication_forms/en/downloads/Bosch_Annual_Report_2013.pdf`. 25/09/2014.

Bosch Group (2014). Bosch today. `http://www.bosch.com/content2/publication_forms/en/downloads/Bosch_Today_2014.pdf`. 25/09/2014.

Boulding, K. E. (1993). Spaceship Earth Revisited. In H. E. Daly and K. N. Townsend (Eds.), *Valuing the earth: economics, ecology, ethics*, pp. 311–314. The MIT Press.

Bradbury, H. and P. Reason (2001). Conclusion: broadening the bandwidth of validity: issues and choice-points for improving the quality of action research. In P. Reason and H. Bradbury (Eds.), *Handbook of action research: Participative inquiry and practice*, pp. 343–351. Sage Publications Ltd.

Bradford, J. L. and D. E. Garrett (1995). The effectiveness of corporate communicative responses to accusations of unethical behavior. *Journal of business ethics 14*(11), 875–892.

Brandt, M. J., C. Höschle, A. Diederichs, K. Betke, R. Matuschek, S. Witte, and G. Nehls (2012). Effectiveness of a sealscarer in deterring harbour porpoises (Phocoena phocoena) and its application as a mitigation measure during offshore pile driving: Final Report.

Brannick, T. and D. Coghlan (2007). In Defense of Being "Native": The Case for Insider Academic Research. *Organizational Research Methods 10*(1), 59–74.

Brydon-Miller, M., D. Greenwood, and P. Maguire (2003). Why action research? *Action Research 1*(1), 9–28.

Burgelman, R. A. (1983a). A Model of the Interaction of Strategic Behavior, Corporate Context, and the Concept of Strategy. *Academy of Management Review 8*(1), 61–70.

Burgelman, R. A. (1983b). Corporate entrepreneurship and strategic management: Insights from a process study. *Management Science 29*(12), 1349–1364.

Burgelman, R. A. (1991). Intraorganizational ecology of strategy making and organizational adaptation: Theory and field research. *Organization Science 2*(3), 239–262.

Burgelman, R. A. and A. S. Grove (1996). Strategie Dissonance. *California Management Review 38*(2), 8–28.

Burn, G. R. H. (2006). *Using participatory action research to develop an organization's strategy*. Ph. D. thesis, University of Brighton, Brighton.

Burnes, B. (2004). Kurt Lewin and the Planned Approach to Change: A Re–appraisal. *Journal of Management Studies 41*(6), 977–1002.

By, R. T. (2005). Organisational Change Management: A Critical Review. *Journal of Change Management 5*(4), 369–380.

Cabezas, H., C. W. Pawlowski, A. L. Mayer, and N. T. Hoagland (2003). Sustainability: ecological, social, economic, technological, and systems perspectives. *Clean Technologies and Environmental Policy 5* (3), 167–180.

Carter, C., S. R. Clegg, and M. Kornberger (2008). Strategy as practice? *Strategic Organization 6* (1), 83–99.

CBC News (2013). Joe Fresh vows to be 'force for good' in Bangladesh. `http://www.cbc.ca/news/business/joe-fresh-vows-to-be-force-for-good-in-bangladesh-1.1329098`. 08/01/2014.

Centi, G. and S. Perathoner (2003). Catalysis and sustainable (green) chemistry. *Catalysis Today 77* (4), 287–297.

Chaffee, E. E. (1985). Three Models of Strategy. *Academy of Management Review 10* (1), 89–98.

Chandler, D. and B. Torbert (2003). Transforming inquiry and action interweaving 27 flavors of action research. *Action Research 1* (2), 133–152.

Chattopadhyay, P., W. H. Glick, and G. P. Huber (2001). Organizational actions in response to threats and opportunities. *Academy of Management Journal 44* (5), 937–955.

Chavis, D. M., P. E. Stucky, and A. Wandersman (1983). Returning basic research to the community: A relationship between scientist and citizen. *American Psychologist 38* (4), 424.

Checkland, P. (1981). *Systems thinking, systems practice*. Chichester [Sussex] and New York: John Wiley & Sons.

Checkland, P. and S. Holwell (1998). Action research: its nature and validity. *Systemic Practice and Action Research 11* (1), 9–21.

Cherp, A., A. Watt, and V. Vinichenko (2007). SEA and strategy formation theories: From three Ps to five Ps. *Environmental Impact Assessment Review 27* (7), 624–644.

Chisholm, R. F. and M. Elden (1993). Features of emerging action research. *Human Relations 46* (2), 275–298.

Clark, J. H. (2006). Green chemistry: today (and tomorrow). *Green Chemistry 8*(1), 17–21.

Coghlan, D. (2011). Action Research: Exploring Perspectives on a Philosophy of Practical Knowing. *The Academy of Management Annals 5*(1), 53–87.

Coghlan, D. and T. Brannick (2005). *Doing action research in your own organization* (2nd ed.). London: Sage Publications.

Collins, T. (2001). Toward Sustainable Chemistry. *Science 291*(5501), 48–49.

Compton, R., L. Goodwin, R. Handy, and V. Abbott (2008). A critical examination of worldwide guidelines for minimising the disturbance to marine mammals during seismic surveys. *Marine Policy 32*(3), 255–262.

Connelly, F. M. and D. J. Clandinin (1990). Stories of experience and narrative inquiry. *Educational researcher 19*(5), 2–14.

Connelly, L. and C. P. Koshland (2001a). Exergy and industrial ecology—Part 1: An exergy-based definition of consumption and a thermodynamic interpretation of ecosystem evolution. *Exergy, An International Journal 1*(3), 146–165.

Connelly, L. and C. P. Koshland (2001b). Exergy and industrial ecology. Part 2: A non-dimensional analysis of means to reduce resource depletion. *Exergy, An International Journal 1*(4), 234–255.

Cooper, H. (2013). Bangladesh factory disasters ask questions of Australian companies. `http://www.abc.net.au/7.30/content/2013/s3748694.htm`. 07/01/2014.

Copping, A. E., K. Blake, R. Anderson, L. Zdanski, G. Gill, and J. Ward (2011). Screening Analysis for the Environmental Risk Evaluation System: Environmental Effects of Marine and Hydrokinetic Energy: Task 2.1.1.2: Evaluating Effects of Stressors Fiscal Year 2011 Progress Report.

Copping, A. E., R. Butner, L. Hanna, and J. Whiting (Eds.) (2012). *Renewable Ocean Energy and the Marine Environment: Filling Gaps in Knowledge*, Dublin.

Costanza, R. and H. E. Daly (1992). Natural Capital and Sustainable Development. *Conservation Biology 6*(1), 37–46.

Coughlan, P. and D. Coghlan (2002). Action research for operations management. *International Journal of Operations & Production Management 22*(2), 220–240.

Daily, G. C. and P. R. Ehrlich (1992). Population, sustainability, and Earth's carrying capacity. *BioScience 42*(10), 761–771.

Danovaro, R., C. Gambi, A. Dell'Anno, C. Corinaldesi, S. Fraschetti, A. Vanreusel, M. Vincx, and A. J. Gooday (2008). Exponential decline of deep-sea ecosystem functioning linked to benthic biodiversity loss. *Current Biology 18*(1), 1–8.

Das, T. K. and B.-S. Teng (1999). Cognitive biases and strategic decision processes: An integrative perspective. *Journal of Management Studies 36*(6), 757–778.

Davis, J. M. (2007). Rethinking the architecture An action researcher's resolution to writing and presenting their thesis. *Action Research 5*(2), 181–198.

Delmas, M. A. and M. W. Toffel (2004). Stakeholders and environmental management practices: an institutional framework. *Business Strategy and the Environment 13*(4), 209–222.

Denzin, N. K. (1978). *The research act: A theoretical introduction to sociological methods* (2 ed.). Transaction publishers.

Dias-Sardinha, I., L. Reijnders, and P. Antunes (2007). Developing sustainability balanced scorecards for environmental services: A study of three large Portuguese companies. *Environmental Quality Management 16*(4), 13–34.

Dick, B. (2002). Postgraduate programs using action research. *The Learning Organization 9*(4), 159–170.

Dickens, L. and K. Watkins (1999). Action research: rethinking Lewin. *Management Learning 30*(2), 127–140.

Diederichs, A., M. J. Brandt, and G. Nehls (2009). Auswirkungen des Baus des Umspannwerks am Offshore-Testfeld "Alpha ventus" auf Schweinswale: Untersuchungen zu Schweinswalen mit T-PODs.

Diederichs, A., M. J. Brandt, G. Nehls, M. Laczny, A. Hill, and W. Piper (2010). Auswirkungen des Baus des Offshore-Testfelds "Alpha ventus" auf marine Säugetiere.

Diederichs, A., G. Nehls, M. J. Brandt, M. Laczny, and W. Piper (2009). Auswirkungen der Vergrämungsmaßnahmen auf Schweinswale beim Bau des Offshore-Testfeldes "Alpha ventus".

Dreusicke, F. (2012). Nachhaltigkeitsbewertung von Werkstoffen: Eine vergleichende Analyse von Werkstoffoptionen in einem Innovationsprojekt der Robert Bosch GmbH: Diplomarbeit, Tübingen.

Dutton, J. E. (1986). The Processing of crisis and non-crisis strategic issues. *Journal of Management Studies 23* (5), 501–517.

Dyllick, T. and K. Hockerts (2002). Beyond the business case for corporate sustainability. *Business Strategy and the Environment 11* (2), 130–141.

Eden, C. and C. Huxham (1996a). Action Research for Management Research. *British Journal of Management 7* (1), 75–86.

Eden, C. and C. Huxham (1996b). *Action research for the study of organizations: Handbook of orgniaztion studies*. Beverly Hills: Sage.

Edenhofer, O., R. Pichs Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, and S. v. S. C. Schlömer (2012). *Renewable energy sources and climate change mitigation: Special report of the Intergovernmental Panel on Climate Change*. New York: Cambridge University Press.

Eesley, C. and M. J. Lenox (2005). Firm responses to secondary stakeholder action. *Academy of Management Annual Meeting Proceedings 8* (1), E1–E6.

Ehrenfeld, J. (2004). Industrial ecology: a new field or only a metaphor? *Journal of Cleaner Production 12* (8), 825–831.

Eisenhardt, K. M. and J. A. Martin (2000). Dynamic capabilities: what are they? *Strategic Management Journal 21*(10-11), 1105–1121.

Elbanna, S. (2011). Multi-Theoretic Perspectives of Strategy Processes.

Elbanna, S. and J. Child (2007a). Influences on strategic decision effectiveness: Development and test of an integrative model. *Strategic Management Journal 28*(4), 431–453.

Elbanna, S. and J. Child (2007b). The Influence of Decision, Environmental and Firm Characteristics on the Rationality of Strategic Decision–Making*. *Journal of Management Studies 44*(4), 561–591.

Elkington, J. (1997). *Cannibals with Forks: The Triple Bottom Line of Twenty First Century Business*. Oxford: Capstone Publishing Ltd.

Enroth, M. (2007). How to formulate and realise a corporate sustainability strategy. *Progress in Industrial Ecology, an International Journal 4*(1), 103–121.

Erkman, S. (1997). Industrial ecology: an historical view. *Journal of Cleaner Production 5*(1), 1–10.

Esty, D. C. (2001). A term's limits. `http://digitalcommons.law.yale.edu/fss_papers/434`. 26/09/2014.

Fichter, K. and M. G. Arnold (2003). Nachhaltigkeitsinnovationen von Unternehmen. Erkenntnisse einer explorativen Untersuchung. In *Handbuch Nachhaltige Entwicklung*, pp. 273–285. Springer.

Figge, F. (2004). Bio-folio: applying portfolio theory to biodiversity. *Biodiversity and Conservation 13*(4), 827–849.

Figge, F., T. Hahn, S. Schaltegger, and M. Wagner (2002). The Sustainability Balanced Scorecard - linking sustainability management to business strategy. *Business Strategy and the Environment 11*(5), 269–284.

Fink, A. (2010). *Conducting research literature reviews: From the Internet to paper* (3 ed.). Thousand Oaks and Calif: Sage Publications.

Fisher, K. and R. Phelps (2006). Recipe or performing art? Challenging conventions for writing action research theses. *Action Research 4* (2), 143–164.

Fleischer, D. (2009). Green teams. Engaging employees in sustainability. `http://www.greenbiz.com/sites/default/files/GreenBizReports-GreenTeams-final.pdf`. 11/08/2014.

Flick, U. (2004). Triangulation in qualitative research. In U. Flick, E. v. Kardoff, and I. Steinke (Eds.), *A companion to qualitative research*, pp. 178–183. London: Sage Publications.

Folke, C., S. Carpenter, T. Elmqvist, L. Gunderson, C. S. Holling, and B. Walker (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. *AMBIO: A Journal of the Human Environment 31* (5), 437–440.

Foth, M. (2006). Network action research. *Action Research 4* (2), 205–226.

Frame, B. (2008). 'Wicked', 'messy', and 'clumsy': long-term frameworks for sustainability. *Environ. Planning C 26*, 1113–1128.

Fraser, E. D. G., W. Mabee, and F. Figge (2005). A framework for assessing the vulnerability of food systems to future shocks. *Futures 37* (6), 465–479.

Frid, C., E. Andonegi, J. Depestele, A. Judd, D. Rihan, S. I. Rogers, and E. Kenchington (2012). The environmental interactions of tidal and wave energy generation devices. *Environmental Impact Assessment Review 32* (1), 133–139.

Friedman, V. J. and T. Rogers (2009). There is nothing so theoretical as good action research. *Action Research 7* (1), 31–47.

Gattie, D. K., M. C. Smith, E. W. Tollner, and S. C. McCutcheon (2003). The emergence of ecological engineering as a discipline. *Ecological Engineering 20* (5), 409–420.

Gaul, L. (2011). Personal communication on sustainability in Engineering Science.

Geels, F. W. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Research Policy 39*, 495–510.

Georgescu-Roegen, N. (1971). *The Entropy Law and the Economic Process*. Cambridge Mass: Harvard University Press.

Georgescu-Roegen, N. (1986). The Entropy Law and the Economic Process in Retrospect. *Eastern Economic Journal 12*(1), 3–25.

Glavic, P. and R. Lukman (2007). Review of sustainability terms and their definitions. *Journal of Cleaner Production 15*(18), 1875–1885.

Gosselin, F. (2008). Redefining ecological engineering to promote its integration with sustainable development and tighten its links with the whole of ecology. *Ecological Engineering 32*(3), 199–205.

Gowdy, J. M. (1995). One world, one experiment: addressing the biodiversity—economics conflict. *Ecological Economics 15*(3), 181–192.

Gowdy, J. M. and S. Mesner (1998). The Evolution of Georgescu-Roegen's Bioeconomics. *Review of Social Economy 56*(2), 136–156.

Graedel, T. E. (1996). Weighted matrices as product life cycle assessment tools. *The International Journal of Life Cycle Assessment 1*(2), 85–89.

Grant, S. (2007). Learning through 'being' and 'doing'. *Action Research 5*(3), 265–274.

Guion, L. A., D. C. Diehl, and D. McDonald (2011). Triangulation: Establishing the validity of qualitative studies: Institute of Food and Agricultural Sciences, University of Florida. pp. 1–3.

Gutowski, T. G. (2011). Manufacturing and the Science of Sustainability. In J. Hesselbach and C. Herrmann (Eds.), *Glocalized Solutions for Sustainability in Manufacturing*, pp. 32–39. Berlin and Heidelberg: Springer.

Gutowski, T. G., D. P. Sekulic, and B. R. Bakshi (2009). Preliminary thoughts on the application of thermodynamics to the development of sustainability criteria. In *2009 IEEE International Symposium on Sustainable Systems and Technology*, pp. 1–6. IEEE.

Hambrick, D. C. (2007). Upper echelons theory: An update. *Academy of Management Review 32*(2), 334–343.

Hambrick, D. C. and P. A. Mason (1984). Upper echelons: The organization as a reflection of its top managers. *Academy of Management Review 9*(2), 193–206.

Hammond, G. P. (2004). Engineering sustainability: thermodynamics, energy systems, and the environment. *International Journal of Energy Research 28*(7), 613–639.

Hansen, E. G., M. Sextl, and R. Reichwald (2010). Managing strategic alliances through a community–enabled balanced scorecard: The case of Merck Ltd, Thailand. *Business Strategy and the Environment 19*(6), 387–399.

Harbottle, M., A. Al-Tabbaa, and C. Evans (2007). A comparison of the technical sustainability of in situ stabilisation/solidification with disposal to landfill. *Journal of Hazardous Materials 141*(2), 430–440.

Harris, N. (2007). Corporate engagement in processes for planetary sustainability: understanding corporate capacity in the non–renewable resource extractive sector, Australia. *Business Strategy and the Environment 16*(8), 538–553.

Hart, S. L. (1992). An integrative framework for strategy-making processes. *Academy of Management Review 17*(2), 327–351.

Hart, S. L. and M. B. Milstein (2003). Creating sustainable value. *Academy al Management Executive 17*(2), 56–67.

Hasna, A. (2009). Chemical Engineering Industry Transition towards Sustainability. In *SSEE International Conference - Solutions for Sustainable Planet*, pp. 1–12.

Hasna, A. M. (2010). Embedding sustainability in capstone engineering design projects. In *IEEE EDUCON 2010 Conference*, pp. 1601–1610. IEEE.

Hendry, J. (2000). Strategic Decision Making, Discourse, And Strategy As Social Practice. *Journal of Management Studies 37*, 955–978.

Herbert, T. T. (1999). Multinational Strategic Planning: Matching Central Expectations to Local Realities. *Long Range Planning 32*(1), 81–87.

Herr, K. and G. L. Anderson (2005). *The action research dissertation: A guide for students and faculty*. Thousand Oaks and Calif: Sage Publications.

Hickson, D. J., R. Butler, D. Cray, G. Mallory, and D. Wilson (1986). *Top decisions: strategic decision-making in organizations*. San Francisco: Jossey-Bass.

Hitt, M. A. and B. B. Tyler (1991). Strategic decision models: Integrating different perspectives. *Strategic Management Journal 12*(5), 327–351.

Hodgkinson, G. P. and M. P. Healey (2008). Cognition in Organizations. *Annual Review of Psychology (Annu. Rev. Psychol.) 59*(1), 387–417.

Hoffmann, V. H., T. Trautmann, and J. Hamprecht (2009). Regulatory uncertainty: A reason to postpone investments? Not necessarily. *Journal of Management Studies 46*(7), 1227–1253.

Hooper, D. U., F. S. Chapin, J. J. Ewel, A. Hector, P. Inchausti, S. Lavorel, J. H. Lawton, D. M. Lodge, M. Loreau, S. Naeem, B. Schmid, H. Setälä, A. J. Symstad, J. Vandermeer, and D. A. Wardle (2005). Effects of biodiversity on ecosystem functioning: A consensus of current knowledge. *Ecological Monographs 75*(1), 3–35.

Horton, B. (1999). Green Chemistry puts down roots. *Nature 400*(6746), 797–799.

Horváth, I. T. and P. T. Anastas (2007). Innovations and Green Chemistry. *Chemical Reviews 107*(6), 2169–2173.

Howell, J. M. and C. A. Higgins (1990). Champions of technological innovation. *Administrative Science Quarterly 35*(2), 317–341.

Huckerby, J. (2009). Marine Energy: Resources, Technologies, Research and Policies.

Hunt, C. B. and E. R. Auster (1990). Proactive environmental management: avoiding the toxic trap. *Sloan management review 31*(2), 7–18.

Hutzschenreuter, T. (2006). Strategy-Process Research: What Have We Learned and What Is Still to Be Explored. *Journal of Management 32*(5), 673–720.

Huxham, C. and S. Vangen (2003). Researching organizational practice through action research: Case studies and design choices. *Organizational Research Methods 6*(3), 383–403.

Idenburg, P. J. (1993). Four styles of strategy development. *Long Range Planning 26*(6), 132–137.

Inger, R., M. J. Attrill, S. Bearhop, A. C. Broderick, W. J. Grecian, D. J. Hodgson, C. Mills, E. Sheehan, S. C. Votier, and M. J. Witt (2009). Marine renewable energy: potential benefits to biodiversity? An urgent call for research. *Journal of Applied Ecology 46*(6), 1145–1153.

IPCC (2013). Climate Change 2013: The Physical Science Basis. 5th Assessment Report. `http://climatechange2013.org/`. 26/09/2014.

Isaacman, L. and K. Lee (2009). Current State of Knowledge on the Environmental Impacts of Tidal and Wave Energy Technology in Canada: Canadian Science Advisory Secretariat Research Document 2009/077. `http://www.dfo-mpo.gc.ca/csas/`. 04/01/2013.

Ishida, T. and M. Haruta (2007). Gold Catalysts: Towards Sustainable Chemistry. *Angewandte Chemie International Edition 46*(38), 7154–7156.

Israel, B. A., S. J. Schurman, and M. K. Hugentobler (1992). Conducting action research: relationships between organization members and researchers. *The Journal of Applied Behavioral Science 28*(1), 74.

Jackson, T. (2009). *Prosperity without growth: Economics for a finite planet*. Earthscan/James & James.

Jacobson, P. T. (2011). Challenges and Opportunities in Tidal and Wave Power. In K. Rao (Ed.), *Energy and Power Generation Handbook: Established and Emerging Technologies*. New York: ASME Press.

Jamieson, D. (2013). Gap Denies Connection To Bangladesh Factory That Employed Children In Al Jazeera Report. `http://www.huffingtonpost.com/`

2013/08/27/gap-inc-old-navy-jeans-bangladesh_n_3822923.html. 07/01/2014.

Jarzabkowski, P. (2004). Strategy as Practice: Recursiveness, Adaptation, and Practices-in-Use. *Organization Studies 25*, 529–560.

Jarzabkowski, P. (2008). Shaping strategy as a structuration process. *Academy of Management Journal 51*, 621–650.

Jennings, P. D. and P. A. Zandbergen (1995). Ecologically Sustainable Organizations: An Institutional Approach. *The Academy of Management Review 20* (4), 1015.

Jesson, J., L. Matheson, and F. M. Lacey (2011). *Doing your literature review: Traditional and systematic techniques*. Sage Publications.

Jett, Q. R. and J. M. George (2005). Emergent Strategies and Their Consequences: A Process Study of Competition and Complex Decision Making. *Advances in Strategic Management 22*, 387–411.

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly 24* (4), 602–611.

Johnson, G., R. Whittington, and K. Scholes (2011). *Exploring Strategy* (Ninth edition ed.). Essex: Prentice Hall.

Johnson, P., J. Duberley, P. Close, and C. Cassell (1999). Negotiating field roles in manufacturing management research: The need for reflexivity. *International Journal of Operations & Production Management 19* (12), 1234–1253.

Kåberger, T. and B. Månsson (2001). Entropy and economic processes — physics perspectives. *Ecological Economics 36* (1), 165–179.

Kaldschmidt, S. (2011). *The Values of Sustainability: The Influence of Leaders' Personal Values on Sustainability Strategies*. Ph. D. thesis, University of St. Gallen, St. Gallen.

Kaneda, K., K. Ebitani, T. Mizugaki, and K. Mori (2006). Design of High-Performance Heterogeneous Metal Catalysts for Green and Sustainable Chemistry. *Bulletin of the Chemical Society of Japan 79* (7), 981–1016.

Kaplan, R. S. (1998). Innovation action research: creating new management theory and practice. *Journal of management accounting research 10*, 89–118.

Karatzoglou, B. (2013). An in-depth literature review of the evolving roles and contributions of universities to education for sustainable development. *Journal of Cleaner Production 49*(Complete), 44–53.

Kärsten, F. (2014). Drivers for implementing sustainability in innovation projects of companies: An interview-based analysis of the Bosch example: Bachelor thesis, Heilbronn.

Kay, J. J. (2000). Ecosystems as self-organising holarchic open systems: narratives and the second law of thermodynamics. In S. E. Jørgensen and F. Müller (Eds.), *Handbook of ecosystem theories and management*, pp. 135–160. Boca Raton, FL.: CRC Press.

Kay, J. J., H. A. Regier, M. Boyle, and G. Francis (1999). An ecosystem approach for sustainability: addressing the challenge of complexity. *Futures 31*, 721–742.

Kernaghan, C. (Oct 3, 2013). Gap and Old Navy in Bangladesh: cheating the poorest workers in the world. `http://www.globallabourrights.org/reports/gap-and-old-navy-in-bangladesh-cheating-the-poorest-workers-in-the-world`. 07/01/2014.

Kibert, C. J. (1997). The Promises and Limits of Sustainability. In G. C. Daily (Ed.), *Nature's services*, pp. 9–38. Washington, D.C.: Island Press.

Kidwai, M. (2006). Green chemistry trends toward sustainability. *Pure and Applied Chemistry 78*(11), 1983–1992.

Kim, H. and D. F. Andersen (2012). Building confidence in causal maps generated from purposive text data: mapping transcripts of the Federal Reserve. *System Dynamics Review 28*(4), 311–328.

Kirchhoff, M. M. (2005). Promoting sustainability through green chemistry. *Resources, Conservation and Recycling 44*(3), 237–243.

Koplin, J. (2006). *Nachhaltigkeit im Beschaffungsmanagement: Ein Konzept zur Integration von Umwelt- und Sozialstandards* (1 ed.). Wiesbaden: Dt. Univ.-Verl.

Kümmerer, K. (2007). Sustainable from the very beginning: rational design of molecules by life cycle engineering as an important approach for green pharmacy and green chemistry. *Green Chemistry 9*(8), 899–907.

Langhamer, O., K. Haikonen, and J. Sundberg (2010). Wave power—Sustainable energy or environmentally costly? A review with special emphasis on linear wave energy converters. *Renewable and Sustainable Energy Reviews 14*(4), 1329–1335.

Lee, J., J. Lee, and H. Lee (2003). Exploration and Exploitation in the Presence of Network Externalities. *Management Science 49*(4), 553–570.

Lehmann-Waffenschmidt, M. (2007). *Innovations towards Sustainability*. Springer.

Lewin, K. (1947). Frontiers in group dynamics. *Human Relations 1*(2), 143–153.

Li, Y. and J. Hu (2008). An empirical research on the patterns and influencing factors of strategy formation processes. *Frontiers of Business Research in China 2*(2), 204–218.

Lohse, D. P., R. N. Gaddam, and P. T. Raimondi (2008). Predicted Effects of Wave Energy Conversion on Communities in the Nearshore Environment. In P. Nelson, D. Behrens, J. Castle, G. Crawford, R. N. Gaddam, S. Hackett, J. Largier, D. P. Lohse, K. L. Mills, P. T. Raimondi, M. Robart, W. J. Sydeman, S. A. Thompson, and S. Woo (Eds.), *Developing Wave Energy in Coastal California: Potential Socio-Economic and Environmental Effects*, pp. 83–109. State of California Energy Commission.

Lok, P., J. Rhodes, and V. Cheng (2010). A framework for strategic decision making and performance among Chinese managers. *The International Journal of Human Resource Management 21*(9), 1373–1395.

Lotila, P. (2010). Corporate responsiveness to social pressure: An interaction-based model. *Journal of business ethics 94*(3), 395–409.

Lowe, A. and A. Jones (2004). Emergent Strategy and the Measurement of Performance: The Formulation of Performance Indicators at the Microlevel. *Organization Studies 25*, 1313–1337.

Luna-Reyes, L. F. and D. L. Andersen (2003). Collecting and analyzing qualitative data for system dynamics: methods and models. *System Dynamics Review 19*(4), 271–296.

Luther, R. (2011). Was gibt's Neues bei Hydraulikfluiden? Normungsaktivitäten für Bioschmierstoffe als Folge der europäischen Leitmarktinitiative für biobasierte Stoffe. In IFAS (Ed.), *Industrie-Kolloquium des IFAS*, Aachen.

Manley, J. B., P. T. Anastas, and B. W. Cue Jr. (2008). Frontiers in Green Chemistry: meeting the grand challenges for sustainability in R&D and manufacturing. *Journal of Cleaner Production 16*(6), 743–750.

Maritz, R., M. Pretorius, and K. Plant (2011). Exploring the Interface Between Strategy-Making and Responsible Leadership. *Journal of Business Ethics 98*(S1), 101–113.

Markham, S. K. (1998). A longitudinal examination of how champions influence others to support their projects. *Journal of Product Innovation Management 15*(6), 490–504.

Markusson, N. (2010). The championing of environmental improvements in technology investment projects. *Journal of Cleaner Production 18*(8), 777–783.

Martinet, A. C. (2010). Strategic planning, strategic management, strategic foresight: The seminal work of H. Igor Ansoff. *Technological Forecasting and Social Change 77*(9), 1485–1487.

McDaniel, C. and J. M. Gowdy (1998). Markets and biodiversity loss: some case studies and policy considerations. *International Journal of Social Economics 25*(10), 1454–1465.

McMurray, G. R. (2007). Wave Energy Ecological Effects Workshop Ecological Assessment Briefing Paper. `http://spo.nmfs.noaa.gov/tm/Wave%20Energy%20NOAATM92%20for%20web.pdf#page=37`. 06/01/2013.

McNiff, J. and J. Whitehead (2009). *You and your action research project.* Routledge.

Meijer, P. C., N. Verloop, and D. Beijaard (2002). Multi-Method Triangulation in a Qualitative Study on Teachers' Practical Knowledge: An Attempt to Increase Internal Validity. *Quality and Quantity 36* (2), 145–167.

Mihelcic, J. R., J. C. Crittenden, M. J. Small, D. R. Shonnard, D. R. Hokanson, Q. Zhang, H. Chen, S. A. Sorby, V. U. James, J. W. Sutherland, and J. L. Schnoor (2003). Sustainability Science and Engineering: The Emergence of a New Metadiscipline. *Environmental Science & Technology 37* (23), 5314–5324.

Mintzberg, H. (1978). Patterns in Strategy Formation. *Management Science 24*, 934–948.

Mintzberg, H. (1990a). Strategy formation: schools of thought. *Perspectives on strategic management 1968*, 105–235.

Mintzberg, H. (1990b). The design school: reconsidering the basic premises of strategic management. *Strategic Management Journal 11* (3), 171–195.

Mintzberg, H. (1994). Rethinking strategic planning part I: Pitfalls and fallacies. *Long Range Planning 27* (3), 12–21.

Mintzberg, H., B. W. Ahlstrand, and J. Lampel (1998). *Strategy safari: A guided tour through the wilds of strategic management.* New York: Free Press.

Mintzberg, H. and A. McHugh (1985). Strategy Formation in an Adhocracy. *Administrative Science Quarterly 30*, 160–197.

Mintzberg, H. and J. A. Waters (1985). Of strategies, deliberate and emergent. *Strategic Management Journal 6*, 257–272.

Mitchell, R. K., B. R. Agle, and D. J. Wood (1997). Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. *Academy of Management Review 22* (4), 853–886.

Mitsch, W. J. (2003). Ecology, ecological engineering, and the Odum brothers. *Ecological Engineering 20* (5), 331–338.

Mitsch, W. J. and S. E. Jørgensen (2003). Ecological engineering: A field whose time has come. *Ecological Engineering 20*(5), 363–377.

Mitsch, W. J. and S. E. Jørgensen (2004). *Ecological engineering and ecosystem restoration*. Hoboken N.J: John Wiley & Sons, Ltd.

Morsing, M. and M. Schultz (2006). Corporate social responsibility communication: stakeholder information, response and involvement strategies. *Business Ethics: A European Review 15*(4), 323–338.

Myers, N. (2002). Biodiversity and biodepletion: the need for a paradigm shift. In T. O'Riordan and S. Stoll-Kleemann (Eds.), *Biodiversity, sustainability, and human communities*, pp. 46–60. Cambridge, New York: Cambridge University Press.

Naeem, S., L. J. Thompson, S. P. Lawler, J. H. Lawton, and R. M. Woodfin (1994). Declining biodiversity can alter the performance of ecosystems. *Nature 368*(6473), 734–737.

Näslund, D. (2002). Logistics needs qualitative research–especially action research. *International Journal of Physical Distribution & Logistics Management 32*(5), 321–338.

Nehls, G. and K. Betke (2011). Darstellung und Bewertung der Auswirkungen von Schallemissionen durch Offshore-Rammarbeiten auf Meeressäugetiere: Im Auftrag des Offshore Forum Windenergie.

Neugebauer, F., F. Figge, and T. Hahn (2014). Planned or emergent strategy making? Exploring the formation of corporate sustainability strategies. *Business Strategy and the Environment*, forthcoming.

Newton, T. and G. Harte (1997). Green Business: Technicist Kitsch? *Journal of Management Studies 34*(1), 75–98.

Nielsen, S. N. (2007). What has modern ecosystem theory to offer to cleaner production, industrial ecology and society? The views of an ecologist. *Journal of Cleaner Production 15*(17), 1639–1653.

Noda, T. and J. L. Bower (1996). Strategy making as iterated processes of resource allocation. *Strategic Management Journal 17*(S1), 159–192.

Nooraie, M. (2011). Decision's familiarity and strategic decision-making process output: the mediating impact of rationality of the decision-making process. *International Journal of Applied Decision Sciences 4* (4), 385.

Odum, H. T. (1996). Scales of ecological engineering. *Ecological Engineering 6*, 7–19.

Odum, H. T. and B. Odum (2003). Concepts and methods of ecological engineering. *Ecological Engineering 20* (5), 339–361.

Olsen, W. (2004). Triangulation in social research: qualitative and quantitative methods can really be mixed. *Developments in sociology 20*, 103–118.

Ortiz, I. and M. Cummins (2011). Global Inequality: Beyond the Bottom Billion: A Rapid Review of Income Distribution in 141 Countries: UNICEF Social and Economic Policy Working Paper. `http://www.unicef.org/socialpolicy/files/Global_Inequality.pdf`. 22/09/2014.

Paoletti, M. G. (1999). Using bioindicators based on biodiversity to assess landscape sustainability. *Agriculture, Ecosystems & Environment 74* (1-3), 1–18.

Papadakis, V. M. and P. Barwise (1998). Research on strategic decisions: where do we go from here? In V. M. Papadakis and P. Barwise (Eds.), *Strategic decisions*, pp. 289–302. Hingham.: Kluwer Academic Publishers.

Papadakis, V. M., S. Lioukas, and D. Chambers (1998). Strategic decision-making processes: the role of management and context. *Strategic Management Journal 19* (2), 115–147.

Papagiannakis, G., I. Voudouris, and S. Lioukas (2013). The Road to Sustainability: Exploring the Process of Corporate Environmental Strategy Over Time. *Business Strategy and the Environment 23* (4), 254–271.

Parker, R. P. M., G. P. Harrison, and J. P. Chick (2007). Energy and carbon audit of an offshore wave energy converter. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy 221* (8), 1119–1130.

Pehnt, M. (2006). Dynamic life cycle assessment (LCA) of renewable energy technologies. *Renewable Energy 31* (1), 55–71.

Peiffer, A. (2012). Entwicklung einer Systematik für die Nachhaltigkeitsbeurteilung von Werkstoffen bei der Robert Bosch GmbH: Master thesis, Düsseldorf.

Perrings, C. (2006). Resilience and sustainable development. *Environment and Development Economics 11* (04), 417–427.

Pestre, F., S. Mercier, and I. Huault (2008). *Une approche processuelle de construction des stratégies de responsabilité sociale des entreprises multinationales françaises.* Ph. D. thesis, Université Paris Dauphine, Paris.

Porac, J. F. and H. Thomas (2006). Managing Cognition and Strategy: Issues, Trends, and Future Directions. In A. M. Pettigrew, H. Thomas, and R. Whittington (Eds.), *Handbook of strategy and management*, pp. 165–181. London and Thousand Oaks CA: Sage Publications.

Prakash, A. (2001). Why do firms adopt 'beyond–compliance' environmental policies? *Business Strategy and the Environment 10* (5), 286–299.

Prins, G. and S. Rayner (2007). The Wrong Trousers: Radically rethinking climate policy.

Rajagopalan, N., A. M. A. Rasheed, and D. K. Datta (1993). Strategic decision processes: Critical review and future directions. *A Special Issue of the Journal of Management 19* (2), 349–384.

Rapoport, R. N. (1970). Three dilemmas in action research with special reference to the Tavistock experience. *Human Relations 23* (6), 499–513.

Raventós, A., T. Simas, A. Moura, G. Harrison, C. Thompson, and J.-F. Dhedin (2010). Life Cycle Assessment for marine renewables: Equimar Deliverable D6.4.2. `http://www.equimar.org/equimar-project-deliverables.html`. 04/01/2013.

Rawls, J. (1999). *A theory of justice* (Rev. ed. ed.). Cambridge Mass: Belknap Press of Harvard University Press.

Reason, P. and W. R. Torbert (2001). The action turn: Toward a transformational social science. *Concepts and Transformation 6*(1), 1–37.

Rebitzer, G., T. Ekvall, R. Frischknecht, D. Hunkeler, G. Norris, T. Rydberg, W.-P. Schmidt, S. Suh, B. P. Weidema, and D. W. Pennington (2004). Life cycle assessment part 1: framework, goal and scope definition, inventory analysis, and applications. *Environment international 30*(5), 701–720.

Regnér, P. (2003). Strategy Creation in the Periphery: Inductive Versus Deductive Strategy Making. *Journal of Management Studies 40*(1), 57–82.

Rifkin, J. (1980). *Entropy: A New World View: The Entropy Law*. New York: Viking Press.

Riordan, P. (1995). The philosophy of action science. *Journal of Managerial Psychology 10*(6), 6–13.

Rittel, H. W. J. and M. M. Webber (1973). Dilemmas in a general theory of planning. *Policy Sciences 4*(2), 155–169.

Robson, C. (2002). *Real world research: A resource for social scientists and practitioner-researchers*, Volume 2. Blackwell Oxford.

Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H.-J. Schellnhuber, B. Nykvist, C. Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. A. Foley (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity. *Ecology and Society 14*(2), 1–33.

Roloff, J. (2008). Learning from Multi-Stakeholder Networks: Issue-Focussed Stakeholder Management. *Journal of Business Ethics 82*(1), 233–250.

Roome, N. (1992). Developing environmental management strategies. *Business Strategy and the Environment 1*(1), 11–24.

Roome, N. (1994). Business strategy, R&D management and environmental imperatives. *R&D Management 24*(1), 65–82.

Røpke, I. (2004). The early history of modern ecological economics. *Ecological Economics 50* (3-4), 293–314.

Roth, J., A. B. Shani, and M. M. Leary (2007). Insider action research: Facing the challenges of new capability development within a biopharma company. *Action Research 5* (1), 41–60.

Rotmans, J. (2005). *Societal innovation: between dream and reality lies complexity*. Rotterdam: Erasmus Research Institute of Management (ERIM).

Rotmans, J. (2006). Tools for integrated sustainability assessment: a two-track approach. *Integrated Assessment 6* (4), 35–57.

Rugman, A. M. and A. Verbeke (1998). Corporate strategies and environmental regulations: An organizing framework. *Strategic Management Journal 19* (4), 363–375.

Russell, B. A., A. R. Knowlton, and B. Zoodsma (2001). Recommended measures to reduce ship strikes of North Atlantic right whales.

Ruth, M. (2005). Insights from Thermodynamics for the Analysis of Economic Processes. In A. Kleidon and R. D. Lorenz (Eds.), *Understanding Complex Systems*, pp. 243–254. Berlin and Heidelberg: Springer.

Sala, E. and N. Knowlton (2006). Global marine biodiversity trends. *Annual Review of Environment and Resources 31*, 93–122.

Sandborn, P. and J. Myers (2008). Designing Engineering Systems for Sustainability. In K. B. Misra (Ed.), *Handbook of Performability Engineering*, pp. 81–103. London: Springer.

Schaltegger, S. and M. Wagner (2011). Sustainable entrepreneurship and sustainability innovation: categories and interactions. *Business Strategy and the Environment 20* (4), 222–237.

Scheffer, M., S. Carpenter, J. A. Foley, C. Folke, and B. Walker (2001). Catastrophic shifts in ecosystems. *Nature 413* (6856), 591–596.

Schein, E. H. (2010). *Organizational culture and leadership*, Volume 2. John Wiley & Sons.

Schilit, W. K. and F. T. Paine (1987). An Examination of the Underlying Dynamics of Strategic Decisions Subject to Upward Influence Activity. *Journal of Management Studies 24*(2), 161–187.

Schneider, S. C. and A. d. Meyer (1991). Interpreting and responding to strategic issues: The impact of national culture. *Strategic Management Journal 12*(4), 307–320.

Schön, D. A. (1963). Champions for radical new inventions. *Harvard Business Review 41*(2), 77–86.

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

Schultz, M. and M. J. Hatch (2005). Building theory from practice: Strategic Organization. *Strategic Organization 3*(3), 337–347.

Schwenk, C. R. (1984). Cognitive simplification processes in strategic decision-making. *Strategic Management Journal 5*(2), 111–128.

Schwenk, C. R. (1995). Strategic Decision Making. *Journal of Management 21*(3), 471–493.

Seliger, G. (2011). Sustainability Engineering by Product-Service Systems. In J. Hesselbach and C. Herrmann (Eds.), *Glocalized Solutions for Sustainability in Manufacturing*, pp. 22–28. Berlin and Heidelberg: Springer.

Sharma, S. (2000). Managerial interpretations and organizational context as predictors of corporate choice of environmental strategy. *Academy of Management Journal 43*(4), 681–697.

Sharma, S., A. L. Pablo, and H. Vredenburg (1999). Corporate Environmental Responsiveness Strategies: The Importance of Issue Interpretation and Organizational Context. *The Journal of Applied Behavioral Science 35*(1), 87–108.

Sharp, Z. and N. Zaidman (2010). Strategization of CSR. *Journal of Business Ethics 93*(1), 51–71.

Shrivastava, P. (1995). The Role of Corporations in Achieving Ecological Sustainability. *Academy of Management Review 20* (4), 936–960.

Siggelkow, N. (2007). Persuasion with case studies. *Academy of Management Journal 50* (1), 20–24.

Simas, T., A. Moura, R. Batty, D. Thompson, and J. Norris (2009). Uncertainties regarding environmental impacts. Equimar Deliverable D6.3.1. Draft. `http://www.equimar.org/equimar-project-deliverables.html`. 04/01/2013.

Simons, R. H. and B. M. Thompson (1998). Strategic determinants: the context of managerial decision making. *Journal of Managerial Psychology 13* (1/2), 7–21.

Siomkos, G. and P. Shrivastava (1993). Responding to product liability crises. *Long range planning 26* (5), 72–79.

Slawinski, N. and P. Bansal (2012). A Matter of Time: The Temporal Perspectives of Organizational Responses to Climate Change. *Organization Studies 33* (11), 1537–1563.

Söllner, F. (1997). A reexamination of the role of thermodynamics for environmental economics. *Ecological Economics 22* (3), 175–201.

Stappen, R. K. (2008). A Sustainable World is Possible: Problemlösungen für das 21. Jahrhundert mit dem Wise-Consensus Verfahren: Working Paper 1.4. `http://faape.org/wise-consensus-4-2008.pdf`. 26/09/2014.

Staw, B. M., L. E. Sandelands, and J. E. Dutton (1981). Threat-rigidity effects in organizational behavior: A multilevel analysis. *Administrative Science Quarterly 26* (4), 501–524.

Stern, N. (2007). *The economics of climate change: The Stern review*. Cambridge UK, New York: Cambridge University Press.

Stone, M. M., B. Bigelow, and W. Crittenden (1999). Research on Strategic Management in Nonprofit Organizations Synthesis, Analysis, and Future Directions. *Administration & Society 31* (3), 378–423.

Stuart, I., D. McCutcheon, R. Handfield, R. McLachlin, and D. Samson (2002). Effective case research in operations management: a process perspective. *Journal of Operations Management 20* (5), 419–433.

Sunstein, C. R. (2007). Of Montreal and Kyoto: a tale of two protocols. *Harvard Environmental Law Review 31*, 1.

Susman, G. I. and R. D. Evered (1978). An assessment of the scientific merits of action research. *Administrative Science Quarterly 23* (4), 582–603.

Tansley, A. G. (1935). The Use and Abuse of Vegetational Concepts and Terms. *Ecology 16* (3), 284–307.

Taylor, A., C. Cocklin, and R. Brown (2012). Fostering environmental champions: A process to build their capacity to drive change. *Journal of environmental management 98*, 84–97.

Thompson, A. W., T. C. Larsson, and G. Broman (2011). Towards Sustainability-Driven Innovation through Product-Service Systems. In J. Hesselbach and C. Herrmann (Eds.), *Functional Thinking for Value Creation*, pp. 117–122. Berlin and Heidelberg: Springer.

Tilley, D. R. (2003). Industrial Ecology and Ecological Engineering: Opportunities for Symbiosis. *Journal of Industrial Ecology 7* (2), 13–32.

Tilman, D., P. B. Reich, and J. M. H. Knops (2006). Biodiversity and ecosystem stability in a decade-long grassland experiment. *Nature 441* (7093), 629–632.

Tranfield, D., D. Denyer, and P. Smart (2003). Towards a methodology for developing evidence–informed management knowledge by means of systematic review. *British Journal of Management 14* (3), 207–222.

Tsai, W. M.-H., I. C. MacMillan, and M. B. Low (1991). Effects of strategy and environment on corporate venture success in industrial markets. *Journal of Business Venturing 6* (1), 9–28.

Tundo, P., P. T. Anastas, D. S. Black, J. Breen, T. Collins, S. Memoli, J. Miyamoto, M. Polyakoff, and W. Tumas (2000). Synthetic pathways

and processes in green chemistry. Introductory overview. *Pure and Applied Chemistry 72*(7), 1207–1228.

Urban, R. A., B. R. Bakshi, G. F. Grubb, A. Baral, and W. J. Mitsch (2010). Towards sustainability of engineered processes: Designing self-reliant networks of technological–ecological systems. *Computers & Chemical Engineering 34*(9), 1413–1420.

van den Bergh, J. C. and J. M. Gowdy (2000). Evolutionary Theories in Environmental and Resource Economics: Approaches and Applications. *Environmental and Resource Economics 17*, 37–57.

Venselaar, J. (2003). Sustainable Growth and Chemical Engineering. *Chemical Engineering & Technology 26*(8), 868–874.

Vinodh, S. (2010). Assessment of sustainability using multi-grade fuzzy approach. *Clean Technologies and Environmental Policy 13*(3), 509–515.

Walsh, J. P. (1995). Managerial and Organizational Cognition: Notes from a Trip Down Memory Lane. *Organization Science 6*(3), 280–321.

Waltner-Toews, D. and J. J. Kay (2005). The Evolution of an Ecosystem Approach: the Diamond Schematic and an Adaptive Methodology for Ecosystem Sustainability and Health. *Ecology and Society 10*(1), 38.

Ward, J., I. Schultz, D. Woodruff, G. Roesijadi, and A. Copping (2010). Assessing the effects of marine and hydrokinetic energy development on marine and estuarine resources. In *Proceedings of MTS/IEEE International Conference Oceans September, Seattle, Washington, USA*, pp. 20–23.

Warner, J. C., A. S. Cannon, and K. M. Dye (2004). Green chemistry. *Environmental Impact Assessment Review 24*(7-8), 775–799.

Watermann, B., B. Daehne, S. Sievers, R. Dannenberg, J. Overbeke, J. Klijnstra, and O. Heemken (2005). Bioassays and selected chemical analysis of biocide-free antifouling coatings. *Chemosphere 60*(11), 1530–1541.

WCED (1987). Our Common Future. The Report of the World Commission on Environment and Development: Chapter 2: Towards Sustainable Development. `http://www.un-documents.net/ocf-02.htm`. 18/08/2014.

Welford, R. (1998). Corporate Strategy, Competitiveness, and the Environment. In R. Welford (Ed.), *Corporate Environmental Management 1*, pp. 13–34. London: Earthscan.

Wernerfelt, B. (1984). A resource–based view of the firm. *Strategic Management Journal 5* (2), 171–180.

Westbrook, R. (1995). Action research: a new paradigm for research in production and operations management. *International Journal of Operations & Production Management 15* (12), 6–20.

Wheeler, D. and M. Sillanpää (1998). Including the stakeholders: the business case. *Long range planning 31* (2), 201–210.

Whitehead, J. and J. McNiff (2006). *Action research: Living theory*. Sage.

Whittington, R. (1996). Strategy as practice. *Long Range Planning 29*, 731–735.

Whyte, W. (Ed.) (1991). *Participatory Action Research*. London: Sage Publications.

Wilson, B., R. S. Batty, F. Daunt, and C. Carter (2007). Collision risks between marine renewable energy devices and mammals, fish and diving birds: Scottish Association for Marine Science, Oban, Scotland, PA37 1QA. `http://depts.washington.edu/nnmrec/workshop/docs/Wilson_Collisions_report_final_12_03_07.pdf`. 16/01/2013.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal 24* (10), 991–995.

Winterton, N. (2003). Sense and sustainability: the role of chemistry, green or otherwise. *Clean Technologies and Environmental Policy 5* (1), 8–20.

Witt, M. J., E. V. Sheehan, S. Bearhop, A. C. Broderick, D. C. Conley, S. P. Cotterell, E. Crow, W. J. Grecian, C. Halsband, and D. J. Hodgson (2012). Assessing wave energy effects on biodiversity: the Wave Hub experience. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 370* (1959), 502–529.

Wright, C., D. Nyberg, and D. Grant (2012). "Hippies on the third floor": Climate Change, Narrative Identity and the Micro-Politics of Corporate Environmentalism. *Organization Studies 33*(11), 1451–1475.

Yin, R. K. (2009). *Case Study Research: Design and Methods* (4 ed.). Thousand Oaks CA: Sage.

Young, W. and F. Tilley (2006). Can businesses move beyond efficiency? The shift toward effectiveness and equity in the corporate sustainability debate. *Business Strategy and the Environment 15*(6), 402–415.

yWorks (2014). yEd Graph Editor: Version 3.12.2. `http://www.yworks.com`. 25/06/2014.

Zuber-Skerritt, O. (2001). Action Learning and Action Research: Paradigm, Praxis and Programs. In S. Sankara, B. Dick, and R. Passfield (Eds.), *Effective Change Management through Action Research and Action Learning: Concepts, Perspectives, Processes and Applications*, pp. 1–20. Lismore, Australia: Southern Cross University Press.

Zuber-Skerritt, O. (2002a). A model for designing action learning and action research programs. *The Learning Organization 9*(4), 143–149.

Zuber-Skerritt, O. (2002b). The concept of action learning. *The Learning Organization 9*(3), 114–124.

Zuber-Skerritt, O. and C. Perry (2002). Action research within organisations and university thesis writing. *The Learning Organization 9*(4), 171–179.

The formation of sustainability strategies is hardly addressed in sustainability research. Instead, it is often implicitly assumed that sustainability strategies are planned and implemented top-down. In contrast, the formation of strategies is a frequent topic of discussion in strategy research where a consensus has been established that strategy making resides on a continuum between planned and emergent.

This dissertation sets out to narrow this gap by investigating the formation of sustainability strategies from a theoretical and an empirical angle. The theoretical angle consists of a conceptual framework to help explain when planned and when emergent sustainability strategy making is more likely. The empirical angle comes into play with the Action Research study that is conducted in cooperation with a corporate innovation project.

The theoretical and empirical angle of this dissertation together shed light on the formation of sustainability strategies, suggesting that the nature of the sustainability problem addressed as well as sustainability champions play a major role for the kind of strategy making to be expected.

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