Sustainable Innovation and Entrepreneurship

NEW PERSPECTIVES IN RESEARCH ON CORPORATE SUSTAINABILITY

Series Editors: Sanjay Sharma, *Dean of the John Molson School of Business, Concordia University, Canada* and Mark Starik, *Professor of Strategic Management and Public Policy, School of Business and Director, Institute for Corporate Responsibility, George Washington University, USA*

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To Kerstin and Lola's future

– Rolf Wüstenhagen

To Monika, Lena and Leo

– Jost Hamschmidt

To Pramodita my life partner and Smita our sustainability future

– Sanjay Sharma

To Margery Moore, loving wife and sustainability partner

– Mark Starik

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1. Sustainability, innovation and entrepreneurship: introduction to the volume

Rolf Wüstenhagen, Sanjay Sharma, Mark Starik and Robert Wuebker[1]

OVERVIEW

Sustainability is back on the global agenda. After intense debates in the late 1970s and early 1980s about limits to growth, rising oil prices, forest dieback (Waldsterben) and the like, environmental and social issues received less attention in European public opinion during the 1990s. In the US, the timing was different, with an increasing level of attention to sustainability issues across businesses and non-governmental organizations (NGOs) occurring in the 1990s. With a new focus on climate change, we have recently seen the discussion about sustainable development return with increased intensity. The threat of uncontrolled changes in the atmosphere has led to an unprecedented wave of public attention to environmental challenges. At the same time, there is also increased awareness of social challenges such as high unemployment rates, increasing inequalities and poverty in developing countries. Global policy makers and corporate leaders are expressing the need for action. Governments have started to embark on ambitious emission targets. Corporate sustainability seems to have become a mainstream issue, at least on paper.

At the same time, though, it becomes apparent that the magnitude of the sustainability challenge calls for more than just incremental changes to existing patterns of production and consumption. Just as global greenhouse gas levels have embarked on a steep path of discontinuous change, we seem to be in need of fundamentally new solutions in the way we do business and govern our economies. And even if we succeed in making substantial changes to corporate strategies and consumer behaviour, it seems to be an open question whether this will be successful. John Doerr, a prominent representative from the cradle of American optimism, the venture capital community of Silicon Valley, recently talked about the accelerating pace of greentech investments, but at the same time commented that he is afraid that what we do might be 'too little, too late'.[2] What this shows us is that it is high time for scholars to address the corporate sustainability discourse from an innovation and entrepreneurship angle.

CONCEPTUALIZING SUSTAINABILITY, INNOVATION AND ENTREPRENEURSHIP

The Corporate Sustainability Perspective: From Environmental Management Systems to Sustainable Business Models

The field of academic research on corporate sustainability management has gained significant sophistication since the beginnings of what is now the Organizations and the Natural Environment (ONE) division in the Academy of Management. Research on corporate sustainability management, with its interest in the connection between the natural environment and various organizational levels of analyses (individuals, subgroups, organizations, or clusters of organizations) is a relatively recent scholarly phenomenon. In comparison with its sister disciplines of strategy, organizational behaviour, and environmental economics, where research spans decades, its history is relatively brief.

In the early 1980s, firms responded to the growing awareness of the long-term consequences of environmental impact by engaging in corporate greening efforts (Hart, 1997) and implementing environmental policies – that in some cases went beyond mere compliance with the law (Marcus, 1980). In the late 1980s, management scholars began to study these firms, developing at first conceptual and then empirical research on the various aspects of organizational greening. Initial descriptive and case-driven work (Buchholz et al., 1992; Starik, 1995) became the touchstones for the evolution of additional theory development and empirical studies (Throop et al., 1993; Hart and Ahuja, 1996; Sharma and Vredenburg, 1998; Dowell et al., 2000).

As befits an evolving field, the theories and paradigms in sustainability management research have drawn from research conducted in the 'home' field of the particular scholar, employing both qualitative and quantitative approaches. Early research on corporate sustainability focused on the individual firm and firm attributes essential to environmental performance, seeking to identify the characteristics and capabilities that enable firms to achieve the best possible environmental performance (Nehrt, 1996) and why some firms comply, and others overcomply, with regulatory requirements (Arora and Gangopadhyay, 1995; Arora and Cason, 1996; Majumdar and

Marcus, 1998). Early work on corporate sustainability drew heavily on the strategic management literature, arguing that excellence in protecting the environment created new opportunities to achieve competitive advantage through the effective use of firm resources (Hart, 1995; Porter and van der Linde, 1995; Russo and Fouts, 1997; Aragón-Correa and Sharma, 2003). The strategy literature, with its focus on achieving superior relative performance, has been extensively used to address operational issues such as environmental management systems (Welford, 1992; Dyllick and Hamschmidt, 2000; Steger, 2000) and eco-efficiency (Schmidheiny, 1992; Schaltegger and Sturm, 1995). If resources are used both uniquely and effectively it is argued that this leads to increased performance (Elkington, 1994; Sharma and Vredenburg, 1998). Early research focusing on the differentiation of environmental products (Reinhardt, 1998) has evolved to address the more thoroughgoing question of how to enact performance-enhancing sustainability strategies as measured by market efficiency (Dowell et al., 2000) rather than resource efficiency (Hart and Ahuja, 1996).

While research at the level of the firm has provided key insights, this is far from the end of the story (Starik and Marcus, 2000; Starik, 2002). Firms exist in an industry and institutional environment, complete with context-specific pressures and institutional norms, and sustainable management scholarship took steps to incorporate these facts into theory development and empirical accounts (Hoffmann and Ventresca, 1999; Hoffmann, 2001; Delmas and Terlaak, 2002; Hart and Milstein, 2003; Doh and Guay, 2006). Research on stakeholder influences on corporate sustainability practices (Dyllick, 1989; Pablo et al., 1999; Sharma, 2000; Sharma and Starik, 2004; Sharma and Henriques, 2005) has enriched our understanding of this critical external dimension, describing firms in terms of their relationships in broader social networks. Stakeholder research has recently moved from looking at how firms react to existing external pressure to investigating how proactive management of stakeholder relations can lead to tapping the potential for new innovative ideas. Examples include research on how engagement of stakeholders by the firm may catalyse learning and innovation (Hart and Sharma, 2004), as well as Prahalad and Hart's work on the 'bottom of the pyramid', which attempts to integrate the social equity and ecological dimensions of sustainability (Hart and Christensen, 2002; Prahalad and Hart, 2002; London and Hart, 2004).

Increasing awareness of the magnitude of current sustainability challenges and a more global perspective have led to the emergence of research on the creation and dissemination of clean technology innovation. Despite the sharply increasing levels of public attention for this theme, it has remained somewhat underexplored by academics (for example, Hart and Milstein, 1999; Hawken et al., 1999; McDonough and Braungart, 2002;

Hall and Vredenburg, 2003; Moore and Wüstenhagen, 2004; Könnölä and Unruh, 2007). This gap in current literature on corporate sustainability management marks the starting-point for this volume.

The research presented in this volume can be described as a shift in corporate sustainability from exploitation to exploration (March, 1991), from environmental management to sustainable entrepreneurship (Schaltegger and Petersen, 2000; Schaltegger, 2002; Mair et al., 2006; Dean and McMullen, 2007) and from eco-efficiency (Ayres, 1995) to clean technology development. This shift in focus suggests increased scope of analysis beyond the largest firms and additional opportunity for personal and scholarly impact. The promise of sustainable entrepreneurship is to apply Schumpeterian-style 'creative destruction' (Hart and Milstein, 1999) to the simultaneous benefit of firms, society and the environment, which may ultimately result in the emergence of sustainable industries (Russo, 2003).

An issue, which has received scant attention by sustainability researchers so far, is the need for financing sustainable innovation and entrepreneurship, for example by means of venture capital (Randjelovic et al., 2003; Moore and Wüstenhagen, 2004; Wüstenhagen and Teppo, 2006).

The Innovation Perspective: Understanding the Emergence of New Markets

How the emergence of radical innovation can transform an industry has been an important research topic in innovation studies. From this perspective, the move from conventional to sustainable products and services could be interpreted as a discontinuity in the technological trajectory of an industry, leading to a technological paradigm change (Nelson and Winter, 1982; Utterback and Suárez, 1993). The emergence of a new technological paradigm leads to a creative destruction (Schumpeter, 1939) of existing competences, which improves the selection environment for industry outsiders who are more flexible to pursue new opportunities without the liabilities of existing assets (Tushman and Anderson, 1986; Utterback, 1994).

In terms of industry development, a technological paradigm change is usually characterized by a high degree of variation, indicated by a large number of new entrants experimenting with new product designs (Utterback and Suárez, 1993; Metcalfe, 1994). After some time, a dominant design (Utterback and Abernathy, 1975) emerges, marking a shift from variation to selection, marked by industry consolidation and an increasing number of exits. The subsectors of what could be referred to as 'emerging clean technology industries' are currently at different stages of development. For example, while the solar photovoltaic industry has been characterized by a high degree of experimentation and new entries in 2003–05, the wind turbine manufacturing industry has started to consolidate in 2002–04, with acquisitions by large incumbent players such as GE and Siemens, and mergers of pioneering firms such as Vestas and NEG Micon (Bear Stearns, 2004; Ernst & Young, 2006).

Moving from industry to firm level, a stream of literature has investigated ways for firms to address radical innovation. A common feature of this literature is that success stories among large incumbent firms are rare and challenges are numerous (Kanter, 1989; Christensen, 1997; Leifer et al., 2000). Innovation management scholars are drawing diverse conclusions from this insight. On the optimistic end, Leifer et al. (2001) argue that by following seven key strategic imperatives, mature companies may successfully embrace radical innovation and eventually 'outsmart upstarts' (Leifer et al., 2000). For example, they argue that creating a radical innovation hub, acquiring both internal and external resources for the radical innovation project, and accelerating project transition from the lab to a mainstream business unit, will help mature companies to succeed. Similarly, Stringer (2000) lists nine different strategies that successful innovators have used to 'attack the problem', including both organizational aspects such as the creation of informal project laboratories and idea markets, as well as proposals to work with outside venture capitalists, a factor that is also stressed by Chesbrough (2000). Burgelman (1985) provided suggestions for improving corporate venturing, but points out that the inherent tensions in marrying large corporations with radical innovation are unlikely to go away. Consequently, he termed new venture departments 'a design for ambiguity'. Other scholars are more on the sceptical end of the spectrum, such as Dougherty (1995) who suggests that large companies should simply focus on a reflected way of managing their 'core incompetences', or Miles and Covin (2002) who have identified an increasing tendency towards replacing the painful exercise of being innovative within the firm by simply acquiring other firms. Despite these sobering results, there seems to be a consensus that innovation remains a strategic imperative (Stringer, 2000), so large companies have to embark on corporate venturing in one form or another if they want to secure their long-term survival.

Turning from the supply side to the demand side of the picture, Rogers (2001) has pioneered a stream of literature that looks at the diffusion of innovation as an evolutionary adoption process. He argues that the diffusion of innovation follows a typical S-curve, with a small group of innovating customers leading the way, followed by early adopters, early majority, late majority and laggards. Rogers also elaborates on features of innovative products that accelerate diffusion, such as relative advantage (over existing products), compatibility, complexity, trialability and observability.

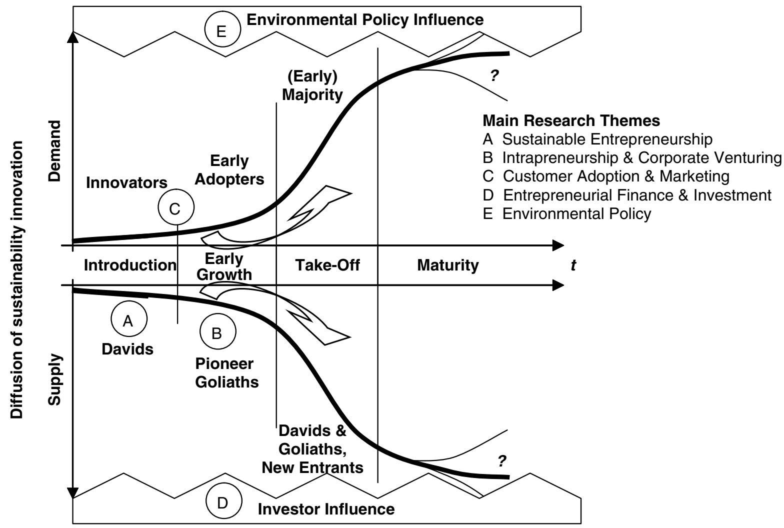
Compared to the classical diffusion process, the diffusion of sustainable innovation has some peculiarities (Villiger et al., 2000). As Rennings (2000) argues, eco-innovation is characterized by a double externality. The first part of the externality, technological spillover that prevents the innovator from appropriating the full value of an innovation, is common to any other technological innovation. The second part of the externality is specific to eco-innovation, which is the lack of internalization of environmental cost for incumbent technologies. The presence of external costs has two important effects: it reduces the relative (private) benefit of eco-innovation for customers, and it assigns a role to government to overcome this problem. The former is a significant barrier to customer adoption, the latter introduces an additional challenge to innovating new firms, as large incumbent firms are typically in a better position to influence regulators than are entrepreneurial start-ups.

Finally, many of the critical natural resource industries such as electricity, oil, gas and water are bound to grid infrastructures and subject to long investment cycles, which inherently increases complexity and reduces trialability of new innovative products as two of the key adoption features identified by Rogers (2001).

While innovation scholars have often looked at *either* the supply side (that is, the influence of radical innovation on firms or industries) *or* the demand side (that is, the adoption of innovation by customers) of the picture, a full understanding of the transformation process requires an examination of both sides and their interdependencies (Villiger et al., 2000). For example, Bhidé (2006) points out that while many scholars have tried to explain the success of the 'Silicon Valley' model of innovation in the United States by supply-side factors such as government research and development (R&D), entrepreneurial activity and venture finance, a key additional factor is the willingness of US consumers to buy and try new, innovative products, which Bhidé calls 'venturesome consumption', that is, their willingness to buy and try new, innovative products. More on a macro level, scholars in the evolution of technological systems tradition are taking a similarly integrated approach to studying the emergence of new industries (Jacobsson and Bergek, 2004).

Putting the Pieces Together: Research Themes in Sustainability, Innovation and Entrepreneurship

Figure 1.1 borrows from both sustainability (Villiger et al., 2000) and innovation (Rogers, 2001) literature to show how the components of this volume are conceptually intertwined. Sustainability, innovation and entrepreneurship is conceptualized as a twofold diffusion process – with



Source: Adapted from Wüstenhagen (2007).

Figure 1.1 Mapping research themes in sustainability, innovation and entrepreneurship

innovation and adoption taking place among both customers and suppliers of sustainable products and services – and being framed by investor and policy influences.

Five main research themes can be identified around the emergence and market penetration of sustainability innovation:

1. the role of ‘Davids’, or sustainable entrepreneurship;
2. the challenges for ‘Goliaths’, or large incumbent companies, in pursuing corporate venturing and promoting sustainable intrapreneurship;
3. customer adoption of and marketing for sustainable products and services;
4. the influence of investors on market emergence for sustainable innovation; and
5. elements of an innovation-friendly environmental policy.

These themes will be introduced in the following section, with reference to the contributions made by the chapters of this volume. Subsequently, we shall discuss some of the remaining challenges for further research on sustainability, innovation and entrepreneurship.

THE CONTRIBUTION OF CHAPTERS IN THIS VOLUME

Part I: Sustainable Entrepreneurship

The five chapters in Part I address various aspects of sustainable entrepreneurship. Three of these have a conceptual focus and two have an empirical focus. Based on a literature review of the different streams of environmental, social and sustainable entrepreneurship, Schaltegger and Wagner develop, in Chapter 2, a framework for sustainability management and a positioning matrix of sustainable entrepreneurship. They distinguish different types of sustainability management along two dimensions: first, whether the impact is limited to a small market niche, to a wider mainstream market or to changing market and society at large, and second, the degree of priority of environmental and social issues as business goals. In their view, true sustainable entrepreneurship is characterized by high scores on both axes, that is, the attempt to have an impact on both mainstream market and society, as well as the ambition to link sustainability performance to core business goals. They go on to argue that this differentiates sustainable entrepreneurs from eco-preneurs (or 'bioneers'), for whom sustainability is key, but who are satisfied with addressing niche markets, as well as from sustainability administrators, who lack the ambition to link social and environmental issues to core business goals and competitive advantage.

In Chapter 3, Spence et al., address issues of sustainable entrepreneurship from a conceptual angle as well. They focus on small and medium-sized enterprises (SMEs) and their involvement in sustainable development. They argue that understanding SME approaches to sustainable development is based on an understanding of a set of internal and external features. On one hand, an SME's approach to sustainable development is a function of personal characteristics of the SME's owners/managers, such as their entrepreneurial orientation, vision, openness to change, self-transcendence, sustainability orientation, and perception of ability and competence. On the other, the approach taken depends on the level of stakeholder pressures, and whether those are perceived as opportunity or threat by the SME's owners/managers. Based on a literature review, Spence et al. describe a set of strategic sustainable development activities that SMEs can pursue, ranging from identification of salient stakeholders through various forms of stakeholder communication and cooperation to pursuing a 'going local' strategy with regard to suppliers and/or customers. The final variable in Spence et al.'s suggested model is sustainability performance of SMEs. Here, they suggest a list of quantitative and qualitative indicators to capture the direct and indirect benefits of ‘going sustainable’. They argue that higher involvement in strategic sustainability activities will lead SMEs to a wider use of non-financial performance indicators, and hence a broader understanding of what performance ultimately means.

As a third contribution to the conceptual discussion of sustainable entrepreneurship, in Chapter 4, Halme et al. focus on business models for material efficiency. The business model concept has originally been developed with a view to explaining new forms of value creation enabled by the internet and the emerging forms of electronic commerce (Timmers, 1999; Afuah and Tucci, 2000) and has only recently been discovered as a unit of analysis by sustainability researchers (Tukker, 2004; Wüstenhagen and Boehnke, 2007). Halme et al. acknowledge that the term ‘business model’ is somewhat ill-defined, but explore its usefulness in a specific application, namely in the context of material-efficiency services. They distinguish three types of business models for material efficiency (the material service company (MASCO) model, material efficiency as additional service, and material flow management service) and investigate them with regard to four typical components of a business model (customer value, competitive advantage, capabilities required, revenue model). A key common element of the business models that they discuss is that they redefine the traditional borderline between suppliers and customers, just as e-commerce enabled new kinds of value configuration that transcended existing supplier–customer relationships. In their assessment of the feasibility of different business models for material efficiency, they highlight the importance of financing challenges. They conclude that the MASCO model and the ‘material efficiency as additional service’ model, as other forms of outsourcing, are particularly appropriate for investment projects with sufficient size which address a sidestream of production rather than the customer’s core business.

The three conceptual contributions to the entrepreneurship theme are complemented by two empirical papers, reporting on a survey among UK clean technology ventures and a Dutch case study, respectively. In Chapter 5, Dee et al. investigate obstacles to commercialization of clean technology innovation from UK ventures, with a view to developing policy recommendations to overcome those obstacles. Based on a survey among 73 micro-SMEs and nine in-depth case studies, the authors investigate the relevance of various barriers to firm growth, including financial factors, management and organizational factors, and product and market factors. Financing challenges turn out to be of high importance to firms, both with regard to securing funding for R&D as well as for commercialization. Government grants, personal finance and venture capital are among the most frequently used sources of funding. Another important obstacle to growth is establishing contacts with customers, which links to our research theme on customer adoption (see Part III). This is also one of the areas where UK clean technology ventures most frequently seek external advice, be it on conducting market research or in actually accessing potential customers. Overall, the results of Dee et al.'s analysis support this volume's main argument that the key challenge is for sustainability ventures to 'cross the chasm' (Moore, 1991) between laboratory and commercialization, and hence to penetrate the mainstream market 'beyond the eco-niche' (Villiger et al., 2000). Dee et al. conclude by giving a number of policy recommendations for improving the situation of UK clean technology ventures. They argue that government should reconsider its public procurement rules in order to make the B2G (business-to-government) purchasing process more open to innovative, sustainable products. Another important role for government is in creating standards and facilitating certification procedures for innovative new technologies.

Starting from a sustainable design perspective, Berchicci's Chapter 6 on the challenges of commercializing a radical innovation in the Dutch transportation sector adds some interesting insights to Dee et al.'s chapter. He argues that in the case of Mitka, an innovative three-wheeled bicycle, designers appeared to have 'too much of a good thing', namely too much environmental ambition. By getting carried away by the environmental and design features of their product, they missed important aspects of customer value, and hence the innovation eventually failed. This example provides a nice illustration of Schaltegger and Wagner's argument that sustainable entrepreneurship essentially relies on integrating environmental and social issues into core business goals. Berchicci also points to another interesting link between environmental ambition and success (or failure) of a sustainable innovation, arguing that higher levels of environmental ambition on the part of the design team are likely to result in higher degrees of complexity.

Part II: Sustainable Corporate Venturing and Intrapreneurship

Sustainable innovation does not just happen in entrepreneurial start-ups, but also within existing firms. This is addressed by the two chapters in Part II.

In Chapter 7, Pichel reports on the results of a major longitudinal analysis among employees of five German companies undergoing introduction of an environmental management system (EMS). Her research interest is to understand whether introduction of an EMS has a positive influence on the contextual, individual and cultural antecedents of ecopreneurship within the firm (defined as proactive environmental behaviour of employees) and on actual behaviour. She concludes that transparency and eco-specific training are the two most important predictors of ecopreneurship, confirming earlier work by Ramus and Steger (2000). Interestingly, she could not find a clear positive link between financial incentives and environmental employee behaviour, and even finds some support for a negative relationship between the two. She concludes that an organizational culture that values environmental issues and individual initiative might be more effective in promoting ecopreneurship within the firm than a command-and-control structure coupled with (extrinsic) incentives. However, she also points out that firms should be aware of their organizational culture and adapt their EMS design accordingly. Introducing an EMS that encourages autonomous employee initiative for environmental issues in a firm with a strong hierarchical culture will not work.

Picking up on the theme of intrapreneurhsip for sustainability, Chapter 8 by Martín-Tapia et al. explores the potential of a high performance work system (HPWS) to contribute to proactive environmental management. The term HPWS summarizes a set of human resource management practices aimed at increasing organizational performance, some of which are directly linked to Pichel's findings about factors enhancing ecopreneurship within firms, such as improved internal communication (transparency), participation and extensive training. Martín-Tapia et al. add a new dimension by taking into account the moderating effect of uncertainty. In their empirical survey of Spanish food firms, they can confirm the positive link between an HPWS and proactive environmental management, while the effect of uncertainty seems not to be significant.

Part III: Customer Adoption of and Marketing for Sustainability Innovation

As we discussed above, an innovation is not successful until it finds a customer. Therefore, research about marketing for and customer adoption of sustainability innovation has been one of the central themes in our call for chapters for this volume. The two chapters in Part III provide particular insights with that respect, one each in a business-to-consumer (B2C) and a business-to-business (B2B) setting.

Kassinis and Soteriou's analysis, in Chapter 9, addresses the relationship between quality, environmental practices and customer satisfaction in a service setting. Based on a survey about hotel services, they argue that environmental practices have a positive mediating influence on the relationship between service quality and customer satisfaction. In other words, signalling environmental practices will increase customer satisfaction beyond standard levels of good quality services. A particularly innovative element of Kassinis and Soteriou's contribution is their methodological approach.

They use video technology to expose the respondents of their survey to realistic scenarios of the service experience in the hotel. By carefully blending in the environmental features that they try to measure, they avoid some of the social desirability issues that traditional surveys on environmental issues and consumer adoption of sustainability innovation would face.

Vermeulen and Ellersiek, in Chapter 10, look at the adoption of an innovative product in a B2B setting, and do so in a longitudinal analysis from an institutional perspective. Based on extensive qualitative research, they reconstruct the diffusion of an environmental innovation in the concrete industry and how this diffusion process is shaped by institutional forces. Vermeulen and Ellersiek's work adds two important dimensions to the research agenda of customer adoption of sustainability innovation. First, they move from individual adoption decisions to their embeddedness in organizational and institutional environments. Second, they draw our attention to the constraints of mature organizational fields, and especially the power of incumbents, against which new entrants have to struggle in order to get their innovation to market. In their Dutch case, ultimate adoption of the innovation has led to a partial reconfiguration of the organizational field, which has only been possible thanks to a change agent, or 'institutional architect', who bridged the diverging interests of existing actors in the field.

Part IV: Investors and Policy

The two chapters in Part IV focus on the two final themes that we think should constitute elements of a comprehensive research agenda on sustainability, innovation and entrepreneurship; that is, how the diffusion of sustainability innovation is shaped by investor and policy influences. This to us indicates the need for further research in this area (see the next section).

In Chapter 11, Cañón-de-Francia et al. investigate the linkages between environmental policy and corporate performance by looking at the effect of a specific regulation, the European Pollutant Emission Register (EPER), on the financial performance of affected Spanish firms. They find confirmation for their hypothesis that the public disclosure of environmental information, in this case the presence of polluting firms on an official 'black list' published by the European Union, does have a measurable effect on these firms' short-term share-price development. While they acknowledge some limitations of their study, their chapter makes two interesting contributions to the debate on sustainability, innovation and entrepreneurship. First, they demonstrate that 'soft', quasi-regulatory policy measures, based on disclosure of information, can indeed provide an incentive for firms to improve their environmental performance. Second, they make a methodological contribution by applying event study methodology to sustainability research. A very popular approach in finance research, this methodology makes use of the abundance of financial data available for publicly traded companies to measure market implications of events such as the introduction of a new policy. Cañón-de-Francia et al. contribute to this literature by comparing three different estimation models, namely a traditional market model, a portfolio model and a multivariate regression model (MVRM), where only the last allows them to determine significant negative abnormal returns on the day after publication of the EPER.

Finally, Chapter 12 by Bürer and Wüstenhagen brings us back to the core of this volume's focus, namely sustainable innovation and entrepreneurship. They explore the link between energy policy and investor decisions to fund clean technology ventures. Policy is important since the energy industry is a typical example of a heavily regulated industry, and particularly large incumbent energy firms have developed significant expertise in influencing the political framework through non-market strategies. New entrants to the energy industry, such as clean energy technology ventures, are also exposed to regulatory risk (and opportunity), but they do not have the means to engage in non-market strategies to a similar extent as large incumbent firms. And yet, the success of investments in these firms significantly depends on managing regulatory risk. Little is known empirically about how venture investors perceive energy policy risk and what they do to manage it. Based on a survey among 60 venture capital firms in Europe and North America, Bürer and Wüstenhagen attempt to close this gap. They build on their survey data to develop a typology of regulatory risk management strategies adopted by these investment firms.

FURTHER RESEARCH

While the chapters in this volume provide fresh and rewarding insights into the complex relationships between sustainability, innovation and entrepreneurship, the individual works also point to opportunities for further research, which we would like to complement by addressing some of the overall open issues. To begin, a suggestion that applies across the different themes discussed in this volume, there is scope for extending research on sustainable innovation and entrepreneurship to new industry sectors (such as resource extraction, other forms of manufacturing not studied in these chapters, distribution and other services, including information systems and security) and geographical regions (including emerging and developing countries).

We would also like to point out that several of the chapters in this volume focus on environmental aspects of sustainability, while there is certainly scope for more work on the social aspects of sustainability. In a comprehensive research agenda, social and environmental sustainability should be integrated, researched jointly, and given roughly equal attention.

Sustainable Entrepreneurship

One of the remaining questions in research on sustainable entrepreneurship is to enhance our understanding of the profile of sustainable entrepreneurs, or probably more appropriately, entrepreneurial teams. Are there specific sources of entrepreneurial talent for sustainability-related ventures? What is the right mix of environmental and social vision (or ambition) versus pure business orientation?

Speaking of the entrepreneurs themselves, while the 'traits' approach to strategic entrepreneurship fell out of favour in the 1980s and 1990s, given the unique features of sustainable entrepreneurship, identifying themes and commonalities of the personal and professional characteristics of these entrepreneurs may be advantageous in both understanding and advancing this phenomenon. In addition, exploring the life-cycle aspects of these entrepreneurs compared to others would also be interesting, since sustainability entrepreneurs, with their presumed deeply held social and environmental values, might be more prone to staying with their ventures longer than entrepreneurs with economic orientations only. They may also be far less likely to hand over their successful ventures or to abandon their less-than-successful businesses, even when walking away may be the most prudent strategy.

It is also important to take a process perspective on sustainable entrepreneurship. As in the case of 'conventional' ventures, what it takes for a sustainable venture to be successful changes over time. We know from conventional entrepreneurship research that entrepreneurs are typically best at managing a venture at a certain stage of development, while changes ('exits') occur once the venture has grown beyond this stage. Zooming in at the exit stage of sustainable entrepreneurial ventures may be an interesting field for further research, since the value captured by conventional entrepreneurs is relatively easily transferable to new owners/managers, while this may not be the case for the social and environmental aspects of value created by a sustainable entrepreneurial venture.

Another issue relates to the inherent complexity of sustainability ventures – what does this imply for the skills and capabilities of successful sustainable entrepreneurs? Perhaps this topic could be addressed by studying how these entrepreneurs conduct strategic planning, compared to other entrepreneurs and other business leaders, and how the sustainable entrepreneurs implement and evaluate their strategies, particularly to ensure that their operations are indeed sustainable.

Given the evolving nature of both sustainability technologies and indicators, from micro to macro, these activities may be especially challenging for sustainable entrepreneurs. While challenges, obstacles, constraints and externalities may be intriguing sustainable entrepreneurship research topics, opportunities, synergies and solutions for sustainable entrepreneurs also hold promise. These may involve the full range of actual and potential stakeholders, in addition to customers and suppliers, including owners, family and network members, investors, partners, managers, employees, consultants, competitors, distributors, franchisees, NGOs (including academics), industry associations and the several levels of government. Focusing particularly on entrepreneurs in NGOs, one especially interesting research topic might be identifying and highlighting those operating in more 'social sustainability' NGOs whose main mission is to advocate for human rights and poverty reduction, for example, but who are also attempting to make environmental changes within their own organizations, such as increasing energy efficiency or reducing the use of toxic materials. Similarly, entrepreneurs in environmental NGOs may have developed some interesting approaches to social issues, such as community participation and physical health of the disadvantaged (Husted et al., 2007).

Some interesting opportunities for further research arise at the interface of gender studies and sustainable innovation and entrepreneurship. For example, the social construction of new energy technologies provides evidence for gender differences (Wajcman, 1991, 2000; Cockburn and Ormrod, 1993). A stronger role for female entrepreneurs may be a road not only to overcoming social inequalities, but perhaps also towards environmental sustainability. It would also be worth exploring whether women are more inclined to start social entrepreneurial ventures, and if so, why.

The perspective of business models for sustainability ventures also provides opportunities for further research. What characterizes successful business models for entrepreneurial ventures in key sustainability areas, such as energy, transportation or water? Given that sustainable innovation is characterized by a double-externality problem (Rennings, 2000), and hence there is an important interface to policy making, how can notoriously resource-constrained start-ups take this into account and manage regulatory risks and opportunities?

Sustainable Corporate Venturing and Intrapreneurship

Sustainable innovation occurs not only in garage ventures, but also within the boundaries of large firms. However, the chapters in this book addressing these issues demonstrate that it is anything but trivial to enhance proactive environmental employee behaviour or the creation of new ventures within the institutional and cultural constraints of incumbent firms – in other words, we are facing a 'battle between organizational genetics and accelerating change'.[3] When it comes to sustainability ventures, this general observation from corporate venturing research is aggravated by the values that come into play in the context of environmental and social issues. An interesting research avenue here might be to ask how corporate venturing arms of incumbent firms deal with the combined conflict that sustainable innovation creates with an incumbent firm's market- and non-market (or regulatory) strategy, and whether this negatively influences their chances of success. This inherent conflict can also be taken to the individual level, where it is interesting to deepen our understanding of the personal profiles of successful promoters of sustainability innovation within incumbent firms. Finally, as research in this volume shows, successful ways of promoting cultural change in large corporations and increasing absorptive capacity are a remaining challenge, perhaps particularly so in old and powerful industries such as oil, electricity and automotive.

Customer Adoption of and Marketing for Sustainability Innovation

In terms of marketing-related research on sustainability innovation, we are facing two main challenges – dealing with the social desirability biases in responses around social and environmental issues, and dealing with the novelty of the products and services at hand – which limit the validity of conventional market research. Therefore, a prime concern in this area is finding valid methods to deal with 'true' customer preferences around new and sustainable products. More sophisticated survey designs, like Kassinis and Soteriou's video simulation presented in Chapter 10, or using methodologies such as conjoint experiments (Sammer and Wüstenhagen, 2006), can help mitigate one or both of these issues. A possible extension might be to introduce test markets for sustainability innovation, for example, in the form of local niche experiments around sustainable transportation (Hoogma et al., 2002).

Another interesting avenue for further research is exploring the uncharted territory between B2C and B2B marketing that characterizes many energy-related consumer decisions, as for example in the case of distributed energy systems or renewable heating technologies, where individual house owners take their decisions influenced by professional advisers such as architects and installers (Känzig and Wüstenhagen, 2006), and hence in a setting that has some but not all the features of a typical buying centre as we know it from organizational buying behaviour.

Finally, similar to what was said above about gender issues on the supply side of innovation, there are opportunities to investigate the demand side of sustainable innovation from a gender perspective. While men are often portrayed as being overrepresented in the adoption of technological innovation, we know from consumer surveys that women often have a strong concern about environmental issues. How does this concern translate into actual purchasing and investment decisions, particularly if decisions are taken jointly in a buying group setting as in the residential energy example mentioned above?

Investors and Environmental Policy

Moving from the core issues of supply of and demand for sustainability innovation to the forces that frame this market, we would like to highlight a number of research opportunities around investor and policy influences.

When it comes to financing sustainability innovation, the role of cleantech investors, from business angels through venture capitalists to private equity firms, deserves scholarly attention. It would be particularly interesting to enhance our understanding of the motivation of these investors and their interaction with entrepreneurs. Given the recent move from 'irrational austerity to (ir)rational exuberance' (Wüstenhagen, 2005) among cleantech venture capital investors, there is a case for looking at cleantech investments from a behavioural finance perspective and trying to track and measure some of the path dependencies and herding phenomena that occur. Doing this will also shed light on the question of how these early-stage investors create value between actually improving the performance of their portfolio firms and/or managing expectations of other investors.

Speaking more broadly about the topic of sustainable finance (Jeucken, 2001; Labatt and White, 2002), this may be an aspect of sustainable innovation and entrepreneurship that is primed for growth in the very near future. From the various kinds of funds, through new security instruments, to the greening of entire professions, such as bankers, insurers, brokers and realtors, sustainable entrepreneurs are poised to help this field emerge as they continue to develop good ideas that demand financial resources for their realization. Researchers can suggest various channels for this development, identifying how sustainability has taken hold in other operations-orientated sectors and professions and how the combination between sustainable entrepreneurs and finance can help advance sustainability both within these areas and, if successful, more broadly through both developed and developing societies.

In the environmental policy realm, a shifting focus would be welcomed from looking at compliance to further understanding how environmental policy can support innovation (Hemmelskamp et al., 2000). A key prerequisite for accomplishing this research task is to come to a diffentiated understanding of how large incumbent firms ('Goliaths') and small entrepreneurial firms ('Davids') are affected by environmental policy changes or new regulatory instruments (Wüstenhagen, 1998). The link between policies and venture investors may again be interesting to look at, since private investment monies can strongly leverage the effect of new policies.

CONCLUSIONS

The magnitude of the environmental and social challenges that our planet is facing calls for a dramatic shift towards new solutions. This volume highlights the central and critical role of entrepreneurship and innovation in moving us towards a sustainable future via business models that incorporate social equity, ecosystem stewardship, and design of environmentally and socially beneficial products, services and processes. By entrepreneurship we refer not only to newly founded firms but also to corporate entrepreneurs that spark organizational creativity and innovation and thus teach corporate 'elephants how to dance' (Kanter, 1989) in a sustainable world. Academic research can play an important role in helping us understand the constraints and challenges that entrepreneurs, corporate managers, policy makers, investors and consumers face in moving towards sustainability. It can also highlight positive examples and point to the multitude of new business opportunities that arise. Ultimately, though, we also need to move from analysis to action and from concept to reality. We hope that readers will find the contributions in this book valuable and inspiring for their journey towards sustainability.

NOTES

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2. See www.ted.com/index.php/speakers/view/id/116.
3. Comment made by Mike Russo at the final panel of the GRONEN 2006 conference in St. Gallen (Switzerland), 12 July 2006.

REFERENCES

Afuah, A. and Tucci, C. (2000), *Internet Business Models and Strategies: Text and Cases*, New York: McGraw-Hill Higher Education.

Aragón-Correa, J.A. and Sharma, S. (2003), 'A contingent resource-based view of proactive corporate environmental strategy', *Academy of Management Review*, **28**(1): 71–88.

Arora, S. and Cason, T.N. (1996), 'Why do firms volunteer to exceed environmental regulations? Understanding participation in EPA's 33/50 program', *Land Economics*, **72**(4): 413–32.

Arora, S. and Gangopadhyay, S. (1995), 'Toward a theoretical model of voluntary overcompliance', *Journal of Economic Behavior and Organization*, **28**: 289–309.

Ayres, R.U. (1995), *Achieving Eco-efficiency in Business*, New York: World Business Council for Sustainable Development, United Nations Environment Programme (UNEP).

Bear Stearns (2004), 'The Future of Power Equipment', European Equity Research Report, 24 November, London.

Bhidé, A. (2006), 'Venturesome consumption, innovation and globalisation', paper presented at the CESifo and Centre on Capitalism and Society conference, Venice, 21–22 July, http://www.cesifo.de/link/vsi06_ep_bhide.pdf.

Buchholz, R.A., Marcus, A.A. and Post, J.E. (1992), *Managing Environmental Issues: A Casebook*, Englewood Cliffs, NJ: Prentice-Hall.

Burgelman, R.A. (1985), 'Managing the new venture division: research findings and implications for strategic management', *Strategic Management Journal*, **6**: 39–54.

Chesbrough, H.W. (2000), 'Designing corporate ventures in the shadow of private venture capital', *California Management Review*, **42**(3): 31–49.

Christensen, C. (1997), *The Innovator's Dilemma*, Boston, MA: Harvard Business School Press.

Cockburn, C. and Ormrod, S. (1993), *Gender and Technology in the Making*, London: Sage.

Dean, T.J. and McMullen, J.S. (2007), 'Toward a theory of sustainable entrepreneurship: reducing environmental degradation through entrepreneurial action', *Journal of Business Venturing*, **22**(1), 50–76.

Delmas, M.A. and Terlaak, A.K. (2002), 'The institutional context of environmental voluntary agreements', in Hoffman, A.J. and Ventresca, M.J. (eds), *Organizations, Policy, and the Natural Environment: Institutional and Strategic Perspectives*, Stanford, CA: Stanford University Press, pp. 346–66.

Doh, J.P. and Guay, T.R. (2006), 'Corporate social responsibility, public policy, and NGO activism in Europe and the United States: an institutional-stakeholder perspective', *Journal of Management Studies*, **43**(1): 47–73.

Dougherty, D. (1995), 'Managing your core incompetencies for corporate venturing', *Entrepreneurship Theory and Practice*, **19**(3), 113–35.

Dowell, G., Hart, S. and Yeung, B. (2000), 'Do corporate global environmental standards create or destroy market value?', *Management Science*, **46**(8): 1059–74.

Dyllick, T. (1989), *Management der Umweltbeziehungen: Öffentliche Auseinandersetzungen als Herausforderung* (Management of environmental relations: public conflicts as a challenge), Wiesbaden: Gabler Verlag.

Dyllick, T. and Hamschmidt, J. (2000), *Wirksamkeit und Leistung von Umweltmanagementsystemen: Eine Untersuchung von ISO 14001-zertifizierten Unternehmen in der Schweiz* (Effectiveness and performance of environmental management systems: an empirical analysis of ISO 14001-certified firms in Switzerland), Zurich: VdF Hochschulverlag.

Elkington, J. (1994), 'Towards the sustainable corporation: win–win–win business strategies for sustainable development', *California Management Review*, **36**(3): 90–100.

Ernst & Young (2006), *TransAction Erneuerbare Energien: Marktüberblick und M&A-Aktivitäten 2001–2006* (TransAction renewable energies: Market Survey and M&A activities 2001–2006), Berlin, July.

Hall, J. and Vredenburg, H. (2003), 'The challenges of innovating for sustainable development', *MIT Sloan Management Review*, Fall: 61–8.

Hart, S. (1995), 'A natural resource-based view of the firm', *Academy of Management Review*, **20**: 986–1014.

Hart, S. (1997), 'Beyond greening: strategies for a sustainable world', *Harvard Business Review*, **75**(1): 66–76.

Hart, S. and Ahuja, I.G. (1996), 'Does it pay to be green? An empirical examination of the relationship between emission reduction and firm performance', *Business Strategy and the Environment*, **5**(1): 530–37.

Hart, S. and Christensen C.M. (2002), 'The great leap: driving innovation from the base of the pyramid', *MIT Sloan Management Review*, Fall: 51–6.

Hart, S. and Milstein, M.B. (1999), 'Global sustainability and the creative destruction of industries', *MIT Sloan Management Review*, **41**(1), 23–33.

Hart, S. and Milstein, M.B. (2003), 'Creating sustainable value', *Academy of Management Executive*, **17**(2), 56–67.

Hart, S. and Sharma, S. (2004), 'Engaging fringe stakeholders for competitive imagination', *Academy of Management Executive*, **18**(1), 7–18.

Hawken, P., Lovins, A. and Lovins, L.H. (1999), *Natural Capitalism: Creating the Next Industrial Revolution*, Boston, MA: Little, Brown.

Hemmelskamp, J., Rennings, K. and Leone, F. (2000), *Innovation-Oriented Environmental Regulation: Theoretical Approaches and Empirical Analysis*, Heidelberg: Physica.

Hoffman, A.J. (2001), *From Heresy to Dogma: An Institutional History of Corporate Environmentalism*, Stanford, CA: Stanford University Press.

Hoffman, A.J. and Ventresca, M.J. (1999), 'The institutional framing of policy debates: economics versus the environment', *American Behavioral Scientist*, **42**(8): 1368–92.

Hoogma, R., Kemp, R., Schot, J. and Truffer, B. (2002), *Experimenting for Sustainable Transport: The Approach of Strategic Niche Management*, London and New York: Spon Press.

Husted, B., Sharma, S. and Starik, M. (2007), 'Organizations and the sustainability mosaic: crafting long-term ecological and societal solutions', in Sharma, S., Starik, M. and Husted, B. (eds), *Organizations and the Sustainability Mosaic*, Cheltenham, UK and Northampton, MA: Edward Elgar, pp. 18–19.

Jacobsson, S. and Bergek, A. (2004), 'Transforming the energy sector: the evolution of technological systems in renewable energy technology', in Jacob, K., Binder, M. and Wieczorek, A. (eds), *Governance for Industrial Transformation: Proceedings of the 2003 Berlin Conference on the Human Dimensions of Global Environmental Change*, Berlin: Environmental Policy Research Centre, pp. 208–36.

Jeucken, M. (2001), *Sustainable Finance and Banking*, London: Earthscan.

Känzig, J. and Wüstenhagen, R. (2006), 'Understanding strategic choices for sustainable consumption: the case of residential energy supply', in Charter, M. and

Tukker, A. (eds), *Sustainable Consumption and Production: Opportunities and Challenges, Proceedings of the Launch conference of the Sustainable Consumption Research Exchange (SCORE) Network*, Wuppertal, Germany, 23–25 November, www.score-network.org.

Kanter, R.M. (1989), *When Giants Learn to Dance*, New York: Simon & Schuster.

Könnölä, T. and Unruh, G.C. (2007), 'Really changing the course: the limitations of environmental management systems for innovation', *Business Strategy and the Environment* (in press).

Labatt, S. and White, R.R. (2002), *Environmental Finance*, Hoboken, NJ: J. Wiley.

Leifer, R., McDermott, C.M., O'Connor, G.C., Peters, L.S., Rice, M. and Veryzer, R.W. (2000), *Radical Innovation: How Mature Companies Can Outsmart Upstarts*, Boston, MA: Harvard Business School Press.

Leifer, R., O'Connor G.C. and Rice, M. (2001), 'Implementing radical innovation in mature firms: the role of hubs', *Academy of Management Executive*, **15**(3): 102–13.

London, T. and Hart, S.L. (2004), 'Reinventing strategies for emerging markets: beyond the transnational model', *Journal of International Business Studies*, **35**(5): 350–70.

Mair, J., Robinson, J. and Hockerts, K. (2006), *Social Entrepreneurship*, Basingstoke, UK: Palgrave Macmillan.

Majumdar, S.K. and Marcus, A.A. (1998), 'Do Environmental Regulations Retard Productivity? Evidence from U.S. Electric Utilities', Working Paper (Faculty) 1, University of Michigan Business School.

March, J.G. (1991), 'Exploration and exploitation in organizational learning', *Organization Science*, **2**(1): 71–87.

Marcus, A. (1980), *Promise and Performance: Choosing and Implementing an Environmental Policy*, Westport, CT: Greenwood–Praeger.

McDonough, W. and Braungart M. (2002), *Cradle to Cradle: Remaking the Way We Make Things*, New York: North Point.

Metcalfe, J.S. (1994), 'Evolutionary economics and technology policy', *Economic Journal*, **104**(425): 931–44.

Miles, M.P. and Covin, J.G. (2002), 'Exploring the practice of corporate venturing: some common forms and their organisational implications', *Entrepreneurship Theory and Practice*, **26**(1): 21–40.

Moore, B. and Wüstenhagen, R. (2004), 'Innovative and sustainable energy technologies: the role of venture capital', *Business Strategy and the Environment*, **13**: 235–45.

Moore, G.A. (1991), *Crossing the Chasm*, New York: HarperCollins.

Nehrt, C. (1996), 'Timing and intensity effects of environmental investments', *Strategic Management Journal*, **17**(7): 535–47.

Nelson, R. and Winter, S. (1982), *An Evolutionary Theory of Economic Change*, Cambridge, UK: Cambridge University Press.

Pablo, A., Sharma, S. and Vredenburg, H. (1999), 'Corporate environmental responsiveness strategies: the importance of issue interpretation and organizational context', *Journal of Applied Behavioral Science*, **35**(1): 87–108.

Porter, M.E. and van der Linde, C. (1995), 'Green and competitive: ending the stalemate', *Harvard Business Review*, **73**(5): 120–34.

Prahalad, C.K. and Hart, S.L. (2002), 'The fortune at the bottom of the pyramid', *Strategy and Business*, **26**: 54–67.

Ramus, C. and Steger, U. (2000), 'The roles of supervisory support behaviours and environmental policy in employee "ecoinitiatives" at leading-edge European companies', *The Academy of Management Journal*, **43**(4), 605–26.

Randjelovic, J., O'Rourke, A.R. and Orsato, R.J. (2003), 'The emergence of green venture capital', *Business Strategy and the Environment*, **12**(4): 240–53.
Reinhardt, F.L. (1998), 'Environmental product differentiation: implications for corporate strategy', *California Management Review*, **40**(4): 43–73.
Rennings, K. (2000), 'Redefining innovation – eco-innovation research and the contribution from ecological economics', *Ecological Economics*, **32**(2), 319–32.
Rogers, E.M. (2001), *Diffusion of Innovations*, New York: Free Press.
Russo, M.V. (2003), 'The emergence of sustainable industries: building on natural capital', *Strategic Management Journal*, **24**: 317–31.
Russo, M.V. and Fouts, P.A. (1997), 'A resource-based perspective on corporate environmental performance and profitability', *Academy of Management Journal*, **40**(3): 534–59.
Sammer, K. and Wüstenhagen, R. (2006), 'The influence of eco-labelling on consumer behaviour – results of a discrete analysis for washing machines', *Business Strategy and the Environment*, **15**, 185–9.
Schaltegger, S. (2002), 'A framework for ecopreneurship – leading bioneers and environmental managers to ecopreneurship', Greener Management International (GMI), **38**, Summer: 45–58.
Schaltegger, S. and Petersen, H. (2000), *Ecopreneurship: Konzept und Typologie* (Entrepreneurship: concept and typology), Lüneburg/Luzern: CSM/RIO-Managementforum.
Schaltegger, S. and Sturm, A. (1995), *Öko-Effizienz durch Öko-Controlling: Zur praktischen Umsetzung von EMAS und ISO 14000* (Eco-efficiency by eco-controlling: on the implementation of EMAS and ISO 14000), Zurich and Stuttgart: Verlag der Fachvereine/Schaefer Poeschel.
Schmidheiny, S. (1992), *Changing Course: A Global Business Perspective on Development and the Environment*, Cambridge, MA: MIT Press.
Schumpeter, J.A. (1939), *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, New York: Free Press.
Sharma, S. (2000), 'Managerial interpretations and organizational context as predictors of corporate choice of environmental strategy', *Academy of Management Journal*, **43**(4): 681–97.
Sharma, S. and Henriques, I. (2005), 'Stakeholder influences on sustainability practices in the Canadian forest products industry', *Strategic Management Journal*, **26**: 159–80.
Sharma, S. and Starik, M. (eds) (2004), *Stakeholders, the Environment and Society*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
Sharma, S. and Vredenburg, H. (1998), 'Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities', *Strategic Management Journal*, **19**(8): 729–53.
Starik, M. (1995), 'Research on organizations and the natural environment: some paths we have traveled, the "field" ahead', in Collins, D. and Starik, M. (eds), *Research in Corporate Social Performance and Policy – Sustaining the Natural Environment: Empirical Studies on the Interface between Nature and Organizations*, Greenwich, CT: JAI Press, pp. 1–42.
Starik, M. (2002), 'Childhood's end? Sustaining and developing the evolving field of organizations and the natural environment', in Sharma, S. and Starik, M. (eds), *Research in Corporate Sustainability: The Evolving Theory and Practice of Organizations and the Natural Environment*, Cheltenham, UK and Northampton, MA: Edward Elgar, pp. 321–2.

Starik, M. and Marcus, A.A. (2000), 'Introduction to the Special Research Forum on the Management of Organizations in the Natural Environment: a field emerging from multiple paths, with many challenges ahead', *Academy of Management Journal*, **43**(4): 539–47.

Steger, U. (2000), 'Environmental management systems: empirical evidence and further perspectives', *European Management Journal*, **18**(1): 23–37.

Stringer, R. (2000), 'How to manage radical innovation', *California Management Review*, **42**(4): 70–88.

Throop, G.M., Starik, M. and Rands, G.P. (1993), 'Sustainable strategy in a greening world: integrating the natural environment into strategic management', in Shrivastava, P., Huff, A. and Dutton, J. (eds), *Advances in Strategic Management*, Greenwich, CT: JAI Press, pp. 63–92.

Timmers, P. (1999), *Electronic Commerce*, New York: John Wiley & Sons.

Tukker, A. (2004), 'Eight types of product-service system: eight ways to sustainability? Experiences from SusProNet: *Business Strategy and the Environment*, **13**, 246–60.

Tushman, M.L. and Anderson, P. (1986), 'Technological discontinuities and organizational environments', *Administrative Science Quarterly*, **31**: 439–65.

Utterback, J. (1994), *Mastering the Dynamics of Innovation*, Boston, MA: Harvard Business School Press.

Utterback, J.M. and Abernathy, W.J. (1975), 'A dynamic model of product and process innovation', *Omega*, **3**(6): 639–56.

Utterback, J.M. and Suárez, F.F. (1993), 'Innovation, competition, and industry structure', *Research Policy*, **22**: 1–21.

Villiger, A., Wüstenhagen, R. and Meyer, A. (2000), *Jenseits der Öko-Nische* (Beyond the eco-niche), Basel: Birkhäuser.

Wajcman, J. (1991), *Feminism Confronts Technology*, University Park, PA: Pennsylvania State University Press.

Wajcman, J. (2000), 'Reflections on gender and technology studies: in what state is the art?', *Social Studies of Science*, **30**(3), 447–67.

Welford, R. (1992), 'Linking quality and the environment: a strategy for the implementation of environmental management systems', *Business Strategy and the Environment*, **1**(1), 25–34.

Wüstenhagen, R. (1998), 'Greening Goliaths versus multiplying Davids', Institute for Economy and the Environment at the University of St. Gallen (IWÖ) Discussion Paper No. 61, University of St. Gallen.

Wüstenhagen, R. (2005), 'Venture capital funding and sustainability innovation: far from irrational exuberance', *Oekologisches Wirtschaften*, Special Issue Nachhaltiges Gründen, 2/2005.

Wüstenhagen, R. (2007), 'Venturing for Sustainable Energy', unpublished synopsis paper of postdoctoral research thesis (Habilitation), University of St. Gallen.

Wüstenhagen, R. and Boehnke, J. (2007), 'Business models for sustainable energy', in Tukker, A., Charter, M., Vezzoli, C., Sto, E. and Andersen, M.M. (eds), *System Innovation for Sustainability: Perspectives on Radical Changes to Sustainable Consumption and Production (SCP)*, Sheffield: Greenleaf, (forthcoming).

Wüstenhagen, R. and Teppo, T. (2006), 'Do venture capitalists really invest in good industries? Risk-return perceptions and path dependence in the emerging European energy VC market', *International Journal of Technology Management*, **34**(1/2): 63–87.

PART I

Sustainable entrepreneurship

2. Types of sustainable entrepreneurship and conditions for sustainability innovation: from the administration of a technical challenge to the management of an entrepreneurial opportunity

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Companies are considered by many to be the main players with regard to creating environmental and social problems and thus to be the source of a lack of sustainability in society. From this point of view, government and non-government organizations have to create and control a tight regulatory framework for business. As a consequence, management is challenged to comply with regulations and requirements and to keep the unwanted, negative impacts under control.

However, while this view tends to overestimate the possibilities of government, political programmes, legal regulations and non-governmental organizations (NGOs), it underestimates and distorts the creative and shaping role of companies in society.

For many years and with increasing visibility, management of leading companies have been core drivers of sustainable development. With their innovations, sustainable entrepreneurs and sustainability managers are shaping markets and society substantially. Cars, computers and the internet, for example, have changed the world more fundamentally than most political programmes. To be innovative means to provide organizational and technical improvements which can be sold successfully in the marketplace.

In a market system, sustainable development requires sustainability innovation and entrepreneurs who can achieve environmental or social goals with superior innovations that are successful in the marketplace of mainstream customers. Market innovations driving sustainable development do not occur by accident but have to be created, promoted and implemented by leaders who put them into the core of their business activities. Actors and companies realizing market success in the mass market and ensuring at the same time environmental and social progress in their core business can be called 'sustainable entrepreneurs'. They generate new products, services, techniques and organizational modes which substantially reduce environmental and negative social impacts and increase the quality of life.

Joseph Schumpeter (1934) referred to such entrepreneurial activities as 'creative destruction'. Sustainable entrepreneurs destroy existing non-sustainable conventional production methods, products, market structures and consumption patterns, and replace them with superior environmental and social products and services. They create the market dynamics of sustainable progress.

This chapter attempts to analyse which actors are most likely to bring about sustainability innovation under different conditions. Hence it provides a typology of sustainable entrepreneurship which distinguishes the concept from other forms of corporate environmental and social responsibility activities. The chapter concludes with a positioning matrix of sustainable entrepreneurship which allows management to assess its state of environmental, social and economic activities in relation to others.

After a first wave of literature beginning in the 1990s, some authors have recently started to deal with environmentally orientated entrepreneurship, often called 'ecopreneurship', in more detail (see Blue, 1990; Bennett, 1991; Berle, 1991; Anderson and Leal, 1997; Staber, 1997; Keogh and Polonsky, 1998; Lober, 1998; Pastakia, 1998; Isaak, 1999; Wiklund, 1999; Larson, 2000; Kyrö, 2001; Schaltegger and Petersen, 2001; Schaltegger, 2002). This body of work focuses on environmentally friendly innovations in processes, products or services and has also stressed the for-profit nature of environmental entrepreneurship. Furthermore, the link of this kind of entrepreneurship to industrial ecology (for example, Cohen, 2006) as well as to eco-efficiency and resource productivity has been addressed (Hawken, 1993; Hawken et al., 1999). Related to the work on ecopreneurship are also the notions of eco-systemic change (for example, Lehmann et al., 2005; Bright et al., 2006) and bioneers (for example, Schaltegger, 2002). Bioneers are considered to be environmental pioneers in niche markets, though with less market impact than ecopreneurs. Environmental management, in turn, focuses on system-orientated management activities such as control, transparency and accountability. Conventional forms of environmental management usually do not question a company's core business activities, products and services of the company, but are rather orientated towards a cost-efficient reduction of negative environmental impacts. Within this context, ecopreneurship is characterized by a stronger environmental orientation that prioritizes the integration of environmental issues integrated into the core business goals and products.

In parallel, a body of literature on social entrepreneurship has developed (Brinckerhoff, 2000; Borzaga and Solari, 2001; Prahalad and Hammond, 2002; Hockerts, 2003; Bright et al., 2006; Milstein et al., 2006). This literature focuses on how social entrepreneurship can create sustainable economic value, such as in providing club goods to members or by providing access to specific market segments (Strothotte and Wüstenhagen, 2005; Desa and Kotha, 2006a) and on bottom-of-the-pyramid innovation in emerging markets and developing economies (Prahalad, 2005, 2006). It is also concerned with detailed case analyses of successful non-profit social ventures, such as Ashoka, the Jaipur Foot (Prahalad, 2006), the Skoll Foundation or Benetech (Desa and Kotha, 2006b). In this literature, social entrepreneurship has been described as a specific form of ownership structure (for example, Mair and Noboa, 2003); a philanthropic, fund-raising or social-purpose business venture (see Mair and Marti, 2004; Hockerts, 2006) linking this distinction has been related to differences in opportunity recognition and exploitation (see Shane 2000 and 2003 on opportunity recognition as the core of entrepreneurship). Some initiatives, such as those of Ashoka, support entrepreneurs of societal change, here defined as individuals working on pathbreaking approaches and projects to solve fundamental societal problems such as poverty, educational deficiencies, health support or environmental pollution. Social entrepreneurship is thus not profit orientated but rather orientated towards achieving societal goals.

It seems that the development of environmental entrepreneurship is more strongly linked to the pursuit of profitable entrepreneurial opportunities, whereas social entrepreneurship has a stronger orientation towards non-profit activities and organizations for welfare purposes. This raises the question whether both types of entrepreneurship are distinct, given their different histories. However, even though the historic trajectories of both types differ, it seems that the underlying motivations for both activities are very similar and that therefore the future will see a convergence of these currently more independent movements. This interpretation is consistent with recent work arguing that specific market failures are the underlying eco-systemic root cause for entrepreneurial activities aimed at social objectives as well as environmental improvements (Cohen and Winn, 2007; Dean and McMullen, 2007).

We therefore attempt a synthesis of these two streams of literature on entrepreneurship with environmental and social objectives and will put it into perspective with regard to the conditions under which sustainable entrepreneurship and sustainability innovation are likely to emerge spontaneously in a market system. Furthermore, the chapter looks at which type of firms are most likely to be involved.

The next section defines the term 'sustainable entrepreneurship' and its derivation from entrepreneurship. The third section discusses a first approach to assessing sustainable entrepreneurship and the elements of a positioning matrix of sustainable entrepreneurship. The fourth section analyses how sustainable entrepreneurs emerge and what their likely characteristics are. The final section draws conclusions based on the ideas developed and identifies future research needs.

WHAT IS SUSTAINABLE ENTREPRENEURSHIP?

Economics and management theory have long neglected the phenomenon of entrepreneurship, as has the environmental management literature. However, over the last few years an increasing number of authors have started to deal with entrepreneurship, following the work of Schumpeter (1934) and Kirzner (1973).

The word 'entrepreneur' derives from French and can be interpreted as 'taking the initiative to bridge'. Entrepreneurs are the catalysers who bring together money, people, ideas and so on. Whereas all entrepreneurs deal with bridging activities between suppliers and customers to create and change markets, sustainable entrepreneurs differ from conventional entrepreneurs in that in addition they build bridges between environmental or societal progress and market success. Entrepreneurship can describe various phenomena (Lambing and Kuehl, 1997):

- Many authors concentrate on the process of a start-up company (Bennett, 1991; Ripsas, 1997). From this point of view, entrepreneurs are actors opening a new company and entrepreneurship is the process of creating and establishing a new company.
- Another aspect of entrepreneurship is the striving for growth (Timmons, 1986; Kyrö, 2001). Entrepeneurs are viewed as actors enlarging companies and expanding businesses.
- Entrepeneurship has also been interpreted as a social movement or another kind of environmental grassroots movement (Pastakia, 1998). In this perspective, entrepreneurs are actors changing existing consumption and production patterns on the basis of individual initiatives.
- Entrepreneurs are sometimes distinguished from traditional companies by their capability to innovate and to create competitive advantage (Schumpeter, 1934; Staber, 1997; Risker, 1998; Wiklund, 1999). Entrepreneurship links inventions with market success.
- Finally, entrepreneurship is characterized by the personal characteristics of a leader, such as ambition, leadership, team-building

> capabilities, personal involvement and commitment (Keogh and Polonsky, 1998; Stevenson and Gumpert, 1998).

The term 'sustainable entrepreneurship' combines – or bridges – two concepts, sustainability and entrepreneurship. Sustainable entrepreneurship is characterized by some fundamental aspects of entrepreneurial activities which are less orientated towards management systems or technical procedures, but rather focus more on the personal initiative and skills of the entrepreneurial person or team to realize market success with environmental or societal innovations. A sustainable entrepreneur in the niche market focusing on environmental aspects has also been termed a 'bioneer' (Schaltegger, 1999, 2002; Schaltegger and Petersen, 2001). As argued above, sustainable entrepreneurs focusing on social aspects can be categorized as social entrepreneurs.

Entrepreneurial thinking first starts off with individuals. Although covering societal topics, environmental and social preferences also emerge from personal concerns. That is why sustainable entrepreneurs such as Hipp (company Hipp, Europe's largest producer of baby food), Duttweiler (company Migros, largest food retailer in Switzerland) or Pfenninger (company Trisa, a leading European producer of brushes and brooms) embody a combination of strong environmental and social values with an energetic personal entrepreneurial attitude. Sustainable entrepreneurs show personal mastery (see Senge, 1996) and consider their professional life as a creative act. Differences between personal goals and the perceived reality are taken as a challenge and not as a problem (see ibid.: 175). Sustainable entrepreneurs, furthermore, mostly influence the company strongly with their personal goals and preferences in a way that these are reflected in the company's goals. This is more often and to a larger extent the case with start-up companies and small companies than with larger enterprises. Whereas environmental or corporate social responsibility managers can leave a company without the company losing substantial character, sustainable entrepreneurs constitute and shape the 'face' of their company. Because of the strong influence of the company leader's (or leaders') personality on company goals, sustainable entrepreneurship and the status of such an entrepreneur can also be related to the company directly.

As a consequence, sustainable entrepreneurship – defined in a narrow sense – deals with a start-up of a very innovative company supplying environmentally or socially beneficial products and services (for a similar definition of entrepreneurship, see Ripsas, 1997).

However, since sustainable entrepreneurship can be found in established companies as the spirit and the process of creating substantial market success with environmentally or socially beneficial products and services, or in the process of building up profit centres, spin-offs and so on, a wider interpretation of sustainable entrepreneurship makes sense. Defined more widely, sustainable entrepreneurship can thus be described as an innovative, market-orientated and personality-driven form of value creation by environmentally or socially beneficial innovations and products exceeding the start-up phase of a company.

This wide definition of sustainable entrepreneurship takes into account intrapreneurs (Pinchot, 1988) as an important subgroup of sustainable entrepreneurs. Intrapeneurs represent actors inside an organization who substantially change and shape the environmental and business growth development of the company (Jorna, 2006). The conceptual idea behind this subgroup is related to that of power and technical or relationship promoters, which are well established in the innovation management literature (see, for example, Witte, 1973 for his pioneering work on this topic).

A FRAMEWORK FOR SUSTAINABILITY MANAGEMENT AND A POSITIONING MATRIX OF SUSTAINABLE ENTREPRENEURSHIP

This section shows in more detail what can be understood by sustainable entrepreneurship and how it is distinguished from other kinds of environmental and socially responsible activities of companies. After an introduction to the positioning matrix of sustainable entrepreneurship, the two main dimensions, priority of environmental and societal goals and market effect, are discussed in more detail.

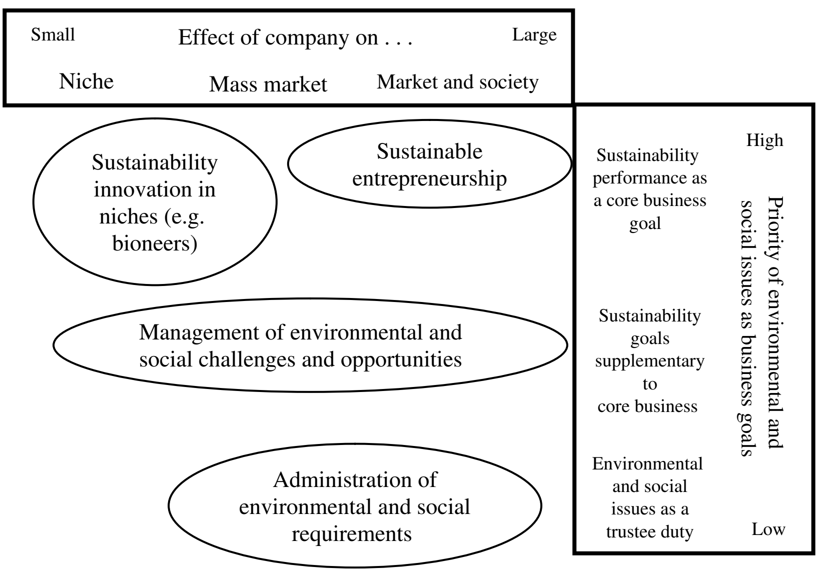
On a pragmatic scale, sustainable development requires the integrative achievement of environmental, social and economic goals now and for future generations. Corporate sustainability management thus attempts to shape the environmental, social and economic effects of a company in a way that results in first, sustainable development of the company itself and second, the company's contribution to the sustainable development of society as a whole (for example, Schaltegger and Dyllick, 2002). Among the core challenges are the management of social and environmental issues with economic approaches and the integration of environmental and social issues in core business processes and tools (see, for example, Figge et al., 2002 for details and examples).

Companies contribute most to sustainable development of an economy and society if their core business deals with solutions to environmental and social problems, if they supply environmentally and socially superior products, and if their sustainability innovations influence the mass market and society substantially.

A positive sustainability influence by companies calls for their real and substantial contribution to sustainable progress. Real improvement can only be created if the production processes, products and services are superior. A substantial contribution requires that the company can exert both a strong market influence and a strong social or political influence. A strong market influence can be based on a large market share or on the ability to influence competitors and other market actors (such as suppliers) to adopt superior sustainability solutions. A strong social and political influence includes the development of trends, fashion, values and political opinions and frameworks.

In its most advanced form, sustainability management becomes sustainable entrepreneurship and fulfils both requirements (see Figure 2.1). Ideally, sustainable entrepreneurship pulls the whole market towards sustainability. Sustainable entrepreneurs strive for business success through sustainability solutions for the mass market. With their innovations they are able to exert a constructive influence on society and public policy.

Both dimensions of sustainability management can be further subdivided. The priority of sustainability goals (vertical axis in Figure 2.1,



Source: Based on Schaltegger and Petersen (2001).

Figure 2.1 Perspectives and development of sustainability management similar to Schaltegger and Petersen, 2001; Schaltegger, 2002) can range from low priority (social and environmental requirements as a trustee duty), via medium priority (sustainability issues as a supplement to conventional business issues) to high priority (sustainability issues as an integral part of core business activities). The market effect of the company and its businesses (horizontal axis) can be either small in a niche, large through a strong influence on the mass market, or even spill over to society and politics at large.

The positions in Figure 2.1 allow for a distinction between different forms of sustainability management. Organizations in which sustainability issues are of low priority – and thus are administered rather than managed – consider these as a trustee duty and concentrate on the implementation of given regulations and standards. Environmental and social issues are left to the legal department and to bureaucracy, which administer the issues according to formally defined rules and regulations. Since, by definition, these firms do not pursue a proactive sustainability strategy, capabilities for sustainability innovation and sustainable entrepreneurship, such as that of being able to integrate stakeholders, are lacking in such firms (for example, Sharma and Vredenburg, 1998; Aragón-Correa and Sharma, 2003).

Company leaders who consider sustainability issues as a supplementary aspect of business establish environmental, quality and social management systems and departments which attempt to pilot and control impacts in the most efficient manner. Reduction of costs, the improvement of competitiveness and eco-efficiency, image campaigns and the differentiation of products and services are major goals of such a sustainable management directed towards doing things right. Firms in this group are likely to carry out some innovation activities, but with a stronger focus on mostly incremental innovations which do not question the current product and production approaches.

Companies in the upper right corner of Figure 2.1 can be called sustainable entrepreneurs. Seen from this angle, sustainability management is concerned with doing the right thing to promote and push sustainable development in the mass market and society. Sustainable entrepreneurs treat sustainability issues as central to their core business because their economic success is strongly linked to their sustainability performance. Focusing on environmental aspects, ecopreneurs and sustainable entrepreneurs can be found in this part of the matrix.

Bioneers and sustainable entrepreneurs aim with their companies at considerably large market shares in the niche market and high or increasing turnover in (more or less ecologically sensitive) mass markets.

Sustainable entrepreneurs' knowledge about substantial environmental problems and social issues also enables them to foresee a demand for fundamental innovations in traditional markets. The entrepreneurial challenge is thus to be economically successful with the supply of products and services which change – on a purely voluntary basis – consumption patterns and market structures leading to an absolute reduction of environmental impacts and negative social effects. Unlike bioneers, sustainable entrepreneurs are mostly not inventors. Instead of spending time in laboratories, sustainable entrepreneurs search for inventions which they can shape and place in markets to create turnover (Murphy, 2000) and influence market structures. Only in exceptional cases are successful inventors sustainable entrepreneurs at the same time. However, sustainable entrepreneurs often work together with bioneers, leading inventions to market success. The core activity of sustainable entrepreneurs is thus to search for business ideas triggered by environmental and social problems and solutions, to identify the market potential of inventions and to realize market success with them.

In the extreme case, sustainable entrepreneurship can thus be defined similarly to Timmons (1994: 48) as

> a human act that builds something of value [spurring sustainable development] from practically nothing. It is the pursuit of opportunity regardless of the resources, or lack of resources, at hand. It requires a vision and a passion and commitment to lead others in the pursuit of that vision. It also requires a willingness to take calculated risks.

To the degree that firms in the upper right corner in Figure 2.1 need to have a minimum economic scale or size to address the mass market, they are likely to have the capability of intrapreneurship (Pinchot, 1988). Fichter (2005), for example, proposes that motivated staff in larger firms play an important entrepreneurial role for sustainability innovation. Based on this, he argues for the necessity to develop partnerships and to integrate users in order to bring about sustainability innovation. Research on the promoter concept links into this as power, technical or relationship promoters have been identified as important individuals within larger firms who enable and accelerate innovation projects (Hauschildt and Gemünden, 1998). It seems that similar to their relevance in general for innovation activities in larger firms they also matter substantially for sustainability innovation.

If firms treat sustainability issues as central to core business activities, however, and are pushing not into the mass market but rather into niche markets, then the result is still highly likely to be a sustainability innovation but in a niche. This is the group of firms positioned in the upper left corner of Figure 2.1. This group is likely to be represented by smaller firms which often start out supplying customers in the alternative scene. The term 'alternative scene' describes new social movements and movements rooted in the ecological or feminist movements of the 1970s (see, for example, Lewis, 1992). Focusing on environmental aspects, 'bioneers' can often be found in this area of the matrix.

Eco-niches mirror medium-sized market segments and are occupied by bioneers. The expression 'bioneer' is a combination of 'bio' and 'pioneer' and attempts to express the central role of research and development (R&D) and the attempt to find customers with high preferences for their inventions and innovations. Bioneers focus on attractive market niches with their customer-focused eco-products.

Autonomy in management without bosses, the renunciation of hierarchies, craftsmanship instead of industrial production and the integration of leisure time and work characterize the goals of the alternative scene, which attempts to create a counterculture to the conventional economy (see Stückelberger, 1979; Conti, 1984). The attraction of the alternative scene is to break out of normality and obligations of any kind and to create a small world of self-assuring structures and procedures (see Schulze, 1996: 747). However, almost by definition, a comprehensive environmental and social effect of entrepreneurship is not of real interest in the alternative scene, as any imitation on a large scale would contradict the intentions and motivations of the actors creating the alternative scene. Nevertheless, in contrast to the student movement of the 1960s, the environmental movement of the 1970s and 1980s has created structures which in some cases have survived for three decades, and which have provided the background for many sustainable entrepreneurs who have entered market niches more recently.

Niche market suppliers are in general companies which focus on one well-defined part of the market by specializing in specific customer preferences (Kotler, 1998; Porter, 1999). The large competitors neglect these niches because they do not recognize them, because they do not consider them to be attractive enough or because they are not able to fulfil these specific customer preferences satisfactorily. The competition strategy is to focus on one precisely defined area of the market which is big enough to be economically successful and small enough to be neglected by mass market suppliers. Niche market suppliers serve exclusive target groups with a consequent differentiation strategy. This requires innovation of the supplied products and services as well as of the production technologies and organizational concepts.

Suppliers driven by environmental invention can be called bioneers as they serve the pioneer function to open new paths of environmental development in markets. The target customers of bioneers are in the intersection of customers with high environmental consumption preferences and customers with a high ability and willingness to pay. This is why the usual marketing and communication approaches of the mass market are not considered by bioneers. Apart from higher income and environmental preferences, the customers usually need substantial market and product knowledge and more time. Furthermore, they tend to accept longer distances to find the products they are looking for.

Many examples of bioneers can be found in the environmental high-tech sector (solar and wind energy), in energy contracting and the textile industry. Another group of bioneers are traditional small and medium-sized enterprises which develop their products and services according to environmental, social or socio-ecological criteria. They are often led and strongly shaped by a company owner or family authority striving for harmony between environmental, social and financial goals.

Although bioneers serve an important function in the sustainable development of products, their direct impact remains small as the majority of customers and the main flow of products, services, materials and energy in the mass markets is not affected. However, with their innovations bioneers can influence competition in the mass market. Whereas in the past many environmentalists have supported the 'small is beautiful' approach, the environmental management literature has recently started to step out of niche market terms and to 'think big' in order to gain a substantial environmental impact in mass markets (Villiger et al., 2000; Schaltegger and Petersen, 2001; Schaltegger, 2002). Most of these analyses can be adopted for the discussion of sustainable entrepreneurship.

Since the 1980s, many autonomous producers and green activists have left the alternative scene and started to enter commercial market niches (Horx, 1985). Some suppliers, for instance, some organic wine producers or jewellery craftsmen, have similarities to the alternative scene. However, among the niche suppliers the property rights are clearly defined. A leader who makes the investment, takes the decisions and wants to earn money, characterizes the company. The idealistic goal of changing the world is rather a matter of private choice than of a political programme or membership of an alternative group. The customers tend to show a strong interest in the products and express their willingness to pay rather than any kind of ideological closeness.

Nevertheless, Sigle and Clausen (2005) find some indication that industry context may matter in this regard when analysing the ecological food production chain and comparing it to green biotechnology. Their findings indicate that both are possible – a strong sustainability orientation of the entrepreneur him- or herself as a key characteristic of sustainable entrepreneurs, but also that a sustainability orientation is more related to current cultural trends which promote this orientation.

Having discussed different forms of sustainability innovation and sustainable entrepreneurship with a focus ranging from large markets to the alternative scene, it should have become clear that the size of a firm, *per se*, is not a defining criterion for sustainable entrepreneurship. Larger firms (for example, the carpet company Interface Inc. in the US) may show this kind of entrepreneurship as well as small start-ups (for example, SkySails) which aim at introducing a product or process with high environmental or social benefits that is attractive not only for niche buyers, but also for the mass market and has the potential for societal transformation. For example, SkySails has developed a traction system for ships that is based on a large kite filled with pressurized air, an auto pilot system and a routing system that makes optimal use of the wind conditions. Founded in Hamburg at the end of 2001, this start-up is still in a niche market, but is increasingly attracting the attention of large commercial ship-building investors (Clausen, 2005).

WHEN DO SUSTAINABLE ENTREPRENEURS EMERGE AND WHO ARE THEY?

Environmentally and socially superior products and production processes exceeding the strictest regulations by far have been created by numerous companies, for example in the textile, food, furniture, electic power generation and other industries. These firms can in principle be small start-ups, but also large incumbent firms that have significant market share in their industry. The decision of a company to get involved in sustainability innovation activities can be triggered by a number of factors, which can, for instance, relate to changes in regulation (see Porter and van der Linde, 1995 for various examples), initiatives of important stakeholders, such as NGOs, or changes in the management team of a firm.

In order to analyse and better understand when sustainable entrepreneurship emerges and who will be most likely to carry out sustainability innovation, we shall define the term 'sustainability innovation' more precisely. According to Fichter (2005: 138) sustainability innovation can be defined as the implementation of those technical, organizational, use system-related, institutional or social improvements that contribute to the conservation of critical natural goods or to globally and long-term sustainable levels and forms of consumption and production. One could add that the newness of an improvement, be it incremental or radical, is another relevant definition criterion of an innovation as is stressed in the patent system and that an innovation needs to be pursued by a company with the ultimate aim of profits (for example, Brockhoff, 1988; Hauschildt, 2004). It seems, however, that this is also assumed by Fichter to be the case.

When involving themselves in sustainable innovation, company representatives can play an important role in society and politics, shaping the market framework towards sustainability. Many important sustainability innovations are the result of a constructive interaction of corporate, political and social leaders. The strong growth of the wind generator industry in Northern Europe may be an obvious example. The question is, what are the underlying factors which determine when sustainable entrepreneurs emerge spontaneously in a market system and carry out sustainability innovation?

Based on these considerations, the question arises as to what are the conditions for spontaneous emergence of sustainable entrepreneurship and sustainability innovation (be it in larger or smaller firms or for the mass market or a niche, respectively). A key requirement for spontaneous emergence seems to be the existence of a business case or the potential to create a business case (for example, Schaltegger and Wagner, 2006), that is, a demand-side potential or demand-side development potential that enables a profitable sustainability innovation. This can imply, among other things, that the willingness to pay in the relevant market is sufficiently high for the product or process innovation in question. If no business case exists *per se*, the question arises whether the regulatory boundaries can be influenced or developed by business companies in order to create the business case. Furthermore, politicians can be motivated by non-business considerations to regulate market failure and to change market conditions if the sustainability innovation in question represents a high social benefit. This, in turn, can create a business case condition for sustainable entrepreneurs.

The existence of a business case for a sustainability innovation is based on the existence and appropriability of social benefits, that is, its transformation into private benefits. If no social benefits (beyond those commonly known for innovations, such as positive spillovers) exist, then an innovation is not a sustainability innovation. If social benefits cannot be appropriated (that is, transformed into a private benefit), then no win–win situation providing incentives for sustainable entrepreneurship exists because the private benefit for a firm is likely to be very small. Non-appropriability can, for example, be caused by the lack of willingness to pay for an innovation that brings about social benefits, for example, in terms of reduced environmental externalities. This results in a non-existence of a business case or an unsufficient business case.

Sustainability innovation is by definition characterized by high social benefits; therefore if social benefits cannot be appropriated and the private benefit is low, this would be particularly detrimental to society. Hence the question arises, what business models exist and can be developed with social benefits which can be partly appropriated? Only with business models should a business case for a sustainability innovation exist and (if the sustainability innovation is suitable for the mass market) sustainable entrepreneurs emerge spontaneously.

Sustainability innovations are in many cases radical innovations. Markides and Geroski (2005) define radical innovations as innovations that are characterized by creating new-to-the-world markets that are disruptive for both customers and manufacturers (ibid.: 17). They argue that because such innovations are commonly the result of efforts by a larger number of distributed R&D organizations and scientists, they are unlikely to have strong lead users or champions inside the firm to promote them. Because of this, they often initially target only small niche markets that are unattractive for larger firms.

Sustainability innovation often meets many of these criteria. For example, concerning climate change, it is difficult to identify lead users that have both a high benefit from the innovation as well as a need that foreshadows that of the large majority of customers at a later point in time. Small island states may be lead users for climate-friendly processes and products. However, they face an externality problem in that they are not the relevant applicants of the innovation compared to all large industrial countries which should use climate-friendly processes and products to slow down global warming. In many cases, the indication is that customers in the most-polluting countries and industries are often not fully motivated to change their development paths to a substantial degree and to bear the learning and switching costs associated with such radical innovations.

Given the insight that a sustainable development of markets and companies in many cases shows characteristics of radical innovations, the innovation management literature provides explanations for and suggestions to search for and create a similar situation and similar activity patterns for radical sustainability innovations as exist for radical innovation in general. In the innovation management literature, it is often argued that large firms are at a disadvantage in carrying out radical (and partly also disruptive) innovations. For example, Henderson and Clark (1990) showed that larger incumbents do not perform well when innovation is architectural, and Christensen (2003) in his seminal work in the hard disk drive industry has shown that disruptive innovation often affects incumbents who are not open enough to more fundamental technology changes.

Reasons for the challenges that radical innovation poses for firms are, for example, rigid routines and higher levels of administration. For instance, Deutsche Bahn AG for a long time did not enter the car-sharing business, even though this was a growing market. Or, as another example, no car company has decided yet to substantially emphasize sustainable mobility concepts. While some authors argue that revolutionary routines can help larger firms circumvent this challenge and capture profitable innovation opportunity, they also acknowledge that incremental routines nevertheless remain attractive to larger firms by reducing costs and risks, enabling firms to maintain their licence to operate and by increasing their reputation (Milstein et al., 2006). The acquisition of Body Shop by L'Oreal may illustrate this move.

Also, larger firms try to circumvent risks related to radical innovation by means of corporate venturing, but with varying success (Birkenshaw et al., 2002). Overall, it seems that the persistent challenge of large firms carrying out radical innovation is similar to transformative innovations that aim at mutual benefits for business, society and the environment, which is precisely what characterizes sustainability innovations according to the definition introduced earlier (Bright et al., 2006).

Conversely, some authors argue that smaller firms have many of the characteristics putting them in a position to be very innovative (Utterback and Abernathy, 1975; Jovanovic, 1982; Klepper, 1996). However, start-ups face the liabilities of newness and smallness (Gruber, 2004; Gruber and Henkel, 2006). This means that they may not always be as successful at radical innovation as, for example, innovation networks, which have been a focus of recent research in the field (Boons and Roome, 2005; Lehmann et al., 2005; Gemünden et al., 1996).

In summary, it has been argued that the difficulties larger firms have with radical innovation should guide them to a strategy of being fast second (Markides and Geroski, 2005), because they are more likely to have complementary assets that enable the innovation to be diffused into a larger market. This means that large firms are not the ones who are (in the words of Markides and Geroski) 'colonizing' a market, but are best off consolidating radical into mass markets. This argument emphasizes the greening of Goliath's strategy (Villiger et al., 2000) where large dominating companies can contribute substantially to the sustainable development of the mass market by improving their own corporate sustainability.

Differences that make large firms more suitable to be fast second are their skills in customer segmentation and marketing versus a start-up's engineering or technology competences (Markides and Geroski, 2005). This relates to the seminal paper of Teece (1986) and its argument relating to complementary assets. Markides and Geroski also note that what distinguishes a fast second from the classical second mover is that the former does not wait until the dominant design is obvious to everybody (Utterback and Abernathy, 1975; Utterback, 1994). Moreover, Markides and Geroski argue that larger firms are better at understanding the needs of standard customers and at producing a good that fulfils the majority of needs for a large number of consumers, rather than focusing on lead users (von Hippel, 1982, 2005) and on novel features. This means that larger firms are more driven by a viable business case, that is, they will consider getting involved in an innovation only if this seems to be a profitable endeavour. This is due to larger firms' competences in production and procurement (rather than product design) and to a stronger drive towards cost control (Markides and Geroski, 2005). Markides and Geroski's arguments also raise questions about proposals for increasing the capability of larger firms for radical innovation. For example, Milstein et al. (2006) observe that the competences of larger firms are systematically conflicting with those needed for radical innovation, and that these are critical success factors for larger firms. This insight poses a significant challenge to the prospect of radical innovation competences being easily acquired by larger firms.

Examples of the concept of large firms being fast second can also be found in the area of sustainability innovation. The earlier example of Deutsche Bahn AG is a very telling case. Car-sharing systems initially originated among users (and small start-ups), which are those that Markides and Geroski consider to be most likely to innovate (Hockerts, 2003). For example, Deutsche Bahn as a 'service manufacturer' and large incumbent firm started to offer car sharing later than others, and integrated it into its offers based on a business case and in a way that ensured it would not jeopardize its profitability.

Another relevant example is that of renewable energies, such as photovoltaics or wind turbines. Again, small start-ups were initially engaged in the development and manufacturing of such renewable energy technologies. Subsequently, large multinational energy suppliers entered this business, partly by acquiring smaller firms, and partly by developing capabilities on their own, even to the extent that oil companies repositioned themselves as energy providers which also manufacture photovoltaic cells (Wüstenhagen, 2003). Similar observations can be made in the area of 'green' biotechnology with regard to innovative products based on renewable resources, such as in the automotive industry and in the case of system innovation for sustainable services (see, for example, von Weizsäcker et al., 1995).

One reason for the prevalence of small firms in innovation activities partly relates to the fact that a clear dominant design has not yet emerged (Utterback and Abernathy, 1975; Utterback, 1994). However, to the degree that sustainability innovations are radical innovations, it seems unlikely that they are carried out by larger firms because they lack specific capabilities to do so (Markides and Geroski, 2005). This is consistent with the frequent empirical finding that more radical sustainability innovation is carried out by smaller firms, that is, there is some negative relation between the size of a firm and the radicality of any sustainability innovation it attempts. This insight also reveals complementarity of sustainable entrepreneurship in smaller firms (which is often associated with earlier stages and smaller niche markets) and of that in large firms which push sustainable innovations into mass markets.

These insights relate to Villiger et al.'s (2000) approach that sustainable entrepreneurship can be realized by 'multiplying Davids' or by 'greening Goliaths', but that large and small firms may differ in their role in the innovation process. Our reasoning implies that these two approaches to sustainability innovation are not unrelated but that a balance between both 'sustainable pioneering Davids' and 'sustainable Goliaths pushing mass markets' is needed in order to ensure a sufficiently high level of sustainability of the innovation on the one hand as well as a sufficiently quick diffusion of such innovations into mass markets on the other.

CONCLUSIONS

This chapter introduced a model of sustainable entrepreneurship and conditions for sustainability innovation. There are a number of ways in which innovation theory and innovation economics are related to sustainable entrepreneurship and sustainability innovation. For example, they can be linked to the systems-of-innovations concept which is rooted in evolutionary and institutional economics and has particular relevance to the subject of sustainability innovations. Furthermore, it can refer to different modes of coordination such as markets, regulation (induced innovation) or networks of actors which may bring about sustainability innovations in firms or between firms. Such avenues could be explored further.

For example, instrument-orientated approaches, which capture much of the current debate about market coordination, could be analysed in case studies to establish variability in firm-level effects between taxes/subsidies, tradable permit systems and voluntary/negotiated agreements.

Similarly, induced innovation has been much framed by the debate of the Porter hypothesis positing private benefits of firms from stringent environmental or social regulation. Case studies of firms are also very suitable to analyse the incidence of such innovation offsets, their determinants and their relevance relative to other factors, for example, R&D subsidies. In particular, they are able to analyse the existence of double externalities as has been proposed for sustainability innovations.

Finally, establishing the firm-level implications of concepts and models from evolutionary and institutional economics such as system failures (for example, lock-in), socio-technical regimes and transition strategies, lead markets, transition managements and windows of opportunity could be directions for future research. What these different perspectives on innovation imply should be addressed through both theoretical reasoning and formal modelling, as well as empirical testing by means of case studies and broad-based survey data.

NOTE

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REFERENCES

Anderson, T. and D. Leal (1997), *Enviro-Capitalism: Doing Good While Doing Well*, Lanham: Rowman & Littlefield.

Aragón-Correa, J.A. and S. Sharma (2003), 'A contingent resource-based view of proactive corporate environmental strategy', *Academy of Management Review*, **28** (1), 71–88.

Bennett, S.J. (1991), *Ecopreneuring: The Complete Guide to Small Business Opportunities from the Environmental Revolution*, New York: Wiley.

Berle, G. (1991), *The Green Entrepreneur. Business Opportunities that Can Save the Earth and Make You Money*, Blue Ridge Summit, PA: Liberty Hall Press.

Birkinshaw, J., R. van Basten Batenburg and G. Murray (2002), 'Venturing to succeed', *Business Strategy Review*, **13** (4), 10–17.

Blue, J. (1990), *Ecopreneuring. Managing for Results*, London: Scott Foresman.

Boons, F. and N. Roome (2005), 'Sustainable enterprise in clusters of innovation – new directions in corporate sustainability research and practice', in S. Sharma and J.A. Aragón-Correa (eds), *Corporate Environmental Strategy and Competitive Advantage*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar, Chapter 12, pp. 259–85.

Borzaga, C. and L. Solari (2001), 'Management challenges for social enterprises', in C. Borzaga and J. Defourny (eds), *The Emergence of Social Enterprises*, New York/London: Routledge, pp. 333–49.

Bright, D.S., R. Fry and D.L. Cooperrider (2006), 'Transformative innovations for mutual benefit in business, society and environment', paper presented at the Academy of Management Meeting, Atlanta, 11–16 August.

Brinckerhoff, P.C. (2000), *Social Entrepreneurship: The Art of Mission-based Venture Development*, New York: John Wiley & Sons.

Brockhoff, K. (1988), *Produktpolitik* (Product policy), Mannheim: UTB.

Christensen, C. (2003), *The Innovator's Dilemma*, New York: Harper.

Clausen, J. (2005), 'Nachhaltig Gründen! Einführung in das Schwerpunktthema' (Sustainable founding! Introduction to the focus topic), *Ökologisches Wirtschaften*, **2**, 11.

Cohen, B. (2006), 'Sustainable valley entrepreneurial ecosystems', *Business Strategy and the Environment*, **15**, 1–14.

Cohen, B. and M. Winn (2007), 'Market imperfections, opportunity and sustainable entrepreneurship', *Journal of Business Venturing*, **22** (1), 29–49.

Conti, C. (1984), *Abschied vom Bürgertum: Alternative Bewegungen in Deutschland von 1890 bis heute* (Escaping the Bourgeoisie. Alternative Movements in Germany from 1890 until Today), Reinbeck: Rowohlt.

Dean, T.J. and J.S. McMullen (2007), 'Toward a theory of sustainable entrepreneurship: reducing environmental degradation through entrepreneurial action', *Journal of Business Venturing*, **22** (1), 50–76.

Desa, G. and S. Kotha (2006a), 'Ownership mission and environment: an exploratory analysis into the evolution of a technology social venture', in J. Mair, J. Robertson and K. Hockerts (eds), *Social Entrepreneurship*, London and New York: Palgrave Macmillan, pp. 155–79.
Desa, G. and S. Kotha (2006b), 'Technology social ventures and innovation: understanding the innovation process at Benetech', paper presented at the Academy of Management Meeting, Atlanta, 11–16 August.
Fichter, K. (2005), *Interpreneurship. Nachhaltigkeitsinnovationen in interaktiven Perspektiven eines vernetzten Unternehmertums* (Interpreneurship. Sustainable Innovations in Interactive Perspectives of Entrepreneurial Networks), Marburg: Metropolis.
Figge, F., T. Hahn, S. Schaltegger and M. Wagner (2002), 'The sustainabiliy balanced scorecard. Linking sustainability management to business strategy', *Business Strategy and the Environment*, **11**, 269–84.
Gemünden, H.G., T. Ritter and P. Heydebreck (1996), 'Network configuration and innovation success: an empirical analysis in German high-tech industries', *International Journal of Research in Marketing*, **13**, 449–62.
Gruber, M. (2004), 'Marketing in new ventures. Theory and empirical evidence', *Schmalenbach Business Review*, **56**, 164–99.
Gruber, M. and J. Henkel (2006), 'New ventures based on open innovation. An empirical analysis of start-up firms in embedded Linux', *International Journal of Technology Management*, **33** (4), 256–372.
Hauschildt, J. (2004), *Innovationsmanagement* (Innovation Management), Munich: Vahlen.
Hauschildt, J. and H.G. Gemünden (1998), *Promotoren. Champions der Innovation* (Promotors. Champions of Innovation), Wiesbaden: Gabler.
Hawken, P. (1993), *The Ecology of Commerce: A Declaration of Sustainability*, New York: Harper Business.
Hawken, P., A. Lovins and L.H. Lovins (1999), *Natural Capitalism: Creating the Next Industrial Revolution*, New York: Little, Brown.
Henderson, R. and K.B. Clark (1990), 'Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms', *Administrative Science Quarterly*, **35**, 9–30.
Hockerts, K. (2003), *Sustainability Innovations. Ecological and Social Entrepreneurship and the Management of Antagonistic Assets*, Bamberg: Difo-Druck GmbH/PhD dissertation, University of St. Gallen.
Hockerts, K. (2006), 'Entrepreneurial opportunity in social purpose business ventures', in J. Mair, J. Robertson and K. Hockerts (eds), *Social Entrepreneurship*, London and New York: Palgrave Macmillan, pp. 142–54.
Horx, M. (1985), *Das Ende der Alternativen* (The End of the Alternative Movement), Munich: Hanser.
Isaak, R. (1999), *Green Logic: Ecopreneurship, Theory and Ethics*, West Hartford, CT: Kumarian.
Jorna, R. (2006), *Sustainable Innovation. The Organisational, Human and Knowledge Dimension*, Sheffield: Greenleaf.
Jovanovic, B. (1982), 'Selection and the evolution of industry', *Econometrica*, **50**, 649–70.
Keogh, P.D. and M.J. Polonsky (1998), 'Environmental commitment: a basis for environmental entrepreneurship?', *Journal of Organizational Change Management*, **11** (1), 38–49.

Kirzner, I. (1973), *Competition and Entrepreneurship*, Chicago: University of Chicago Press.
Klepper, S. (1996), 'Entry, exit, growth and innovation over the product life cycle', *American Economic Review*, **86**, 562–83.
Kotler, P. (1998), *Marketing Management: Analysis, Planning, Implementation and Control*, Englewood Cliffs, NJ: Prentice-Hall.
Kyrö, P. (2001), 'To grow or not to grow? Entrepreneurship and sustainable development', *International Journal of Sustainable Development and World Ecology*, **8** (1), 15–28.
Lambing, P. and C. Kuehl (1997), *Entrepreneurship*, Upper Saddle River, NJ: Prentice-Hall.
Larson, A.L. (2000), 'Sustainable innovation through an entrepreneurship lens', *Business Strategy and the Environment*, **9**, 304–17.
Lehmann, M., P. Christensen, and J. Møller Larsen (2005), 'Self-regulation and new institutions. The case of green networks in Denmark', in S. Sharma and J.A. Aragón-Correa (eds), *Corporate Environmental Strategy and Competitive Advantage*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar, Chapter 13, pp. 286–308.
Lewis, P.G. (1992), *Democracy and Civil Society in Eastern Europe*, London: Macmillan.
Lober, D.J. (1998), 'Pollution prevention and corporate entrepreneuship', *Journal of Organizational Change Management*, **11** (1), 26–37.
Mair, J. and I. Marti (2004), *Social Entrepreneurship: What Are We Talking About? A Framework for Future Research*, Barcelona: IESE Business School.
Mair, J. and E. Noboa (2003), *The Emergence of Social Enterprises and their Place in the New Organisational Landscape*, Barcelona: IESE Business School.
Markides, C. and P. Geroski (2005), *Fast Second. How Smart Companies Bypass Radical Innovation to Enter and Dominate New Markets*, San Francisco: Jossey-Bass.
Milstein, M.B., T. London and S. Hart (2006), 'Capturing the opportunity of creating a more inclusive capitalism', paper presented at the Academy of Management Meeting, Atlanta, 11–16 August.
Murphy, M. (2000), 'Kohle mit Sonne' (Coal with sun), *Econy*, **5**, www.econy.de/magazin/05-00/special2.html.
Pastakia, A. (1998), 'Grassroots ecopreneurs. Change agents for a sustainable society', *Journal of Organizational Change Management*, **11** (2), 157–73.
Pinchot, G. (1988), *Intrapreneuring* (in German), Wiesbaden: Gabler.
Porter, M. (1999), *Competitive Advantage*, Frankfurt: Campus.
Porter, M.E. and C. van der Linde (1995), 'Toward a new conception of the environment–competitiveness relationship', *Journal of Economic Perspectives*, **9** (4), 97–118.
Prahalad, C.K. (2005), *The Fortune at the Bottom of the Pyramid: Eradicating Poverty through Profits*, Philadelphia, PA: Wharton School.
Prahalad, C.K. (2006), 'The innovation sandbox', *Strategy and Business*, **44**, 1–10.
Prahalad, C.K. and A. Hammond (2002), 'Serving the world's poor profitably', *Harvard Business Review*, **80** (9), 48–57.
Ripsas, S. (1997), *Entrepreneurship als ökonomischer Prozess* (Entrepreneurship as Economic Process), Wiesbaden: Gabler.
Risker, D.C. (1998), 'Toward an innovation typology of entrepreneurship', *Journal of Small Business and Entrepreneurship*, **15** (2), 27–42.

Schaltegger, S, (1999), 'Von Bionieren zu Ecopreneuren' (From bioneers to ecopreneurs), *Basler Zeitung*, 14 June, 18.
Schaltegger, S. (2002), 'A framework for ecopreneurship. Leading bioneers and environmental managers to ecopreneurship', *Greener Management International*, **38**, 45–58.
Schaltegger, S. and T. Dyllick (2002), *Nachhaltig managen mit der Balanced Scorecard* (Managing Sustainably with the Balanced Scorecard), Wiesbaden: Gabler.
Schaltegger, S. and H. Petersen (2001), *Ecopreneurship. Konzept und Typologie* (Ecopreneurship, Concept and Typology), Lueneburg/Lucerne: CSM/Rio Managementforum.
Schaltegger, S. and M. Wagner (2006), *Managing the Business for Sustainability*, Sheffield: Greenleaf.
Schulze, G. (1996), *Die Erlebnisgesellschaft* (The Events Society), Frankfurt am Main: Campus.
Schumpeter, J. (1934), *Theory of Economic Development*, Cambridge, MA: Harvard University Press.
Senge, P. (1996), *Die Fünfte Disziplin: Kunst und Praxis der lernenden Organisation* (The Fifth Discipline. Art and Practice of Learning Organisations), Stuttgart: Klett-Cotta.
Shane, S. (2000), 'Prior knowledge and the discovery of entrepreneurial opportunities', *Organization Science*, **11** (4), 448–69.
Shane, S. (2003), *A General Theory of Entrepreneurship*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
Sharma, S. and H. Vredenburg (1998), 'Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities', *Strategic Management Journal*, **19** (8), 729–53.
Sigle, M.A. and J. Clausen (2005), 'Öko-Gründer und Biotechnologie-Gründer im Vergleich. Unterschiede und Gemeinsamkeiten' (Eco-founders and biotechnology founders compared), *Ökologisches Wirtschaften*, **2**, 14.
Staber, U. (1997), 'An ecological perspective on entrepreneurship in industrial districts', *Entrepreneurship and Regional Development*, **24** (1), 37–48.
Stevenson, H. and D. Gumpert (1998), 'Der Kern unternehmerischen Handelns' (The core of entrepreneurial action), in G. Faltin (ed.), *Entrepreneurship*, Munich: Beck, pp. 93–112.
Strothotte, T.G. and R. Wüstenhagen (2005), 'Structure of sustainable economic value', *Social Entrepreneurial Enterprises, Research on Technological Innovation, Management and Policy*, **9**, 129–40.
Stückelberger, C. (1979), 'Konsumverzicht' (Refraining from consumption), in R. Brun (ed.), *Der neue Konsument* (The New Consumer), Frankfurt: Fischer, pp. 7–16.
Teece, D.J. (1986), 'Profiting from technological innovation: implications for integration, collaboration, licensing and public policy', *Research Policy*, **15**, 285–305.
Timmons, J. (1986), 'Growing up big', in D. Sexton and R. Smilor (eds), *The Art and Science of Entrepreneurship*, Cambridge, MA: Ballinger, pp. 223–39.
Timmons, J. (1994), *New Venture Creation: Entrepreneurship for the 21st Century*, Boston, MA: Irwin.
Utterback, J.M. (1994), *Mastering the Dynamics of Innovation*, Boston, MA: Harvard Business School Press.
Utterback, J.M. and W.J. Abernathy (1975), 'A dynamic model of process and product innovation', *OMEGA*, **6**, 639–56.

Villiger, A., R. Wüstenhagen and A. Meyer (2000), *Jenseits der Öko-Nische* (Beyond the Eco-Niche), Basel: Birkhäuser.

von Hippel, E. (1982), *The Sources of Innovation*, Oxford and New York: Oxford University Press.

von Hippel, E. (2005), *Democratizing Innovation*, Cambridge, MA: MIT Press.

von Hippel, E., S. Thomke and M. Sonnack (1999), 'Creating breakthroughs at 3M', *Harvard Business Review*, September–October, 47–57.

von Weizsäcker, E.U., A.M. Lovins and L.H. Lovins (1995), *Faktor Vier: Doppelter Wohlstand – halbierter Naturverbrauch* (Factor Four. Double Wealth by Halving Nature Consumption), Munich: Droemersche Verlagsanstalt.

Wiklund, J. (1999), 'The sustainability of the entrepreneurial orientation–performance relationship', *Entrepreneurship, Theory and Practice*, **24** (1), 37–48.

Witte, E. (1973), *Organisation für Innovationsentscheidungen. Das Promotoren-Modell* (Organisation for Innovation Decisions. The Promoter Model), Göttingen: Schwartz & Co.

Wüstenhagen, R. (2003), 'Sustainability and competitiveness in the renewable energy sector; the case of Vestas wind systems', *Greener Management International*, **44**, 105–15.

3. A framework of SMEs' strategic involvement in sustainable development

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A wind of concern is blowing through every strata of society with respect to our present production and consumption practices and their impact on the future of our planet and its inhabitants. Consequently, environmental and societal factors are increasingly putting pressure on small and medium-sized enterprises (SMEs) to jump on the sustainable development bandwagon (Spence, 2007). It is recognized that the trend towards corporate social responsibility will not be sustainable without the adoption of this philosophy by a critical mass of SMEs (Luetkenhorst, 2004) which represent more than 95 per cent of firms and account for two-thirds of the jobs in the OECD countries (OECD, 2005).

This, however, raises the question of SMEs' willingness and capability to implement sustainable strategies. Indeed, SMEs may not have the resources or the know-how in this field that many larger firms have had to develop to meet their obligations, following the introduction by several governments of regulations to report on the environmental and societal impact of business activities. Even if entrepreneurs are aware of the role they have to play to be part of this movement, the obstacles they face may be too much of a hurdle to commit themselves to such strategies (DTI, 2002; CBSR, 2003). Nevertheless, some SMEs have taken steps to engage in sustainable activities with, so far, positive results in a number of areas such as visibility, image enhancement, customer loyalty and operational savings (DTI, 2002).

The question raised by the above arguments is therefore whether specific conditions – environmental, organizational and managerial – as perceived by SME owners/managers are more likely to entice SMEs to integrate sustainable development (SD) strategies in their regular activities and the reasons for their level of engagement. More specifically, the objectives of this chapter are to appreciate the factors that influence the intensity of strategic SD activities among SMEs. Therefore, our aims are:

1. to determine the influence of SME owners'/managers' SD orientation on their strategic involvement in SD;
2. to determine the importance of their perception of internal capabilities and external pressures on the entrepreneur's strategic involvements in SD; and
3. to determine the influence of SMEs' strategic involvement in SD on the performance evaluation criteria used.

First, the chapter reviews the theoretical foundations to this study. It then builds on this prior research to develop a conceptual model of SMEs' determinants of involvement in strategic SD activities and performance evaluation. The final section concludes.

THEORETICAL BACKGROUND

Defining Sustainable Development

Sustainable development has been defined as: 'meeting the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland, 1987: 43). For firms, this implies that profitability is still a major aim in order to ensure the long-term survival of the business, but it cannot be obtained through any means. Respect for the environment, the society and the people are just as important. Consequently, for SMEs, focusing on what is known as the 'triple bottom line' presents challenges due to their limited resources. It is nevertheless becoming an increasingly common mindset among various stakeholders (Luken and Stares, 2005) to which SMEs will sooner or later need to adhere through either imposed pressures or voluntary actions.

Although there is near consensus on the three paths of action – economic, environmental and social – which both large and small firms need to follow to embrace SD principles, the activities in each path are broad ranging. For Starik and Rands (1995), sustainability features five components. Sustainable activities are ones that are: (i) environmentally sound (ecologically non-degrading or even restorative); (ii) socially just (do not harm, and hopefully benefit, the poor/needy); (iii) economically sound (profitable or at the very least break even); (iv) culturally acceptable (consistent with the values of enough of the population that they will be widely engaged in or at least not bitterly opposed); and (v) 'managerially' sound (accompanied by a sense of self-efficacy – people believe that they know or can learn what to do, and can successfully carry out the needed actions).

Because of the broad scope of the term, most studies concentrate on one specific path instead of being holistic. Wolff (2004) indicated that research seems to favour environmental development studies (40–60 per cent of the studies), followed by social responsibility (25–50 per cent), stakeholders (6–22 per cent) and ethics (3–15 per cent). Indeed, sustainable development is an emergent field, still in search of a theoretical framework (Lauriol, 2004).

Underlying Theories to Sustainable Development

Social responsibility and SD research has primarily focused on the behaviour of large firms and has used many economic and organizational theories to analyse and explain this behaviour. Capron and Quairel-Lanoizelée (2004) identify two paradigms used in this research: the first includes the liberal and classical approach (Friedman, 1971), the stakeholder theory (Freeman, 1984) and the resource dependence theory (Pfeffer and Salancik, 1978); the second includes neo-institutional sociological theories (Meyer and Rowan, 1977; DiMaggio and Powell, 1983; Oliver, 1991). Although multi-paradigmatic approaches exist (Oliver, 1991, 1997), they are not as common.

In this research, we propose to combine some of these prior theories to describe and explain SMEs' level of involvement in SD and their drivers. To explore in more depth and bring forward the special challenges of pursuing SD activities for SMEs, we shall focus on the role of the entrepreneurs–managers. Entrepreneurship theory will be the heart of the research framework. In a multi-paradigmatic approach, it will be combined with stakeholder theory, the resource-based view and neo-institutional theory.

Entrepreneurship theory

SMEs present specific characteristics of flexibility and simple structure and as such are considered to be entrepreneurial organizations (Mintzberg, 1987). According to Gasse (2007), 'entrepreneurship is the action of mobilizing resources to launch projects and create firms whose products and services meet the needs of society'.

Entrepreneurship theory consists of several paradigms. Verstraete and Fayolle (2005) identify four of them: opportunity recognition, business creation, value creation and innovation. The common denominator between authors who have worked on the development of entrepreneurship theory is the 'newness' of the actions taken. For Schumpeter (1939), innovation refers to the destructive discovery of a new process, a new resources combination or a new product. Other authors have broadened the term to include invention, extension, duplication and synthesis (Kuratko and Hodgetts, 2001).

Innovation is preceded by opportunity recognition and development, which consists of discovering and exploiting an opportunity as a source of profit before competitors do. These two paradigms are at the centre of Shapero's (1975) model, one of the first entrepreneurship models. Entrepreneurs anticipate, or react to, their perception of the environment or a particular situation, as no two individuals share all of the same information at the same time. As a consequence, life idiosyncrasies are perceived differently by particular individuals. For instance, the development of the internet and the variety and relatively uneven entrepreneurial opportunities it has generated illustrate that opportunity identification is person specific (Shane, 2000; Shane and Venkataraman, 2000). An opportunity is therefore considered as a future situation which is both desirable and feasible. Verstraete and Fayolle (2005) talk about 'opportunity recognition' and 'business creation', implying that entrepreneurship theory applies only to for-profit organizations, hence leaving aside social entrepreneurs, entrepreneurs and entrepreneurship behaviours in other walks of life (Filion et al., 2001). The fourth paradigm, value creation, considers the entrepreneurs as a source of wealth for the firm and society in general.

Hence, SME involvement in SD can be considered as an entrepreneurial act. It is innovative in that, under weak institutional and market pressures, entrepreneurs still engage on this path and act as pioneers. Moreover, it creates value for stakeholders and preserves wealth for future generations as demonstrated by Biondi et al. (2002) and Longo et al. (2005). Finally, when these actions are considered as opportunities, SMEs integrate them at the core of their strategic activities for increased economic prosperity.

Stakeholder theory

Stakeholder theory is the one that is most used in corporate responsibility research (Déjean and Gond, 2002; Lauriol, 2004). In spite of some of its limitations, it presents a relevant framework to implement the concepts of SD in a business environment (Dontenwill, 2005). It is articulated in two core questions: what is the purpose of the firm and what responsibility does management have to stakeholders? It posits that business activities concern 'all groups or individuals who can affect or be affected by the achievement of business objectives' (Freeman, 1984: 53), directly or indirectly, in a primary or secondary fashion (Clarkson, 1995), and either voluntarily or contractually. Hence, coupled with entrepreneurship theory, stakeholder theory is useful to implement the SMEs' level of involvement in SD as it does for the other types of firms.

Freeman (1984) suggests that stakeholders' relationship with a firm can be on three different levels: (i) the 'rational' level which consists of identifying stakeholders and their interests; (ii) the 'process' level which takes these interests into account in the firm's strategy development; and (iii) the 'transactional' level which examines the negotiation process between the firm and its stakeholders. In other words, entrepreneurs need to articulate the kind of relationships they want and develop them together with their stakeholders to make them meaningful. Mitchell et al. (1997) demonstrate that stakeholders are not all equal. Their visibility for the firm depends on three attributes: the power to influence the firm, the legitimacy of the relationship, and the urgency of the stakeholder's claim on the firm. The presence of only one of these attributes will be deemed of little relevance for the owner–manager. On the contrary, when the three attributes are present, stakeholders' demands will be considered as priorities. As an example, small firms in Canada have engaged voluntarily in SD activities under the demand of a growing segment of customers requiring natural and biological food. By doing so, they submit themselves to stringent standards to obtain their legitimacy from various public institutions (Spence et al., 2007).

Resource-based view of the firm

The origins of the resource-based view (RBV) can be found in the work of Penrose (1959) or Wernerfelt (1984), but Barney (1991) is considered as the father of modern RBV. This research perspective holds that firms can earn sustainable and superior returns if and only if they have superior resources (valuable, rare, imperfectly imitable and non-substitutable (VRIN)) protected by some form of isolating mechanism preventing their diffusion throughout the industry.

These resources can be tangible or intangible assets, but RBV authors largely associate firm performance with intangible resources such as management skills, organizational processes and routines, and information and knowledge that the firm controls (Barney, 1991; Barney et al., 2001). In a voluntary approach, RBV emphasizes strategic choice and a firm's abilities to exploit imperfect and incomplete factor markets, providing the firm's decision makers with the important tasks of identifying, developing and deploying key resources to maximize returns.

RBV has been used to explain corporate social responsibility by highlighting the impact of socially responsible behaviours on competitive advantage (Gond and Mullenbach-Servayre, 2004). Indeed, the ability to manage stakeholders has been recognized as a strategic resource (Barney, 1991).

In an entrepreneurial firm, within the constraints of bounded rationality, entrepreneurial alertness, knowledge and ability to coordinate resources are viewed as resources in their own right. It is the entrepreneur's unique competence in developing insights into existing resources and recognizing opportunities when others do not that creates heterogeneity in the market (Alvarez and Busenitz, 2001).

Oliver (1997), however, criticizes RBV as it does not take into account the social context within which resource selection decisions are embedded or the process of resource selection. She proposes to expand this theory using the neo-institutional theory.

Neo-institutional theory

The neo-institutional theory posits that 'highly structured organizational fields provide a context in which individual effort to deal rationally with uncertainty and constraint often lead in the aggregate to homogeneity in structure, culture and output' (DiMaggio and Powell, 1983: 147). Firms' behaviours are compliant, habitual and socially defined, which is why, within an industry sector, firms often present similar behavioural patterns and responses to outside stimuli. Survival and success depend upon their conformity to social expectations and compliance with the predominant schemas, rules, norms and routines in their social context (Meyer and Rowan, 1977; DiMaggio and Powell, 1983). Indeed, similarities between practices among firms are more the result of a search for legitimacy, social justification and social obligation, than a rational response to economic constraints or a search for efficacy.

Using this theory to explain social responsibility or involvement in SD implies that the behaviour of firms is seen as an institutional isomorphic change that occurs through a reproduction (by coercive, mimetic or normative isomorphic mechanisms) of organizational behaviours in response to political influence such as state pressures, collective standard responses to uncertainty or the expectation of trade institutions. Hence, firms may respond to a new environmental law passively with mere compliance to obtain their legitimacy, and would not look beyond to try to gain a competitive advantage from it.

In its purest form, this theory may seem too deterministic, but Oliver (1991) supplemented it with the resource dependence theory to account for the fact that firms are not just passive agents but instead proactive entities that may digress from the status quo. Oliver (1997: 698) specifies that three levels of analysis are needed to explain the full spectrum of firms' responses to institutional pressures: 'At the individual level, the institutional context includes decision-makers' norms and values, at the firm level, organisational culture and politics, and at the interfirm level, public and regulatory pressures and industry-wide norms'. As such, managerial and organizational factors are taken into account and embedded into their social context, which is more closely related to the philosophy of entrepreneurism (Kao et al., 2002). Firms would therefore engage in SD because of the entrepreneur's convictions and values and would look for like-minded consumers in order to survive. They would then proactively request legitimacy through the institutionalization of their behaviour from public bodies (Spence et al., 2007).

A FRAMEWORK FOR SMEs' INTENSITY OF INVOLVEMENT IN SUSTAINABLE DEVELOPMENT

Sustainable Development Orientation

A number of studies in change management demonstrate that change has to be endorsed by a strong leader, a champion who believes in the new path of action and will motivate followers to accompany him/her to realize his/her vision (Flannery and May, 1994; Portugal and Yukl, 1994; Filion, 1997a; Verstraete and Saporta, 2006). In the area of sustainable development, such a leader would feature a strong SD orientation which consists of entrepreneurial acumen augmented by an altruistic personality.

Entrepreneurial Orientation

Entrepreneurial orientation is recognized as a key factor in firms' success (Miller and Friesen, 1982). It is characterized as the owners'/managers' propensity to develop new opportunities (Stevenson and Jarillo, 1990; Churchill and Muzyka, 1994; Julien and Marchesnay, 1996) and can be divided into three types of behaviours: the propensity to innovate, to act proactively and their attitude towards risks (Miller and Friesen, 1982; Covin and Slevin, 1989; Knight, 1997; Quairel and Auberger, 2005).

The management of the interdependency between SMEs and some of their stakeholders depends upon owners'/managers' ability to recognize and anticipate sometimes antagonistic expectations; that is, to act proactively (Knight, 1997). Such owners/managers would demonstrate leadership by drawing stakeholders to consider their own perspective and act in a way that is acceptable to both parties, leading to a win–win situation. It is therefore important to cultivate networks to obtain reliable information and influence its members (Quairel and Auberger, 2005).

Although the advantages of SD are put forward in the literature, in practice, SMEs face difficulties in implementing these activities. Their success depends upon the owners'/managers' propensity to consider sustainable requirements as opportunities, innovation or a risk worth taking, therefore demonstrating an entrepreneurial orientation towards SD (ibid.).

Personality of SMEs' Owners/Managers

A clear vision of what the entrepreneur considers to be a desirable and feasible future is the prerequisite for a relevant entrepreneurial orientation. Filion (1997b) defines entrepreneurial vision as 'an image projected in the future of the place we want our product to have in the market, as well as the image of the type of organisation we need to achieve these goals'. The owners'/managers' clear vision becomes a dominant logic. A strong vision reveals their anticipatory attitudes, their ability to conceptualize the future they want to develop (Flannery and May, 1994; CFIB, 2000; CBSR, 2003; Verstraete and Saporta, 2006) and facilitates the employees' actions at all levels of the organization (Portugal and Yukl, 1994). It takes a central place in their decision to adopt SD strategies, and their values and attitudes are the driving forces behind the formalization of these strategies. These values have a sociological as well as a psychological origin. Hence, even if some environmental, social, economic, cultural or managerial factors are constraining, they may not be strong enough to prevent them from achieving established objectives. Finally, environmental requirements are a matter of both perception and available resources to implement those strategies (Spence et al., 2007).

It has been demonstrated that adopting SD practices needs a different leadership style from the traditional one (Shrivastava, 1994; Egri and Herman, 2000). For Shrivastava, these owners'/managers' values are translated into a strategic vision that integrates the natural environment and the 'long-term ecological welfare'. These are implemented as 'empowerment' (creating a work climate that encourages employees to buy into the values), 'eco-identity' (developing an ecological culture in the firm), 'economic balance' (taking into account stakeholders' concerns) and 'thinking globally and acting locally' (confirming through one's local activities one's concern for the global environment). In the same vein, Portugal and Yukl (1994) identify three attitudes of transformational leadership which are crucial in the adoption of environmental strategies: articulating an appealing vision with environmental elements, changing perceptions about environmental issues, and taking symbolic actions to demonstrate personal commitment to environmental issues.

Egri and Herman (2000) highlight the fact that such leaders demonstrate self-transcendence values (motivation to improve others' well-being and that of nature) and not self-enhancement (concerned about their own personal interests). Furthermore, they are all open to changes as opposed to being conservative. These characteristics shed some light on the differences highlighted by Marschenay (1997) between SIG

SMEs (sustainability–independence–growth) compared to GAS SMEs (growth–autonomy–sustainability). The culture of a sustainable environment is more prominent in the former, for which sustainability is the major concern, than for the latter, which are more concerned with short-term profitability. We can infer from the above discussions the following propositions:

P1: SME owners/managers with a strong entrepreneurial orientation are more likely to also show a strong SD orientation.

P2a: SME owners/managers with a clear vision are more likely to also show a strong SD orientation.

P2b: SME owners/managers who are open to change are more likely to also show a strong SD orientation.

P2c: SME owners/managers who value self-transcendence are more likely to also show a strong SD orientation.

P3: SME owners/managers with a strong SD orientation are more likely to engage in strategic SD activities.

Perceived Stakeholder Pressures on SME Owners/Managers

In several countries, governments have stepped up the environmental and social requirements of their economic entities and require increasingly more transparency in the reporting of firms' practices. Consequently, if in the past most external pressures came from government agencies, new players such as consumers, suppliers, financial institutions and shareholders are demonstrating a growing interest in firms' social and environmental reliability (Biondo et al., 2002; Ammenberg and Hjelm, 2003; Simpson et al., 2004; Longo et al., 2005; Spence, 2007). These pressures, however, are not yet institutionalized or deemed strong enough to change the behaviours of SMEs, even though demands from clients and regulatory agencies are increasing (DTI, 2002; Quairel and Auberger, 2005). It is, therefore, a challenge to promote an SD philosophy within this group (Quairel and Auberger, 2005). It has been demonstrated that, in the Netherlands, a more forceful stance from the government in directing socially responsible behaviours has had a positive impact on businesses and society, much more so than in the UK where the policy tends to encourage voluntary actions (Revell and Rutherfoord, 2003).

At the cognitive level, firms' social responsibility varies between companies and depends on the owner's/manager's perception of institutional pressures (Déjean and Gond, 2002). Indeed, stakeholders' demands are processed and prioritized according to their level of legitimacy and urgency (Flannery and May, 1994; Mitchell et al., 1997). Owners'/managers' perceptions are influenced by their cognitive mindset, their past experience as well as their personal beliefs. The interpretation of events is thus person specific and may be enacted (Weick, 1979; Gioa and Chittipeddi, 1991; Shane, 2000; Shane and Venkataraman, 2000). In the field of strategic decision making, it is recognized that the way people collect and interpret information impacts upon the choice of the final decision and firms' behaviours (Dutton and Jackson, 1987). Hence, cognitive bias could be an explanation in the differences in decision making between firms (Schwenk, 1984, 1988).

When the environment is perceived as favourable to SD, SMEs are found to be more motivated to follow a strategy which is congruent with ongoing concerns. They consequently take advantage of the opportunities offered by various stakeholders. Some SMEs, however, invest in environment-friendly technologies and change some of their social practices in order to comply, which may lead to positive improvements on two of the three poles of the triple bottom line, but endanger their long-term survival as no competitive advantage is gained (Simpson et al., 2004). This may be due to the management team's lack of vision or 'eco-literacy'. Those interested in SD will envisage the type of gains they can achieve, considering them as opportunities (Sharma, 2000). They would then build a conceptual image of the advantages to be gained by adopting SD practices and trying to convince stakeholders to follow. Consequently, the principles and requirements of SD may be perceived by some as opportunities and by others as threats. Hence, the following proposition:

P4: SME owners/managers with a strong SD orientation are more likely to perceive stakeholders' pressures as opportunities and engage in strategic SD practices.

Perception of Ability and Competence by SME Owners/Managers

The resource-based view of the firm stipulates that the combination of unique resources will lead to the development of a competitive advantage. In the SD field, of the change agent or the instigator of SD initiatives is a visionary manager whose personal beliefs are strongly aligned with that of the triple bottom line (CFIB, 2000; CBSR, 2003) and the idea that these changes instilled a more positive atmosphere in the firm (DTI, 2002; CBSR, 2003). Most SD activities have a long-term scope, so the focus should be on innovation with a view to generating new revenue streams rather than a short-term outlook based on minimization of production costs (Biondi et al., 2002; Gubler, 2003). Managerial competence and insights to direct the firm to new ground are therefore necessary as it has been demonstrated that the more innovative the SMEs, the more likely they will be to adopt SD practices (European Commission, 2002).

Employees' competences also constitute a driver to SD (CBSR, 2003) and a source of competitive advantage as they are important sources of innovation, information and strategy implementation. The more aware and informed that employees are about the potential gains to be had through sustainable behaviours, the more likely the firm will be to direct itself towards this path (Friedman and Miles, 2002; Ammenberg and Hjelm, 2003).

Technological competences have also been deemed crucial to improve the environmental performance of SMEs. Technology may reduce the negative impacts of production and consumption, which are often the present focus, or help in developing a new paradigm of growth which is more sustainable (Adeoti, 2000). It therefore seems that managerial competence drives astute technological investments and improved performance. Larger size has been mentioned as a feature not only for being involved in sustainable practices (European Commission, 2002), but also for being related to the importance of the perception of being engaged in such practices (DTI, 2002).

Finally, it has been demonstrated that networks are a source of unique competences for SMEs when implementing SD strategies. These firms benefit from the experience of others, from experts, government institutions and so on, which provide not only practical advice, but also encouragement, a social group (Friedman and Miles, 2002) and cost savings through the sharing of technology.

An objective analysis would lead to the conclusion that the adoption of sustainable strategies would present challenges for SMEs because of their inherent characteristics, such as economic and competitive vulnerability, uncertainty, lack of information, competences and time and local scope, the lack of 'return' in company terms (Castka et al., 2004; Tencati et al., 2004; Longo et al., 2005; Quairel and Auberger, 2005).

Solutions to these challenges can, however, be found or developed by owners/managers who are willing to engage in SD. Their motivations would be stronger than the perceived barriers that limited resources or a hostile environment may present. Hence, the personal beliefs of owners/managers strongly influence the way a situation is perceived and the ease with which required resources are gathered, as well as the culture surrounding the adoption of SD (Oliver, 1997). Hence, the following proposition:

P5: SME owners/managers with a strong SD orientation are more likely to achieve an optimal combination of internal capabilities and engage strategically in SD.

Strategic Actions for Sustainable Development in SMEs

Engaging in SD may seem an overwhelming task for SMEs. Nevertheless, some of these SMEs have integrated SD in order to develop a strategic advantage.

SMEs' simultaneous involvement in several poles of SD (economic, social and environmental) is a determinant of their diversity of action and their adoption of the SD philosophy. The first step in this direction is the firm's identification of strategic stakeholders in each field. Dontenwill (2005) suggests shareholders and clients for the economic side, Non Government Organization (NGO) and territorial entities for the environment, and employees and local associations for the social aspect. Identifying and prioritizing the pressures exerted by these various stakeholders should precede the development of strategic actions for each field. In the environment field for instance, Flannery and May (1994) put forward the protection of the biosphere, sustainable natural resource use, reduction of waste, marketing of safe products and services, and assessment and annual environmental audits of their operations.

SMEs' intensity of involvement in SD could be appreciated through the owners'/managers' efforts to transform their intentions into tangible realizations. Authors have identified strategies that ease SMEs' intensity of involvement while maximizing their limited resources and taking advantage of present opportunities. These strategies include: (i) collaborating to improve the triple bottom line; (ii) supporting green early adopters; (iii) going local; (iv) prioritizing and building on existing assets; and (v) communicating effectively with stakeholders. An overview of SMEs' strategies of involvement in SD and their implications is presented in Table 3.1.

Outcomes of Engagement in SD

The question is now to determine whether the adoption of sustainable strategies by SMEs has led to increased performance and the development of a sustainable advantage (Porter and van der Linde, 1995). On this matter, the rationale put forward by supranational organizations such as the ICC/WBCSD to adopt SD practices and the anticipated benefits are appealing (ICC/WBCSD, 1998; Luetkenhorst, 2004), but empirical results have been mixed (Margolis and Walsh, 2003). This can be partially explained by the longer time frame needed to evaluate the full impact of these types of measures (Ammenberg and Hjelm, 2003), the variety of measures used which make the findings between studies difficult to compare, or questionable methodology (Margolis and Walsh, 2003).

Table 3.1 Strategies and implications to facilitate SME involvement in SD

Strategies	Implications	Authors
SME strategies to diversify SD activities		
Identifying strategic stakeholders ● Selecting stakeholders who are sympathetic to owners'/managers' personal beliefs and business objectives	Focusing the firms' efforts and resources	Flannery and May, 1994; Dontenwill, 2005
Prioritizing according to intensity of pressures	Maximizing the use of scarce resources	Mitchell et al., 1997; Tencati et al., 2004
SME strategies to intensify SD activities		
Collaborating with various stakeholders to improve the triple bottom line ● Participating in networks	Maximizing the use of limited resources Idea sharing Cost sharing Obtaining moral support Acting as change agent Challenges: ● Finding collaborators because of weak bargaining power	Sharma, 2000; Biondi et al., 2002; Friedman and Miles, 2002; Ammenberg and Hjelm, 2003; Nelson, 2004; Rothenberg and Cost, 2004
Supporting green early adopters ● Identifying change agents through non-profit organizations	Green early adopters will spread the message among their followers through word-of-mouth, their purchasing actions	Bouquet and Hénault, 1998; Nelson, 2004; Hénault and Spence, 2006

Table 3.1 (continued)

Strategies	Implications	Authors
Going local ● Favouring local suppliers, employees, government agencies and social entities whenever feasible	Stimulating the local economy Building a foothold in the local community Gaining a competitive advantage Challenges: ● Non-availability of required skills among local employees ● Non-availability of local suppliers	Shuman, 1998; McCurry, 2001; Freidman and Miles, 2002; Stead, Stead and Shemwell, 2002; Weeks, 2006
Prioritizing and building on existing assets	Making use of 3R principles of SD: reuse, rethink, recycle Taking into account SME context Exerting creativity and innovation	Mitchell et al., 1997; CBSR, 2003; Castka et al., 2004; Rothenberg and Cost, 2004; Tencati et al., 2004; Günther and Kaulich, 2005
Communicating effectively to stakeholders ● Creating cultural artifacts such as slogans, symbols, rituals and stories which serve to articulate and reinforce the importance of SD performance	Increase SME visibility, legitimacy, reputation, image Challenges: ● Disconnect between communication and actions ● Communicating only the 'green' aspects of a product as opposed to the advantages to customers	Starik and Rands, 1995; Nelson, 2004

Although the primary focus of businesses has been economic, SMEs still face a challenge when needing to collect relevant data to support their growth in an increasingly complex environment. This is due to their lack of resources, poor strategic planning, use of tacit knowledge instead of formalized processes and misconception of performance measurement (Garengo et al., 2005). When social and economic data are added, the difficulty is even greater. Consequently, performance measurement systems have to respond to SMEs' specific needs and should be efficient and easy to implement. Tencati et al. (2004) suggest that SMEs should collect only data that are significant, that is, data that matter to stakeholders linked to the firms by a power, legitimacy or urgency relationship (Mitchell et al., 1997). A maximum of 20 indicators of performance to evaluate the three poles of SD – economic, social and environmental – have been proposed to keep it both manageable and meaningful for SMEs (Tencati et al., 2004).

The performance measurement system must also be balanced and include internal and external as well as financial and non-financial measures to provide a 'holistic' assessment of the company's performance (Garengo et al., 2005). For SMEs, such a system should focus on breadth rather than depth (Dickinson et al., 1998; McAdam, 2000). In the evaluation of their integrated environmental, health and safety and SD initiatives into business systems, Oktem et al. (2004) included direct and indirect costs and benefits linked to the implementation of these initiatives, as well as intangible savings from internal and external sources and business opportunities. Although a direct link between social and environmental responsibility and economic rewards is still difficult to demonstrate, Boiral (2005) argues that respecting the integrity of ecosystems and population health is priceless for society, and therefore the evaluation of SD performance should not be based solely on economic indicators. The indicators in Table 3.2, adapted from Oktem et al. (2004) and completed by the work of other authors, are suggested for the evaluation of SD initiatives in SMEs.

SMEs which consider SD as a strategic direction are more likely to gain from it than those which invest only to meet compliance requirements (DTI, 2002; Simpson et al., 2004) as 'understandably, SMEs are eager to innovate only when they understand that they may obtain economic and competitive benefits by going beyond the limits defined by the law' (Biondi et al., 2002: 617). Consequently, education and providing best-practice examples are crucial in changing SMEs' owners'/managers' perceptions of the adoption of sustainable strategies (see Figure 3.1).

SD, however, should not be considered as an unattainable goal, but as a process to be initiated on the firms' present foundations and capabilities and developed with a long-term orientation as resources become available (CBSR, 2003; Castka et al., 2004). To support such goals, a well-designed

Table 3.2 Suggested indicators of performance of SD activities

Indicators	Description
Direct costs	Salaries of part-time and full-time employees dedicated to SD activities
Direct benefits	Expected savings in waste disposal (Biondi et al., 2002), lost work days, workers' compensation
Indirect costs	Costs associated with monitoring, reporting and other activities related to regulatory requirements
Potential savings in future and contingent liability	Savings that would materialize due to reduced fines, penalties and future liabilities (e.g., non-compliance, remediation, personal injury, property damage, industrial accidents) (Petts et al., 1999)
Intangible savings	Internal: savings from costs that would be borne by the company (e.g., customer acceptance, worker morale, union relations, community relations) (McCurry, 2001; DTI, 2002; Ammenberg and Hjelm, 2003; CBSR, 2003; Longo et al., 2005) External: savings in costs borne by society (e.g., impact of operation of housing costs, degradation of habitat)
Business opportunities	New business or modified operations: identifying new businesses (e.g., providing SD services, creating a new product line to help low-income societies), savings in resources consumption (e.g., energy, water, raw materials) due to modified processes and products (Biondi et al., 2002; CBSR, 2003; Simpson et al., 2004)

Source: Adapted from Oktem et al. (2004).

performance measurement system should focus on lead indicators (measures of the factors that drive the outcomes) and use more non-financial measures (Perera and Baker, 2005). The above discussion leads to the following proposition:

> *P6: The higher the SME involvement in strategic SD activities, the greater the number of non-financial performance indicators used.*

CONCLUSION

The purpose of this chapter was to appreciate the factors that influence the strategic involvement of SMEs in SD activities. Since SME owners/managers

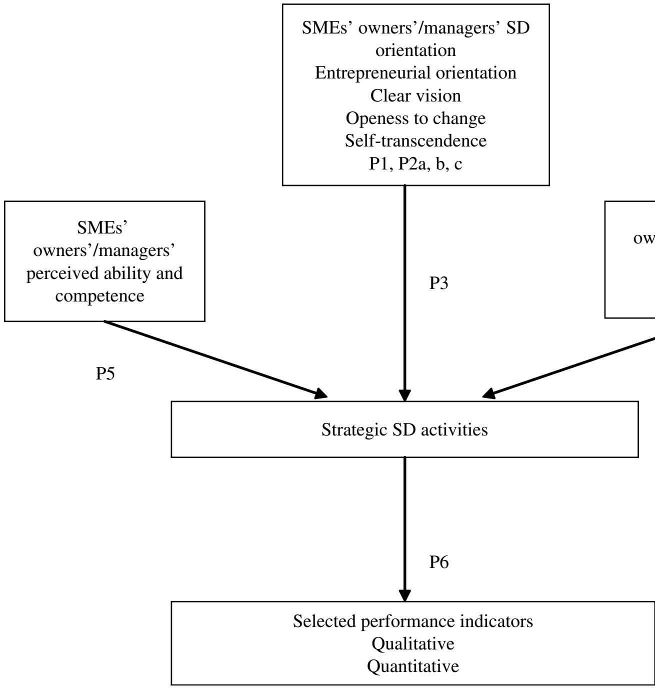

Figure 3.1 Factors of influence on SMEs' strategic involvement in SD activities

are at the centre of the firm's decision making and strategic orientation, the proposed framework includes factors that capture the firm's entrepreneurial orientation and the entrepreneur's personality. Moreover, the framework is based on these individuals' perceptions of their environment, their resources and their performance, which emphasizes the importance of the subjective rationality that directs small firms' strategic directions. This approach was also used by Sharma (2000) and Angell and Rands (2002), and recommended by Déjean and Gond (2002).

The chapter contributes further to the literature by proposing a construct of an 'entrepreneur's sustainable development orientation' which will need to be refined with more-focused qualitative interviews and tested on a larger sample. The model also infers that a strong sustainable orientation will have an influence on the performance criteria implemented within the SMEs. Indeed, past research has demonstrated that appropriate behaviours are reinforced by being recognized (Flannery and May, 1994; Portugal and Yukl, 1994). In the present state of institutional pressures regarding SME involvement in SD and its voluntary dimension, the proposed framework may be useful in assisting decision makers to identify owners/managers with a strong SD orientation and to target them for further involvement, as well as role models or mentors.

The limitations of this framework are that: (i) it remains theoretical and is based upon published documents only, and (ii) the SD orientation of the entrepreneur is the only one that has been considered, while in many firms a management team actually decides on the firm's directions.

The next step of the research consists of the empirical validation of the framework with a large sample of SMEs in Canada. A comparative study on the textile and food industries in Cameroon, Canada and Tunisia is also planned, the purpose of which is to contrast SMEs' strategic involvement in SD activities between sectors and countries, and more specifically, the differences in approaches between the North and the South. An exploratory phase based on qualitative interviews will be necessary prior to the quantitative evaluation.

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REFERENCES

Adeoti, J. (2000), 'Small enterprise promotion and sustainable development: an attempt at integration', *Journal of Developmental Entrepreneurship*, **5**(1): 57–71.

Alvarez, S. and Busenitz, L. (2001), 'The entrepreneurship of resource-based theory', *Journal of Management*, **6**: 755–75.

Ammenberg, J. and Hjelm, O. (2003), 'Tracing business and environmental effects of environmental management systems – a study of networking small and medium-sized enterprises using a joint environmental management system', *Business Strategy and the Environment*, **12**(3): 163–74.

Angell, L. and Rands, G. (2002), 'Factors influencing successful and unsuccessful environmental initiatives', in S. Sharma and M. Starik (eds), *Research in Corporate Sustainability*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 155–86.

Barney, J. (1991), 'Firms resources and sustainable competitive advantage', *Journal of Management*, **17**(1): 99–120.

Barney, J., Wright, M. and Ketchen, D. (2001), 'Resource-based view of the firm: 10 years after 1991', *Journal of Management*, **27**: 625–41.

Biondi, V., Iraldo, F. and Meredith, S. (2002), 'Achieving sustainability through environmental innovation: the role of SMEs', *International Journal of Technology Management*, **24**(5/6): 612–26.

Boiral, O. (2005), 'Concilier environnement et compétitivité ou la quête de l'éco-efficience, *Revue Française de Gestion*, **31**(158): 163–86.
Bouquet, C. and Hénault, G. (1998), 'Commerce international équitable, logique marchande et marketing des causes sociales: vers une symbiose?', *Revue Française du Marketing*, **166**(1): 7–18.
Brundtland, G.H. (1987), *Our Common Future*, Oxford: Oxford University Press.
Canadian Business for Social Responsibility (CBSR) (2003), *Engaging Small Business in Corporate Social Responsibility*, October, Vancouver: CBSR.
Canadian Federation of Independent Business (CFIB) (2000), *Environment Survey*, November, Winnipeg: FCEI, www.cfib.ca.
Capron, M. and Quairel-Lanoizelée, F. (2004), *Mythes et réalités de l'entreprise responsable*, Paris: Éditions La découverte.
Castka, P. Balzarova, M., Bamber, C.E. and Sharp, J. (2004), 'How can SMEs effectively implement the CSR agenda? A UK case study perspective', *Corporate Social Responsibility and Environmental Management*, **11**: 140–49.
Churchill, N.C. and Muzyka, D.F. (1994), 'Entrepreneurial management: a converging theory for large and small enterprises', Working Paper 94/64/ENT/SM, INSEAD (European Institute of Business Administration, Paris).
Clarkson, M. (1995), 'A stakeholder framework for analysing and evaluating corporate performance', *Academy of Management Review*, **20**(1): 92–117.
Covin, G.J. and Slevin, D.P. (1989), 'Strategic management of small firms in hostile and benign environments', *Strategic Management Journal*, **10**: 75–87.
Déjean, F. and Gond, J.-P. (2002), 'La responsabilité sociétale des entreprises: enjeux stratégiques et stratégies de recherche', *Sciences de gestion et pratiques managériales*, réseau des IAE, Paris: Economica, 389–400.
Department of Trade and Industry (DTI) (2002), *Engaging SMEs in Community and Social Issues*, Research Report, London: DTI.
Dickinson, T., Saunders, I. and Shaw, D. (1998), 'What to measure about organization performance', *Quality Magazine*, **7**: 71–8.
DiMaggio, P.J. and Powell, W.W. (1983), 'The iron cage revisited: institutional isomorphism and collective rationality in organizational fields', *American Sociological Review*, **48**: 147–60.
Dontenwill, E. (2005), 'Comment la théorie des parties prenantes permet-elle d'opérationnaliser le concept de développement durable pour les entreprises?', *La revue des sciences de gestion*, January–April, **40**(211–12): 85–97.
Dutton, J.E. and Jackson, S.E. (1987), 'Categorizing strategic issues: links to organizational action', *Academy of Management Review*, **12**: 76–90.
Egri, C. and Herman, S. (2000), 'Leadership in the North American environmental sector: values, leadership styles, and context of environmental leaders and their organizations', *Academy of Management Journal*, **43**(4): 571–604.
European Commission (2002), 'European SMEs and social and environmental responsibility', *Observatory of European SMEs*, No. 4.
Filion, L.-J. (1997a), 'Le métier d'entrepreneur', *Revue Organisation*, Autumn: 29–45.
Filion, L.-J. (1997b), 'Le champ de l'entrepreneurial: historique, évolution, tendances', *Revue Internationale PME*, **10**(2): 129–72.
Filion, L.-J. et al. (2001), *Réaliser son projet d'entreprise*, Montreal, Qbc: Éditions Transcontinentale.
Flannery, B. and May, D. (1994), 'Prominent factors influencing environmental activities: application of the environmental leadership model (ELM)', *Leadership Quarterly*, **5**(3/4): 201–21.

Freeman, R. (1984), *Strategic Management: A Stakeholder Approach*, Marshfield: Pitman Publishing.
Friedman, A. and Miles, S. (2002), 'SMEs and the environment: evaluating dissemination route and handholding levels', *Business Strategy and the Environment*, **11**: 324–41.
Friedman, M. (1971), *Capitalisme et liberté*, Paris: Robert Laffont.
Garengo, P., Biazzo, S. and Bitici, U. (2005), 'Performance measurement systems in SMEs: a review for a research agenda', *International of Management Reviews*, **7**(1): 25–47.
Gasse, Y. (2007), 'Création et gestion de l'entreprise', in L.-J. Filion (ed.), *Management des PME, de la création à la croissance*, Montréal: FPPI.
Gioia, D.A. and Chittipeddi, K. (1991), 'Sensemaking and sensegiving in strategic change initiation', *Strategic Management Journal*, **12**: 433–48.
Gond, J.-P. and Mullenbach-Servayre, A. (2004), 'Les fondements théoriques de la responsabilité sociétale de l'entreprise', *La revue des sciences de gestion*, **205** (January–February): 93–116.
Gubler, D. (2003), 'SME pertinent-PME performante: un outil novateur', Workshop 13, Promotion du management durable dans les PME, Carouge, Geneva, http://archives.smia.info/2003/Wshp11_Gubler_SMP-PME_Fulltext.pdf.
Günther, E. and Kaulich, S. (2005), 'The EPM-KOMPAS: an instrument to control the environmental performance in small- and medium-sized enterprises (SMEs)', *Business Strategy and the Environment*, **14**: 363–71.
Hénault, G. and Spence, C. (2006), *Marketing International: Synergie, Èthique et Liens*, Québec: Presses de l'Université du Québec.
ICC/WBCSD (International Chamber of Commerce/World Business Council for Sustainable Development) (1998), 'Responsible Entrepreneurship', Policy Statement, ICC Commission on Environment, 30 January; UN Commission on Sustainable Development, 20 April–1 May, www.iccwbo.org.
Julien, P.A. and Marchesnay, M. (1996), *L'entrepreneuriat*, Paris: Economica, collection Gestion poche.
Kao, R., Kao, K. and Kao, R. (2002), *A Philosophy and a Sensible Alternative: Entrepreneurism for the Market Economy*, London: Imperial College Press.
Knight, G.A. (1997), 'Cross-cultural reliability and validity of a scale to measure firm entrepreneurial orientation', *Journal of Business Venturing*, **12**: 213–25.
Kuratko, D.F. and Hodgetts, R.M. (2001), *Entrepreneurship: A Contemporary Approach*, Orlando, FL: Harcourt College Publishers.
Lauriol, J. (2004), 'Le développement durable à la recherche d'un corps de doctrine', *Revue Française de Gestion*, September–October, **30**(152): 137–50.
Longo, M., Mura, M. and Bonoli, A. (2005), 'Corporate social responsibility and corporate performance: the case of Italian SMEs', *Corporate Governance*, **5**(4): 28–42.
Luetkenhorst, W. (2004), 'Corporate social responsibility and the development agenda – a case for actively involving small and medium enterprises', *Intereconomics*, May/June: 157–66.
Luken, R. and Stares, R. (2005), 'Small business responsibility in developing countries: a threat or an opportunity?', *Business Strategy and the Environment*, **14**: 18–53.
Margolis, J. and Walsh, J. (2003), 'Misery loves company: rethinking social initiatives by business', *Administrative Sciences Quarterly*, **48**: 268–305.
Marschenay, M. (1997), 'Petite entreprise et entrepreneur', in Y. Simon (ed.), *Encyclopédie de Gestion*, Paris: Economica, pp. 2209–19.

McAdam, R. (2000), 'Quality models in an SME context', *International Journal of Quality and Reliability Management*, **17**: 305–23.

McCurry, P. (2001), 'Balancing interests', *Director*, October, **55**(3): 30–31.

Meyer, J.W. and Rowan, B. (1977), 'Institutional organizations: formal structure as myth and ceremony', *American Journal of Sociology*, **80**: 340–63.

Miller, D. and Friesen, P.H. (1982), 'Innovation in conservative and entrepreneurial firms: two models of strategic momentum', *Strategic Management Journal*, **3**: 1–25.

Mintzberg, H. (1987), 'Crafting strategy', *Harvard Business Review*, **65** (July–August): 66–74.

Mitchell, R., Agle, B. and Wood, D. (1997), 'Toward a theory of stakeholder identification and salience: defining the principles of who and what really counts', *Academy of Management Review*, **22**(4): 853–86.

Nelson, K. (2004), 'How small firms innovate sustainably', *In Business*, **26**(6): 24–6.

Oktem, U., Lewis, P., Donovan, D., Hagan, J. and Pace, T. (2004), 'EMS and sustainable development: a model and comparative studies of integration', *Greener Management International*, **46**: 11–29.

Oliver, C. (1991), 'Strategic responses to institutional processes', *Academy of Management Review*, **16**(1): 145–79.

Oliver, C. (1997), 'Sustainable competitive advantage: combining institutional and resource-based views', *Strategic Management Journal*, **18**(9): 697–713.

Organization for Economic Cooperation and Development (OECD) (2005), *Perspectives de l'OCDE sur les PME et l'entrepreneuriat*, Paris: OECD.

Penrose, E.T. (1959), *The Theory of the Growth of the Firm*, New York: Wiley.

Perera, S. and Baker, P. (2005), 'Measure for measure, SMEs got the idea', *In the Black*, **75**(10): 60–63.

Petts, J., Herd, A., Gerrard, S. and Horne, C. (1999), 'The climate and culture of environmental compliance within SMEs', *Business Strategy and the Environment*, **8**(1): 14–30.

Pfeffer, J. and Salancik, G.R. (1978), *The External Control of Organizations*, New York: Harper & Row.

Porter, M. and van der Linde, C. (1995), 'Green and competitive: ending the stalemate', *Harvard Business Review*, September–October: 120–34.

Portugal, E. and Yukl, C. (1994), 'Perspectives on environmental leadership', *Leadership Quarterly*, **5**(3/4): 271–6.

Quairel, F. and Auberger, M.N. (2005), 'Management responsable et PME: Une relecture du concept de "responsabilité sociétale de l'entreprise"', *Revue des Sciences de Gestion: Direction et Gestion*, **40**(211/212): 111–26.

Revell, A. and Rutherfoord, R. (2003), 'UK environmental policy and the small firm: broadening the focus', *Business Strategy and the Environment*, **12**(1): 26–35.

Rothenberg, S. and Cost, F. (2004), *Lean Manufacturing in Small- and Medium-sized Printers*, Rochester, NY: Research Monograph of the Printing Industry Center, Rochester Institute of Technology.

Schumpeter, J.A. (1939), *Business Cycles*, Vol. 1, New York: McGraw-Hill.

Schwenk, C.R. (1984), 'Cognitive simplification processes in strategic decision management', *Strategic Management Journal*, **5**: 111–28.

Schwenk, C.R. (1988), 'The cognitive perspective on strategic decision making', *Journal of Management Studies*, **25**(1): 41–55.

Shane, S. (2000), 'Prior knowledge and the discovery of entrepreneurial opportunities', *Organization Science*, **11**(4) 448–69.

Shane, S. and Venkataraman, S. (2000), 'The promise of entrepreneurship as a field of research', *Academy of Management Review*, **25**(1): 217–26.
Shapero, A. (1975), 'The displaced, uncomfortable entrepreneur', *Psychology Today*, **7**: 83–9.
Sharma, S. (2000), 'Managerial interpretations and organizational context as predictors of corporate choice of environmental strategy', *Academy of Management Journal*, **43**(4): 681–97.
Shrivastava, P. (1994), 'Ecocentric leadership in the 21st century', *Leadership Quarterly*, **5**(3/4): 223–6.
Shuman, M. (1998), *Going Local: Creating Self-reliant Communities in a Global Age*, New York: Free Press.
Simpson, M., Taylor, N. and Baker, K. (2004), 'Environmental responsibility in SMEs: does it deliver competitive advantage?', *Business Strategy and the Environment*, **13**(3): 156–71.
Spence, M. (2007), 'PME et développement durable', in L.-J. Filion (ed.), *Direction et Gestion de PME Concepts et Cas*, Montréal, Qbc: ERPI, pp. 415–28.
Spence, M., Ben Boubaker Gherib, J. and Ondoua Biwolé, V. (2007), 'Développement durable et PME: Une étude exploratoire des déterminants de leur engagement', *Revue Internationale des PME*, **20**(3–4): Forthcoming.
Starik, M. and Rands, G. (1995), 'Weaving an integrated web: multilevel and multisystem perspective of ecologically sustainable organizations', *Academy of Management Review*, **20**(4): 908–36.
Stead, W.E., Stead, J.G. and Shemwell, D. (2002), 'Community sustainability comes from the Southern Appalachian region of the USA: the case of Johnson county, Tennessee', in S. Sharma and M. Starik (eds), *Research in Corporate Sustainability: The Evolving Theory and Practice of Organizations in the Natural Environment*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 61–84.
Stevenson, H.H. and Jarillo, J.C. (1990), 'A paradigm of entrepreneurship: entrepreneurial management', *Strategic Management Journal*, 11 (Summer): 11–28.
Tencati, A., Perrini, F. and Pogutz, S. (2004), 'New tools to foster corporate socially responsible behaviour', *Journal of Business Ethics*, **53**: 173–90.
Verstraete, T. and Fayolle, A. (2005), 'Paradigmes et entrepreneuriat', *Revue de l'Entrepreneuriat*, **4**(5): 33–52.
Verstraete, T. and Saporta, B. (2006), 'Création d'entreprises et entrepreneuriat', Les Éditions de l'ADREG, January.
Weeks, J. (2006), 'Take this product back and recycle it!', *In Business*, **28**(6): 12–15.
Weick, K.E. (1979), *The Social Psychology of Organizing*, 2nd edn, Reading, MA: Addison-Wesley, (1969 1st edition).
Wernerfelt, B. (1984), 'A resource-based view of the firm', *Strategic Management Journal*, **5**: 171–80.
Wolff, D. (2004), 'Le concept de développement durable: Entre logique de marché et attentes de la société civile', *Revue Sciences de Gestion*: *Direction et Gestion*, May–June, **39**(207): 119–32.

4. Exploration of business models for material efficiency services[1]

Minna Halme, Markku Anttonen and Mika Kuisma

Business enterprises are still not making the best possible use of the many opportunities for energy and material efficiency improvements although there is abundant research on eco-efficiency and growing recognition of the need to dematerialize the economy. More than a decade ago, Porter and van der Linde (1995) presented compelling evidence that efficient resource use can be a major competitive advantage for an enterprise. More efficient resource use not only reduces the environmental burden from industrial operations, but often translates into lower procurement and waste management costs as well (Hinterberger et al., 1997; von Weizsäcker et al., 1997; Schmidt-Bleek, 1998). From an ecological point of view, inefficient use of materials or energy causes pollution, destroys ecosystems and depletes natural resources. The imperative of saving natural resources and minimizing pollution by using them more efficiently in industrial production is acknowledged at both national and international levels. Several political measures have been planned and introduced to minimize environmental harm by steering manufacturing and other economic activity. For instance, both the European Union and the OECD are aiming to decouple economic growth and the use of natural resources (EU, 2002; OECD, 2002). The United Nations has also joined the quest for more efficient use of natural resources (UN, 2002).

There are a number of reasons why business enterprises are prevented from using their resource-saving potential to the full. First, quite a few enterprises lack the expertise to recognize other than the most obvious opportunities for material or energy saving. This is especially true for energy and support materials that do not lie in the organization's area of core competence. Negligent use of resources is frequently aggravated by the fact that in most firms, resource efficiency is not a high priority since constant improvements in extraction techniques have made resources ever more inexpensive. Second, even if enterprises do recognize opportunities for material or energy efficiency improvements, they do not necessarily act upon them. All too often and all too easily, there is a tendency not to make any improvements that would require investment even with relatively short payback periods or that would add to the workload of management or staff (Kontoniemi, 2004; Halme et al., 2005).

This situation opens up business opportunities for various service providers offering material or energy efficiency services. The basic idea is that the service provider takes over the efficiency improvement, and that compensation to the provider is tied to the cost savings achieved from that improvement. As distinct from other types of eco-efficient services, this is usually called a 'result-orientated service'. Compared to product-based or use-orientated services, for example, result-orientated services arguably hold the greatest promise in terms of eco-efficiency (Tukker, 2004).

Result-orientated services, however, are a relatively unconventional form of business and they are therefore not necessarily readily accepted in the market. Result-orientated services focus on fulfilling customers' needs, providing a well-lit or warm space, for example (Hockerts, 1999; Roy, 2000). They can include various forms of contracting, such as energy contracting, facility management, waste minimization services (Heiskanen and Jalas, 2003; Vine, 2005) or a chemicals management service (CMS) (CSP, 2004; OECD, 2004; Kortman et al., 2006). In essence, the aim of result-orientated services is to 'sell functional results'. This not only breaks with traditional economic thinking, but in some instances also creates difficulties with regard to some financial stipulations, as will be discussed later in this chapter (Heiskanen and Jalas, 2003; Bertoldi et al., 2005; Vine, 2005).

Eco-efficient products and services, which can help significantly to reduce the use of natural resources while still meeting people's needs, have attracted a lot of research and led to numerous innovations since the launch of the concept in the mid-1990s. However, despite the abundance of innovation and ideas, only a few eco-efficient products and services have made their way to the marketplace (Tukker, 2004). One of the reasons for the marginal market penetration of eco-efficient services is the slow rate of change in institutions and in ways of thinking. Another hindrance to the spreading of radical eco-efficiency improvements is that business models of eco-efficient services are fuzzy to many practitioners. The main focus has been on the technical design of eco-efficient services (Bleischwitz, 2003). The shortcomings in understanding the business perspective around eco-efficient services became apparent a couple of years ago, when it was widely recognized that one of the reasons for the failure of what seemed to be sound eco-service concepts was the lack of attention paid to the market viability of such services. Hence the term 'business model' has proliferated in the discussion on eco-efficient or sustainable services (Tukker, 2004; Mont et al., 2006).

However, while the business model terminology has now been widely adopted by those promoting and researching sustainable services, it is still very rarely that any explanation is offered as to what exactly it means (Tukker and van Halen, 2003); sometimes it is understood simply as a revenue model (Vercalsteren and Gerken, 2004) or in terms of flowcharts portraying 'service logistics' (Tempelman, 2004). This is not surprising because there is no established or comprehensive definition of the term 'business model' (Timmers, 1999; Wüstenhagen and Boehnke, 2007). However, if we are to gain a better understanding of the business opportunities of eco-efficient services, then some kind of conceptualization or framework for business models is called for.

This chapter introduces a conceptual framework for the analysis of different business models for eco-efficient services and applies the framework to material efficiency services. Three business models are outlined and their feasibility is studied from an empirical vantage point. In contrast to much of the previous research, special emphasis is laid on the financial aspects.

In this chapter we propose a conceptual framework that has its roots in the work of Normann and Ramirez (1994), Räsänen (2001) and Magretta (2002), and also draws on Hamel (2000). The proposed business model framework allows us to analyse the competitive advantage of the services, the customer benefits, the resources and capabilities of the service providers, and the financing arrangement. After presenting the framework, we apply it to the material efficiency services offered by outside service providers to client organizations. The actual material efficiency improvements made by individual companies within their own facilities thus fall outside the scope of our study. Likewise, we exclude services targeted for waste that has already accumulated. The feasibility of these business models is also assessed. The chapter ends with a brief review of the different means of promoting material efficiency in industry.

THE RESEARCH DESIGN

We were interested in looking into opportunities for material efficiency services in the paper and food industries. Most interviewees represented paper and food[2] branches, as the potential customers for material efficiency services. Beyond the demand, we sought to gain a better understanding of the potential supply of material efficiency services, as well as the necessary financial and regulatory mechanisms. For that purpose we interviewed representatives of four finance institutions, two waste management companies, four ESCOs (energy service companies), a seller of chemical products, a manufacturer of pine oil-based industrial washing chemicals as well as environmental policy makers and regulators. Altogether the empirical data consist of material collected in 61 thematic interviews and three focus group discussions organized in 2004 and 2005 (Appendix 4A).

In the paper industry we set out to explore the interest in and obstacles to using material-saving services by interviewing representatives of 10 different units at four corporations. In the food industry we focused on three companies: a meat processing company, a coffee roaster and a dairy firm. In addition to personal interviews, we organized three focus group discussions in order to elaborate on the design, the conditions of interest and the potential opportunities for the use of material-saving services. It soon became clear that it would make sense to focus on specific cases, because production processes and thereby the material efficiency instances in the food industry involve more variation than in the paper industry. The food industry cases were concerned with opportunities to: (i) reduce grease waste in food production, (ii) reduce gut waste in sausage production, (iii) prevent harmful coffee packaging waste (aluminium laminate) and (iv) prevent packaging waste by introducing reusable milk packaging (Kontoniemi, 2004; Halme et al., 2005).

Additional data were also sought from archival material on energy and chemicals management services from the United States and Europe. Moreover, data were obtained in the form of feedback from the research project's final seminar, which was attended by 40 industry representatives.

BUSINESS MODELS OF MATERIAL EFFICIENCY SERVICES

Structured assessment of business models for eco-efficient services would make it easier to establish why some models are successful in the market and others are not. As mentioned above, the whole idea of a 'business model' is quite commonsensical, but in order to provide a more solid foundation for systematic discussion about business models, we propose here a simple framework which captures most of the relevant aspects that determine the viability of a service concept in the market. The framework consists of four questions for probing the market viability of a service:

- what benefits can users or customers derive from the service (compared to more traditional ways and means of fulfilling their needs) – added value to the customer;
- what kind of competitive advantage does the sustainable service offer;

- what capabilities and other resources does the provider or the network of providers have; and
- how is the service financed (formation of the income flow)?

In this section we sketch three business models for material efficiency services:

- the MASCO[3] model;
- material efficiency as additional service; and
- material flow management service.

One can question whether the three business models proposed here are genuinely separate models or whether indeed some of them are variations of the same model. The logic applied is that when even one of the above factors (customer benefit, competitive advantage, capabilities or finance arrangements) is different, the focal business is different from that in the other models.

Moreover, we outline only business models which involve some untraditional element *vis-à-vis* the arrangement between supplier and user. It is possible that there are other prominent novel business models too, which were not identified under the auspices of this research project.

The MASCO Model

This is a business model that follows the ESCO concept (energy service company) as applied in the energy field. An enterprise specialized in material efficiency (MASCO, material service company) makes the material saving investment in the customer company and is compensated on the basis of the cost savings achieved.

A MASCO takes charge of the whole material efficiency project within the customer company. The service relationship often begins with a materials audit at the customer's premises. However, the customer may also bring in a MASCO to implement a material savings investment that it already has in mind, and in this case there is no need for an audit. In other words, the customer may specify the tasks it wants the service provider to carry out on its behalf. A MASCO project may comprise all or some of the following elements:

- site survey and preliminary evaluation;
- identification of possible material-saving and efficiency-improving actions;
- assessment of material and cost savings;

- acquisition of project financing;
- engineering, project design and specifications;
- procurement and installation of equipment;
- project management, commissioning and acceptance;
- final design and construction;
- operation and maintenance for the contract period; and
- measurement and verification of the savings results.

The MASCO will probably subcontract some or most of these tasks. In theory it could do everything itself, depending on its qualifications, but in practice it is unlikely that MASCOs will deliver all services in-house.

The customer benefit is that no financial or personnel resources are tied to the investment and project planning. The costs of the project will be covered by the savings achieved. The added value results from the tailored material efficiency solution and the improved production process. The competitive advantage comes from the financing model in which the customer company only pays for actual results. Compared to the traditional engineering or consulting business model in which the customer pays for hours worked, the MASCO model is more attractive for the customer. In addition, if a MASCO specializes in certain techniques or technologies, that has the potential to add to the cost efficiency of the business. In our food industry study, the respondents felt that one of the competitive advantages is that the same party is responsible for financing, implementation and maintenance. In this situation it is more likely that the investment (equipment) functions according to plan.

What competences and capabilities does a MASCO need? Its capabilities should include management and implementation of the basic functions of a material efficiency project. On the one hand, this means finding the best suppliers for various project parts and phases. Unlike energy services, materials and related technologies differ considerably between industries and therefore it is likely that material efficiency companies would specialize in certain branches of industry, or even in certain technologies or production lines within an industry. Another, often more challenging task is to secure the necessary financing. Judging by earlier ESCO experiences, this is likely to be a stumbling block for small MASCOs offering only material efficiency services. A MASCO should also have the ability to find customers and projects where a material efficiency investment can yield profits for both partners. For the time being this is not easy since potential customers are not yet familiar with the service.

The income flow consists of the annual service fee, which is tied to the savings achieved with the help of the investment. When the service period ends, all savings will benefit the client company. The challenge for the

MASCO is that it must be able to assess accurately the amount of future savings in advance and, furthermore, carry out the project in such a way that the projected savings actually materialize.

To give an example, the first MASCO project in Finland was conducted in 2004 at the Tako board mill in Tampere between M-real Ltd, a pulp and paper company and Inesco, an ESCO. The project aimed especially at increasing the efficiency of fibre recovery at Tako. The mill had been built up in several stages during many decades, making the process too complicated and ineffective. The management of waste fibre had also caused increasing waste management costs for the mill. As a result of this MASCO project, the production process at the mill was streamlined and simplified, more fibre could be recovered from the effluent flow for reuse as a raw material for board, waste management costs were cut and even the quality of the product was improved. Inesco invested in the fibre recovery equipment and Tako paid back this investment by means of the savings from the more efficient process. The total costs of the MASCO project were approximately one million euros and the payback time was 18 months (Viljakainen, 2004; Halme et al., 2005).

Material Efficiency as Additional Service

Some companies can offer material saving services in addition to their main service; examples include waste management firms, maintenance companies and equipment providers. This business model is grounded in the same premise as the model above: the provider takes charge of the material efficiency investment from financing to implementation throughout the investment period. The competitive advantage and the provider's competence, however, are composed differently.

Customer benefit shares some features in common with the MASCO model. The client does not need to tie up any resources in the investment in production efficiency. An additional benefit is that the client does not have to negotiate with new service providers. The fact that the service provider already has a relationship with the customer and therefore has a thorough knowledge of the customer's operations, or at least parts of them (for example, waste management, equipment or machinery), is the main competitive advantage. This means that the provider is often in the position to recognize opportunities for material savings. It emerged clearly in the interviews that clients prefer familiar providers for this kind of service. Transaction costs are lower in situations where the business partners know and trust each other. Project administration is also likely to be more efficient.

The competence component is also different from the MASCO model. In this concept, the service company can often take charge of a larger part of the project itself, which means it needs fewer subcontractors. For instance, a waste management company that is familiar with the customer's processes will know how much waste is accumulated in these processes, so it will probably also be able to plan and possibly implement process improvements. However, there still remains the challenge of providing the necessary funding. Equipment providers may be an exception here: because of the nature of their core business (sales of industrial equipment and machinery), they have more experience of offering financial arrangements for customers.

The income flow is formed in the same way as in the MASCO concept. The only difference is that the customer simultaneously pays the service provider for a basic service (for example, maintenance, waste management) according to the traditional model.

The growing interest in outsourcing non-core functions will probably lead to an increasing number of business partnerships. Already many major production units at industrial facilities have personnel who are employed by cleaning, waste management and technical service companies. This is a particularly useful model in situations where the service provider and the client company are in a development-orientated partnership.

Material efficiency services offer considerable new business potential for waste management companies. The trend and commitment in modern society to reducing waste volumes means that there is no long-term growth in sight for traditional waste treatment businesses, and it is crucial therefore that waste management companies find new business areas. However, starting up a business that in the short term appears deliberately to try to reduce the volume of current waste treatment business is a major challenge for the management logics of these companies (Phillips et al., 1998; Ligon and Votta, 2001). The trend, however, is inevitable. For instance, Upstream WM, a business unit of Waste Management Inc., offers a so-called 'resource management service'. The aim of the service is to reduce the costs and environmental effects of waste streams and, furthermore, continuous improvement of customers' operational processes. Its services include waste minimization programmes, cost follow-up and third-party management. Its personnel work on customers' sites. Upstream's compensation is based on its ability to achieve the customer's waste- and cost-reduction goals, not just the volume of waste handled (Upstream, 2006). There are also other waste management companies whose services resemble those of Upstream, but not all of them explicitly conceptualize their services as resource management services.

Management Service for Material Flows

The third business model, 'management service for material flows', is distinctively different from the two previous ones, and it also has more practical applications, many of which are in the category of chemical materials and some in the field of the so-called 'resource management'. In this model, a service provider takes over the management of a certain materials group, for example, chemicals. In other words, its business is not based on a one-off material saving investment, but on a long-term partnership with the customer. This kind of service will typically cover 'support materials' in which the client organization does not have strong expertise. There are many instances where a professional service provider can be more effective in the management of support materials. The model can be applied not only to chemicals, but to other material groups as well. Resource management (Ligon et al., 2000; Ligon and Votta, 2001; EPA, 2006) is based on a similar idea: in this concept the aim is to align the relationship between service provider and the customer such that they both have incentives to move from traditional hauling and disposal contracts towards increased prevention and to decouple service providers' income from the quantity of the handled waste (Ligon and Votta, 2001; OECD, 2004).

The customer benefit results from a more professional operator taking control of part of the production process which is not core business for the client organization. For instance, chemicals are crucial to the operation of air carriers and other transport companies, but they are not an immediate part of their production and therefore not core business. The service provider can take over a more limited or extensive set of responsibilities: buying the chemicals, handling them throughout the production process, storing and reporting, together with environmental and health and safety responsibilities (Jakl et al., 2004). In the most extensive service, the 'shared savings relationship', the service provider may even participate in production planning (Bierma and Waterstraat, 2000; Reiskin et al., 2000; Stoughton and Votta, 2003).

Competitive advantage results from a more efficient organization of the production process. A CMS can help to increase process efficiency by combining orders, replacing more expensive chemicals with cheaper alternatives, and streamlining internal logistics. This is possible because the service provider has more competences and capabilities in the material (for example, chemicals) and the processing of that material. In the short term, benefits usually accrue from centralized purchasing, better stock management and diminished waste management costs. According to CSP (2004), the first-year cost saving ranges from 5 to 25 per cent. In the longer term, savings tend to vary from 30 to 80 per cent compared to the starting-point. Corbett and Decroix (2001) argue that long-term partnerships usually offer the greatest benefits to the service provider and user (see also Ligon and Votta, 2001). For instance, long-term benefits from better maintenance and operation of manufacturing machinery can generate savings by diminished downtime. However, some perceive that savings are highest during the first years of service period, and become more even during the later years.[4] Developing and maintaining such relationships requires particular capabilities on the part of the service provider, especially when it has multiple competing customers in the same branch of the industry (Corbett and Decroix, 2001).

The conceptual roots of material flow management lie in the broader concept of performance-based contracting, within which the service provider offers efficiency services and gains revenues from the cost savings generated by optimized processes and reduced material consumption and waste (Ligon et al., 2000). The customer company pays for the performance, not for the chemicals purchased or waste accumulated. Cost savings are the basis of the income flow to the service provider. In chemicals management, savings accrue because the cost of chemicals not only consists of their purchase price, but there are also various other expenses related to different parts of the chemicals' life cycle, such as handling, storage and waste treatment. It has been estimated that for every dollar spent on purchasing chemicals, an extra one to ten dollars has to be spent on these additional 'hidden' costs (Oldham and Votta, 2003; CSP, 2006).

The spectrum of CMSs is varied. We have identified four crude CMS types, but these are by no means definitive (Anttonen et al., 2006). First, some companies seem to concentrate on the supply side by purchasing chemicals, taking care of deliveries, reporting and subcontracting waste management. Examples are Swedish-based AGA (part of the Linde Group), which offers CMSs in the Nordic countries, and US-based Avchem. The second type are companies that concentrate more on managing chemicals, especially fluids such as coolants, cutting fluids or cleaners in customers' processes. Castrol is a good example of these kinds of services. Third, we can distinguish companies that offer mainly information and communications technology (ICT)-based solutions for chemicals management including e-procurement, chemicals tracking and labelling, Material Safety Data Sheets (MSDSs) and so on. US-based Chemical Safety is an example of this kind of service provision. Fourth, some companies such as BASF have a kind of hybrid approach to CMSs. BASF offers a wide variety of services from consulting to technical or legislative support to the customer.

This classification should be interpreted as indicative. A large number of chemicals management companies offer both supply and process management services, including ICT-based solutions.

It is possible to combine a MASCO investment element to a material flow management service. For instance, Kemira Industrial and Environmental Services (KIES), a business unit of the Kemira Corporation, offers a CMS for waste-water treatment plants. It takes over the treatment of customers' waste water with the aim of reducing waste and preventing waste streams to landfill. The primary aim is to make customers' processes more material efficient by internal optimization, reuse and recycling. When that is not possible, KIES seeks to find new uses and customers for such waste material. This is made possible through Kemira's considerable R&D capabilities, as well as the large customer base of the corporation. KIES builds industrial ecology-type geographically limited networks of waste-accumulating facilities and the facilities that use the respective waste fragment in their process. It can also invest in equipment installed in customers' facilities. As in the MASCO model, the pay-back of the investment accrues from the material savings resulting from the investment. However, the customer pays it as part of the service fee. Unlike the MASCO model, the investment is only a supportive element, and is not central to the business model. Table 4.1 summarizes the various business models.

Note that the above business models are suited to situations where considerable savings can be expected, and where for financial or other reasons it makes sense to contract out the management of the efficiency improvements to a service provider. Yet there are many instances where an ordinary consultancy service paid by the hour is a more appropriate solution. If no substantial savings are anticipated, but other reasons such as regulatory pressure or image benefit speak to a material efficiency improvement, and the firm's own personnel are not in a position to do the job, material efficiency consultancy may be a better option.

FINANCING CHALLENGES AND FEASIBILITY

Are the above models feasible in practice? We address this question by looking at the financing aspect in material efficiency services and the instances for which the various business models are best suited.

Financing Challenges

The financing challenges related to material efficiency depend on the business model. In the MASCO and 'material saving as additional service' models, the (main) challenge is usually related to finding the necessary initial funding, because the model involves a substantial early investment. The 'management service for material flows' model, on the other hand, does not involve any up-front investment. The financial challenges centre around determining the service company's compensation.

Table 4.1 Summary of business models for material efficiency services

	MASCO	Material efficiency as additional service	Management service for material flows
How does the customer benefit from the service?	Does not tie up client's funds or (operational) resources (e.g., time of personnel)	Does not tie up client's funds or (operational) resources	Outsourcing non-core operations to a specialist firm
What is the competitive advantage of the service?	Financing model: customer pays only for results; cost efficiency	Existing contact between provider and customer: trust and low transaction costs	More efficient organization of operations
What capabilities does the service provider have?	Arranging financing, finding suitable know-how (subcontractors), finding customers on a regular basis	Knowledge of client's processes or part of them, e.g., waste management or maintenance of machinery	Profound knowledge of a material(s) and its (their) processing
How is the service financed (income flow)?	From the savings gained from the material efficiency investment	From the savings gained from the investment, but client simultaneously pays fees for other services	Charges are based on results instead of paying for material amounts
What kind of instances is the business model suited for?	Large, one-off projects	Material efficiency improvements that complement the provider's service (equipment provider, waste management company, maintenance provider)	Long-term strategic partnerships, e.g., CMS

Finance questions in investment-based material efficiency services (includes the MASCO and 'material efficiency as additional service' models)

To begin with the financing of investment-based material saving services, we can draw some inferences from the energy service business where there are three broad financing options: the energy efficiency project is funded by the ESCO, by the customer or by a third party. If these funding options are applied to material saving agreements, the financing options could be as follows (see Bertoldi et al., 2006).

In MASCO financing, the investment would be financed by the MASCO's own internal funds. Lack of own funds would limit the MASCO's capability to implement projects on a continuous basis. The second alternative is customer financing, backed by a material savings guarantee provided by the MASCO. Third-party financing refers solely to debt financing from a third party, such as a finance institution. Either the finance institution may assume the rights to the material savings or it may take a security interest in the project equipment. The money is borrowed either by the MASCO or by the client. If the customer takes out a loan from a finance institution, it is backed by a (material) savings guarantee by the MASCO. The purpose of the savings guarantee is to demonstrate to the bank that the project for which the customer is taking out the loan will generate savings that cover the debt repayment. In other words, the guarantee trims the bank's perception of risk, which in turn will have implications for the interest rates. The 'cost of borrowing' is very much influenced by the size and credit history of the borrower. Small and/or undercapitalized MASCOs that cannot borrow significant amounts of money (from the financial market) cannot finance material efficiency investments (see Parviainen, 2004; Halme et al., 2005; Bertoldi et al., 2006).

The two major performance contracting models used in energy service contracts are guaranteed savings and shared savings (NAESCO, 2006). To continue with the energy field analogy, under a shared savings contract the cost savings are split for a predetermined length of time. In a shared savings arrangement a MASCO would assume responsibility for financing, either with its own funds or by taking out a loan. According to Bertoldi et al. (2006) the shared savings concept is a good introductory model in markets where energy (or material) saving services are still at the early stages of development because customers assume no financial risk.[5] However, this model does tend to create barriers for small companies; it could be expected that small MASCOs implementing projects based on shared savings might rapidly become too highly leveraged and unable to contract further debts for subsequent projects (Bertoldi et al., 2006).

A guaranteed savings contract is a scheme whereby the MASCO guarantees a certain level of material savings and in this way shields the customer from any performance risk. It arranges the necessary funding, but, technically speaking, customers are financed directly by a bank or financing institution; they repay the loan and the credit risk remains with the lender (ibid.). The guaranteed savings scheme has been applied in energy saving contracts. In the United States, for instance, 90 per cent of ESCO projects are financed under a guaranteed savings arrangement (Hansen, 2002). However the guaranteed savings model is usually considered less appropriate for markets where ESCO (or MASCO) business is newly developing. If the customer's own funds are tied to the investment, many will find the service less attractive, and consequently the market penetration of ESCO (or MASCO) business will probably be slower (Parviainen, 2004). Guaranteed savings contracting is probably a viable solution only in countries with an established banking structure, where there is high familiarity with project financing, and where there is sufficient technical expertise, even within the banking sector, to understand energy efficiency (or material efficiency) projects (Vine, 2005; Bertoldi et al., 2006).

Finance questions in the 'management service for material flows' model

In this model, financing is a less complicated issue, but none the less challenging enough, especially in the most extensive service relationships. To take chemicals management as an example, service use usually begins with simple additional services such as concentrating the procurement or provision of environmental data for compliance and reporting. In limited chemicals management programmes, the fee structure usually includes a dollar or euro per kilo fee plus services and management fees (Bierma and Waterstraat, 2000).

In the most advanced CMS, a shared savings relationship, the provider and customer align their financial interests to reduce the overall chemical volume. In this model the chemical user no longer buys the chemicals, that is, the payment to the supplier is not tied to the chemical volume. Instead, the supplier receives a fee in exchange for meeting certain performance expectations. Within a shared savings business model there are different ways of determining the compensation: fixed fees, unit pricing and gainsharing. Under a fixed fee structure, suppliers are typically paid a fixed monthly fee, against which the supplier agrees to meet certain performance expectations negotiated for the plant. The monthly fee is usually determined by historical chemical costs. The supplier can increase its profits by decreasing chemical volumes. Ultimately, some of these savings must be shared with the chemical user so that both parties have an incentive to pursue cost reductions (Bierma and Waterstraat, 1999, 2000).

A unit price is a fee paid to the service provider for every unit of product produced by the chemical user. For example, the supplier might be paid five euros for each car or washing machine produced by the plant. If a gainsharing agreement is applied, the cost savings will be shared between the service provider and the user. Succeeding in unit pricing and shared savings contracts requires that the baseline (production costs, materials, quality of finished products, liabilities and so on) is thoroughly defined by the customer and the service provider together. That is the only way to ensure that the performance expectations can be defined and met. Should a supplier's idea or innovation generate savings for the buyer, those savings are divided between both parties. This strengthens the alignment of the buyer's and supplier's financial interests. Because gainsharing can be extended to any savings, including those unrelated to chemicals, it increases the potential benefits of the service relationship. It is typical of this arrangement that if financial losses accrue, they too should be divided between the service provider and user (CSP, 2004).

Feasibility of the Business Models

The idea of material efficiency services is still very much in its infancy. At this early stage, we believe that the most viable business models are 'material efficiency as additional service' and 'management service for material flows'. The former requires an initial investment – usually a considerable one – and the service provider should be able to arrange the necessary financing. Reliability and credibility in the eyes of financing institutions are therefore crucial to the whole service concept. Companies that will probably be seen as reliable include equipment providers, waste management companies (some of which already call themselves environmental service companies) or ESCOs with good solidity and a track record in energy services (upper right-hand corner in Figure 4.1). Start-up MASCOs, on the other hand, will probably have difficulties as long as material efficiency services remain unknown among financing institutions (lower left-hand

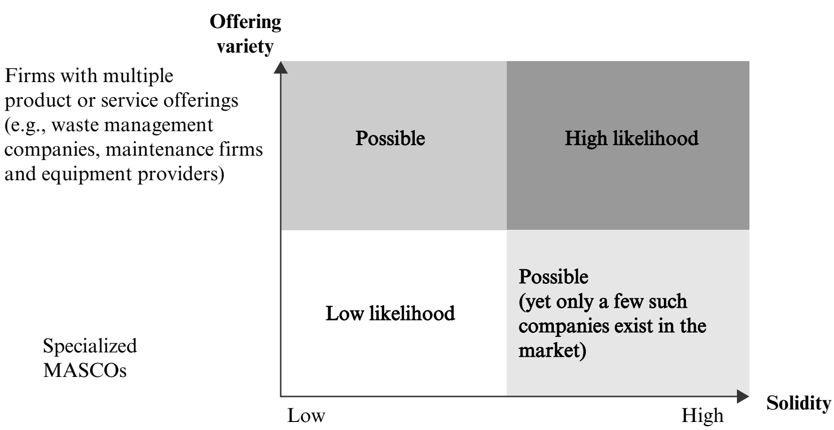


Figure 4.1 Likelihood of enterprise types offering investment-based material efficiency services

corner in Figure 4.1) (Halme et al., 2005; see also Vine, 2005; Bertoldi et al., 2006). If these services become better known in the future, it is possible that specialized MASCOs will enter the market as well. Figure 4.1 describes the propensity of various types of enterprises to offer investment-based material efficiency services.

Our empirical evidence about customer preferences indicates that there are certain preconditions for investment-based material efficiency services. One factor that needs to be taken into account is that materials and technologies differ considerably between different industries. For instance, in the paper industry material efficiency can be improved by recovering raw material for reuse in the process, whereas in the food industry this is not possible for reasons of hygiene. The implication is that some industries may lend themselves more readily to investment-based material efficiency services. For example, one of the prerequisites for the economic viability of such services is that the investment is technically easy enough to conduct with relatively little variation across multiple facilities. This is preferable for at least two reasons. First, excessive resources should not be devoted to planning the investment in order to keep the costs manageable. Perhaps more importantly, the technology should be known and the solutions reliable so that the service provider (MASCO) can accurately assess the savings and not run the risk of negative returns.

Second, the willingness of potential client companies to use the service appears to depend on their size and solidity. For example, most of the paper industry companies interviewed were large corporations with a solid financial situation and strong in-house engineering expertise. Except for material audits, they did not feel that there was a need for efficiency services. The food industry representatives, on the other hand, showed a keen interest in the whole palette of a MASCO's services. However, despite these differences, the empirical data allow us to identify some general conditions under which the MASCO and the 'material efficiency as additional service' models appear to be most suitable (Halme et al., 2005):

- the potential for economic savings from the material efficiency investment is sufficiently high;
- the investment is so big that the customer company feels that planning and implementation is too difficult or time-consuming;
- the payback period is more than three years; and
- the project focuses on a sidestream of production rather than on the customer's core business.

If there is only minor potential for economic savings, and if there is no other incentive such as regulatory pressure or an image benefit, the reward will appear too insignificant for client companies to engage in a project. Another point mentioned by the interviewees in favour of using the services of a MASCO was the extent of the investment: if it is so big that the client considers planning and implementation to be too complicated or time-consuming, then the service alternative becomes more attractive. Payback time is yet another determinant. Not surprisingly, the empirical evidence suggests that companies are more willing to use their own funds when the investment has a short payback period. Three years was typically considered as the watershed. Finally, organizations prefer to keep core products or business lines under their own control. Sidestreams or support materials are more easily trusted to outsiders. Material efficiency services are particularly suitable for those instances because even economically profitable investments may be ignored year after year, while funds are used for core business improvements.

As for the management of material flows, that is a service that can be offered for instance by chemical suppliers who despite being engaged in chemicals production can see a business opportunity in services aimed at reducing the use of chemicals. In the United States, approximately 75 per cent of CMS providers represent this type (CSP, 2004). Hazardous waste management companies can also develop new business out of material efficiency services aimed at reducing the production of hazardous waste. In both types of firms a dramatic change is needed in ways of thinking because the income flow would no longer be based on the amount of chemicals sold or waste treated, but on the service that supports customers' production processes. One solution is to set up a subsidiary, but some problems may still remain. According to CSP (ibid.), subsidiaries tend to push their own products to service users even if a competitor's product was cheaper or more appropriate. This problem is less likely to emerge if the service is provided by a separate firm operating in a different field from the service (for example, AGA Gas of the Linde Gas corporation, a gas company offering CMS; AGA Gas, 2006), or if the service provider is an engineering firm or consultancy without its own production.

To sum up, the firms that can be expected to offer material flow management services are:

- great likelihood: chemical producers (offer CMSs) or waste management companies (offer resource management services);
- average likelihood: engineering or consultancy firms specialized in management of certain material group (usually chemicals); and
- low likelihood: production firms that do not have own production of the material group for which the service is offered (for example, AGA Gas offers a CMS).

There might be a mismatch between the supply and demand sides. As mentioned earlier, large corporations with good solidity and strong in-house expertise are not that keen to use material efficiency services, whereas smaller or medium-sized enterprises see more benefits in these services. The study by Mont et al. (2006) on CMSs, on the other hand, indicates that CMS providers seek large customers because of economic feasibility. Consequently, the large potential clients that are preferred by providers tend to have in-house expertise, whereas small and medium-sized clients needing these services are not considered to be a lucrative prospect by providers.

CONCLUSIONS AND IMPLICATIONS FOR THE FUTURE

In addition to a reduced environmental burden and cost savings, material efficiency services can offer new business for environmental service companies. The latter is particularly important in many Western (European) countries which are seeking to create new job opportunities in the service sector in order to compensate for the steady decline in industrial employment. Over and above skilled employment, industrial services offer a long-term source of competitive advantage. This is because they are less tangible and more dependent on competences and thus much more difficult for competitors to imitate (Economist, 2000; Oliva and Kallenberg, 2003). A recent global study also shows that profitability of business-to-business services is up to 75 per cent better than that of manufacturing operations (Deloitte, 2006). Moreover, if first developed domestically, environmental service businesses may in time evolve into a new type of industrial expertise for export (Ekins, 2005). Despite its benefits, the business of selling 'functional utility' is not common in current business thinking. Therefore the alternative business models need to be carefully scrutinized so as to increase knowledge and awareness about them.

The conceptual framework introduced in this chapter for the purpose of analysing different business models of eco-efficient services comprises the competitive advantage of these services, the customer benefits, the resources and capabilities of the service providers, and the financing arrangements. Applying this framework, we identified three business models for result-orientated material efficiency services: the MASCO model, the material efficiency as additional service model and the material flow management service model. In the MASCO model, an enterprise specializing in material efficiency makes the material saving investment in the customer company and is compensated according to the savings achieved.

The additional service model is essentially the same, but the service provider and user have an existing business relationship, typically in the field of maintenance, waste management, or equipment provision. The provider takes charge of a material efficiency investment from financing to implementation throughout the investment period. Apart from the fees for the ordinary service, the provider is compensated on the basis of the cost savings achieved through the investment. The third model differs from the first two with respect to the investment. Here the service provider takes over the management of a certain materials group, such as chemicals. In other words, the customer company outsources the management of a material flow to a service provider, and the compensation can be tied to an agreed result measuring the outcomes of the client's facility, for example, the number of coated washing machines. It is also possible for service providers to combine two business models, that is, the service provider that takes charge of the management of the material flow could also offer a financing service for material efficiency investments. Depending on the business model, prominent material efficiency service providers differ from large companies that offer multiple products and/or services to smaller, specialized providers.

Potential clients typically lack the resources (expertise, management's time or initial funds) to conduct material efficiency improvements themselves. The competitive advantage of these services relates to the increased efficiency that is achieved from the handing over of an activity to a professional operator. Regardless of the business model, enterprises seemed to be more willing to use material efficiency services for sidestream materials than for core business operations. That said, it should be emphasized that not all manufacturers necessarily benefit from these services.

Companies with abundant funds of their own and/or in-house expertise in materials efficiency improvements, may be best off going it alone. Potential client organizations with a strategy of outsourcing support activities and with experience of outsourcing are keener to use material efficiency services. If the organization has experience of outsourcing more straightforward functions such as cleaning or catering, it will more readily outsource more complex activities as well. This experience is needed because even if the materials that need to be serviced are support materials, they are still usually closely interwoven in productive operations and their management requires a certain level of professional skill.

Service providers should possess strong expertise and know-how in the materials concerned and related technologies. In the case of investment-type services, they must also be capable of arranging the necessary financing and recruiting a network of cooperators to whom to subcontract various parts of the investment process. Which firms, then, are most realistically able to offer material efficiency services? Here we must make a distinction between investment-based services and those for the management of material flows. Investment-based services are most likely to be offered by firms that have an existing business relationship with the client, such as waste management companies. These firms should be viewed by financing institutions as reliable partners so that they can arrange the necessary funding for the investment. Second, ESCOs can also extend their business to a MASCO. If and when the business becomes more commonplace, it is likely that enterprises will emerge that specialize exclusively in material efficiency investment projects. For the time being small, specialized MASCOs do not enjoy sufficient credibility among financiers, and they usually do not have enough funds of their own to invest in projects on a continuous basis. Material flow management services are most typical in chemicals management. Most of the providers are subsidiaries of major chemical companies, whereas the remaining one-quarter are smaller service providers without their own production (CSP, 2004).

What is the point of exploring all these options in one study rather than concentrating on one of them, say, chemicals management services? By putting all the various material efficiency services in one picture, we should be able to gain a fuller understanding of the ways and means of introducing material efficiency to enterprises through external agents. Different types of customers need different types of services. It goes without saying that cooperation is more intense and deeper in material flow management services than in investment projects. The latter are one-off projects and have a fixed end point, whereas in the former case an employee working for the provider will usually be assigned to work at the client's site and the service relationship will run on a continuous basis, that is, it is not usually projected to finish at a certain point in time. Sometimes it may be a more attractive option to allocate one single efficiency project to an outside provider rather than to outsource the management of an entire material.

Since the models represent new ways of doing business, there are a number of organizational and institutional aspects that ought to be taken into account. With regard to the organizational aspects, the service provider has to convince its potential customers that the efficiency measures will be profitable, that it is capable of handling the technological solutions and that it is capable of managing extensive projects that are (usually) closely interwoven with the customer's production or operational process. The client organization, for its part, has to sell the idea of the innovative service at many organizational levels. Here attitudes, experiences and contacts between people and organizations are of crucial importance.

What about the future of these services? In spite of the economic and ecological benefits foreseen, some mechanisms of promotion would certainly boost the demand for these services and help them move on from the initial stage. These mechanisms can range from well-designed legislation and regulation to a variety of voluntary measures (Halme et al., 2005). The new European chemicals regulation REACH is likely to accelerate the emergence of material efficiency services in Europe. Other means that could be utilized are environmental permits and Best Available Technology (BAT) reference documents under the EU's Integrated Pollution Prevention Control (IPPC) Directive; government grants for material efficiency projects; and the promotion of material efficiency in public procurement and the imposition of environmental taxes on selected materials (see Ekins, 2005). Voluntary agreements, when properly designed, have also proved a useful way to promote both energy and material efficiency (Kautto et al., 2000; Delmas and Terlaak, 2001; ten Brink, 2002; Bressers and de Bruijn, 2005; Hardgroves and Smith, 2005). Access to data on material use at industrial sites would facilitate efficiency comparisons between different sectors and encourage lower performers to make improvements. In Denmark and Finland there are experiments where the public authorities provide benchmarks by gathering data on raw material use and waste creation at industrial sites and by making these data publicly available (Danish EPA, 2003; Jokinen, 2005; YTV, 2006). In order to promote material efficiency in industry, in 2007 the Finnish government established a material savings unit within the Centre for Energy Conservation (Motiva). The material unit's tasks consist of multiple measures such as assistance in material savings auditing, communication about state-of-the-art information and experience in the field, and development of new policy tools with which to advance material efficiency in the industry.

The approach presented here, material efficiency services, needs to be coupled with other measures such as innovation of novel environmentally benign materials, as well as legislation and economic instruments supporting material efficiency. The attraction of this solution lies in the fact that it could be aligned with the economic interests of business enterprises, which largely depends on whether the intake of materials in the economy can be reduced.

NOTES

1. An earlier version of this chapter was presented at the Greening of the Industry conference, Cardiff, Wales, 2–5 July 2006 and a version based on similar concepts and data is published in *Ecological Economics*, doi:10.1016/j.ecolecon.2006.10.003.
2. In connection with opportunities for material efficiency services for the food sector, we also investigated food retailing and interviewed representatives from the largest retailing chain, KESKO, in Finland.

3. The acronym MASCO stands for 'Material Service Company'. It will be explained in more detail in the coming sections.
4. Stated by Tom Votta and Jill Kaufmann Johnson of Chemical Strategies Partnership in an interview for the material efficiency services project which is the background for this chapter, San Francisco, USA, 30 October 2006.
5. See http://energyefficiency.jrc.cec.eu.int/esco_energy_performance.htm.

REFERENCES

AGA Gas (2006), SISOURCE® chemical management services, www.aga.se/international/web/lg/se/likelgagase.nsf/docbyalias/newbusiness_sisource, 10 February 2006.

Anttonen, M., Kuisma, M. and Halme, M. (2006), 'Materiaalitehokkuutta edistävistä palveluista ympäristömyötäistä liiketoimintaa ja asiakaskumppanuuksia (MASCO2)' (in Finnish) (Green business and partnerships through materials efficiency services, an intermediate report for MASCO2-project), www.hse.fi/MASCO.

Bertoldi, P., Rezessy, S. and Vine, E. (2006), 'Energy service companies in European countries: current status and a strategy to foster their development', *Energy Policy*, **34**(14): 1818–32.

Bierma, T. and Waterstraat, F. (1999), 'Cleaner production from chemical suppliers: understanding shared savings contract', *Journal of Cleaner Production*, **7**: 145–58.

Bierma, T. and Waterstraat F. (2000), *Chemical Management: Reducing Waste and Cost through Innovative Supply Strategies*, John Wiley & Sons, New York.

Bleischwitz, R. (2003), 'Cognitive and institutional perspectives of eco-efficiency', *Ecological Economics*, **46**: 453–67.

Bressers, H. and de Bruijn, T. (2005), 'Conditions for the success of negotiated agreements; partnerships for environmental improvement in the Netherlands', *Business Strategy and the Environment*, **14**: 241–54.

Corbett, C.J. and DeCroix, G.A. (2001), 'Shared-savings contracts for indirect materials in supply chains: channel profits and environmental impacts', *Management Science* **47**: 881–93.

CSP (2004), 'Chemical management services', Industry Report 2004, Chemical Strategies Partnership, San Francisco.

CSP (2006), 'What is CMS?', Chemical Strategies Partnership, San Francisco, www.chemicalstrategies.org/mission_and_goals.htm, 10 February 2006.

Danish EPA (2003), 'The Danish green accounts: experiences and internal effects', Danish Environmental Protection Agency, www.mst.dk/indu/05050000.htm, 21 February 2006.

Delmas, M. and Terlaak, A. (2001), 'A framework for analyzing environmental voluntary agreements', *California Management Review*, **43**: 44–63.

Deloitte (2006), 'The service revolution in global manufacturing industries', *Deloitte Research*: 24.

Economist (2000), 'In search of Fiat's soul', *The Economist*: 69–70.

Ekins, P. (2005), 'Eco-efficiency: motives, drivers, and economic implications', *Journal of Industrial Ecology*, **9**: 12–14.

EPA (2006), 'WasteWise resource management: innovative solid waste contracting methods', Environmental Protection Agency, Washington, DC, www.epa.gov/epaoswer/non-hw/reduce/wstewise/wrr/rm.htm, 15 February 2006.

European Union (EU) (2002), Decision No. 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme, http://europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&type_doc=Decision&an_doc=2002&nu_doc=1600&lg=en, 21 February 2006.

Halme, M., Heino, E., Anttonen, M., Kuisma, M. and Kontoniemi, N. (2005), *Materiaalinsäästöpalveluista liiketoimintaa – Kohti jätteiden synnyn ehkäisyä* (Generating business out of material efficiency services – towards source prevention), Suomen Ympäristö 767, Edita, Helsinki.

Hamel, G. (2000), *Leading the Revolution*, Harvard Business School Press, Boston, MA.

Hansen, S. (2002), *Manual for Intelligent Energy Services*, Marcel Dekker, New York.

Hardgroves, K. and Smith, M. (eds) (2005), *The Natural Advantage of Nations: Business Opportunities, Innovation and Governance in the 21st Century*, Earthscan, London.

Heiskanen, E. and Jalas, M. (2003), 'Can services lead to radical eco-efficiency improvements? A review of the debate and evidence', *Corporate Social Responsibility and Environmental Management*, **10**: 186–98.

Hinterberger, F., Luks, F. and Schmidt-Bleek, F. (1997), 'Material flows vs. "natural capital": what makes an economy sustainable?', *Ecological Economics*, **23**: 1–14.

Hockerts, K. (1999), 'Innovation of eco-efficient services: increasing the efficiency of products and services', in M. Charter and J. Polonsky (eds), *Greener Marketing: A Global Perspective on Greening Marketing Practice*, Greenleaf, Sheffield, pp. 95–107.

Jakl, T., Joas, R., Nolte, R., Schott, R. and Windsperger, A. (2004), *Chemical Leasing: An Intelligent and Integrated Business Model with a View to Sustainable Development in Materials Management*, Springer Verlag, Vienna.

Jokinen, V. (2005), 'Pääkaupunkiseudun palvelujen sekajätteen määrä. Toimistot, sairaalat, koulut, ravintolat ja hotellit sekä kaupat' (Mixed waste generated by service industries in the Helsinki metropolitan area: offices, hospitals, schools, restaurants, hotels and grocery shops), Pääkaupunkiseudun julkaisusarja C 2005:1, www.ytv.fi/FIN/tietoa_ytv/julkaisusarja/2005/, 20 February 2006.

Kautto, P., Melanen, M., Saarikoski, H., Ilomäki, M. and Yli-Kauppila, H. (2000), 'Suomen jätepolitiikan ohjauskeinot – vaikutukset, vaikuttavuus ja kehittämistarpeet' (Waste policy instruments in Finland – effects, effectiveness and development needs), Suomen ympäristö 430, Ympäristöministeriö, Helsinki.

Kontoniemi, N. (2004), 'Materiaalinsäästöpalvelun mahdollisuudet elintarviketeollisuudessa' (Material saving services as business in the food industry), Master's thesis, Helsinki School of Economics.

Kortman, J., Theodori, D., van Ewijk, H., La Roca, F., Ferrer, G., Esteve, E. and Gench, C.-O. (2006), 'Chemical product-services in the European Union', Final report, European Commission Joint Research Centre, Institute for Prospective Technology Studies, Technical Report Series, EUR 22213 EN, http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1389.

Ligon, P., Mishra, P.N. and Votta, T. (2000), 'New paradigm for disposal contracts: waste service providers become resource managers', *BioCycle: Journal of Composting and Organics Recycling*, April: 51–2, http://www.jgpress.com/BCArticles/2000/040051B.html.

Ligon, P. and Votta, T. (2001), 'Strategic contracting increases waste prevention and materials recycling', *Resource Recycling: North America's Recycling and Composting Journal*, March 1–4, http://www.epa.gov/epaoswer/non-hw/reduce/wstewise/pubs/rr_rm.pdf.

Magretta, J. (2002), 'Why business models matter?', *Harvard Business Review*, **80**(5): 86–92.

Mont, O., Dalhammar, C. and Jakobsson, N. (2006), 'A new business model for baby prams based on leasing and product remanufacturing', *Journal of Cleaner Production*, **14**: 1509–18.

Mont, O., Singhal, P. and Fadeeva, Z. (2006), 'Chemical management services in Sweden and Europe – lesson for the future', *Journal of Industrial Ecology*, **10**(1–2): 279–92.

NAESCO (2006), 'What is an ESCO?', National Association of Energy Service Companies, Washington, DC, www.naesco.org/about/esco.htm, 15 February 2006.

Normann, R. and Ramirez, R. (1994), *Designing Interactive Strategy: From Value Chain to Value Constellation*, John Wiley & Sons, Chichester.

Oldham, J. and Votta, T. (2003), 'Chemical management services – greening the supply chain', *Greener Management International*, **41**: 89–100.

Oliva, R. and Kallenberg, R. (2003), 'Managing the transition from products to services', *International Journal of Service Industry Management*, **14**(2): 160–72.

Organization for Economic Security and Development (OECD) (2002), *Working Together towards Sustainable Development: The OECD Experience*, OECD, Paris.

Organization for Economic Security and Development (OECD) (2004), *Strategies in Chemicals Industry and Related Areas*, OECD Environment, Health and Safety Publications, Series on Risk Management No. 17, OECD, Paris.

Parviainen, J. (2004), 'Energiansäästöpalveluiden rahoitukselliset ratkaisut ja niiden hyödynnettävyys materiaalinsäästöpalvelu-liiketoiminnan kannalta' (Finance solutions for energy efficiency services and their applicability in materials efficiency business), Master's thesis, Helsinki School of Economics.

Phillips, P.S., Gronow, B. and Read, A.D. (1998), 'A regional perspective on waste minimisation: a case study of the East Midlands of England', *Resources, Conservation and Recycling*, **23**: 127–61.

Porter, M. and van der Linde, C. (1995), 'Green and competitive: breaking the stalemate', *Harvard Business Review*, **73**(5): 120–34.

Räsänen, K. (2001), *Kehittyvä liiketoiminta: Haaste tulevaisuuden osaajille* (Business in development: challenging capabilities), Weilin & Göös, Helsinki.

Reiskin, E., Kauffman Johnson, J. and Votta, T. (2000), 'Servicizing the chemical supply chain', *Journal of Industrial Ecology*, **3**: 19–31.

Roy, R. (2000), 'Sustainable product-service systems', *Futures*, **32**: 289–99.

Schmidt-Bleek, F. (1998), *Das MIPS-Konzept. Weniger Naturverbrauch – mehr Lebensqualität durch Faktor 10*, (Factor 10: Making sustainability accountable. Putting resource productivity into practice), (in Finnish: Luonnon uusi laskuoppi: Ekotehokkuuden mittari MIPS), Gaudeamus, Helsinki.

Stoughton, M. and Votta, T. (2003), 'Implementing service-based chemical procurement: lessons and results', *Journal of Cleaner Production*, **11**: 839–49.

Tempelman, E. (ed.) (2004), 'SusProNet Report. PSS for Need Area Food: An Overview', www.suspronet.org/fs_reports.htm.

ten Brink, P. (ed.) (2002), *Voluntary Environmental Agreements: Process, Practice and Future Use*, Greenleaf, Sheffield.

Timmers, P. (1999), *Electronic Commerce: Strategies and Models for Business-to-Business Trading*, John Wiley & Sons, Chichester.

Tukker, A. (2004), 'Eight types of product-service system: eight ways to sustainability? Experiences from SusProNet', *Business Strategy and the Environment*, **13**: 246–60.

Tukker, A. and van Halen, C. (2003), 'Innovation scan for product service systems', www.suspronet.org/, June 2005.

United Nations (UN) (2002), 'Report of the World Summit on Sustainable Development', Johannesburg, South Africa, 26 August–4 September.

Upstream (2006), 'Customized services', www.wmupstream.com/customized/resource.asp, 7 December 2006.

Vercalsteren, A. and Gerken, T. (2004), 'Suspronet Report WP11: Need Area Households', www.suspronet.org/fs_reports.htm.

Viljakainen, S. (2004), 'Materiaalinsäästö paperiteollisuudessa – materiaalinsäästöpalvelu apuvälineenä (Materials savings in the paper industry: materials efficiency services as a tool), Master's thesis, University of Helsinki, December.

Vine, E. (2005), 'An international survey of the energy service company (ESCO) industry', *Energy Policy*, **33**: 691–704.

Von Weizäcker, E., Lovins, A. and Lovins, L.H. (1997), *Factor Four: Doubling Wealth, Halving Resource Use*, Earthscan, London.

Wüstenhagen, R. and Boehnke, J. (2007), 'Business models for sustainable energy', in A. Tukker, M. Charter, C. Vezzoli, E. Sto and M.M. Andersen (eds), *System Innovation for Sustainability: Perspectives on Radical Changes to Sustainable Consumption and Production (SCP)*, Greenleaf, Sheffield,

YTV (2006), 'Jätebenchmarking' (Waste benchmarking), *Pääkaupunkiseudun yhteistyövaltuuskunta YTV*, www2.ytv.fi/jateh/benchmark/index.html, 15 January 2006.

APPENDIX 4A

Table 4A.1 Interview summary

Enterprise/organization	Sector	Number of interviews
Ekokem Oyj	Hazardous waste management	2
Lassila & Tikanoja	Waste management	3
Kesko Oyj	Retailing	1
M-real Tako Board	Paper	3
M-real Äänekoski Paper	Paper	4
Myllykoski Paper	Paper	2
Stora Enso Anjalankoski	Paper	1
Stora Enso Imatra	Paper	1
Stora Enso Kotka	Paper	3
Stora Enso Oulu	Paper	3
Stora Enso Varkaus	Paper	1
UPM-Kymmene Jämsänkoski	Paper	1
UPM-Kymmene Rauma	Paper	1
HK Ruokatalo	Food industry (meat processing)	6
Oy Gustav Paulig	Food industry (coffee brewer)	4
Ingman	Food industry (dairy)	3
Finnvera	Finance	1
Nordea bank	Finance	1
OP-Rahoitus	Finance	1
Enespa	ESCO	1
Inesco	ESCO	3
Suomen Lämpöpumpputekniikka	HPAC engineering, heat pumps, ESCO	1
YIT Kiinteistöhuolto	Building management and maintenance, ESCO	1
Würth Finland	Fixing and assembly materials (incl. chemicals), and stockkeeping and picking systems	3
Tekno-Forest	Chemicals and cleaning systems	3
Government	Departments of Environment, Trade & Industry	7
Total		61

5. Obstacles to commercialization of clean technology innovations from UK ventures

Nicky Dee, Simon Ford and Elizabeth Garnsey[1]

Since the Industrial Revolution, the economies of the industrialized world have been founded on a carbon-intensive production paradigm. Economically valuable energy resources have been obtained from stores of coal, oil and natural gas. Established companies that produce these energy resources, along with products reliant on these resources, have a market position founded on this paradigm that is not easily modified or abandoned. Prior developments limit opportunities that established firms can see or take up. So while many existing companies are aware of pressures from changing environmental conditions, they are constrained in their capacity to generate novelty of organization and output. The result of such constraints is that established companies have a poor track record addressing environmental issues:

> Many utility companies have failed to take the key steps to equip themselves for the new environment. Fewer than one in five of European companies . . . has a strategy for climate change and emissions trading in place and fully operational. Even more worryingly, one in five said they had no climate change strategy at all. Progress is even slower in other markets. Only one in eight of the American companies surveyed, for example, has fully implemented a climate change strategy. (Wiegand and Gledhill, 2004, p. 2)

While they occasionally introduce breakthroughs that build on their competences to extend their markets (Tushman and Anderson, 1997), the majority of innovations by established companies are incremental since they are unlikely to undertake innovations that undermine their hard-earned competences (Utterback, 1994). Penrose was one of the first to identify the limits to innovation experienced by individual companies, and her observations anticipated those of many writers on innovation since her time (Penrose, 1959). Each company 'will be guided in its expansion programmes as much by the nature of its own resources as by market demand, for every firm is . . . a more or less specialised collection of resources and cannot move with equal ease in every direction' (p. 224). Moreover their past experience shapes the extent to which existing companies are even able to perceive new opportunities: 'the expected profitability of expansion is controlled by the ability of the firm to see opportunities for the use of its own resources' (p. 216).

Environmental experts have called for prompt and significant changes to the current energy paradigm (Meadows et al., 2004; Stern, 2006; Intergovernmental Panel for Climate Change[2]). Freeman (1992) describes the most pervasive type of change to industry to be a techno-economic paradigm change, which is: 'a radical transformation of the prevailing engineering and managerial common sense for best productivity and most profitable practice' (p. 135).

The start of a paradigmatic shift is usually punctuated by numerous radical and disruptive innovations. These types of innovations typically come from outsiders of an established industry (Christensen, 1997). This leaves scope for new enterprises that have no stake in prevailing forms of activity; indeed, entrepreneurship has been defined as 'the pursuit of opportunity without regard to resources currently controlled' (Stevenson, 1999, p. 10). Such new ventures are ready to take risks in pursuit of emerging opportunities despite a minimum of resources and are able to thrive. Their forte is in finding and creating niches for production and exchange, some of which grow into mainstream activities. It is these characteristics that make new ventures potential agents of radical environmental innovations.

It is not enough, however, for new companies to innovate. They are much more likely to have an impact if they grow their customer base and diffuse their technology (Rogers, 2003). While the opportunities for new activity meeting environmental needs are in principle extensive, there are many obstacles in the way of expansion for new ventures of this kind. This chapter investigates both opportunities and obstacles facing new environmental ventures, first through a review of prior work on the growth of new ventures, then through an examination of new empirical research from the UK. Evidence from a database of 73 micro small and medium-sized enterprises (SMEs) allows a comparison between different environmental sectors and identifies obstacles particular to each sector which affect the ability of new ventures to create and capture value. Richer detail is gained through nine case profiles. These investigate the role of access to finance and business support in venture growth, along with how new ventures perceive opportunities and obstacles in the innovation process. By way of conclusion we identify some of the implications for environmental innovation policy that emerge from analysis of these data.

ESTABLISHMENT AND GROWTH OF NEW VENTURES

The recent entrepreneurship literature has raised questions about the source of entrepreneurial opportunities, asking whether they are discovered or created by the entrepreneur, and the means by which they are exploited (Shane and Venkataraman, 2000; Ardichvili et al., 2003). Two contrasting perspectives on entrepreneurial opportunities are offered by Kirzner (1997) and Schumpeter (1928); while Kirzner assumes that entrepreneurs are alert to and able to exploit already existing opportunities, Schumpeter holds that entrepreneurs create new opportunities. It is through an attempt to reconcile these viewpoints and discover an integrative framework for entrepreneurship that recent scholars have pursued a focus on entrepreneurial opportunity:

> Perception of an opportunity to create value triggers the process of new firm formation. The recognition of such an opportunity is determined by the imagination of the entrepreneur. This opportunity can be developed with the resources entrepreneurs have direct access to, with the resources they can acquire outside the firm or those they can create internally . . . (Stam and Garnsey, 2005, p. 3)

For a venture to survive and grow it must create value for customers and capture value in the form of profits. This can be problematic when the new venture needs to demonstrate the potential for value creation so as to access resources that enable productive activity, prior to reaching customers. The 'barriers to growth' literature indicates that the new venture must overcome three main categories of barriers to achieve financial sustainability: (i) financial factors, (ii) management and organizational factors, and (iii) product and market factors.

Financial Factors

New ventures face typical barriers to finance. When risk capital funds have short time horizons they do not allow for the development time required by new ventures to achieve returns for investors. The development time is particularly uncertain for radical innovations, and when managers have short time horizons this results in poor financial planning (Feldman and Klofsten, 2000). For a number of reasons there is an information asymmetry between the entrepreneurs' and investors' knowledge of a new technology and venture. There may also be some divergence of interests between the two parties, as where investors seek and entrepreneurs resist control. Even when interests are shared, entrepreneurs may be unwilling to divulge information which they believe could endanger their competitive position.

Management and Organizational Factors

The survival of the majority of small firms is heavily dependent on the entrepreneurial and managerial abilities of their founders. The centrality of the owner–manager to the venture's initial business strategy, organizational structure and access to resources means that her/his talents, skills, values and social networks are often critical factors in the start-up period (Chrisman et al., 1998).

The personal characteristics of the entrepreneur include attributes such as education and previous experience, along with more technical and managerial skills, such as knowledge of the market. Moreover, the demands on the entrepreneur's skills shift as the company grows and this may present problems: the single-mindedness which ensured the company's formation may be a liability when reacting to a changing market. The individual founder is particularly vulnerable here, whereas the existence of a founding team may offer a greater range of skills as well as alternative perspectives and strategies: 'growth usually leads to an extensive division of labour with functional specialists having different responsibilities . . . through specialization key managerial, innovative and sales functions become divided' (Feldman and Klofsten, 2000, p. 634).

Coordinating these different functions becomes more difficult with growth, requiring an increase in the management of human resources. Growth can also increase bureaucracy and create communication blocks which stifle coordination. As new employees are brought into the firm, communication can be further complicated as the new recruits lack specialized knowledge specific to the firm (Garnsey, 1998).

Product and Market Factors

Successful innovation arises when a firm offers a product or service that is both technically viable and commercially marketable (Freeman and Soete, 1997). Nevertheless, many new ventures are launched without adequate understanding of either the demands of producing goods or the market into which they will be sold. Many small firms originate as 'one-product' (or service) firms and are thus heavily dependent on a specific market. An overestimation of the size of this market, or the failure to respond to its development, are common causes of business failure. For production-based companies, development times and costs are frequently underestimated and, even if the initial product is successful, follow-up products are often harder to identify and develop.

Increased competition can make innovation-based rents obsolete. New and small firms are particularly vulnerable to an increased competitiveness in their niche market (Roure and Maidique, 1986). The initial success of a new firm in a market will attract new competitors, driving the need for efficient production to reduce costs and maintain competitive prices. If a new venture manages to capture temporary rents from an innovation, these can result in an overemphasis on short-term profit-orientated behaviour at the expense of knowledge generation. This can create organizational inertia potentially fatal to the new venture in the face of increased competition (Feldman and Klofsten, 2000).

Literature is limited on whether the generalized barriers to growth identified apply to new environmental ventures. Recent contributions to environmental entrepreneurship literature focus on typologies of sustainable entrepreneurship (Walley and Taylor, 2002; see also Schaltegger and Wagner, this Volume, ch. 2) and the role of market failures in the creation of environmental entrepreneurial opportunities (Cohen and Winn, 2007; Dean and McMullen, 2007). We shall show that as with new companies in other sectors, firms aiming to grow in the environmental sector face obstacles in the pursuit of opportunities. In addition, there are also many regulatory requirements in the environmental sector that create both opportunities and obstacles to new firms. In this chapter our focus is on the new venture as a vehicle for exploiting opportunities both discovered and created. In the analysis, we investigate the various obstacles that prevent environmental ventures from innovating successfully and achieving growth, despite the presence of potential business opportunities.

THE EMPIRICAL STUDY

During 2004–05, the Environmental Innovation Unit (EIU) of the UK government's Department of Trade and Industry (DTI) compiled a cross-sectoral database of UK firms pursuing innovations in the environmental domain. This investigation analyses a subset of 73 micro-SMEs from this database. The selection of these particular firms was made on two accounts. In the first case, micro-SMEs are resource constrained, a factor that is less operative in larger firms, and we wish to investigate how this constraint affects the development and commercialization process. In the second case, we wish to gain insight into some of the common challenges faced by firms within particular environmental sectors. To this end, the firms in this analysis are disaggregated into five sectors, based on the DTI classification (number of firms studied in each sector are shown in brackets):

- Cleaner Technologies and Processes (19).
- Renewable and Low Carbon Energy – Stationary (12).
- Renewable and Low Carbon Energy – Transport (18).
- Recovery and Recycling (12).
- Water and Wastewater Treatment (12).

This classification scheme is based on technology rather than target markets. Some of the technologies, particularly 'Renewable and Low Carbon Energy', are generic technologies which can be applied to a variety of markets.

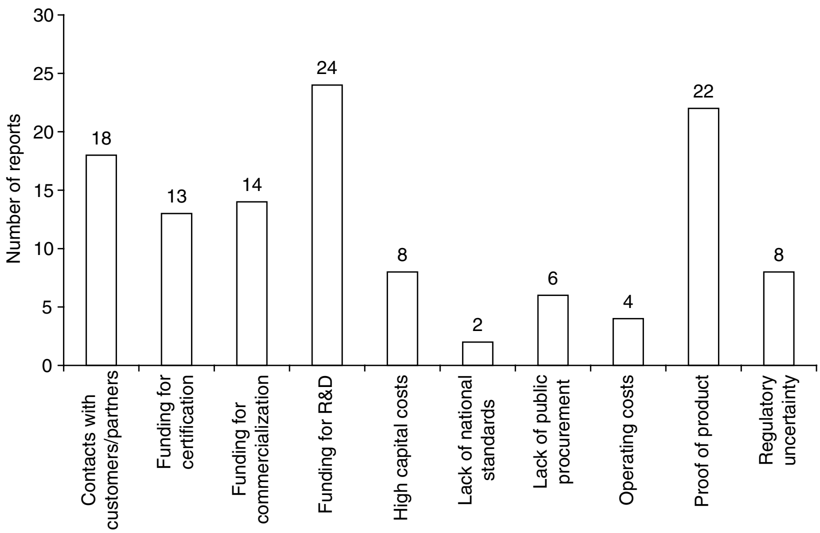
Stage I: Categorization of Obstacles to Growth

A problem with the notion of barriers to growth is that there is co-dependence and interconnection between a broad range of obstacles to successful technological development and commercialization rather than a discrete set of barriers. Growth and development obstacles, and some business opportunities, were self-reported by respondents in this study, and categorized later, as in many studies of 'obstacles to growth'. Some reported external obstacles differ between companies facing similar conditions. This occurs because self-reported problems reflect the perceptions and aspirations of respondents. Firms that do not seek to expand on a scale that requires external finance do not cite its absence as an obstacle. A major US study showed that firms lacking growth aspirations reported fewer problems than more ambitious firms (Reynolds and White, 1997). The term 'barriers' to growth could be misleading since it is not associated with the considerations expressed above, so we refer to 'obstacles' to growth. This study reveals the relative magnitude of obstacles which new ventures must overcome to develop and grow, and how these vary according to sector.

While obtaining finance was a prevalent theme, the context in which the funds were required varied greatly. A distinction was drawn between the need for external finance and the reason for that need. These needs, in combination with the other factors affecting the firms in the development and commercialization of environmental technologies, led to 10 obstacles being selected for investigation. For simplicity of analysis these are organized initially as seven internal obstacles to the firm and three obstacles external to the firm, as in Table 5.1. Obstacles external to the firm all relate to features of the 'selection regime' facing these firms. In evolutionary theory these are the conditions that determine which firms are selected for allocation of

Table 5.1 *Internal and external obstacles reported as affecting the development of the firm*

Internal obstacles	External obstacles
Contacts with customers/partners	Lack of national standards
Funding for certification	Lack of public procurement
Funding for commercialization	Regulatory uncertainty
Funding for R&D	
High capital costs	
Operating costs	
Proof of product	



Note: $N = 73$.

Figure 5.1 *The aggregate set of obstacles facing firms*

resources in an economy, that is, demonstrate 'fitness' for that environment (Metcalfe, 1998). Only operating costs are internal to the firms (which we viewed as open systems), since the other 'internal' obstacles refer to the firms' relations with other parties in their business environment.[3] Moreover, where the technologies are generic they can be applied in diverse markets with a variety of external conditions.

The result of this analysis across the 10 obstacles is presented in Figure 5.1. Only 16 out of 119 reported obstacles (13.4 per cent) concern factors entirely external to the firm (related to their selection environment). Among 'internal' obstacles, 'contacts with customers/partners', 'funding for R&D' and 'proof of product' emerge as the dominant challenges facing those firms in the dataset.

However, while this aggregate analysis highlights these problem areas as ones in which firms could be offered capacity-building assistance, it disguises those challenges that are of greater importance in particular sectors. Using the DTI categorization previously described yields the results displayed in Table 5.2. These figures reveal that, for firms in this sample, the obstacles affecting the ability to develop and commercialize environmental innovations differ significantly between sectors. For the firms developing cleaner technologies and processes, 'contacts with customers/partners', 'funding for certification' and 'high capital costs' emerge as the key obstacles. It is significant that for this category, 'funding for R&D' is of little concern. In this sample, firms in this sector have market- or near-market-ready technologies but experience difficulties in the early stages of the commercialization process.

In the recovery and recycling sector, establishing 'proof of product' is the dominant challenge. For firms in this sector, demonstrable working prototypes or pilot plants appear necessary to convince prospective customers, partners and funding bodies of the value of the technology. This is evidenced by the other significant emergent obstacles: 'contacts with customers/partners' and 'funding for R&D'.

The profiles for firms in the renewable and low carbon energy sectors (both stationary and transport) are very similar. In each, 'funding for R&D' is of primary concern. Other significant obstacles, 'contacts with customers/partners', 'funding for commercialization' and 'proof of product', highlight the need for firms to establish capabilities across a much broader range of skills and that resources might be stretched more tightly as a result. The difference in attitudes towards 'regulatory uncertainty' provides the main distinction between the stationary and transport sectors, as it is revealed to be of higher concern to those developing stationary technologies.

In the final sector, water and wastewater treatment, 'proof of product' emerges as the most common obstacle, with 'funding for R&D', 'contacts with customers/partners' and 'funding for certification' also highly represented. The main obstacle for firms in this sector appears to be achieving a demonstrable technology that convinces conservative customers of the value of their technology.

This analysis of a sample of 73 firms according to their DTI classification reveals that entrepreneurial firms in the environmental industry face significantly different obstacles according to the sector in which they

Table 5.2 Analysis of the challenges facing firms developing and commercializing environmental innovation (%)

	Cleaner technologies and processes (%)	Recovery and recycling (%)	Renewable and low carbon energy – stationary (%)	Renewable and low carbon energy – transport (%)	Water and wastewater treatment (%)
1. Funding for R&D	2.8	14.3	40	33.3	20
2. High capital costs	19.4	0	0	5.6	0
3. Funding for commercialization	11.1	9.5	12	16.7	10
4. Proof of product	11.1	33.3	12	11.1	30
5. Funding for certification	16.7	9.5	4	5.6	15
6. Contacts with customers/partners	19.4	14.3	12	16.7	15
7. Operating costs	5.6	4.8	4	0	0
8. Lack of national standards	0	4.8	0	5.6	0
9. Lack of public procurement	11.1	4.8	4	0	0
10. Regulatory uncertainty	2.8	4.8	12	5.6	10
Total internal factors $\Sigma(1–7)$	86.1	85.6	84	88.8	90
Total external factors $\Sigma(8–10)$	13.9	14.4	16	11.2	10

Note: $N = 73$.

operate. This points to the salience of conditions enabling supply and relating to demand in the various sectors and the need for environmental innovation policy to reflect these differences.

Stage II: Case Profiles

Following the analysis of 73 micro-SMEs, a number of firms were selected from this sample to be investigated in more detail, with a focus on how they pursued raising finance and accessing business support. Early-stage companies were chosen that had been founded between 1999 and 2003, across a variety of UK regions. Nine companies still in operation in 2006 were selected from four sectors:

1. Renewable and low carbon energy – stationary: Viridian, HelioDynamics, Voller Energy.
2. Water and waste-water treatment: Gentronix, Advanced Oxidation Limited, EEC.
3. Cleaner technologies and processes: Natural Building Technologies, Salvtech.
4. Environmental monitoring: Neptune Oceanographics.

Research methodology

Case profiles were issued with a questionnaire comprising a series of open and closed questions that enabled an in-depth inquiry into each case profile. Questions are summarized in association with the analysis. This methodology facilitated a comparative analysis between case profiles, focusing on issues associated with raising finance and accessing business support. A summary of case profiles is shown in Table 5.3.

Access to finance

All of the companies contacted required finance from outside their firms to develop their business. The case profiles have all accessed at least one government grant with success. In addition, two of the Cambridge-based companies have accessed business angel finance. In the case of Viridian, some private investment came from the company founders themselves, who had raised money from the sale of a previously successful venture. Natural Building Technologies, Advanced Oxidation and Gentronix have all successfully raised venture capital finance.

The companies were then asked questions to determine whether their awareness of different sources of finance was a limiting factor for accessing finance, and whether they had been unsuccessful when seeking certain types of finance. All case profiles had full awareness of their options for raising

Table 5.3 Introductory summaries for case profiles

Company name	Sector	Formed	Region	Full-time employees	Part-time employees	Profit 2004/05	Manufacturing capabilities	Description
Natural Building Technologies	Cleaner technologies and processes	Late 1999	Buckinghamshire	12	3	−£500k	Subcontracted manufacturing	Pavatex boards; Natilin Insulation; Warmcell Insulation; Thermofleece Insulation; Baumit Bayosan plasters and renders; Claytec plasters and boards; Ziegel Blocks; NBT Trade Paints; Beeck Silicate Paints; NBT Unfired clay blocks (in development)
Salvtech	Cleaner technologies and processes	2002	Taunton, Somerset	2	0	−£2k	In-house and subcontracted	Environmental board and moulded products from wastepaper; Recycling plant residues; WRAP and Blink Kent

Table 5.3 (continued)

Company name	Sector	Formed	Region	Full-time employees	Part-time employees	Profit 2004/05	Manufacturing capabilities	Description
Voller Energy	Low carbon – stationary	2002 March	Basingstoke, Hampshire	15	5	N/A	In-house manufacturing	Manufacturer of portable fuel cell systems, battery chargers and generators
Viridian Concepts	Low carbon – stationary	2003 Jan	Cambridgeshire	2 (soon to be 3)	3	£100k	Subcontracted	Cost optimized solar hot water system for inclusion in new build dwellings
Helio Dynamics Ltd	Low carbon – stationary	2001 October	Cambridgeshire	5	3	£0k	Some in-house and subcontracted	Solar concentrator which can provide heat and power
Advanced Oxidation Ltd	Water and waste-water treatment	2002	Penryn, Cornwall	4	1	£0k	Subcontracted	Electrochemical treatment of waste-water (Finance Cornwall invested July 2005)

Gentronix	Water and waste-water treatment	1999	Manchester	7	3	N/A	In-house manufacturing	Gentronix's core technology is Green Screen, a living yeast biosensor which can be used to detect toxic and specifically genotoxic chemicals
EEC	Water and waste-water treatment	2002 Sept	South Yorkshire	1	As and when needed	Small net loss	Sub-licence manufacturing agreements with company in Doncaster, South Yorkshire and company in Bucharest, Romania	'High-Speed Bio Tech' Environmental Equipment Waste-water Treatment
Neptune Oceano-graphics Ltd	Environmental monitoring	1999	Charlbury, Oxfordshire	2	0	N/A	N/A	Services to the offshore oil and gas industry, mainly subsea pipelines leak detection

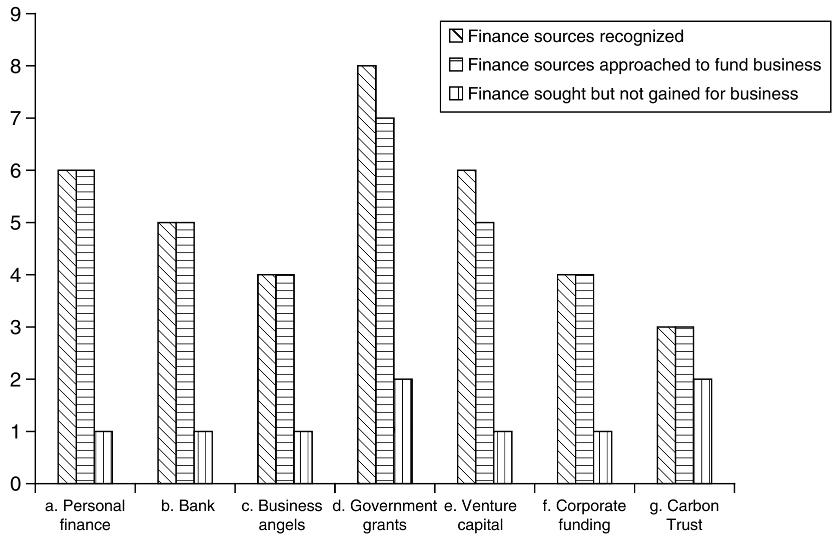


Figure 5.2 A comparison of sources of finance of which businesses are aware, which have been approached, and which have been unsuccessful (8/9 respondents)

finance from external sources, including funds specific to environmental technology, for example, Carbon Trust (Figure 5.2).

Problems in raising finance stemmed from a mixture of internal and external factors. Internal factors reported included criticisms of company management, a substandard business plan, insufficient processes to exploit intellectual property rights (IPR) and being at an early stage of development. External factors reported included the opinion that engineering businesses are 'no longer in fashion' with investors, that investors lack the knowledge to understand some types of environmental businesses, and have difficulty accessing bank finance due to the reluctance of banks to provide finance to companies lacking an income stream or assets to secure against borrowing (for example, if the entrepreneur is not a house owner). All firms had accessed government grants which played a critical role in the early development of their businesses. Some firms had also raised finance from a variety of other sources, including venture capital finance, Carbon Trust R&D funding and business angels. There were concerns regarding venture capital finance, including equity dilution, early exit pressures and a loss of control by founders over their companies.

These findings show that environmental entrepreneurs share some generic problems with entrepreneurs operating in other industries, but also indicate a sector-specific issue regarding investors' knowledge of environmental technologies.[4] This exacerbates the information asymmetry gap between entrepreneurs and investors. One entrepreneur makes a comment typical of the sector:

> To date any difficulties [raising finance] centred on too early stage, modest revenues and difficulty of some potential investors in supporting technology they don't understand. (Gentronix, 2006)

Although the number of investors in clean technology has increased over the last few years, investment in clean technology is still dwarfed by investment in other sectors (Makower et al., 2006). In 2005, energy technology investments comprised 4.2 per cent of total venture capital investments in US-based companies (ibid.). A recent UK report found similar findings, showing that few venture capital investors have made repeat investments in clean technology, with only 11 investors making three or more different clean technology investments (Library House, 2005). Investors may be deterred from repeat investments for a variety or reasons: investments may not have performed as expected;[5] investment opportunities may be lacking; investors may lack the experience to identify investment opportunities; or the experience of investing may highlight the utility of sector-specific competences to fulfil clean technology investments. Three out of nine of the DTI case profiles identified financial barriers as the biggest obstacle they faced in 2006.

Business support needs

For new ventures to access customers and secure sales, they need to build confidence in their products and services. The analysis of 73 micro-SMEs showed that achieving proof of product and certification were significant barriers faced by companies in various environmental sectors (Figure 5.1). Without certification, demonstration of a product can build consumer confidence, but in some industries this is also problematic:

> [N]o one builds 'prototype' houses, all experimentation is done on real products. NHBC has so far not been especially supportive to our demonstrating new products. Big companies can stand behind their innovative products and give housebuilders confidence. Housebuilders will not try out a product if it means their house doesn't qualify for NHBC or Zurich insurance. (Viridian Concepts, 2006)

Building customer confidence is especially challenging when operating in industries unreceptive to new technologies: 'The conservatism of the construction industry leads to resistance to change and a very long and tortuous process between product specification and actual sales' (Neil May, Natural Building Technologies, February 2006).

Another company operating in the waste industry faced a similar problem, commenting on an 'industry lack of interest in step change technology and modest risk taking' (Gentronix, 2006). Five of the nine DTI case studies identified problems associated with accessing customers as the main obstacle they faced in 2006. In addition to customer conservatism, one company found the transition from identifying customers to securing sales a particular challenge, and another was concerned about maintaining customer confidence during the lengthy development of production processes.

Setting up partnerships and making contact with customers created difficulties for companies in all the environmental sectors in this study. The DTI case studies identified that the business support need least readily met by existing services was help accessing potential customers. Public sector procurement can provide revenues and endorsement for new products. However, a lack of innovative public sector purchasing was only cited as an issue by six firms; the remaining companies in the study do not seem to have considered the public sector as a realistic revenue source. Government sector organizations rarely source innovative products from new companies in the UK.

Government regulation can have a vital role enabling the creation of value by environmental ventures, for their customers and other stakeholders. Two of the nine companies cited regulatory factors as their biggest business opportunity in 2006:

> Implementation of the EU Water Framework Directive and REACH legislation and expansion of Integrated Pollution Prevention and Control legislation which all highlight 'mutagens and carcinogens' as key pollutants of concern, yet very few methods to analyse these species are readily accessible to industrial laboratories and regulators. (Gentronix, waste)

> The legislative drive towards more ecological building combined with increased consumer demand and awareness are leading to huge large scale opportunities across the board. Large projects in new housing and schools are probably the biggest immediate opportunity. (Natural Building Technologies, construction)

Although regulation has a direct effect on many environmental businesses, it was not identified by case profiles as a business support need, nor a readily or not readily available business support service. This discrepancy needs to be further explored, but may be because regulatory support is not viewed as a business support service at the present time. The areas of business activity for which firms sought business support can be seen in Figure 5.3. This shows the companies' main needs for business support are 'raising finance' and 'product R&D'. This is perhaps of little surprise when considering the case profiles are all early-stage companies that were

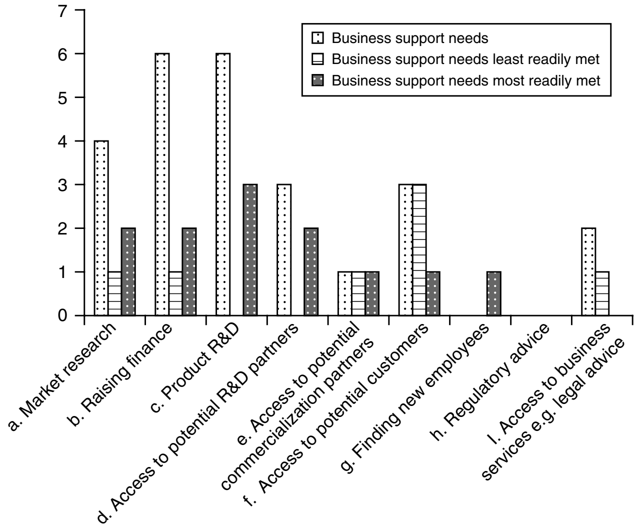


Figure 5.3 Comparison between business support sought (9/9 respondents), business support which was difficult to obtain (6/9 respondents), and most readily available business support (6/9 respondents)

contacted prior to sustainable revenue generation. Following the results from the analysis of the 73 micro-SMEs in the EIU database, it appears that the needs for business support are influenced by differences in sector and maturity.

Business support services

The case-profile companies were asked for their awareness and opinions of business support services available to them. All respondents were aware of Business Link[6] as a source of business support but had mixed awareness of other types of business support. It can be seen that companies were generally aware of more business support services than they accessed (Figure 5.4).

A variety of responses were obtained when the companies were asked about their opinions of the best sources of business advice they had received. Despite the different sources of business advice, Voller, Gentronix, Natural Building Technologies and EEC all mentioned the value of receiving advice from individuals with business and/or industry experience. Companies reported very favourably on the value of business support received from experienced individuals who have the capacity to take on a mentoring role. However, there was no apparent pattern in the organizations

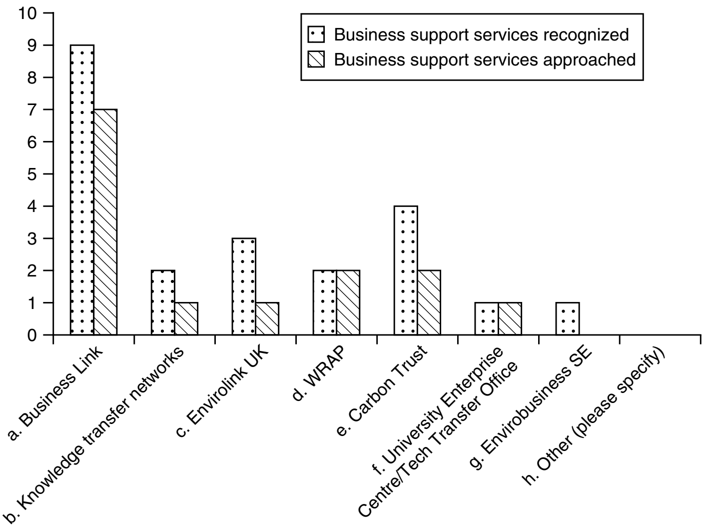


Figure 5.4 Comparison of business support services of which respondents are aware (9/9 respondents), and which people approached (9/9 respondents)

from which these individuals were accessed, for example, incubators, investors, company networks and universities.

As regards business support organizations, the government support offices of Business Link received variable responses, not on the whole favourable, although there were regional variations. Some business support organizations were even described as a hindrance (WRAP) but again comments ranged depending on the individuals contacted within these organizations. Working with universities was reported to have been 'very fruitful'. HelioDynamics found the incubator Life-IC in Sheffield to be of value even though the incubation period was terminated prematurely. Neptune Oceanographics remarked that passport and export support for overseas exhibitions had been valued business support.

CONCLUSION AND POLICY IMPLICATIONS

Current global environmental conditions call for a reduction in the collective time to market of innovations which benefit society. Yet despite the attempts of the innovative firms in this study to provide a supply of environmental goods and services, they faced a lack of innovative response and uptake in the customer supply chain. While tax incentives have been suggested as one means to encourage the uptake of alternative energy technologies, these could leave companies vulnerable to changes in fiscal measures. More could be done to encourage public sector procurement so that new entrants could use endorsement from public sector customers in extending demand for products and services that deliver value. Government procurement[7] could provide a channel through which small firms could gain their first customers, improving the visibility and demonstrability of their products (Connell, 2004). In an age of privatized national industries, industry regulators could require well-placed established incumbents to act as customers to the new environmental firms.[8]

One of the main obstacles faced by firms involved in the development and commercialization of innovative environmental products and services is selling innovative new products into uncertain markets. These firms have difficulty persuading customers that they will benefit from the value provided by these innovations. Such difficulties include persuading customers that the product does something better than the competition (functions more effectively, has an improved performance–price ratio) or does something new (solves a customer problem that no other current product or service can solve). But an information asymmetry problem arises between eco-enterprises and potential customers. It may be difficult for these eco-enterprises to reach customers with these potential solutions, even when new environmental regulations have come into effect. It may also prove problematic to persuade customers that the information is reliable even if they are reached. These difficulties are amplified when selling into highly regulated, conservative industries such as those of construction and water.

All the companies studied in the case profiles faced difficulties in achieving the transition between product development and product sales. Technological and market development need to occur concurrently to prevent barriers to commercialization; unfortunately this can take a long time and be problematic for generic technologies[9] (Maine and Garnsey, 2006). The areas of business support that companies had difficulty obtaining related to this commercialization process (see Figure 5.4). For example, selling novel environmental products to the builders of new housing has proved to be particularly difficult. Among other reasons, there are few opportunities to test products on 'prototype' houses since most experimentation is done on 'real' housing developments. Studies of innovation diffusion have revealed the benefits of observability and trialability for a new product seeking customer adoption (Rogers, 2003). Despite the potential for these new products to have a relative advantage over existing technologies or to meet as yet unmet user requirements, it is difficult for customers to test products. This low trialability gives rise to the low observability of the innovation's effectiveness. That the technology might be difficult for the customer to understand or incompatible with the organizational culture of the customer also contributes to the eco-entrepreneur's difficulties in diffusing the innovation.

However, a particularly interesting business model adopted in an effort to reduce the obstacles in the commercialization process was that of Viridian. From the outset of their product development, Viridian created a consortium of potential customers and worked with them to define the product specifications. Through engaging with their potential customers throughout the process, they ensured that these customers would be informed of the value offered by their innovation, thus reducing the possibility that the benefits of their novel product would go unrecognized. As this example illustrates, the adoption of an appropriate business model is crucial to the growth of a new venture; its importance should not be underestimated.

In this study, certification and standards were found to be a specific sectoral problem that made it difficult for firms to gain customer confidence in their new products. Certification services are required for all new products, whether from independent or government bodies. Government-authorized and -funded certification could be used more effectively to assure potential customers of the credibility and benefits of new environmental products.

Financial sources and business support available to eco-enterprises are rapidly changing in response to renewed interest in the commercial potential of innovative environmental technology products and services. However, there is a contrast between the business support which companies actively seek and the areas of business support which they have difficulty obtaining. Companies do not seek types of business support that are not readily available. Our study highlights the considerable value that firms receive in business support from experienced individuals. Such individuals have the capacity to take on a proactive mentoring role, with these mentors coming from a variety of organizations, for example, incubator, investor and company networks. The DTI is currently re-examining the role of business links and how to provide early-stage companies with better links to prospective mentors. Information and communication technologies make it easier to seek out individuals who possess specialist scientific or technical knowledge. As markets for environmentally beneficial offerings have emerged relatively recently, few people have experience of forming new ventures in this sector. Alternative business support can, however, be provided by mentors with skills transferable from experience in other start-up companies or who have considerable experience and contacts in a company's target markets. There is much scope for improving the involvement of knowledgeable individuals in the creation of the next generation of environmental firms.

NOTES

1. We are grateful to company members who shared their time and knowledge with us. We thank Jonathan Lonsdale at the Environmental Innovations Unit of the DTI for his help and support.
2. See www.ipcc.ch.
3. However operating costs are influenced by supply costs, another external factor.
4. This finding is supported by Wüstenhagen and Teppo (2006).
5. There is limited analysis of the risk/return of clean energy investments, but a recent study shows that while many investors perceive returns to be poor, some investments generate very favourable returns. Such perceptions may be driven by a lack of investor experience in this sector (Wüstenhagen and Teppo, 2006).
6. See www.businesslink.gov.uk.
7. The US Small Business Innovation Research (SBIR) Program is an example of a system which requires procurement of innovative products and services which has been more effective than the UK optional equivalent.
8. The UK has the renewables obligation certificates (ROCs) which require all licensed electricity suppliers in England and Wales to supply a specific proportion of their electricity from renewables, but there is no requirement governing what types of companies should provide these renewables.
9. Many sustainable energy technologies are generic, which means they can be applied to a variety of markets; this complicates the technological and market development matching process.

REFERENCES

Ardichvili, A., Cardozo, R. and Ray, S. (2003), 'A theory of entrepreneurial opportuntiy identification and development', *Journal of Business Venturing*, **18**: 105–23.

Chrisman, J.J., Bauerschmidt, A. and Hofer, C.W. (1998), 'The determinants of new venture performance: an extended model', *Entrepreneurship Theory and Practice*, Fall, 5–29.

Christensen, C.M. (1997), *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Boston, MA: Harvard Business School Press.

Cohen, B. and Winn, M.I. (2007), 'Market imperfections, opportunity and sustainable entrepreneurship', *Journal of Business Venturing*, **22**, 29–49.

Connell, D. (2004), 'Exploiting the UK's science and technology base: how to fill the gaping hole in the UK government policy', Cambridge: TTP Venture Managers Limited, www.ttpventures.com/docs/Filling The Gap.pdf.

Dean, T.J. and McMullen, J.S. (2007), 'Toward a theory of sustainable entrepreneurship: reducing environmental degradation through entrepreneurial action', *Journal of Business Venturing*, **22**, 50–76.

Feldman, M.W. and Klofsten, M. (2000), 'Medium-sized firms and the limits to growth: a case-study in the evolution of the spin-off firm', *European Planning Studies*, **8**(5), 631–50.

Freeman, C. (1992), *The Economics of Hope: Essays on Technical Change, Economic Growth and the Environment*, London: Pinter.

Freeman, C. and Soete, L. (1997), *The Economics of Industrial Innovation*, Cambridge, MA: MIT Press.

Garnsey, E.W. (1998), 'A theory of the early growth of the firm', *Industrial and Corporate Change*, **7**(3), 523–56.

Kirzner, I. (1997), 'Entrepreneurial discovery and the competitive market process: an Austrian approach', *Journal of Economic Literature*, **35**(1), 60–85.

Library House (2005), *Investment Trends in UK Clean Technology 2000–2004*, Cambridge: Library House, www.libraryhouse.net/publications/download/Investment+Trends+In+Uk+Clean+Technology+2000_2004.pdf.

Maine, E. and Garnsey, E. (2006), 'Commercializing generic technology: the case of advanced materials ventures', *Research Policy*, **35**(3), 375–93.

Makower, J., Pernick, R. and Wilder, C. (2006), *Clean Energy Trends 2006*, San Francisco and Portland: CleanEdge, www.cleanedge.com/reports/index.php?report=trends 2006.

Meadows, D.H., Randers, J. and Meadows, D.L. (2004), *Limits to Growth: The 30 Year Update*, London: Earthscan.

Metcalfe, J.S. (1998), *Evolutionary Economics and Creative Destruction*, London: Routledge.

Penrose, E.T. (1959), *The Theory of the Growth of the Firm*, Oxford: Blackwell. Reprinted 1995, Oxford University Press.

Reynolds, P.D and White, S.B. (1997), *The Entrepreneurial Process: Economic Growth, Men, Women, and Minorities*, Westport, CT: Quorum Books.

Rogers, E.M. (2003), *Diffusion of Innovations*, New York and London: Free Press.

Roure, J.B. and Maidique, M.A. (1986), 'Linking prefunding factors and high-technology venture success: an exploratory study', *Journal of Business Venturing*, **1**(3), 295–306.

Schumpeter, J.A. (1928), 'The instability of capitalism', *Economic Journal*, **38**(151), 361–86.

Shane, S. and Venkataraman, S. (2000), 'The promise of entrepreneurship as a field of research', *Academy of Management Review*, **25**(1), 217–26.

Stam, E. and Garnsey, E.W. (2005), 'New firms evolving in the knowledge economy; problems and solutions around turning points', Papers on Economics and Evolution 05-2005, Max Planck Institute of Economics – Evolutionary Economics Group, Jena.

Stern, S.N. (2006), 'Stern Review: The Economics of Climate Change', London: HM Treasury, UK Government.

Stevenson, H.H. (1999), 'A perspective of entrepreneurship', in Sahlman, W.A., Stevenson, H.H., Roberts, M.J. and Bhide, A.V. (eds), *The Entrepreneurial Venture*, Boston, MA: Harvard Business School Press, pp. 7–23.

Tushman, M.L. and Anderson, P.C. (1997), 'Technology cycles, innovation streams, and ambidextrous organisations: organisation renewal through innovation streams and strategic change', in Tushman, M.L. and Anderson, P.C. (eds), *Managing Strategic Innovation and Change*, Oxford: Oxford University Press, pp. 3–23.

Utterback, J.M. (1994), *Mastering the Dynamics of Innovation*, Boston, MA: Harvard Business School Press.

Walley, E.E. and Taylor, D. (2002), 'Opportunists, champions, mavericks . . .? A typology of green entrepreneurs', *Greener Management International*, **38**, 31–43.

Wiegand, M. and Gledhill, R. (2004), *Emission Critical: Connecting Carbon and Value Strategies in Utilities*, PricewaterhouseCoopers, www.pwc.com/at/pdf/publikationen/Emission_critical.pdf.

Wüstenhagen, R. and Teppo, T. (2006), 'Do venture capitalists really invest in good industries? Risk-return perceptions and path dependence in the emerging European energy VC market', *International Journal of Technology Management*, **32**(1/2), 63–87.

6. Too much of a good thing? Innovation driven by environmental ambition

Luca Berchicci

Many scholars in the environmental new product development (ENPD) field argue that by going green, corporations may reduce costs, capture emerging market and gain first-mover advantage (Hart, 1995; Porter and Van der Linde, 1995). Nevertheless, the ambition to develop environmentally driven innovations often clashes with the less than exciting performance of these products once introduced. Some of the products are developed to the prototype stage and then abandoned. Do green innovations fail due to the intrinsic uncertainties of every innovation process or do they have additional complex attributes, which make green innovative projects more risky? This chapter addresses this issue, in particular exploring the role of environmental concerns in new product development. Here ENPD is defined as the development of new products rather than the redesigning of existing products according to environmental criteria, following market rules rather than regulatory ones.

Although concerns for the natural environment may lead to the discovery of new opportunities for innovation (for example, Sharma, 2000), we do not know exactly how the environmental concerns may influence the exploitation of new opportunities, such as the development of new products and services. The concern for the natural environment is pervasive among both consumers and business organizations and it is therefore an important phenomenon that needs more scholarly attention (Banerjee, 2001; Bansal, 2003).

In organization and the natural environment studies, many scholars suggest that the recognition and integration of environmental concerns into a firm's decision-making process is becoming an increasingly accepted way to address environmental issues in business (for example, Menon and Menon, 1997; Banerjee et al., 2003). Prior research has investigated managers' responses to environmental issues in relation to managerial practices and strategic management, identifying antecedents (for example, Menon and Menon, 1997; Flannery and May, 2000), and scale and scope of the responses (for example, Andersson and Bateman, 2000; Bansal, 2003). Others have explored the conditions under which environmental issues and sustainable business practices are introduced at the very beginning of new business ventures (Larson, 2000). It seems, however, that few studies are concerned with the question of how and to what extent the environmental concerns of managers and product developers influence their decisions in organizational activities. In particular, the influence of environmental concerns on decisions dealing with new product development (NPD) activities is overlooked. How to balance environmental concerns with other concerns in NPD? How does the environmental concern of product developers affect product performance? Understanding this phenomenon is particularly important since managers and entrepreneurs are encouraged to undertake ENPD projects (for example, Charter and Tischner, 2001).

The environmental concern may constitute a motivation to undertake an NPD project. In the light of this, development teams within organizations may seek to create environmentally friendly products, which must satisfy some basic expected functionality of the products. This may imply that the integration of environmental concern with other concerns, such as cost, market acceptance or product functionality, may influence the way in which project performances are assessed and supported. Consequently, if the environmental concern is a primary objective for undertaking an NPD project, it may dictate the progress of the project. This may have relevant implications. First, the project may be difficult to evaluate according to environmental concerns, because such concerns are ill-defined (Chen, 2001). Second, the environmental concern may make decisions difficult for the development team when a trade-off is needed between environmental and other concerns, for example in the case of energy efficiency, cost or convenience. Third, in the case of radical projects, development teams may emphasize environmental concerns whereas other concerns may be marginalized.

This chapter explores the challenges that entrepreneurs and product developers face in matching environmental issues with market demands in NPD projects. To address this facet of environmental concern, an in-depth exploration of an ENPD project is carried out. The Mitka case study is illuminating. A coalition of entrepreneurial actors was strongly motivated to develop and implement a new environmentally friendly vehicle as a substitute for the car for commuters in the Netherlands. They believed that only radical solutions could substantially improve the natural environment. The emphasis on environmental considerations often created design challenges in product development. Despite sophisticated market techniques, developers often decide not to integrate market feedback. Indeed, the Mitka development is a story of contradictions reflecting the wider dilemma surrounding the ENPD, driven by a strong environmental concern. To explore these contradictions and dilemmas, the chapter begins with an overview of the literature and continues with sections on method, case description and analysis. Given the iterative process between existing theoretical frameworks and data, a set of propositions are proposed and discussed in the penultimate section.

LITERATURE REVIEW

Environmental Ambition

Scholars in the environmental field have often used the term 'environmental concern' to describe and explain the responses of individuals to environmental issues. Nevertheless, the term 'environmental ambition' is introduced here and is defined as a specific intention to carry out ENPD. Although the term 'environmental ambition' is not new (it has been used differently by Klassen and Angell (1998) to define the scope of environmental efforts by firms' management), here it is considered to be more apt than environmental concern to indicate an effective manager's determination to act in the innovation domain.

A high degree of environmental ambition on the part of entrepreneurs, managers or product developers may create the conditions whereby environmental issues are seen as opportunities for value creation. Given the nature of problem solving, environmental ambition may be a stimulus to find innovative solutions to growing environmental problems. There are several studies suggesting how the concern for environmental issues may stimulate organizational change (Azzone and Noci, 1998) or how entrepreneurs may spot environmental opportunities (Krueger, 1998). If environmental ambition creates the process of identification of environmental opportunities, then the challenge for green entrepreneurs is to exploit them. The task facing environmental entrepreneurs is to match environmental issues with market demands in NPD projects. However, green entrepreneurs who have tried to develop more environmentally friendly products have had mixed experiences. Here it is suggested that although environmental ambition may lead entrepreneurs to discover opportunities, the normative and ideological nature of environmental ambition may act as a constraint on actual product innovation. The paradox of environmental ambition is that it enables the discovery of opportunities but it may constrain their successful exploitation. Here two constraining factors are highlighted: the nature of environmental product attributes and addressing environmental problems through the search for radical solutions.

The Nature of Environmental Product Attributes

Environmental product attributes are not defined exclusively (Chen, 2001; Berchicci and Bodewes, 2005) and it is not clear to what extent environmental concerns should be acknowledged in the development of new products, given different perceptions of consumers, producers and government (Kleiner, 1991). Environmental attributes are seen as distinct from the more traditional ones such as price and quality (Chen, 2001), although they do not necessarily have to be separate from traditional attributes, and may, on the contrary, overlap or coexist. Incorporating levels of both green and regular attributes in one product might occur through the design process in terms of material selection, energy efficiency or toxic waste (ibid.). Problems may occur when trade-offs are required and environmental attributes are overemphasized at the expense of traditional attributes, regardless of consumer preferences, technological or financial risks. The ill-defined concept of 'greening' also manifests itself from a market perspective. Many scholars and practitioners seem to assume that consumers are willing to pay a premium for green products when they indicate that they care about the natural environment or look for environmentally friendly products or brands. Unfortunately, people's attitudes towards the environment may not always be reflected in their purchasing behaviour (Simon, 1992). Therefore the integration of environmental attributes into NPD may increase the complexity of the innovation process and make it difficult for product developers to successfully trade off environmental issues within regular product attributes. This task is more challenging in the case of radical projects. In a radical setting, project performances are unclear because, by definition, these projects incorporate parts that are unknown, uncertain and untested. Given the poorly defined performance criteria, development teams with high environmental ambition may emphasize environmental concerns and persist in a course of action regardless of any new information that would suggest otherwise.

The Call for a Radical Undertaking

The radical setting is especially important since scholars, practitioners and policy makers in the environmental field assume that only by shifting from incremental innovation to a more radical innovation, can the win–win paradigm be achieved (for example, Hart and Milstein, 1999; Ashford, 2000). Scholars have emphasized that the development of new products and services rather than the optimization of existing products is a necessary condition to reach consistent improvement in eco-efficiency (Charter and Tischner, 2001). Consequently, focusing on incremental approaches might be one reason why companies and entrepreneurs are distracted from pursuing radically different products and business models (Senge and Carstedt, 2001; Hart and Milstein, 2003).

Although green entrepreneurs are encouraged to undertake radical innovations, few studies have examined what radical undertaking entails for the organization – for example, explaining to a design team how to deal with the higher degree of uncertainty intrinsically linked to project radicalness. The innovation process, and specifically the way that new products are designed, developed and implemented, is an uncertain journey into the unknown (Arrow, 2000). This is because radical undertakings entail a much higher degree of uncertainty than less ambitious projects. Overlooking this uncertainty may jeopardize regular as well as environmental product development.

Summarizing, the environmental ambition of product developers and green entrepreneurs may increase the uncertainty in the product development process because of an ill-defined concept of greening (and the consequent difficult trade-offs) and the call for a radical undertaking.

METHOD

This research project utilizes the longitudinal case study research strategy for various reasons. First, this method allows an investigation into how product innovation unfolds in a real-world environment in which decisions actually take place (Yin, 1994). Second, it allows the researcher to gain a full understanding of and to describe in detail the context of the phenomenon under study. Finally, it is an appropriate strategy for enriching or extending a theory, while at the same time accommodating existing theories through an iterative process between the existing theories and data (ibid.).

Case Selection

Qualitative sampling, unlike quantitative sampling, tends to be purposive rather than random. In this research study, the author had the opportunity to become involved in a project started in the Netherlands in which the objective was to design and develop a new human-powered vehicle. One of the motivations to start the Mitka project ('Mitka' is a Dutch acronym meaning: 'Mobility solution for individual transportation over short distances') was to provide a sustainable mobility solution for individual transportation over short distances. The project aimed to reduce the number of kilometres each individual travelled by car. Therefore, it was considered an interesting case study for understanding the influence of environmental ambition on decision making during the NPD process. First, the environmental ambition was a strong driver to start the project – the idea was to have a new solution for commuters, as an alternative to car use. Second, there was a strong belief that in order to address the environmental imperative, a radical approach is needed.

Data Sources

The Mitka case resembles longitudinal research in real time, meaning that the researcher lives with an organization over time or carries out periodic interviews (Pettigrew, 1990). Over a period of more than two years, real-time data were gathered through observation, archival documents, meetings and interviews with key informants. In total, 17 discussions and several informal conversations took place with the team members regarding technical development as well as market research. Members of the Mitka coalition and other relevant key informants were interviewed, resulting in 30 semi-structured interviews which lasted from one-and-a-half to three hours. The interview data were supplemented with information from archival documents and press releases, enabling the findings to be cross-checked (triangulation). More than 500 archival documents such as internal reports, archival information, emails, newspaper and magazine articles were used to confirm the reliability of the interviewees' responses, and permitted directed and detailed probing in the interviews.

Data Analysis

A detailed written case history and timeline were prepared, along with a schematic representation of the main phases and events. The descriptive time-orientated display is achieved by arranging a series of concrete events into chronological time periods. These periods are based on the categorizations made by Van de Ven et al. (1999), who identified major periods during the innovation process: initiation, development and implementation. These periods are then sorted into two categories that represent the units of analysis: the management team level and the design team level. This separation allows one to examine the part played by environmental ambition at the management and design team levels.

Although many decisions were taken with the support of all the partners, strictly technical decisions were adopted by the design team while the management team's focus was mainly on business and market development. The management team comprised the TNO team (Dutch research institute) and the project leader, the Gazelle (bike manufacturing company) director, the business developer, the Delft University of Technology group (TUDelft) and the Nike manager. The design team involved Vd Veer designers, the TNO team, Freewiel Techniek (director) and TUDelft students. For reasons of confidentiality, the actors remain anonymous and only the function and the organization are identified.

THE MITKA CASE

The Mitka is a three-wheeled human-powered vehicle with a protective roof cover and an electric engine that doubles human pedal power. It has a maximum speed of 25–40 km/hour and automatically tilts during steering (Figure 6.1). The concept is based on the assumption that people will use the Mitka instead of the car and thus will use less energy in regular (home to work, shopping, visiting) transportation.

Initiation Period: From Vision to Design Concept

To understand the technological, economical and ecological potential of a new mobility vehicle, TNO performed two market studies in the European

Source: Author's own photo.

Figure 6.1 Mitka vehicle, October 2002

Nike headquarters in Hilversum. The first study consisted of several tests lasting for a couple of weeks with different bicycle concepts, from regular safety bikes to electric ones and also recumbent bikes and trikes. The second study, in March 2000, was launched through an internet-based questionnaire given to Nike employees. The respondents were asked to describe their current mobility situation and to 'build' on a computer screen, out of individual components, a vehicle that would meet the general set of specifications defined earlier by the Mitka coalition and their own preferences as future Mitka users.

From the questionnaire some important findings emerged. One of the central findings from this exercise was the strong user preference for a two-wheeled vehicle over a three-wheeled version. However, in May 2000, the coalition decided to develop a three-wheeled Mitka for two reasons. First the three-wheeled concept was considered more innovative than the two-wheeled one, and the challenge stimulated the design team as well as the management. The second reason was because it was 'better for the natural environment'. The coalition felt that a two-wheeled version would be likely to attract cyclists, with unwanted and disastrous consequences from an environmental impact view. As the project leader explained: 'in this way [the three-wheeled vehicle] it is hoped to encourage car users to switch to the Mitka.'[1]

After this important decision, the design team worked on a scale model (1:3), which was presented on 20 September 2000 at the Nike European head office in Hilversum. At the symposium, the Mitka model attracted the curiosity of many people, including journalists, who reacted very positively to it. In the following days, extensive press coverage described the futuristic vehicle enthusiastically.[2] The enthusiasm was contagious and the coalition was determined to explore the promising Mitka trajectory. The euphoria boosted the ENPD project, which was expected to result in a marketable product in less than three years. This proactive attitude was translated into a new set of objectives for the following phases: the development and testing of a vehicle prototype, and later the production of a pre-series of 50–100 vehicles with dedicated support services for a new market (Joore, 2000: 7).

The main idea for the business plan was to sell an attractive package of 'sustainable mobility solutions' to employers of large and medium corporations. The goal was to reach 1 per cent of the bicycle market, or 10,000 units per year. The suggested price for the Mitka was set at around €3,000.

The design team focused on building both a working and a mock-up model. The former was to explore the technical feasibility of the trike, while the latter was to be exhibited as a 'concept car' for feedback.

The challenge faced by the team was to build a three-wheeled vehicle where an upright position, which means a high centre of gravity, was combined with the tilting and steering mechanism of the two front wheels. With the help of computer simulations, computer modelling and biomechanical models, the project team decided to have separate mechanisms for steering and tilting, adopting a parallelogram construction; that is, the short beams of the parallelogram represented by the wheels would be able to bend (Van Gemert, 2001). With this construction the pedal system needed to be positioned between the wheels in the centre of the parallelogram.

However, there were a couple of problems with this configuration, namely stability and manoeuvrability: the width would have to be about 85 cm to enable good manoeuvrability. However, this width for the tilting/steering mechanism soon presented a practical problem: vehicles wider than 80 cm would have difficulty negotiating doors, a problem highlighted by the market research.[3] Moreover, concerns about the combination of a high centre of gravity and a three-wheeled configuration were expressed by bike experts and velomobile producers, because at low speeds the tilting effect was dangerously strong and the vehicle might just tip over because of the high centre of gravity. After experimenting with several parallelogram constructions, the tilting problem persisted, but the project team was confident and committed to resolving it despite the limited technical support from Gazelle, where 'there is know-how neither on the 3-wheeled configuration nor on the electric engine'.

Between February and March 2001 the coalition sought feedback on the Mitka concept. Two group discussions with nine Nike employees took place in February 2001. The goal was twofold: first, to gain insight into and obtain personal opinions about the Mitka model (1:3); and second, to generate ideas for useful services. It emerged that the participants had difficulty envisaging daily life with the new artifact:

> The three-wheeled design was not entirely appreciated, mainly because problems were expected concerning manoeuvrability, which was, according to them, one of the most important advantages of a bike over the car. Many group members were quite enthusiastic about the design, but also a significant number thought it would be 'too new' for them. (Luiten et al., 2001)

In March 2001, the mock-up version was presented at FIETSRAI, the largest bicycle fair in the Netherlands, in the Gazelle showroom. A questionnaire was handed to visitors, who were asked to express their opinion about the presentation, consisting of the model (1:1), a video impression of the prototype and a graphic description of some of the service arrangements that had been proposed by the Nike employees in the group discussion. The results from the questionnaire appeared to be more optimistic than those of the discussion group (ibid.).

In April and May 2001, a series of in-depth interviews took place with Nike employees to obtain further feedback. As in the group discussions, the interviewees were sceptical about the three-wheeled configuration and ambivalent about the radicality of the design. Moreover, the three-wheeled vehicle was seen to have manoeuvrability problems, especially with regard to passing through doors. There were also mixed reactions regarding rain protection.

Development Period

This phase started just as the previous one had, with great enthusiasm after another public presentation of the Mitka mock-up where the future King of the Netherlands sat on it next to his wife. Marketers affirmed that everything the Princess is seen to endorse would sell. This prediction, combined with high expectations, created the conditions under which Gazelle and Nike were prepared to invest in the Mitka. The general feeling was clearly expressed by the business developer: 'the world stands still without the Mitka'. Rather than performance criteria, the prospects and expectations of the coalition were the main mechanism for project support. However, before any real commitment could be made, the vehicle needed to be up and running. Therefore, another project, MOVE II, was set up in October 2001, and €600,000 were invested to fulfil the ambitious objectives. These objectives included completing the final Mitka prototype, testing it, and finally entering into production.

The decision to develop such a brand-new environmentally friendly vehicle presented both technical challenges for the team and business and market risks for the entire coalition. All the working packages entailed completely new design and development techniques, with very few standard parts. The team had difficulty coordinating not only the separate developments but also the whole product architecture. The team's limited experience with some of the new components and the lack of priority among the product components and their developments increased the complexity of the concept.

Unfortunately, it took eight more months (May 2002) before the first Mitka prototype could be ridden, and 13 months (October 2002) before the only prototype could be tested. Expectations based on announcements via e-mails or meetings of the coming prototype and test runs were regularly dashed. One of the effects of the procrastination of the project was the relocation of resources. Resources previously allocated to market research activities were transferred to strictly technical product development. During the test in October 2002, the insufficient lighting, and poor visibility and manoeuvrability forced the two drivers to travel during off-peak hours to avoid other bicycles on the path. As one of them said: 'it was fighting all the way home!'. Not surprisingly, the test was halted prematurely.

Implementation Period: The End of the Mitka Development and the Spin-off

With the termination of the MOVE II programme at the end of 2002, the three-wheeled Mitka project suddenly lost its impetus. Although a functioning prototype was developed and, to some extent, tested, the promised 50 pre-series vehicles and the pledged creation of support services were not delivered. Moreover, the lack of business partners forced the Mitka project to be terminated prematurely. After three years of product and service development and an investment of about €1,150,000, the ambitious project ended with only one prototype.

However, one spin-off was launched on the market in 2003, the Easy Glider, by one member of the Mitka consortium acting independently. Following a test with the three-wheeled Mitka in July 2002, the Gazelle director rejected it on the grounds that it was too innovative and expensive. However, Gazelle decided to invest in a two-wheeled version. The reactions from the other coalition members were mixed. On the one hand, the spin-off demonstrated the added value of the concept. On the other, the behaviour was considered opportunistic, 'betraying' the idea behind the Mitka project: an environmentally friendly alternative for car drivers. The Easy Glider was considered to be a rather small step towards a better sustainable society.

ANALYSIS

The Mitka case highlights the complexity of carrying out and supporting projects that are strongly driven by environmental ambition. The high level of environmental ambition was a strong motivation to start the project, yet it was not restricted to this mission. The high level also manifested itself in the key decisions taken during the development of the Mitka. Moreover, the assumption that a higher environmental benefit related to the radicality of the project, was strongly held and supported during the whole process.

Environmental ambition also influenced the way in which general, yet different, needs were addressed. In the Mitka case, tension emerged between addressing social and market needs simultaneously. The environmental imperative as a new concern was translated into specific attributes for the product concept, such as the target group (car driver), comfort (electric engine) and wheel configuration (three wheels). These attributes, however, were in conflict with others such as manoeuvrability, user acceptance or convenience. A series of market research studies clearly indicated that the concept of the Mitka was appreciated, but the vehicle was not suitable for most potential users because it was perceived as highly expensive and awkward to use and store. Moreover, testing unmistakably highlighted its limitations. This was a kind of paradox. The decision to start such a project was based on the assumption of combining user need, an ideal mobility concept, with more general societal needs, the preservation of the natural environment. However, the crucial decisions during the process were not influenced by user preferences.

At Management Level

The management team supported the project both for its innovativeness and for the 'feel good' factor of 'doing the right thing' for the natural environment. Furthermore, there was the feeling among the team that they had finally developed a real ENPD with a substantial level of environmental benefit. Rather than performance criteria, the prospects and expectations of the coalition were the main mechanism for project support. They let the design team work on the Mitka, adopting a 'wait and see' attitude. Therefore, the design team was actually leading the project while the management team was waiting for the results. The wait and see attitude postponed any reflections, self-assessment and critical evaluation of goals and objectives, allowing the project to proceed without any real performance judgements being made. Moreover, the limited ability to understand the technical development reinforced this attitude.

At Design Team Level

The wait and see attitude of the management conflicted with the great efforts made by the design team. The unexpected technical problems did not undermine the confidence of the team, despite their limited expertise and knowledge about the three-wheeled configuration or a protective roof and power assistance. On the contrary, their commitments locked the design team within the boundaries of the ideal means of transport, obliging them to work extra hours, sometimes including weekends. The design team did not challenge the requirements of the Mitka. It was felt that any downgrading from the original design would have negatively affected its sleek appearance and intrinsic environmental value. Intriguingly, it seems that the team opted for the most complex and radical solutions among different technical choices.

The search for superior solutions and the extremely confident attitude in combination with the lock-in effect of the original requirements pushed the Mitka concept beyond the current street regulations and infrastructures, and against lead users' opinions. For example, consider again the width of the vehicle. At 85 cm, it was 5 cm too wide to pass through most regular household doors. This requirement was explicitly mentioned by most of the market research respondents. The justification may illustrate how environmental ambition dictated the development process: according to the project leader, only through dramatic changes in the current system could significant environmental benefits be achieved. Therefore, the development of the Mitka should not necessarily be constrained by the current regulations and infrastructure; on the contrary, it might itself provoke a desirable change in the system, shaping it and making it more sustainable.

The intertwined events illustrate the difficulty for the project team in reconciling the feedback received with their own view. Positive feedbacks were emphasized while negative ones were avoided or completely ignored if they did not conform to the beliefs of the project team.

In the next section, the main findings are discussed and propositions formulated.

DISCUSSION

First Proposition

The management team supported the Mitka project, investing time, and human and financial resources. The psychological rewards from doing something positive for the natural environment influenced decisions to prolong support for the Mitka project on various occasions, even in the face of a poor or ambiguous performance. Environmental ambition appears to be a non-rational component of the advocacy innovation process. Nevertheless, environmental ambition alone may not be sufficient to reduce performance–judgement thresholds. The network members were willing to support such a project despite the moderate risk involved for each of them, especially at the beginning of the project. On the other hand, there was a great deal of uncertainty within the management team regarding the uniqueness of the project. The high level of environmental ambition in combination with ambiguous performance indicators reduced the performance–judgement threshold:

> *P1: A high level of environmental ambition is likely to influence the managers' support process, which will result in a lower performance –judgement threshold when ambiguous performance indicators exist.*

This study finds that supporting radical projects that address societal needs may increase, rather than decrease, the uncertainty of the innovation journey. In situations with a high level of uncertainty and ambiguous performance indicators, environmental ambition may influence the go/no-go decision. A project with high potential environmental gains may be supported enthusiastically by the management team, which implies that the threshold for the performance indicators may be lowered. As a result, managers may support an environmentally driven project regardless of its performance. This proposition is consistent with a small, yet increasing, body of environmental literature that underlines the difficulties that management faces in clearly defining environmental issues and measuring environmental performance (Walley and Whitehead, 1994; Chen, 2001; Banerjee et al., 2003). The Mitka management's difficulty in checking performance evaluations highlights the higher degree of uncertainty involved in adopting a radical approach to NPD projects and the difficulty in dealing with environmental performance.

With regard to the innovation literature, this proposition is consistent with studies on supporting projects despite poor performance (Schmidt and Calantone, 1998; Green and Welsh, 2003). This research extends the literature on NPD and proposes that environmental ambition is a non-rational component of the support process for innovative projects.

Second Proposition

The team's high level of environmental ambition emphasized the search for the ideal means of transport for a more sustainable mobility system. The high level pushed the team to look for radical solutions and subsequently it locked them into a failing course of action. This course of action entailed a limited reassessment of design choices, which occasionally challenged the current infrastructure system, avoiding trade-offs and dismissing signals from potential users. The high level of environmental ambition and the radicality of the project reinforced each other in a positive feedback loop. Moreover, the supportive management team, which was waiting for the concept to materialize, did not moderate the escalation of commitments by the design team.

> *P2: In a radical undertaking a high level of environmental ambition is likely to influence the commitments of design team members, resulting in an escalation of commitments.*

The environmental literature does not specifically address the effect of environmental ambition on design team commitments during project development, although it gives some clues to the way in which coordination and communication within the team may be affected when undertaking environmental projects (Lenox and Ehrenfeld, 1997; Handfield et al., 2001). For example, Handfield et al. found a difference in expectations and perceptions within the team between environmentally responsible manufacturing tool supporters and the users of those tools, the designers. Given the lack of empirical data and conceptual frameworks within the environmental literature, the results from the Mitka case help us to understand how a design team's environmental ambition affects the innovation process.

This contribution also has implications for the innovation literature. Previous studies found that the escalation of commitments was likely to occur when the design team was performing radical undertakings (Schmidt and Calantone, 1998; Green and Welsh, 2003). The findings from the Mitka case confirm these previous studies, yet suggest that environmental ambition is an important factor in the escalation of commitments. The high level of environmental ambition not only triggered the search for radical solutions to mobility problems, but also reinforced the lock-in effect in the decision-making process. Internal values and initial beliefs buffered the integration of new external information about the project, escalating their commitments (Biyalogorsky et al., 2006). The explanation may lie in the psychological rewards of doing something new and beneficial for the natural environment. This means that some projects have been continued despite their poor performance, which may explain why some green products have performed poorly.

Third Proposition

The high level of environmental ambition led environmental entrepreneurs to assume that only through the search for and development of radical solutions is it possible to decrease the burden on the natural environment. The search for radical solutions and the integration of new attributes increased the complexity of the Mitka concept. Another effect of the high level of environmental ambition to the product concept emerged: the dilemma of trading off different product attributes while taking into consideration the environmental dimension. The team tended to avoid trade-offs.

It seems that there was a dichotomy between short- and long-term goals that was not fully understood by the management and the project team. The team saw a number of new product attributes in a single concept, the changes required in infrastructure and the prospect of making the Mitka a blockbuster in the market as possible short-term goals rather than long-term ones. The short-term goal to launch the Mitka on the market clashed with the time required to develop the product service system in the light of the infrastructure changes. Environmental ambition seems to have made the distinction between long- and short-term goals unclear. Projects driven by environmental concerns may imply higher risks due to a higher degree of complexity, given the ill-defined concept of greening and the search for radical solutions.

P3: A high level of environmental ambition will likely result in a higher degree of product complexity.

The previous propositions suggest that when the search for radical solutions is driven by high-level environmental ambition and psychological rewards are obtained from doing something good for the natural environment, the uncertainties in undertaking innovative projects increase. Consequently, this increases the complexity of the product concept. This proposition is consistent with the innovation and product design literature.

Undertaking radical projects also means increasing the product's complexity. In the product innovation context, uncertainties are intrinsic in the product development process and form part of the complexity of the product. According to Novak and Eppinger (2001), the complexity of a product increases when a product involves new or indeterminate attributes and there is no stable, well-understood set of interactions between components. The process of identifying and understanding these relationships adds to the difficulty of coordinating development. Indeterminate attributes, such as environmental ones, can be judgemental, subjective or ideological, and they are difficult to translate into product attributes. When designers try to integrate indeterminate attributes into the design of a product, the additional trade-offs increase the complexity of a project. Environmental concerns may be the main rationale for developing a new product, in which case environmental attributes may be overemphasized at the expense of market-driven product specifications – as occurred in the Mitka project, where potential users were considered to be too conservative and resilient to behavioural change. Without taking into account the potential consumer response, the risk is that the product may turn out to have an added value in social, technological and environmental terms, and respond to social needs and fundamental research priorities, while failing to address market demand. What emerges from this discussion is a green entrepreneur's dilemma: to what extent do green entrepreneurs need to diverge from the market and technology environment to be able to create successful new green products in a new domain, when performance criteria are unclear?

CONCLUSION

This research shows that environmental ambition influences the innovation process in various ways. Environmental ambition is one of the reasons why a firm may engage in NPD, and is likely to have an impact when objectives are established, resources are mobilized and performance criteria are evaluated. A high level of environmental ambition increases the complexity of the product innovation process. Concern for the natural environment encourages the search for radical innovative opportunities; however, the actual exploitation of these opportunities may be difficult because of the non-rational nature of environmental ambition.

Environmental ambition may reinforce beliefs that managers hold about 'what is feasible', which leads them to pursue a radical path. Because of the high degree of uncertainty involved, it may not be possible to evaluate fully the outcome of any radical paths and their performance. With ambiguous performance criteria, the individual evaluation of events may be the manifestation of one's own beliefs (Weick, 1979). Therefore, environmental ambition may be a non-rational factor that justifies and reinforces the belief that one is 'doing the right thing' for the natural environment, which results in psychological rewards in supporting and developing ENPD. The risk however, is that a high level of environmental ambition may hamper a product innovation process because it may lead the developers or green entrepreneurs away from the market that their product is to serve. If an organization is to develop products that address environmental concerns, its managers need a better understanding of both the support process and environmental ambition.

This chapter and the methodology applied are not without their weaknesses. First, a single case may describe an idiosyncratic phenomenon. Therefore, other cases with a high level of environmental ambition in different organizational settings or industries would be welcomed to strengthen the results. Second, the findings are not tested because the new relationships were induced from the cases. Further research can improve the generalization of the results by translating the propositions into testable hypotheses based on a large sample of ENPD projects. Finally, one may propose other rival explanations as to why the project, for example, became too complex or too costly. For instance, limited or inadequate skills and expertise within the team or simply mismanagement may have caused the Mitka project to fail to achieve the desirable, yet too ambitious, objectives. Nevertheless, we should ask ourselves why a group of capable people, from well-known companies, made ineffective decisions or evaluated project performances poorly. The radicality of the project may at least explain why the evaluation of performance criteria was overlooked or unrecognized, leaving room for additional explanatory factors such as environmental ambition.

NOTES

1. In www.Kathalys.com, accessed September 2000.
2. For example, articles from two national newspapers: *Algemeen Dagblad*, 21 September 2000 and *Telegraaf*, 29 September 2000.
3. In the Netherlands, bicycles are often stored inside houses, whose front doors are about 80 cm wide.

REFERENCES

Andersson, L.M. and Bateman, T.S. (2000), 'Individual environmental initiative: championing natural environmental issues in U.S. business organizations', *Academy of Management Journal*, **43**(4): 548–70.

Arrow, K.J. (2000), 'Innovation in large and small firms', in R. Swedberg (ed.), *Entrepreneurship*, Oxford: Oxford Management Reader, pp. 229–43.

Ashford, N.A. (2000), 'An innovative-based strategy for a sustainable development', in J. Hemmelskamp, K. Rennings and F. Leone (eds), *Innovation-oriented Environmental Regulation: Theoretical Approaches and Empirical Analysis*, New York/Berlin: Physica-Verlag, pp. 67–107.

Azzone, G. and Noci, G. (1998), 'Seeing ecology and "green" innovations as a source of change', *Journal of Organizational Change Management*, **11**(2): 94–111.

Banerjee, S.B. (2001), 'Managerial perceptions of corporate environmentalism: interpretations from industry and strategic implications for organizations', *Journal of Management Studies*, **38**(4): 489–513.

Banerjee, S.B., Iyer, E.S. and Kashyap, R.K. (2003), 'Corporate environmentalism: antecedents and influence of industry type', *Journal of Marketing*, **67**(2): 106–22.

Bansal, P. (2003), 'From issues to actions: the importance of individual concerns and organizational values in responding to natural environmental issues', *Organization Science*, **14**(5): 510–27.

Berchicci, L. and Bodewes, W.E.J. (2005), 'Bridging environmental issues with new product development', *Business Strategy and the Environment*, **14**(5): 272–85.

Biyalogorsky, E., Boulding, W. and Staelin, R. (2006), 'Stuck in the past: why managers persist with new product failures', *Journal of Marketing*, **70**(2): 108–21.

Charter, M. and Tischner, U. (2001), *Sustainable Solutions: Developing Products and Services for the Future*, Sheffield, UK: Greenleaf.

Chen, C.L. (2001), 'Design for the environment: a quality-based model for green product development', *Management Science*, **47**(2): 250–63.

Flannery, B.L. and May, D.R. (2000), 'Environmental ethical decision making in the US metal-finishing industry', *Academy of Management Journal*, **43**(4): 642–62.

Green, S.G. and Welsh, M.A. (2003), 'Advocacy, performance, and threshold influences on decisions to terminate new product development', *Academy of Management Journal*, **46**(4): 419–34.

Handfield, R.B., Melnyk, S.A., Calantone, R.J. and Curkovic, S. (2001), 'Integrating environmental concerns into the design process: the gap between theory and practice', *IEEE Transactions on Engineering Management*, **48**(2): 189–208.

Hart, S.L. (1995), 'A natural-resource-based view of the firm', *Academy of Management Review*, **20**(4): 986–1014.

Hart, S.L. and Milstein, M.B. (1999), 'Global sustainability and the creative destruction of industries', *Sloan Management Review*, **41**(1): 23–33.

Hart, S.L. and Milstein, M.B. (2003), 'Creating sustainable value', *Academy of Management Executive*, **17**(2): 56–67.

Joore, P. (2000), *Projectplan MITKA*, Delft: TNO Industry.

Klassen, R.D. and Angell, L.C. (1998), 'An international comparison of environmental management in operations: the impact of manufacturing flexibility in the U.S. and Germany', *Journal of Operations Management*, **16**(2–3): 177–94.

Kleiner, A. (1991), 'What does it mean to be green?', *Harvard Business Review*, **69**(4): 38–47.

Krueger, N. (1998), 'Encouraging the identification of environmental opportunities', *Journal of Organizational Change Management*, **11**(2): 174–83.

Larson, A. (2000), 'Sustainable innovation through an entrepreneurship lens', *Business Strategy and the Environment*, **9**(5): 304–17.

Lenox, M.J. and Ehrenfeld, J. (1997), 'Organizing for effective environmental design', *Business Strategy and the Environment*, **6**: 187–96.

Luiten, H., Knot, M. and Silvester, S. (2001), 'Consumer involvement in the development of sustainable product/service systems', paper presented at the Sustainable Services and Systems (3S) Conference: 'Transition towards Sustainability?', Amsterdam, 30 October.

Menon, A. and Menon, A. (1997), 'Enviropreneurial marketing strategy: the emergence of corporate environmentalism as market strategy', *Journal of Marketing*, **61**(1): 51–67.

Novak, S. and Eppinger, S.D. (2001), 'Sourcing by design: product complexity and the supply chain', *Management Science*, **47**(1): 189–204.

Pettigrew, A. (1990), 'Longitudinal field research on change: theory and practice', *Organization Science*, **1**(3): 267–92.

Porter, M.E. and Van der Linde, C. (1995), 'Green and competitive – ending the stalemate', *Harvard Business Review*, **73**(5): 120–34.

Schmidt, J.B. and Calantone, R.J. (1998), 'Are really new product development projects harder to shut down?', *Journal of Product Innovation Management*, **15**(2): 111–23.

Senge, P.M. and Carstedt, G. (2001), 'Innovating our way to the next industrial revolution', *MIT Sloan Management Review*, **42**(2): 24–38.

Sharma, S. (2000), 'Managerial interpretations and organizational context as predictors of corporate choice of environmental strategy', *Academy of Management Journal*, **43**(4): 681–97.

Simon, F.L. (1992), 'Marketing green products in the triad', *Columbia Journal of World Business*, **27** (Fall–Winter): 268–85.

Van de Ven, A.H., Polley, D.E., Garud, R. and Venkataraman, S. (1999), *The Innovation Journey*, Oxford and New York: Oxford University Press.

Van Gemert, G. (2001), 'Kritische succesfactoren van Bike-up en car-down vervoersmiddelen', unpublished Master's thesis, Delft University of Technology, Delft.

Walley, N. and Whitehead, B. (1994), 'It's not easy being green', *Harvard Business Review*, **72**(3): 46–51.

Weick, K.E. (1979), *The Social Psychology of Organizing*, New York: Random House.

Yin, R.K. (1994), *Case Study Research Design and Methods*, 2nd edn, London: Sage.

PART II

Sustainable corporate venturing and intrapreneurship

7. Enhancing ecopreneurship through an environmental management system: a longitudinal analysis of factors leading to proactive employee behaviour

Kerstin Pichel

Ecopreneurship (Petersen, 2000) – individual environmental initiatives taken by employees – is an important basis for a company's success in environmental performance (Kolluru, 1994; Ruiz-Quintanilla et al., 1996). But how can it be enhanced?

Ecopreneurship is an extraordinary type of behaviour that derives not from an employee's job description or the management's requirements, but from personal engagement (Ramus and Steger, 2000). Therefore it cannot simply be demanded but must be encouraged. A range of contextual, individual and cultural factors can support it, including resources such as time and money (Hoffman, 2005: 36ff.), qualifications (Bansal and Roth, 2000), environmental attitudes (Cordano and Frieze, 2000), self-efficacy (Hostager et al., 1998), supervisory support (Ramus and Steger, 2000) and the pro-environmental commitment of managers and other key personalities (Hostager et al., 1998; Prakash, 2001). Can all these antecedents be allocated by a certain management system?

In 1995, Europe saw the start of a boom in companies implementing an environmental management system (EMS), and scholars expected the European Eco-Management and Audit Scheme (EMAS) and the International Standard for Environmental Management Systems (ISO 14001) to organize environmental policies, programmes and measures. Ecopreneurship was seen as an important byproduct (UNI and ASU, 1997: A34; Höppner et al., 1998: 74; Hamschmidt and Dyllick, 1999: 43).

Executives of companies with EMS activities reported as follows (Liedtke et al., 1997: 43):

> Employees make more suggestions. They feel better informed and are more interested. (Femira)

> Employees were all interested in realizing their own suggestions and those of colleagues. (Kambium)

> Because of the EMS you have more insight into everybody's activities. That provides more overview and more exchange. (Zeyko)

An EMS provides various opportunities to enhance the three dimensions of potential antecedents of ecopreneurship. First, a company's environmental policy can be an important cultural antecedent, as it is a sign of the management's commitment and can therefore strengthen proactive behaviour (Ramus and Steger, 2000). Second, environmental programmes can integrate employees' knowledge and aims and strengthen a motivational antecedent: employees' individual convictions about their effectiveness. Third, environmental measures can allocate important contextual antecedents such as knowledge, time and money. Therefore developing an EMS gives a company the opportunity to support proactive organizational behaviour.

Current impact analyses of an EMS primarily focus on its influence on a company's performance (Feldman et al., 1996; Klassen and McLaughlin, 1996; Rennings et al., 2003) or on employee motivation, which is often not specified. This study, however, focuses on the impact that an EMS has on the antecedents of ecopreneurship and on ecopreneurship itself to study the behavioural consequences of instituting an EMS.

I conducted a longitudinal study on the impact of EMSs and various antecedents on ecopreneurship within five companies that had implemented an EMS and one company that served as a control group. I distilled the contextual and individual antecedents of ecopreneurship from the literature and developed them into a questionnaire. A correlation and regression analysis revealed their impact on ecopreneurship. I also distilled several cultural antecedents from the literature and examined their impact on ecopreneurship through a series of interviews, analysed qualitatively. By comparing the EMS and non-EMS companies and changes over time, I analysed the impact that an EMS had on the contextual and individual antecedents of ecopreneurship and on behaviour. Three research questions guided the study:

1. Which contextual, individual and cultural antecedents are important drivers for ecopreneurship?
2. Does the presence of an EMS have a positive impact on the antecedents of ecopreneurship?
3. Does the presence of an EMS have a positive impact on ecopreneurship itself?

The chapter is structured as follows. First, a literature review provides insights into definitions and descriptions of ecopreneurship and its contextual, individual and cultural antecedents as well as the potential influences of an EMS. Based on the literature, hypotheses are derived for the study. I then describe the sample of the five companies that have an EMS and the control company, and explain the quantitative and qualitative measures. Third, I present my findings on the influence that the three types of antecedents have on ecopreneurship, and explain the impact of the EMS on both antecedents and behaviour. Finally, I reflect on my findings regarding ways in which the three dimensions work together, the implications for a company's aims in ecopreneurship, along with limitations of the study and directions for future research.

LITERATURE REVIEW AND HYPOTHESES

This review of the literature is divided as follows. First, I review the literature on ecopreneurship and its antecedents, identifying the main antecedents, which I used as variables for the empirical survey. I then review the EMS literature to derive hypotheses about the impact it has on the antecedents and on ecopreneurship. Figure 7.2 below illustrates the identified antecedents and the hypotheses I deduced about them.

Ecopreneurship

The concept of ecopreneurship has its roots in environmental psychology. After the Meadows report on environmental problems (Meadows et al., 1972), psychologists began to focus on environmental behaviour (Maloney and Ward, 1973). Spada (1990) distinguished several of the components that had been used during the previous 20 years to define environmental behaviour: environmental knowledge, environmental consternation, environmental values, and environmental intention to behave and manifest environmental behaviour. The 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro marked a turning-point; now environmental behaviour at work became more interesting and both management and employees were asked to show more proactive environmental behaviour (Hedstrom, 1996). Scholars started to talk about 'environmental empowerment' (Wittmann, 1994), 'ecoinitiatives' (Ramus and Steger, 2000), 'ecopreneurship' (Petersen, 2000) and 'sustainopreneurship' (Petersen and Schaltegger, 2000).

These terms refer to constructs from organizational psychology. They all describe behaviour that is not formally required, and not conducted to fulfil one's job duties; rather, it is individual discretionary behaviour to improve a company's performance (Wright et al., 2003: 25). When employees agitate to improve workplace activities beyond their formal job requirements, organizational psychology uses a range of terms: 'co-intrapreneurship' (Wunderer, 2001), 'extrarole behaviour' (Katz, 1964; Van Dyne et al., 1995), 'organizational citizenship behaviour' (Organ, 1988), 'prosocial behaviour' (Brief and Motowidlo, 1986), 'organizational spontaneity' (George and Brief, 1992) or 'discretionary behaviour' (MacDuffie, 1995).

So far, two approaches describe proactive environmental behaviour at work: one focuses on intensity and the other on content. The intensity-based approach focuses on the degree of individual engagement, classifying it as reactive, active or proactive behaviour (Tiebler, 1992: 186). Ramus (2002: 152) follows this approach, describing proactive environmental behaviour at work as 'actions (or initiatives) taken by individuals and teams that improve the environmental performance of companies'. The content-based approach focuses, for example, on waste separation, water reduction, energy saving and so on (for an overview, see de Young, 2000: 516).

In this study, ecopreneurship is understood as extrarole behaviour, deriving from individual ideas and engagement. Therefore much of its content may be impossible to define in advance. Thus I have chosen to use the intensity-based approach: I describe ecopreneurship as individual, self-driven, independent, highly motivated environmental behaviour at work. It includes such behaviours as making suggestions for environmental improvement, changing one's personal work behaviour, becoming informed about developments and possibilities of changes as well as contacting other people to test their potential to engage in pro-environmental activities.

Antecedents of Ecopreneurship

Three dimensions of antecedents are discussed as important influences on ecopreneurship: contextual factors in the work environment (Huse, 1996; Schumann, 1997), individual factors of workers' motivation and knowledge (Bird, 1996); and cultural factors such as a company's attitudes and values (Barrett and Murphy, 1996; Wehrmeyer and Parker, 1996). The significance of contextual antecedents is based upon job analysis (Fine and Cronshaw, 1999), identifying resources and elements of the infrastructure which are important for job performance. Individual antecedents are derived from motivational theory, focusing on the impact that attitudes and values have on behaviour. Cultural factors are deduced from organizational psychology (von Rosenstiel, 1999), emphasizing the meaning that a group's or organization's values have for individual engagement.

A long and diverse list of factors can explain and enhance ecopreneurship in the three dimensions; examples are providing data to identify appropriate solutions, support from top management, participation, environmental awareness, emotions and individual priorities (for an overview, see Kollmuss and Agyeman, 2002).

So far no organizational model has been established to explain ecopreneurship (Ramus and Killmer, 2005: 102; Starik and Marcus, 2000: 543). The study reported on here analyses the three dimensions of influencing factors or antecedents, drawing on established models: contextual antecedents are deduced from research on job stress (Peters and O'Connor, 1980; Frese, 1985) and internal motivation (Hackman and Oldham, 1980). Individual antecedents are derived from the motivational model of behavioural intent (Fishbein and Ajzen, 1975). Cultural antecedents are drawn from Schein's (1985) model of corporate culture.

Contextual antecedents of ecopreneurship

In this subsection, I outline the main contextual antecedents for work performance as described in the literature, in three categories: physical resources, organizational climate and corporate training.

Resources are important external circumstances that influence job satisfaction and work performance (Frese, 1985). Sharma (2000: 685) refers to resources as 'discretionary slack' allowing managers to adjust to changes and strategic or creative behaviour. When employees perceive their equipment as being of poor quality, it becomes a job stressor, leading to dissatisfied and unmotivated behaviour; it also inhibits proactive initiatives (Peters and O'Connor, 1980). The discretionay slack influences significantly the managerial interpretation of environmental issues such as opportunities (Sharma, 2000: 691). For ecopreneurship, two important variables are:

- the appropriateness of equipment; in electroplating, examples would be adjustable thermostats or controllable access gates to the metal tubes; and
- the availability of extra money for environmental initiatives.

The second contextual parameter is *organizational climate*. It includes the social norms and arrangements in a company and influences job satisfaction and work performance (Payne et al., 1976). For ecopreneurship, many variables are important:

- Management offers of information about environmental activities within the company and requirements for employees. They can be given in work meetings, company internal journals or on pinboards. Such information facilitates a positive orientation towards pro-environmental changes so it is an important precondition for their acceptance and realization (Prehn et al., 1998: 83; Sharma et al., 1999).

- Job feedback. This is an important antecedent to internal self-generated motivation (Hackman and Oldham, 1980: 77, 81), which is closely linked to ecopreneurship. Management feedback about environmental suggestions for improvement is regarded as an important antecedent for ecopreneurship.
- Time availability for environmental activities (for example, meetings, efforts to develop environmentally optimized charges and production lines). The management offer of using time for environmental activities is an important sign of the willingness to realize changes (Peters and O'Connor, 1980).
- Transparency of corporate environmental management activities. This makes environmental management perceptible to the individual employee. When employees believe they know about the consequences of their own ongoing environmental activities and those of their colleagues and employees in other units, it reduces the free-rider problem: the more predictable the firm's environmental efforts are, the more easily people can make up their minds about their own proactive behaviour (Wall, 1995).
- Participation and coordination. These enable management and employees to adjust competences, duties and responsibilities, and approaches and arrangements (Pugh, 1981). Individual initiatives such as ecopreneurship can be made effective and efficient.
- Incentives. Managers often use incentives for individual initiatives in order to improve company-wide environmental initiatives (Theyel, 2000: 250). But incentives carry a risk: employees may take on a more instrumental attitude towards the expected proactive behaviour, engaging in it only because they expect a reward (Luyben and Cummings, 1981–82; Diekmann and Preisendörfer, 1991; Kohn, 1993; Schahn, 1993: 40). For pro-environmental behaviour there are research findings about a positive correlation of incentives and proactive initiatives (Ramus and Steger, 2000) and about negative correlations (Sharma, 2000: 692).
- Executives' own pro-environmental behaviour. This may convey management's orientation about environmental activities and ecopreneurship (Ramus and Steger, 2000).

A third contextual parameter is *training*:

- General soft-skill training includes classes and workshops to support employees in promoting their own initiatives, discussing potential

activities effectively and asking for support. These key skills are not ecospecific but have an impact on ecopreneurship (Klinger, 1980; Ramsey and Hungerford, 1989: 32).
- Ecospecific training provides professional competence towards environmental issues and methods at work, for example changeovers to environmentally optimized print colours or criteria for environmentally orientated suppliers. Ecospecific training raises the awareness and acceptance of proactive behaviour (Bansal and Roth, 2000; Sharma, 2000).

Individual antecedents of ecopreneurship

The individual antecedents of environmental behaviour can be deduced from the motivational model of behavioural intent developed by Fishbein and Ajzen (1975). The model can be applied to environmental behaviour to study attitudes towards the outcome of environmental behaviour, subjective norms of behaviour towards nature and the environment, and perceived behavioural control as a determinant of behavioural intent (Taylor and Todd, 1995; Cordano and Frienze, 2000). Drawing on the work of Walker and Thomas (1982), Ramus and Killmer (2005) show additional ways to measure employees' perceptions of the organization's norms towards ecoinitiatives.

For the present study, individual antecedents are placed in two clusters. Of the five variables derived from the literature, three focus on ecospecific motivation and two on general motivation:

- Expectation of eco-success is based on attribution theory (Weiner, 1986). It describes the individual's expectation that the intended pro-environmental behaviour will succeed. The perceived level of personal responsibility for successful efforts towards environmental change has an impact on the individual's willingness to participate in environmental projects (Kastenholz, 1994: 75–8).
- Valence of nature and environment describes subjective norms: the personal meaning of environmental protection. It has both an emotional and a cognitive aspect (based on the perceived probability of environmental problems). The attitude towards the environment is linked to protective behaviour (Hines et al., 1986; Cordano and Frieze, 2000), especially if the behaviour is not very easy or is unusual (Guagano et al., 1995).
- Knowledge about environmental duties at work is an individual antecedent, and thus not a variable of the Fishbein–Ajzen model, but it is often referred to in environmental research (Hines et al., 1986). The more specifically the environmental knowledge is linked to the

content of the environmental behaviour, the more important it becomes as an antecedent (ibid.).

- Self-efficacy is a construct related to general motivation, describing a self-confidence in individual influence. Belief that one is personally effective is an important antecedent for personally engaging in changes and ecoinitiatives (Campell and Pritchard, 1976: 85–91; Hostager et al., 1998).
- Extrinsic motivation describes an instrumental attitude towards work. When employees focus on salary and not on accomplishing work tasks, it has a negative impact on proactive environmental behaviour (Luyben and Cummings, 1981–82).

This review of the literature on job analysis and motivational theory shows that all these variables have a positive influence on job performance and individual initiatives. Only incentives and extrinsic motivation are identified as having a negative influence on personal engagement. This finding leads to my first set of hypotheses (for a detailed formulation see Appendix 7A2):

Hypotheses 1a 1–14: Almost all contextual and individual antecedents are positively and significantly related to ecopreneurship.

Hypotheses 1b 1–2: Incentives and extrinsic motivation are negatively and significantly related to ecopreneurship.

Cultural antecedents of ecopreneurship

Research shows that the culture of an organization has an impact on the employees' active work behaviour (von Rosenstiel, 1999; Wunderer and Jaritz, 1999: 97ff.) and environmental innovations (Seidl, 1993). This is also true for the contextual and individual antecedents, however, no model has yet been established for surveying the cultural influence on ecopreneurship. Thus I chose to use Schein's (1985) well-known model to specify cultural aspects that are likely to explain ecopreneurship, combining it with findings of culture-focused research on active working behaviour (von Rosenstiel, 1999; Wunderer and Jaritz, 1999) and on environmental innovations (Seidl, 1993; Huse, 1996; Böttcher, 1999; Ramus and Steger, 2000). I selected those cultural aspects that were often named in the research findings and specified Schein's general variables for environmental management.

I specified Schein's construct 'relationship of company and environment' as the first cultural assumption for ecopreneurship. I focused on the 'strategic meaning of environmental protection in the company', and developed two variables to measure it:

- The 'importance of environmental protection in the business strategy' describes the alignment of the business model and strategic projects with environmental opportunities and threats. The fit of the core strategy and environmental initiatives is important for the success of both (Hoffman, 2006; Porter and Kramer, 2006).
- The 'environmental manager's role as promoter' distinguishes between hierarchical promoters who have the power to decide, knowledge promoters who have expert competences, and process promoters who have social competence (Witte, 1973; Hauschild and Chakrabarti, 1988). Lechler (1999: 198) found that assertiveness and the ability to motivate are important antecedents of innovation.

For this study, I adapted Schein's construct of 'assumption about reality and truth' to 'appreciation of change' and developed one variable: 'willingness to change'. The ability to appreciate changes and focus on changing one's own behaviour and decisions indicate individuals' potential to engage in environmental protection (Hallay, 1996; Schreyögg, 1996: 529).

Finally, I adapted Schein's construct 'assumptions about behaviour' as 'appreciation of individual initiative', and placed it into the model using the variable 'promotion of individual or group effort'. Managers' willingness to accept individual initiatives is similar to the construct 'management of goals and responsibilities' developed by Ramus and Steger (2000), which they found to have a direct effect on ecoinitiatives.

My review of the literature on environmental behaviour indicates that all these cultural antecedents have a positive impact on ecopreneurship, leading to the second set of hypotheses:

Hypothesis 2a: The more important environmental protection is for the business strategy, the more ecopreneurship occurs in a company.

Hypothesis 2b: The more multilayered the promoter's role of the environmental manager, the more ecopreneurship occurs.

Hypothesis 2c: The more individual effort is promoted, the more ecopreneurship occurs.

Hypothesis 2d: The more willingness to change is given, the more ecopreneurship occurs.

The Influence of EMS on Ecopreneurship and Its Antecedents

EMAS and ISO 14001 focus on constantly and systematically improving environmental strategy and policy, as well as on programmes and activities in corporations. Both standards emphasize that a successful EMS must address all the employees in a company (ISO 14001, 1996: A.4.1; EMAS II, 2001: Annex I, B4). Recent EMS research looks at employee involvement from a resource-based perspective, suggesting that successful environmental performance depends on internal capabilities such as knowledge and staff behaviour (Hart, 1995; Sharma and Vredenburg, 1998; Bansal, 2005). Companies implementing an EMS have similar expectations and experiences: they see that improved motivation and eco-innovation among employees are important byproducts of an EMS (Rondinelli and Vastag, 2000; UNC-ELI, 2001; Rennings et al., 2003).

The environmental management standards justify the expectations for improving internal capabilities. Each element of an EMS can be designed in a motivating, participatory way: for example the environmental policy can inform employees about the overall aims and sense of an environmental business, while the environmental management measures can include new criteria for tasks or provide infrastructural equipment (Figure 7.1).

Several EMS requirements are linked to the antecedents of ecopreneurship:

- Analyse and allocate resources such as work equipment (ISO 14001, 1996: 3.5, 4.3.4b, 4.4.1; EMAS II, 2001: Annex I, A.4.1).
- Provide employees with information about environmental activities (ISO 14001, 1996: 4.4.5c; EMAS II, 2001: Annex I, A.4.1).

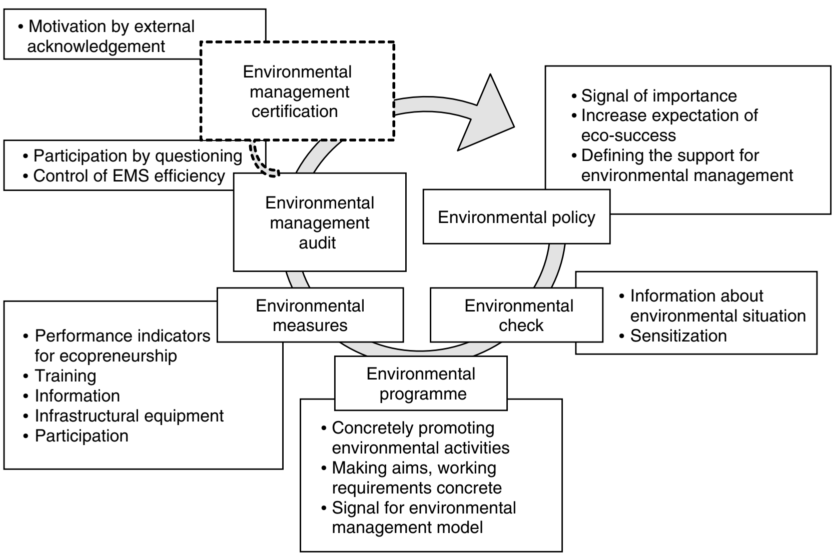


Figure 7.1 Motivating potentials of EMS elements

- Ensure adequate internal communication (ISO 14001, 1996: 4.4.3a; EMAS II, 2001: Annex I, A.4.3).
- Offer opportunities for employees to participate in and coordinate activities (ISO 14001, 1996: 3.5, 4.3.4b, 4.4.1; EMAS II, 2001: Article 1.2.d, Annex I, B.4.1).
- Ensure that feedback is provided (ISO 14001, 1996: 4.4.3a; EMAS II, 2001: Annex I, B.4).
- Appoint environmental officers who can serve as good role models (ISO 14001, 1996; EMAS II, 2001: Annex I, A.4.1).
- Create a system for eliciting employee suggestions, probably one offering monetary incentives (ISO 14001, 1996: 3.5, 4.3.4b, 4.4.1; EMAS II, 2001: Annex I, B.4.2).
- Offer training and strengthen environmental awareness (ISO 14001, 1996: 4.4.2; EMAS II, 2001: Annex I, A.4.2).

Although not all the ecopreneurship antecedents itemized above are named in EMAS or ISO 14001, the standards claim to improve awareness of the environment and create procedures to meet environmental goals. Thus they justify the hypothesis that an EMS can have a positive influence on ecopreneurship's contextual and individual antecedents. I would not expect an EMS to have an influence on cultural antecedents, and therefore do not test it, because one new management system is not likely to change a company's culture (Figure 7.2). These elements in the literature lead to the third set of hypotheses (for a detailed formulation, see Appendix 7A2):

Hypotheses 3a 1–16: The assessment of most contextual and individual antecedents is significantly better the longer a company works with an EMS.

Hypotheses 3b: The assessment of extrinsic motivation is not significantly better the longer a company works with an EMS.

Hypotheses 3c 1–15: After the two years of research, the assessment of most contextual and individual antecedents improves significantly in companies that had an EMS during this time.

Hypotheses 3d 1–15: In the company without an EMS, the assessment of contextual and individual antecedents does not improve significantly.

Hypotheses 3e–f: The assessment of extrinsic motivation does not improve significantly during the two years of research in companies with an EMS or in the one without an EMS.

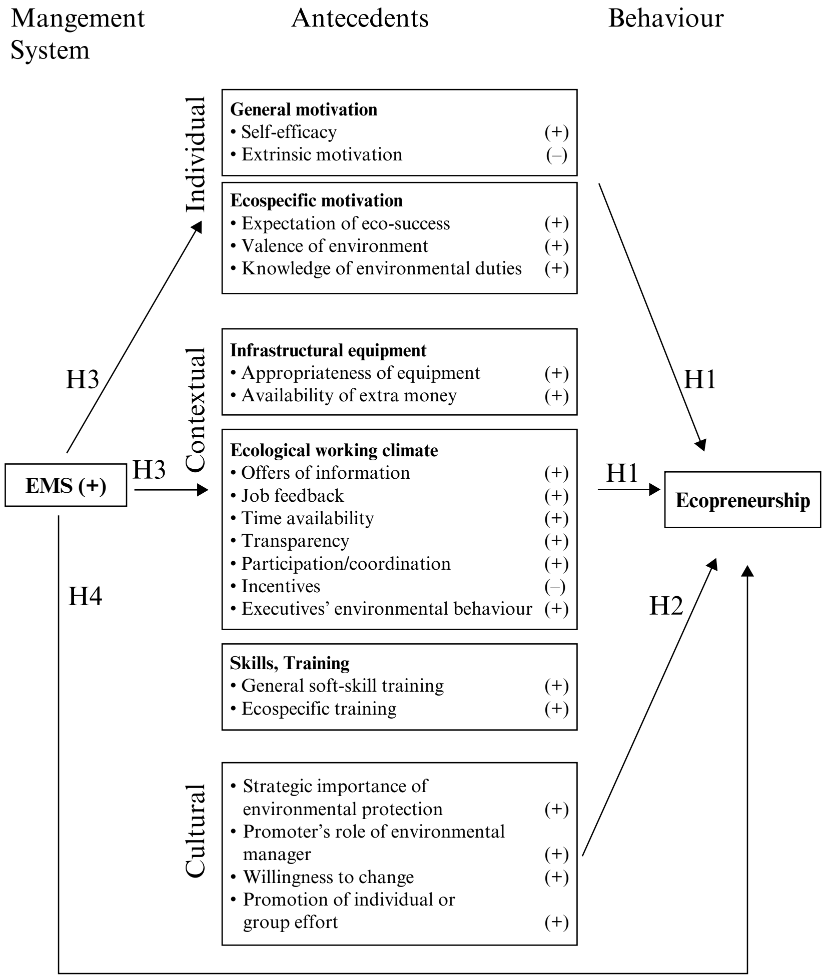


Figure 7.2 Empirical model of ecopreneurship, its antecedents and the impact of an EMS

Assuming that the itemized contextual and individual antecedents influence ecopreneurship and that those antecedents are positively influenced by an EMS, the final set of hypotheses state:

> *Hypothesis 4a: Ecopreneurship is reported as significantly higher in companies that have implemented an EMS compared to the one that had not.*

Hypothesis 4b: During the two years of research, the assessment of ecopreneurship improves significantly in companies that worked with an EMS during this time, but not in the one without an EMS.

METHODS

Sample

To find out what impact an EMS and the defined antecedents have on ecopreneurship, I conducted a two-year longitudinal study in six German manufacturing companies. An EMS had already existed for about two years in two of these companies: a small tofu production company (30 employees) and a medium-sized printing plant (90 employees). During the study period, an EMS was established by three more of the companies: a small electroplating company (40 employees), a medium-sized components supplier (190 employees) and a large metal processing plant (500 employees). One company, whose 360 employees produced lamps, did not have any EMS activities and served as the control group for the study.

This diverse set of companies offers the opportunity to study various aims and configurations of EMSs and therefore a variety of toeholds in the effort to influence ecopreneurship. Studying companies of the same size or structure would have led to an overly specific focus on EMSs and ecopreneurship. This can be useful to examine how people accept and act on one specific behaviour, such as reducing the use of toxic agricultural chemicals in the wine industry (Marshall et al., 2005: 94) or using sustainability measures to reduce costs in small and medium-sized companies (Baylis et al., 1998), but such a specific focus was not the intention in this study. To find out whether an EMS can have an impact on the various antecedents and on ecopreneurship itself, it is important to study environmental management activities that cover a variety of behavioural antecedents.

This study made use of both quantitative and qualitative methods. I started with the quantitative analysis of contextual and individual antecedents of ecopreneurship and the impact of an EMS on antecedents and behaviour. As the results of the quantitative analysis seemed to provide insufficient explanation for the observed variation of ecopreneurship, I added a qualitative analysis of cultural antecedents.

To study the contextual and individual antecedents I used a quantitative analysis. Between 1997 and 1999, I collected three rounds of data, using mainly employee questionnaires in the six companies. Employees participated voluntarily. In the smaller companies I invited all employees to participate; in the larger companies I invited a sample of employees at different hierarchical levels and in different divisions. To make it possible to compare panel data during the three collection periods for the large companies, I obtained samples of 50 to 70 respondents per company, aiming to ensure a similar mix of respondents in each division.

During the first round of data collection, 231 employees participated; 239 in round two; and 251 in round three.

To review the effects of cultural antecedents on ecopreneurship I developed a subsample of companies. My quantitative longitudinal analysis revealed that ecopreneurship developed in strikingly different ways in the tofu, electroplating and metal plants. The tofu production company had an extremely high level of ecopreneurship at the start but showed a slight decrease in proactive behaviour. The electroplating company had a low starting level of ecopreneurship but became notably more proactive. Finally the metal processing plant had began with a very low level of ecopreneurship which decreased further during the study period. In these companies I used qualitative interviews to analyse the cultural antecedents, interviewing the environmental manager and one to five employees before and after each round of data collection. At the tofu and electroplating companies I conducted three interviews with the CEO. At the metal processing company I conducted two interviews with product managers who had been at the company for more than seven years.

Measures

The analysis included two stages, one quantitative and one qualitative. In the first step I analysed the contextual and individual antecedents primarily through a regression analysis. The quantitative results allowed me to develop a significant subsample of the companies whose development of ecopreneurship was most striking. In the second stage I studied these companies' cultural antecedents using qualitative methods.

Quantitative data collection: ecopreneurship, contextual and individual antecedents

As mentioned earlier, I gathered data on the level of ecopreneurship and the perceived constitution of contextual and individual antecedents, using questionnaires three times over the course of two years. I personally distributed the questionnaires and collected them within two days. The rate of return ranged between 68 and 100 per cent. The questionnaires contained mainly closed questions; below I describe how I integrated the concepts into the questionnaires.

As my review of the literature showed, authors often claim to describe 'ecopreneurship' but seldom define it (Parker, 2000: 448f.). For this study I developed a scale for ecopreneurship that included the concepts of eco-initiatives (Schreiner, 1991: 299ff.; Ramus and Steger, 2000), general proactive working behaviour (Frese et al., 1996: 46) and environmental working behaviour (Hammerl, 1994; Kastenholz, 1994; Huse, 1996; Schumann, 1997; Ewers and Meynen, 1998; Steinheider et al., 1999). I also screened definitions of environmental policies (for example, Günther, 1995: 16; Oktoberdruck, 1995: 6) and conducted interviews with 15 experts in the field: three German EMS consultants, three EMS auditors, six German environmental managers and three German and Swiss scholars on EMS.

To develop my ecopreneurship scale, I used an explorative principal component analysis with varimaxrotation (eigenvalue >1); this process produced a scale with four items ($\alpha 1$: 0.70; $\alpha 2$: 0.70; $\alpha 3$: 0.62). Using the scale, employees were asked to answer four sets of questions regarding their work behaviour related to the environment: how often did they make suggestions for environmental improvement and on what topics, had they changed their relevant work behaviour, how often did they inform themselves about developments and potential changes, and how often did they make contact with others to consider engaging in ecological activities? (see Appendix 7A1, Table 7A1.1)

To identify the most important antecedents for ecopreneurship, I reviewed the research literature on personal environmental behaviour (Ajzen and Fishbein, 1980; Fietkau and Kessel, 1981: 9; Diekmann and Preisendörfer, 1992; Kaufmann-Hayoz, 1996: 510ff.; Homburg and Matthies, 1998: 139) and work-related environmental behaviour (Wiendieck and Franke, 1993: 826; Hopfenbeck and Willig, 1995; Antes, 1996: 93ff.; Huse, 1996; Schumann, 1997; Wella, 1998: 51; Schinnenburg and Funck, 1999; Ramus and Steger, 2000). I also drew on the 15 interviews with experts, described earlier.

For the three dimensions, I adopted items from six existing instruments: the Job Diagnostic Survey (Hackman and Oldham, 1975), Subjective Work Analysis (Udris and Alioth, 1980), the Instrument for Stress-orientated Work Analysis (Semmer, 1984), the Brief Questionnaire for Work Analysis (Prümper et al., 1995), the Michigan Organizational Assessment Questionnaire (Camman et al., 1980) and a test of environmental attitudes developed by Kley and Fietkau (1979). Using a 6-point Likert scale, I asked interviewees to note how strongly they agreed with statements about the quality of the antecedents in their company (1 = very good; 6 = very poor). For items related to qualification, the scale included a seventh possible answer: 'training not offered'.

Quantitative data analysis

For all three datasets, I ran an explorative principal component analysis with varimaxrotation (eigenvalue >1), using Cronbach's alpha as the reliability coefficient. The component analysis yielded seven contextual factors, which are named after well-known behaviour antecedents of the literature review (see the section on Antecedents of Ecopreneurship, above): appropriateness of working equipment, availability of extra money for environmental initiatives, availability of time, transparency of corporate environmental management activities, incentives, general soft-skill training and ecospecific training.

The component analysis suggested one further factor, combining several items of diverse content. I decided to ignore this statistical combination and separated it into four, because in the interviews and literature, these four factors were always distinguished: management offers of information, job feedback, participation and coordination, and executive behaviour.

A further factor analysis revealed five personal factors: expectation of eco-success, valence of nature and environment, knowledge about environmental duties at work, self-efficacy and extrinsic motivation (see Appendix 7A1, Table 7A1.2).

Qualitative data collection and analysis: cultural antecedents

In addition to the quantitative results, I also used qualitative methods to gather information about the development of the EMS, ecopreneurship and its antecedents and about the corporate culture. Over the two years of the study I conducted 42 interviews with employees, 23 with environmental officers and 15 with company directors. The semi-structured interviews contained questions about how interviewees experienced the development of an EMS (what measures were taken, what main changes took place), about their interpretation of observed changes of ecopreneurship and its antecedents, and about the company's cultural indicators.

To understand the strategic importance of environmental protection to these six firms, I asked about the firm's business development over the past three years, plans for the next three years and the role that environmental management played in this development. To understand the role that environmental managers were playing as promoters, I asked about organizational configuration, the boundaries of individual decision-making authority, and their perceived persuasive power. I used the positive or negative associations between changes during the last three years and the coming three years as indicators of the individuals' willingness to change. In order to understand how the company promotes individual initiative, I asked them for examples of striking individual activities and their practical and social consequences. I also asked them to assess the current level of such engagement and the level of perceived individual authority.

Finally, I analysed company documents about the EMS (policy statements, job instructions, action plans), and about training and general management activities (strategic initiatives, restructuring) to understand the actions that were implemented and the organizational culture.

Using the survey-feedback method (Bowers, 1973), after each round of data collection I presented the results to the management and employees at each company, and discussed with them my interpretations of the observed changes.

RESULTS

I report the results in four sections: quantitative findings about contextual and individual antecedents and their impact on ecopreneurship, qualitative findings about cultural antecedents and their impact on ecopreneurship, the impact of an EMS on contextual and individual antecedents and behaviour, and longitudinal changes of antecedents and ecopreneurship.

Quantitative Results: Contextual and Individual Antecedents of Ecopreneurship

To determine the importance of the contextual and individual antecedents of ecopreneurship, I ran correlation and regression analyses using an overall sample that combined the non-identical, independent samples of the two last data collection rounds. The sample collected in round 3 was supplemented by the samples from the large companies in round 2. The large-company samples contained a comparable but different set of employees in each round, so I could combine the sample of round 3 ($n = 251$) with the non-identical ones of the big companies in round 2 (n non-identical = 121), making a total of 372 respondents. (See Table 7.1.)

In the network of antecedents that emerged from this analysis some interesting connections appear between contextual and individual factors. The correlation analysis revealed weak relationships between the variables of resources (appropriateness of equipment, availability of money) and the other antecedents of ecopreneurship. The need for money and appropriateness of equipment – for example, for technical solutions to environmental problems – seems to be independent from the organizational measures taken (Hamschmidt and Dyllick, 2006).

The correlation analysis reveals strong correlations between the climate variables; these might justify treating them as one scale in future studies. Most striking are the strong relationships between two variables – managerial offers of information and transparency of environmental activities at work – and the other antecedents of ecopreneurship. The orientation of

Table 7.1 Correlations of antecedents of ecopreneurship

Dimension	Variable	1. Ecopreneurship	2. Appropriateness of equipment	3. Extra money	4. Information	5. Job feedback	6. Time available
Resources	2. Appropriateness of equipment	n.s.					
	3. Extra money	n.s.	0.230**				
Organizational climate	4. Information	0.349**	0.099	0.202**			
	5. Job feedback	0.194*	−0.016	0.167**	0.503**		
	6. Time available	0.244**	0.114*	0.180**	0.654**	0.456**	
	7. Transparency	0.425**	−0.067	0.057	0.678**	0.420**	0.506**
	8. Participation	0.269**	0.092	0.174**	0.700**	0.587**	0.724**
	9. Incentives	n.s.	0.017	0.047	0.474**	0.608**	0.465**
	10. Executives' environmental behaviour	0.219**	0.124*	0.193**	0.725**	0.462**	0.629**
Training	11. Soft-skill training	0.360**	0.044	0.013	0.371**	0.196**	0.296**
	12. Ecospecific training	0.400**	0.031	0.053	0.407**	0.227**	0.352**
Ecospecific motivation	13. Expectation of eco-success	0.251**	0.253**	0.353**	0.370**	0.189**	0.278**
	14. Valence of nature and environment	0.157**	0.058	0.198**	0.019	0.142**	0.001
	15. Knowledge of environmental duties at work	0.193**	0.033	0.132*	0.355**	0.169**	0.238**
General motivation	16. Self-efficacy	0.318**	−0.069	−0.036	0.335**	0.167**	0.223**
	17. Extrinsic motivation	−0.189**	−0.155*	−0.219**	−0.300**	−0.263**	−0.222**

7. Transparency	8. Participation	9. Incentives	10. Executives' environmental behaviour	11. Soft-skill training	12. Ecospecific training	13. Expectation of eco-success	14. Valence of nature and environment	15. Knowledge of environmental duties at work	16. Self-efficacy
0.513**									
0.355**	0.584**								
0.520**	0.643**	0.416**							
0.361**	0.323**	0.254**	0.275**						
0.438**	0.338**	0.222**	0.349**	0.663**					
0.273**	0.363**	0.106	0.254**	0.175**	0.151**				
0.003	0.064	0.050	−0.016	0.012	0.015	0.298**			
0.308**	0.270**	0.144**	0.283**	0.074	0.150**	0.209**	0.116*		
0.393**	0.290**	0.172**	0.185**	0.235**	0.150**	0.221**	0.053	0.251**	
−0.292**	−0.319**	−0.234**	−0.350**	−0.196**	−0.152**	−0.228**	−0.153**	−0.192**	−0.254**

Note: Pearson correlations, non-identical samples rounds 2 and 3, $N = 372$, $* = p \leq 0.05$, $** = p \leq 0.01$.

environmental business activities seems to be a unifying characteristic of antecedents of proactive environmental behaviour.

The variables measuring ecospecific motivation are strongly correlated with the other antecedents of ecopreneurship. Only one, valence of nature and the environment, does not correlate, indicating that it might be an individual antecedent that is not likely to be influenced by organizational antecedents.

The two variables of general motivation (extrinsic motivation and self-efficacy) have very different relationships with the other antecedents of ecopreneurship. Self-efficacy has positive correlations with the other variables, while extrinsic motivation has negative correlations. Respondents who are mainly interested in the financial benefits of their work see resources, working climate, qualification and their own motivation less positively than those who are not extrinsically motivated.

Another interesting finding is the relationship between general and ecospecific self-efficacy. The two individual antecedents correlate significantly and positively with each other, reminiscent of the 'environmental champions' described by Walley and Stubbs (1999: 27). They also correlate with the managers' offers of information and transparency of environmental activities at work variables, but not with incentives and training. Self-efficacy and influence seems to be linked more with the orientation about environmental management activities than with the typical personal promotions.

The correlations between contextual and individual antecedents and ecopreneurship give a first hint towards the testing of Hypotheses (H) 1a 1–14: as predicted, almost all antecedents have significant and positive correlations with ecopreneurship. Only appropriateness of equipment and availability of extra money (resources) have an unexpected relationship to ecopreneurship: H1a 1–2 cannot be confirmed because no significant correlations were revealed. A proactive environmental working behaviour is not correlated with either working equipment meeting environmental necessities or the availability of extra money.

As expected, incentives and extrinsic motivation were not positively correlated with ecopreneurship (H1b 1–2). Thus the assumption of H1b 2 – that extrinsic motivation has a significant negative correlation with ecopreneurship – was confirmed. But incentives were not significantly correlated with ecopreneurship (H1b 1). Respondents interested in the financial benefits of their job do not report as much proactive behaviour as respondents who are less extrinsically orientated.

To eliminate distortions in the explanation caused by intercorrelations between the antecedent variables, I conducted a multiple regression analysis using the same non-identical, independent samples as in the correlation analysis (372 respondents). The regression analysis integrated only one

Table 7.2 Predictors for ecopreneurship, multiple regression analysis

Predictors of the multiple regression analysis ($N = 372$)	β	T	Sig. T	R^2
Transparency	0.305	5.063	0	0.207
Ecospecific training	0.248	4.618	0	0.254
Self-efficacy	0.190	3.668	0	0.287
Valence of nature and environment	0.143	2.957	0.003	0.306
Incentives	−0.105	−2.039	0.042	0.315

main explaining variable for each dimension in the equation (see Table 7.2). That indicates a similar content of the variables within one dimension.

The antecedents can explain 31 per cent of the variance in ecopreneurship. The variable that best explains the antecedents for ecopreneurship is transparency of environmental business activities, accounting for 20 per cent of the variance in behaviours. Transparency provides a positive orientation to environmental business activities and the feeling of being part of a larger effort. On the other hand, not knowing whether other employees also participate in making environmental changes and whether one's actions have good or poor results can lead employees to a situation of discouraging insecurity: 'Is my effort worth it, if no one else is doing anything? Am I doing the right thing, or are my attempts wrong?'. Researchers have called this situation the prisoner's dilemma, because isolated prisoners have no information about the others' activities and decisions and their consequences; this leads to unsocial, egocentric behaviour that maximizes only the individual benefit (Endres, 1985: 13ff.).

The second most important variable is ecospecific training, which explains a further 5 per cent of the variation in ecopreneurship. It has a low intercorrelation with variable knowledge of environmental opportunities at one's own workplace (0.150**); this suggests that the content of ecospecific training is not so much about learning what to do. The high intercorrelation with the transparency variable (0.438**) makes it more likely that the value of ecospecific training is in learning why to do something and what the others do.

The third factor explaining the antecedents is self-efficacy, which explains a further 3 per cent of the variance. This is the only antecedent for ecopreneurship that is not specific to the environmental topic. Employees who are convinced they can make their own decisions at work and realize their own beliefs are more likely to behave as environmental activists at work. Gebert (1987: 947ff.) suggests improving self-efficacy by stimulating criticism, delegating responsibility and resources, having employees participate in solving problems, and engaging in open discourse.

The valence of nature and environment variable has a positive impact on ecopreneurship. While on the one hand it is obvious that the meaning of environmental protection is important to self-driven environmental working behaviour, it is also surprising how little explanatory value this variable has (2 per cent, in addition to the others). We can interpret this by saying that actions that improve environmental business depend less on the 'green' people in a company than on those who know why they should take action and how their colleagues are participating.

Finally, the impact of incentives on ecopreneurship is negative, as expected, confirming the findings of Sharma (2000: 692). One explanation could be that incentives convey the attitude that an employee is only responsible for something when he/she is paid for it, which destroys intrinsic motivation. Another explanation may be statistical: incentives act as a suppression variable (Bortz, 1999: 445); that is, they eliminate the irrelevant variances in other predictor variables and therefore increase their capacity for prediction. In this study, incentives only became a relevant predictor during the regression analysis, where ecospecific training was also part of the set of prediction variables. A statistical calculation conducted according to the method of Tzelgov and Henik (ibid.: 445) did not identify incentives as a suppression variable. But comparing the means for ecopreneurship with the good and poor assessments of incentives identified no significant difference in behaviour when the incentives differ (t-test, $N = 372$; $t = -1.56$; $p = 0.12$). That would suggest that incentives in themselves did not make a significant difference to ecopreneurship. They help to explain it by suppressing the demand aspect of training. An interpretation of this finding might be that ecospecific training and incentives have the aspect of demand in common. Training on environmental business activities not only conveys an orientation towards the environment and transparency about what is going on in the company. It also gives employees the feeling that they are expected to become part of these activities. This demanding aspect of qualifications can impair the ability of ecopreneurship to explain the variance in qualification.

In any case, the negative connection between incentives and ecopreneurship can be understood as the negative impact that control-orientated activities can have on voluntary, self-motivated behaviour.

Given these results, Hypotheses 1a and 1b were shown to be accurate to some extent (see Appendix 7A2, Table 7A2.1). The variables of four factors – organizational climate (H1a 3–8), training (H1a 9–10), ecospecific motivation (H1a 11–12) and general motivation (H1a 13–14) – have significant positive correlations with ecopreneurship. Only the variables of the factor resources – appropriateness of equipment and availability of extra money (H1a 1–2) – have no expected correlations. The variable of incentives has no significant correlation with ecopreneurship – H1b 1 cannot be confirmed. Extrinsic motivation has a significant negative correlation with ecopreneurship – H1b 2 can be confirmed.

The regression analysis validates all the model factors but not all the variables. A positive orientation towards environmental management activities seems to be the most important unifying factor for ecopreneurship.

Qualitative Results: The Cultural Antecedents of Ecopreneurship

I analysed the corporate culture indicators of the three sample companies where I found striking developments in ecopreneurship. To review, the tofu manufacturer started with a high level of ecopreneurship and decreased its activities; the electroplating company started at a middle level and showed the strongest increase; while the metal processor started at a low level and actually decreased its level of ecopreneurship (see Figure 7.3).

On the basis of the 15 individual interviews, my observations at the companies and the group discussions, I compared the characteristics of the four cultural indicators in the three selected companies: strategic importance of environmental protection, environmental manager's role as promoter, willingness to change, and promotion of individual or group effort (see Figure 7.4).

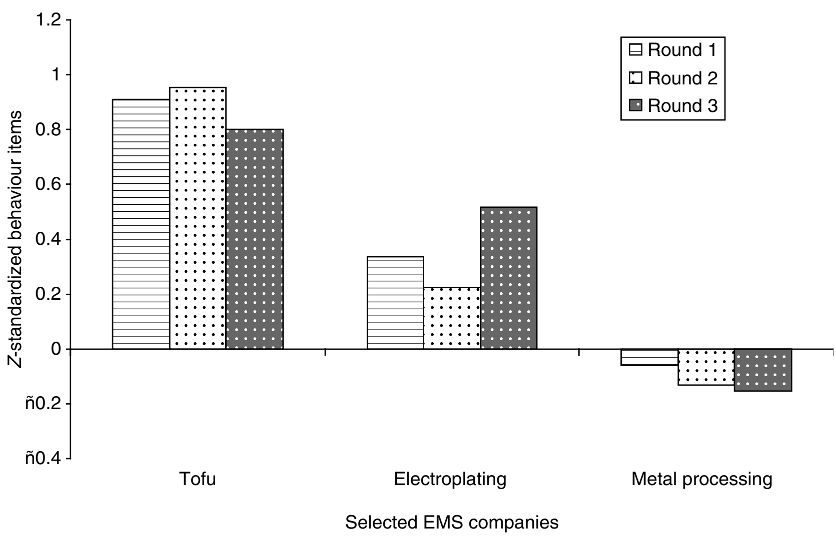
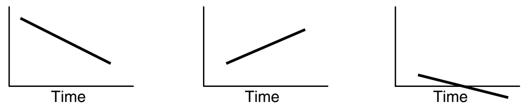


Figure 7.3 Three companies where ecopreneurship developed in striking ways



Cultural assumptions	Cultural indicators	a. Tofu	b. Electroplating	c. Metal processing
Meaning of environmental protection	1. Importance of environmental protection in business strategy	~ Environmental business strategy normally has high meaning; now? partly superimposed	+ Latently always important, now very up-to-date	--- Almost completely superimposed
	2. Promoter role of environmental manager	~ Specialist and process manager	+ Specialist, process manager, decision maker	--- Process manager
Appreciation of change	3. Willingness to change	+ High willingness to change	---/+ Medium willingness to change	--- Low willingness to change
Appreciation of initiative-taking behaviour	4. Promotion of individual or group efforts	+ Individual employeesí own efforts appreciated	---/+ Group compliance; executives call for more individual initiative	--- No individualism appreciated; unclear development of appreciation

Figure 7.4 Selected cultural aspects in the three sample companies

The tofu company paid a medium amount of attention to environmental protection in its business strategy, because a demand for increased production forced it to shift away from its original focus on environmental themes. Its strategic initiatives for the next two years were extending its manufacturing facilities, buildings and staff and finding new European suppliers. Moreover, the role of the environmental manager is not strictly one of enforcement; he is a specialist in environmental and production matters and a process manager, facilitating decision-making groups.

Also striking at this company are the willingness to change and the autonomy of the employees. Starting with two employees in 1985, the company has 35 today. Its relatively new product line is constantly emerging and changing; therefore, so is its workflow. Employees are used to changes and participate in developing new products by testing variations of tofu every day in their lunchroom. They discuss the pros and cons of new projects very directly and openly with the executives on the lunchroom sofa. This open, autonomous atmosphere may be one reason for the high level of ecopreneurship I found at the beginning of my study. The forthcoming pressure to increase production might be one reason for the apparent decrease in ecopreneurship during the time of the study.

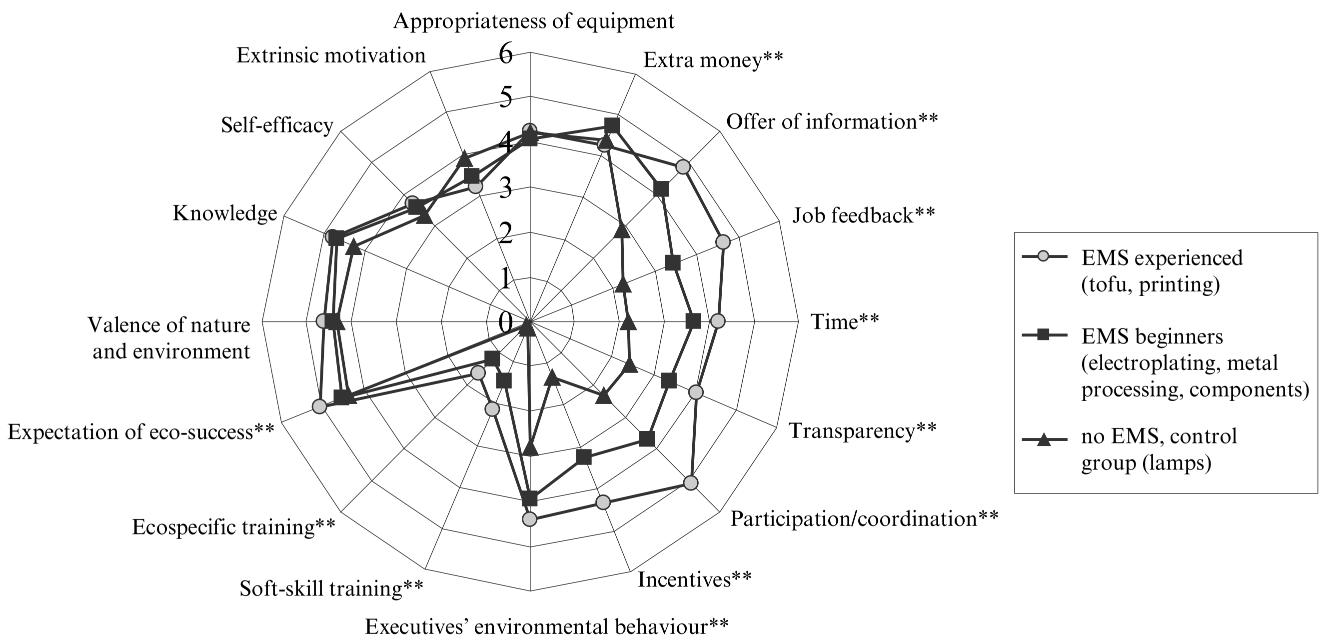
The electroplating company focused comprehensively on environmental change. The environmental manager was also the production manager, and thus able to make strategic decisions. And he did: he invested in new analytic equipment, changed the formula for the dipping-bath, renovated the room where chemicals are stored, regulated access to chemicals, and tried to convince customers to select less environmentally critical products. Environmental protection became meaningful to the company's strategy because of a chemical accident that almost forced it to close down. But, unlike the tofu plant, this firm has little tradition of change or individual behaviour choices. The chairman and the environmental manager are both young and new to the company; they began to establish a participative style of leadership and a willingness to change. But about a third of the employees were long-established workers, there for more than 13 years, and not at all used to such changes. While the younger employees embraced the development, the older ones were afraid of new and different demands (for example, handling new analysis apparatus). The lack of a tradition of change and autonomy could explain the middle level of ecopreneurship the company revealed during the first round of my survey. The high value placed on environmental improvement, coupled with the environmental manager's strong promoter role, could explain the increase of ecopreneurship during the period of the study.

The metal processing plant went through a period of reorganization during this study: one division was sold three times during those two years. In that context, environmental protection became a lower priority; the environmental manager could gain little access to the executives who were busily arranging the reorganization. His decisions were often foiled by sudden organizational changes such as the suspension of the environmental delegates. Because of the insecurity caused by the organizational changes, and the need for stability, employees were not willing to face further change. New environmental demands at work made them more insecure and nervous. The previous management had established an autocratic leadership style, so the company had no tradition of autonomy and individual decision making. This could explain the low level of ecopreneurship I found there at first. The all-absorbing efforts at reorganization could explain the further decrease of ecopreneurship.

These findings support the second set of hypotheses. The promotion of individual efforts (H2c) and the willingness to change (H2d) probably serve as the individual basis for ecopreneurship. The strategic importance of environmental protection (H2a) and the environmental manager's role as promoter (H2b) seem to influence the further development of the behaviour.

Impact of an EMS

To analyse the impact that an EMS had on ecopreneurship and its contextual and individual antecedents I compared the independent variables and



Note: ** = $p \leq 0.001$.

Figure 7.5 Differences in assessment of antecedents, according to EMS status behaviour of the five sample companies and the one control company, and the ways they developed during the three survey rounds.

Given H3a and H4a, I expected to find higher scores on the antecedents and ecopreneurship in the survey companies than in the control company.

I tested H3a 1–16, H3b and H4a by comparing the assessment of antecedents and behaviour in the companies with an EMS and the control company. To conduct this test I clustered the sample companies into three groups: EMS experienced (tofu, printing plant), EMS beginners (electroplating, metal processing, components supplier) and the control company without an EMS (lamps). I used a non-parametric *H*-test (Kruskal and Wallis: Bortz, 1999) to compare the assessment of antecedents and behaviour for these clusters in each survey round (see Tables 7A3.1–3, Appendix 7A3). I chose to use the *H*-test because some of the samples were small (25 respondents) and some items were not normally distributed.

The test results show that the more mature an EMS is, the more highly its employees assess the contextual antecedents. Table 7A3.3 shows examples of the assessment within the three clusters in round 3. In all three rounds the employees assessed the organizational climate and the training as significantly better in the companies experienced with an EMS than in the EMS beginners. And in all five companies the employees assessed them as being significantly better than in the control company.

It is interesting to observe that the results for most individual antecedents – ecospecific motivation and general motivation – do not differ according to EMS status. Probably the individual variables are less affected by a new management system than the contextual ones.

The EMS makes a difference to the most important predictors of ecopreneurship: transparency and ecospecific training are rated significantly more highly the more mature an EMS is. The less important predictors – valence of nature and environment, and self-efficacy – are not assessed as differently; but incentives are.

The same picture applies to ecopreneurship itself: the more mature an EMS is, the more examples of environmental activities the employees could name (see Figure 7.6).

A statistical *H*-test (Kruskal and Wallis: Bortz, 1999) showed that in all three survey rounds, ecopreneurship was significantly higher in the EMS-experienced companies than in the EMS beginners; they also had significantly more activities than the control company. My questionnaire asked for examples of such behaviour, and the examples below are typical:

- use a shorter pretreatment process (electroplating);
- reuse the test splash (components supplier);

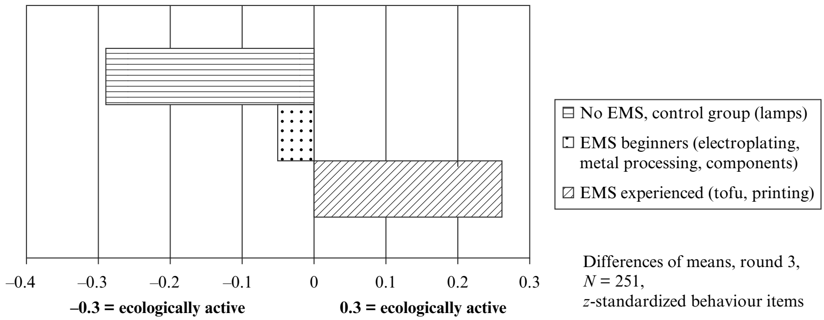


Figure 7.6 Differences in ecopreneurship according to EMS status

- use washing machines to clean the production equipment;
- use rainwater for washing;
- return packaging to the messenger;
- install apparatus to stop water flow at water tube;
- let barrel plate rotate to get rid of liquid chemicals;
- take a break when the production on a specially adjusted machine is finished;
- pack various product types one after the other, when no adjustment of machines is necessary;
- clean the leach container to keep leach clean and of constant quality; and
- get information from a colleague about his/her product plans, to plan own work.

Given these findings, H3a 2–12 and H4a can be verified. Respondents at companies with an EMS assess most contextual antecedents of ecopreneurship more highly and show more proactive behaviour than those at the company without an EMS. Only the appropriate equipment is not assessed better in EMS companies, contradicting H3a 1. The individual antecedents were not significantly better assessed in the companies with an EMS than in the one without. H3a 13–15 cannot be confirmed, H3b is verified.

One way to explain these differences in assessment may be that an EMS influences the contextual antecedents, but has less and slower influence on the individual antecedents.

Longitudinal Changes

H3c–f and H4b predicted that ratings of most antecedents and ecopreneurship would improve significantly over time in companies with an EMS but not in the one without. To test these hypotheses, I compared the development of antecedents and behaviour at the five EMS companies across the two years of the study, conducting a non-parametric *U*-test (Mann and Whitney: Bortz, 1999) to find significant changes. I also compared the changes in the EMS companies to those in the control group, also by means of a non-parametric *U*-test.

During the two years, the assessments of ecopreneurship and of the antecedents did not simply increase as the EMS developed; instead, the patterns differed according to developments at each company.

Table 7.3 shows the differences in means and their significances, at the EMS companies and the control company over the two years.

In the EMS companies the assessments increased for almost all the contextual antecedents. The *U*-test showed that several variables' improvements were significant: management offers of information, time availability, transparency of environmental activities at work, and participation. Obvious changes in the other antecedents may reflect shifts at only one or two companies, not in the entire sample over time. For example, the strong decrease in the job feedback variable was triggered by falling assessments at the metal processing company, as it underwent reorganization during the study and management provided little information about environmental issues. Interestingly, ecospecific training did not show improvement in any of the companies.

Individual antecedents did not change as strongly as the contextual ones. In fact, the expectation of eco-success and the valence of nature and environment actually decreased, although these changes are not significant across the entire sample. The decreased expectation of eco-success is again due to the reorganization at the metal processing plant. Interviewees explained the decrease in the valence of nature and environment as great enthusiasm when the company began its EMS programme and a more realistic later attitude about what it could achieve in what time frame.

Overall, the level of ecopreneurship decreased significantly over time. Interviewees explained that after realizing an environmental effort during the first survey round, they needed some time to become familiar with the change, experience the consequences and analyse possibilities for further improvement. And of course the efforts that were noted in the first survey – such as more exact cuts of tofu or a more accurate cleaning of metal products – became a routine, not noted again in the second and third rounds. Therefore, a company's level of environmental activities might have continued to rise, but the level of new activities – the ecopreneurship – diminished, in a phenomenon such as the 'constructive dissatisfaction' described by Bruggemann (1974).

Table 7.3 Differences of means in EMS companies and control company during the research period (means)

Factor dimensions	Antecedents: 1 = very good; 6 = very poor Ecopreneurship: the higher the Z-scores = the more active	EMS companies: tofu, electroplating metal processing, components Round 1, $N = 167$	Round 3, $N = 169$	Significance of means' differences for EMS companies (non-parametric U-test, Mann and Whitney)	Control company: lamps Round 1, $N = 49$	Round 3, $N = 49$	Significance of means' differences for control company (non-parametric U-test, Mann and Whitney)
Resources	Appropriateness of equipment	3.07	2.92	n.s.	3.36	2.82	n.s.
	Availability of extra money	2.45	2.30	n.s.	2.42	2.63	n.s.
Organizational climate	Management offers of information	3.23	2.76	0.001	4.21	4.13	n.s.
	Job feedback	3.21	3.39	n.s.	4.98	4.75	n.s.
	Time availability	3.79	3.28	0.003	4.52	4.81	n.s.
	Transparency of corporate environmental management activities	3.93	3.51	0.004	4.66	4.57	n.s.
	Participation/coordination	3.47	3.11	0.022	4.77	4.69	n.s.
	Incentives	3.76	3.64	n.s.	5.60	5.67	n.s.
	Executives' own pro-environmental behaviour	3.20	2.95	n.s.	4.32	4.21	n.s.
Training	Soft-skill training	5.35	5.40	n.s.	6.74	6.86	n.s.
	Ecospecific training	5.70	5.71	n.s.	6.87	6.89	n.s.

Ecospecific motivation	Expectation of eco-success	2.31	2.36	n.s.	2.51	2.62	n.s.
	Valence of nature and environment	2.40	2.56	n.s.	2.80	2.70	n.s.
	Knowledge of environmental work duties	Not determined	2.29	Not determined	Not determined	2.72	Not determined
General motivation	Self-efficacy	3.33	3.39	n.s.	3.65	3.66	n.s.
	Extrinsic motivation	4.04	3.79	n.s.	3.87	3.27	0.049*
Ecopreneurship, z-standardized		0.098	0.079	0.046	−0.25	−0.28	n.s.

Note: * = $0.001 \geq p \leq 0.005$; n.s. = not significant.

The changes in the control group were not as systematic and as strong as those in the EMS companies. Striking findings were the increase in several variables: appropriateness of equipment, job feedback, valence of environment and nature and extrinsic motivation. Except for the increase in extrinsic motivation, none of the differences was significant. The employees probably rated their working equipment as being more environmentally appropriate because the company shifted to a less toxic glue and reactivated its waste separation process. Interviewees explained their improved ratings on job feedback and valence of environment and nature in a discussion after I presented my results. They did not have an environmental management but it became a topic at this company because of the research. I could not explain the increased score for extrinsic motivation but it might have developed because the employees replied with more confidence. Finally, the score for ecopreneurship decreased slightly.

Given these findings, the survey verified H3c–f 1–15 and H4b only partially (see Table 7A2.2 in Appendix 7A2). The employees gave a slightly higher assessment of the antecedents but it was not systematic across all the samples. The scores for ecopreneurship fluctuated; this can be explained by two phenomena: the volatility of extraordinary efforts and constructive dissatisfaction. Extraordinary behaviour is not seen all the time – as the term already suggests. It describes special activities that take some time to develop out of experiences and more time to be tested and implemented. Thus extraordinary efforts are volatile. As soon as the extraordinary behaviour becomes standard, people no longer experience it as extraordinary – and they do not report it on the questionnaires.

DISCUSSION: DO WE REALLY WANT INTERNAL ECOPRENEURS?

This study showed that the most important predictors of ecopreneurship are transparency and ecospecific training that orientates employees to the rationale and procedures for environmentally sound business activities. These findings coincide with those of Ramus and Steger (2000), who identify the two most important factors in ecoinitiatives as building environmental competence through training, and developing environmental communication (creating a 'we' feeling, developing open and direct lines of communication, Ramus, 2002: 156): 'Transparency and open communication, both internal and external, will make it easier to promote the environmental awareness and understanding of employees and customers' (OSRAM, 2006: 8).

Two of the individual antecedents – valence of nature and environment, and self-efficacy – influence ecopreneurship positively, while incentives are negatively linked to ecopreneurship. This may be explained by a statistical suppression effect, explained above, which emphasizes the importance of a self-determined work climate.

Certain aspects of corporate culture are most likely linked to the development of ecopreneurship: these include the strategic meaning the company places on environmental protection, the willingness to change, and the appreciation of employees taking the initiative. This finding coincides with those of other studies. Rennings et al. (2003) found that when companies place strategic importance on an EMS, it had an impact on environmental innovations. Ramus and Steger (2000), in a study of 353 employees, found that supervisor behaviours – having ‘openness to new environmental ideas’ and ‘sharing goals and responsibilities’ – had a particular impact; these are very similar to the cultural indicators that were key in this survey.

During the two years of my study, antecedents tended to develop more fully in the companies with EMS activities than in the control company that had no EMS plan. An explanation for this could be found in the phase model for the temporal development of EMS programmes (see Kottmann et al., 1999). It proposes that in phase one the company is installing the formal elements of the EMS; in phase two, the technical and organizational processes are analysed and reorganized; and in phase three the facility-related EMS broadens, becoming more cooperative.

My findings support the findings of other research. In a longitudinal survey over two years, Bradford et al. (2000) studied the development of ecopreneurship and its antecedents in six German companies at different stages of EMS implementation. They found that the more mature an EMS was, the more highly the employees assessed the antecedents and ecopreneurship within that company.

Rennings et al. (2003) surveyed 1,277 facilities and found that the age of an EMS had a positive influence on organizational development. That is similar to the enhancement of contextual antecedents found in this study.

The scores for ecopreneurship itself did not increase consistently over the two years of the study. Three explanations can be offered for the unequal development of antecedents and behaviour. The first is the volatility of a proactive behaviour: new efforts are followed by a period of observing, analysing and generating new ideas. The second is constructive dissatisfaction: after some time, improvements come to be seen as normal. The third is the lack of time between the development of antecedents and their translation into action.

For further analysis of the long-term influence and development of ecopreneurship, future studies should concentrate on a congruent definition of behaviour and antecedents, making it possible to compare different research findings. The definitions and items used in this study seem applicable but the climate variables might be clustered differently. A longitudinal survey should be conducted with a larger sample, making it possible to compensate company-specific developments. Studies should also be conducted over a longer period of time in order to capture more behavioural responses over time and gain more insights into the volatility of ecopreneurship. The strategic importance of environmental protection, the willingness to change, and the promotion of individual and group efforts are obviously linked to the development of ecopreneurship in the three companies that were qualitatively examined. This pattern should be investigated in more companies to see whether these findings can be generalized and replicated.

Finally, an interesting issue arose within the participating companies: my findings showed that an atmosphere of command and control seems to be counterproductive for ecopreneurship, even when it is combined with incentives. Instead, factors that seem to best facilitate ecopreneurship include a culture of autonomy and change, and an emphasis on environmental protection in the overall business strategy. The environmental manager should have a strong role as promoter. To improve ecopreneurship, companies and consultants should consider the link between the cultural aspects: the more important environmental protection is in the business strategy, the more likely it is that the environmental manager will have a strong role as promoter. But the more that environmental manager behaves as an enforcer, the greater the potential for conflict with autonomously orientated employees. To increase ecopreneurship it is important to consider the combination of cultural aspects and ensure that the EMS fits into the corporate culture.

Given all these findings, a company may well raise this question: can we afford to provide all this? Companies should consider their corporate culture and sustainable aims before they define their behavioural expectations for their employees and design an EMS. Does a company really want ecopreneurs? Does the corporate culture welcome self-driven, responsibility-demanding employees, who are more willing to act according to their own motivation than to a system of command and control? Can the management offer a lot of freedom to support ecopreneurs? It should not be a cause for shame but simply a sign of neutrality if a company answers these questions by saying no.

Figure 7.7 provides alternative design possibilities for EMS programmes, corresponding to the culture of a given company.

My findings about the ways in which antecedents develop suggests that employees are aware of changes that take place. Ramus and Steger (2000) conclude, from their research on ecoinitiatives, that EMS programmes sensitize employees to the support that their supervisors are offering.

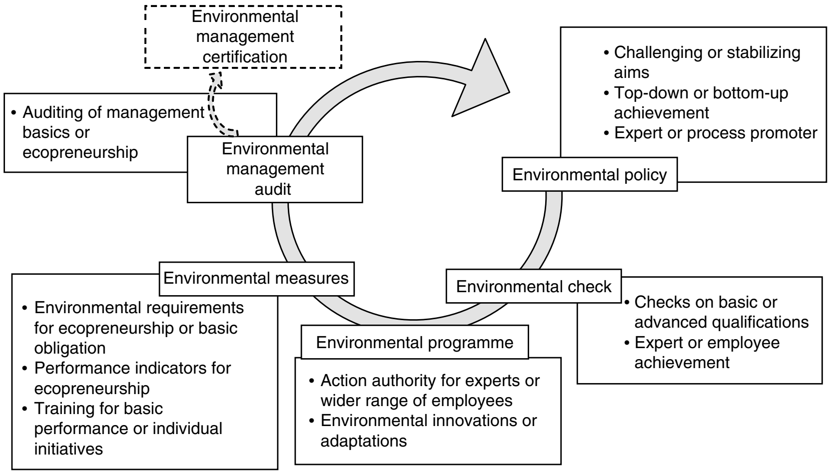


Figure 7.7 Alternatives to consider in designing an EMS

Employees are aware of announcements that are made but not implemented adequately. It seems worthwhile to decide – based on the corporate culture – whether a company may be demanding not ecopreneurs but reliable performers. In that case, the EMS design should fit these demands: the environmental policy should not speak about 'employees who take responsibility for our efforts towards environmental improvement' but about 'employees we can rely on to realize our environmental aims and projects'.

The environmental check needs no focus on sophisticated environmental know-how among most of the employees – which can make respondents nervous – but rather on basic qualifications. The environmental programme should concentrate on having experts who are competent to make important decisions rather than having all employees try to meet that kind of expectation.

CONCLUSION

Before this study, little empirical work analysed the comprehensive contextual, individual and cultural factors behind ecopreneurship, and the impact that an EMS has on these antecedents, on proactive behaviour, and on their long-term development. This study provides preliminary evidence that the antecedents of ecopreneurship, in all three dimensions, are linked with proactive behaviour and influence one another. Companies should be aware of the relationships between the antecedents and should frame their expectations about the environmental behaviour of employees according to their initial position in this constellation. In particular, the remarks about cultural antecedents in this chapter may explain this necessitiy. Furthermore, companies should design their EMS programmes to fit with their initial position on ecopreneurship. On this basis an environmental policy and programme may frame aims that motivate and measures that support the majority of employees and management.

REFERENCES

Ajzen, I. and Fishbein, M. (1980), *Understanding Attitudes and Predicting Social Behavior*, Englewood Cliffs: NJ: Prentice-Hall.

Antes, R. (1996), *Präventiver Umweltschutz und seine Organisation im Unternehmen*, Wiesbaden: Gabler.

Bansal, P. (2005), 'Evolving sustainably: a longitudinal study on corporate sustainable development', *Strategic Management Journal*, **26**, 197–218.

Bansal, P. and Roth, K. (2000), 'Why companies go green: a model of ecological responsiveness', *Academy of Management Journal*, **43** (4), 717–37.

Barrett, M. and Murphy, D.F. (1996), 'Managing corporate environmental policy', in Wehrmeyer, W. (ed.), pp. 75–98.

Baylis, R., Connell, L. and Flynn, A. (1998), 'Sector variation and ecological modernization: towards an analysis at the level of the firm', *Business Strategy and the Environment*, **7**, 150–61.

Bird, A. (1996), 'Training for environmental improvement', in Wehrmeyer (ed.), pp. 227–46.

Bortz, J. (1999), *Statistik für Sozialwissenschaflter*, 5, Auflage, Berlin: Springer.

Böttcher, K. (1999), *Ökologisch-innovative Unternehmensführung, Entwicklungsstand, Empirie, Gestaltungskonzept*, Mering: Rainer Hampp.

Bowers, David G. (1973), 'OD techniques and their results in 23 organizations: the Michigan ICL study', *Journal of Applied Behavioral Science*, **9** (1), 21–43.

Bradford, D., Gouldson, A., Hemmelskamp, J., Kottmann H., and Marsanich, A. (2000), *The Impact of the EU Eco-Audit Regulation on Innovation in Europe*, Institute for Prospective Technological Studies (IPTS) Report, Joint Research Centre, 8/00, Seville.

Brief, A.P. and Motowidlo, J. (1986), 'Prosocial organizational behaviours', *Academy of Management Review*, **2** (4), 710–25.

Bruggemann, A. (1974), 'Zur Unterscheidung verschiedener Formen von Arbeitszufriedenheit', *Arbeit und Leistung*, **28** S, 281–4.

Camman, C., Fichman, M., Jenkins, D. and Klesch, J. (1980), 'The Michigan Organizational Assessment Questionnaire', unpublished paper, Ann Arbor, MI, cited in Karg, P. and Staehle, W.H. (1982), *Analyse der Arbeitssituation: Verfahren und Instrumente*, Freiburg: Haufe.

Campell, J.P. and Pritchard, R.D. (1976), 'Motivation theory in industrial and organisational psychology', in Dunette, M.D. (ed.), *Handbook of Industrial and Organisational Psychology*, Chicago: Rand McNally, pp. 63–130.

Cordano, M. and Frieze, I.H. (2000), 'Pollution reduction preferences of environmental managers: applying Ajzens's theory of planned behaviour', *Academy of Management Journal*, **43** (4), 627–41.

De Young, R. (2000), 'New ways to promote proenvironmental behavior: expanding and evaluating motives for environmentally responsible behavior', *Journal of Social Issues*, **56** (3), 509–26.

Diekmann, A. and Preisendörfer, P. (1991), 'Umweltbewusstsein, ökonomische Anreize und Umweltverhalten – Empirische Befunde aus der Berner und Münchner Umweltbefragung', *Schweizerische Zeitschrift für Soziologie*, 1991/2, 207–31.

Diekmann, A. and Preisendörfer, P. (1992), 'Persönliches Umweltverhalten. Diskrepanz zwischen Anspruch und Wirklichkeit', *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, **44**, 226–51.

EMAS II (2001), *Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organisations in a Community eco-management and audit scheme (EMAS)*, Official Journal L 114 page 1 on 24 April 2001, Brussels: Amtsblatt der Europäischen Gemeinschaft.

Endres, A. (1985), *Umwelt- und Ressourcenökonomie*, Darmstadt: Wissenschaftliche Buchgesellschaft.

Ewers, E. and Meynen, C. (1998), *Ökologisches Verantwortungsbewusstsein: interindividuelle Unterschiede, Erklärungsmöglichkeiten und Zusammenhänge mit tatsächlichem Umwelthandeln*, unpublished Bachelor's thesis, Institut für Arbeits-, Organisations- und Gesundheitspsychologie (WE 10) der FU Berlin.

Feldman, St. J., Soyka, P.A. and Ameer, P. (1996), 'Does improving a firm's environmental management system and environmental performance result in a higher stock price?', ICF Kaiser International, Inc., http://www.icfi.com/Publications/doc_files/resp_pay pdf, 3 April 2007.

Fietkau, H.J. and Kessel, H. (1981), *Umweltlernen*, Königstein: Anton Hain.

Fine, A. and Cronshaw, St. F. (1999), *Functional Job Analysis: A Foundation for Human Resources Management*, Mahwah, NJ: Erlbaum.

Fishbein, M. and Ajzen, I. (1975), *Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research*, Reading, MA: Addison-Wesley.

Frese, M. (1985), 'Stress at work and psychosomatic complaints: a causal interpretation', *Journal of Applied Psychology*, **70**, 314–28.

Frese, M., Kring, W., Soose, A. and Zempel, J. (1996), 'Personal initiative at work: differences between East and West Germany', *Academy of Management Journal*, **1**, 37–63.

Gebert, D. (1987), 'Führung und Innovation', *Zeitschrift für Betriebswirtschaft*, **10**, 941–51.

George, J.M. and Brief, A.P. (1992), 'Feeling good – doing good: a conceptual analysis of the mood at work–organizational spontaneity relationship', *Psychological Bulletin*, **112**, 310–29.

Guagano, G.A., Stern, P.C. and Dietz, T. (1995), 'Influences on attitude–behavior relationship: a natural experiment with curbside recycling', *Environment and Behavior*, **5**, 699–718.

Günther GmbH (1995), *Umwelterklärung*, Lengerich.

Hackman, J.R. and Oldham, G.R. (1975), 'Development of the Job Diagnostic Survey', *Journal of Applied Psychology*, **60**, 159–70.

Hackman, J.R. and Oldham, G.R. (1980), *Work Redesign*, Reading, MA: Addison-Wesley.

Hallay, H. (1996), *Ökologische Entwicklungsfähigkeit von Unternehmen*, Marburg: Metropolis.

Hammerl, B.M. (1994), *Umweltbewusstsein in Unternehmen, eine empirische Analyse des Umweltbewusstseins im Rahmen der Unternehmenskultur*, Frankfurt a.M.: Peter Lang.

Hamschmidt, J. and Dyllick, Th. (1999), *ISO 14001 in der Praxis; Wirkungen von Umweltmanagementsystemen in Schweizer Unternehmen*, Institut für Wirtschaft und Ökologie Discussion Paper 75, St. Gallen: IWÖ-HSG.

Hamschmidt, J. and Dyllick, Th. (2006), 'ISO 14001: Profitable? Yes? But is it eco-effective?', in Schaltegger, S. and Wagner, M. (eds), *Managing the Business Case for Sustainability*, Sheffield: Greenleaf, pp. 554–68.

Hart, S.L. (1995), 'A natural-resource-based view of the firm', *Academy of Management Review*, **20**, 986–1014.

Hauschild, J. and Chakrabarti, A.K. (1988), 'Arbeitsteilungen im Innovationsmanagement – Forschungsergebnisse, Kriterien und Modelle', *Zeitschrift für Führung und Organisation*, **57**, 378–88.

Hedstrom, G.S. (1996), 'Foreword', in Wehrmeyer, W. (ed.), pp. 9–10.

Hines, J.M., Hungerford, H.R. and Tomeran, A.A. (1986), 'Analysis and synthesis of research on responsible environmental behavior: a meta-analysis', *Journal of Environmental Education*, **2**, 1–8.

Hoffman, A.J. (2005), *Prepare for the Pew Center on Global Climate Change*, Ann Arbor, MI: University of Michigan Press.

Hoffman, A.J. (2006), *Getting ahead of the Curve: Corporate Strategies that Address Climate Change*, Ann Arbor, MI: University of Michigan Press.

Homburg, A. and Matthies, E. (1998), *Umweltpsychologie: Umweltkrise, Gesellschaft und Individuum*, Weinheim/Munich: Juventa.

Hopfenbeck, W. and Willig, M. (1995), *Umweltorientiertes Personalmanagement: Umweltbildung, Motivation, Mitarbeiterkommunikation*, Landsberg/Lech: Verlag Moderne Industrie.

Höppner, N.-O., Sietz, M., Seuring, St. and Czaja, F. (1998), 'Öko-Audit-Verordnung – Ergebnisse einer Befragung validierter Unternehmen', *Umtweltwirtschaftsforum*, **2**, 73–6.

Hostager, T.J., Neil, T.C., Decker, R.L. and Lorentz, R.D. (1998), 'Seeing environmental opportunities: effects of intrapreneurial ability, efficacy, motivation and desirability', *Journal of Organizational Change Management*, **2** (1), 11–25.

Huse, K. (1996), *Entwicklung eines Instrumentariums zur Erfassung der Bestimmungsfaktoren des Umweltbewusstseins der Mitarbeiter in betrieblichen Organisationen*, Kölner Arbeiten zur Wirtschaftspsychologie (Cologne Studies on Business Psychology) (13), Frankfurt a.M.: Peter Lang.

ISO 14001 (1996), *Umweltmanagementsysteme*, Spezifikation mit Anleitung zur Anwendung (Specification with direction how to use), Berlin.

Kastenholz, H.G. (1994), *Bedingungen umweltverantwortlichen Handelns in einer Schweizer Bergregion: eine empirische Studie unter der besonderen Berücksichtigung anthropogen verursachter Klimaveränderungen*, Bern: P. Lang.

Katz, D. (1964), 'The motivational basis of organizational behaviour', *Behavioral Science*, **9**, 131–3.

Kaufmann-Hayoz, R. (1996), 'Förderung umweltverantwortlichen Handelns, Versuch einer Synthese', in Kaufmann-Hayoz, R. and Giulio, A. (eds), *Umweltproblem Mensch: Humanwissenschaftliche Zugänge zu umweltverantwortlichem Handeln*, Bern: Paul Haupt, pp. 510–36.

Klassen, R.D. and McLaughlin, C.P. (1996), 'The impact of environmental management on firm performance', *Management Science*, **42** (8), 1199–214.

Kley, J. and Fietkau, H.J. (1979), 'Verhaltenswirksame Variablen des Umweltbewusstseins', *Psychologie und Praxis*, **23**, 13–22.

Klinger, G. (1980), 'The effect of instructional sequence on the environmental action skills of a sample of southern Illinois eighth graders', Master's thesis, Southern Illinois University at Carbondale.

Kohn, A. (1993), *Punished by Rewards: The Trouble with Gold Stars, Incentive Plans, A's, Praise and Other Bribes*, New York: Houghton Mifflin.

Kollmuss, A. and Agyeman, J. (2002), 'Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior?', *Environmental Education Research*, **8** (3), 239–60.

Kolluru, R.V. (1994), *Environmental Strategies Handbook*, New York: McGraw-Hill.

Kottmann, H., Hoffmann, E. and Nill, J. (1999), 'Innovationswirkungen von Umweltmanagementsystemen – komplexer Zusammenhang', *Ökologisches Wirtschaften*, **5–6**, 30–31.

Lechler, Th. (1999), 'Was leistet das Promotoren-Modell für das Projektmanagement?', in Hauschildt, J. and Gemünde, H.G. (eds), *Promotoren: Champions der Innovation*, Wiesbaden: Gabler, pp. 180–209.

Liedtke, Ch., Jürgens, G. and Rohn, H. (1997), *Zukunftsfähiges Unternehmen (2) – Beurteilung des Öko-Audits im Hinblick auf Ressourcenmanagement in kleinen und mittleren Unternehmen – Eine Untersuchung an 13 Praxisbeispielen*, Wuppertal: Wuppertal Institute for Climate, Environment and Energy Wuppertal Paper 72.

Luyben, P.D. and Cummings, S. (1981–82), 'Motivation beverage container recycling on a college campus', *Journal of Environmental Systems*, **11**, 235–45.

MacDuffie, J.P. (1995), 'Human resource bundles and manufacturing performance: organizational logic and flexible production systems in the world auto industry', *Industrial and Labor Relations Review*, **48**, 197–221.

Maloney, M.P. and Ward, M.P. (1973), 'Ecology: let's hear from the people', *American Psychologist*, **28** (7), 583–6.

Marshall, R., Cordano, M. and Silvermann, M. (2005), 'Exploring individual and institutional drivers of proactive environmentalism in the US wine industry', *Business Strategy and the Environment*, **14**, 92–109.

Meadows D.H., Meadows, D.L. and Randers, J. (1972), *The Limits to Growth*, New York: Universe Books.

Oktoberdruck (1995), *Umwelterklärung*, Berlin: Oktoberdruck GmbH.

Organ, D.W. (1988), *Organizational Citizenship Behavior: The Good Soldier Syndrome*, Lexington, MA: Lexington Books.

Osram (2006), *Environmental Guidelines*, http://www.osram.com/osram_com/About_Us/Global_Care/OSRAM_and_the_environment/OSRAM_Environmental_Guideline html, 13 April 2006.

Parker, K. (2000), 'From passive to proactive motivation: the importance of flexible role orientations and role breadth self-efficacy', *Applied Psychology*, **3**, 447–69.

Payne, R.L., Fineman, S. and Wall, T.D. (1976), 'Organizational climate and job satisfaction: a conceptual synthesis', *Organizational Behaviour and Human Performance*, **16**, 45–62.

Peters, L.H. and O'Connor, E.J. (1980), 'Situational constraints and work outcomes: the influences of a frequently overlooked construct', *Academy of Management Review*, **5** (3), 391–7.

Petersen, H. (2000), 'Die bewegten Gründer', *Ökologisches Wirtschaften*, **2**, 4–5.

Petersen, H. and Schaltegger, S. (2000), 'Sustainopreneurship', unpublished working paper, University of Lüneburg.

Porter, M.E. and Kramer, M.R. (2006), 'Strategy and Society', Harvard Business Report, Cambridge, MA, December.

Prakash, A. (2001), 'Why do firms adapt "beyond-compliance" environmental policies?', *Business Strategy and the Environment*, **10**, 286–99.

Prehn, M., Richter, G., Schwedt, B. and Tiebler, P. (1998), 'Auswertung der Ergebnisse von Modellprojekten zur Umsetzung der EG-Umwelt-Audit-Verordnung', in Umweltbundes Amt (ed.), *Umweltmanagement in der Praxis*, Parts I–III, Texte 20/98, Berlin.

Prümper, J., Harmannsgruber, K. and Frese, M. (1995), 'KFZA. Kurz-Fragebogen zur Arbeitsanalyse', *Zeitschrift für Arbeits- und Organisationspsychologie*, **39**, 125–32.

Pugh, D.S. (1981), 'The Aston Program perspective', in Van de Ven, A.H. and Joyce, W.F. (eds), *Perspectives on Organization Design and Behaviour*, New York: John Wiley & Sons, pp. 155–66.

Ramsey, J.M. and Hungerford, H.R. (1989), 'The effects of issue investigation and action training on environmental behaviour', *Journal of Environmental Education*, **4**, 29–34.

Ramus, C.A. (2002), 'Encouraging innovative environmental actions: what companies and managers must do', *Journal of World Business*, **37** (2), 151–64.

Ramus, C.A. and Killmer, A.B. (2005), 'Corporate greening through prosocial extrarole behaviours – a conceptual framework for employee motivation', online article in advance of print in *Business Strategy and the Environment*, http://www3.interscience.wiley.com/cgi-bin/abstract/112126905/ABSTRACT/, 28 November 2005.

Ramus, C.A. and Steger, U. (2000), 'The roles of supervisory support behaviors and environmental policy in employee "ecoinitiatives" at leading-edge European companies', *Academy of Management Journal*, **47** (4), 605–26.

Rennings, K., Ziegler, A., Ankele, K., Hoffmann, E. and Nill, J. (2003), 'The influence of the EU environmental management and auditing scheme on environmental innovations and competitiveness in Germany: an analysis on the basis of case studies and a large-scale survey', Discussion Paper 03-14, Mannheim: Zentrum für Europäische Wirtschaftsforschung GmbH.

Rondinelli, D.A. and Vastag, G. (2000), 'Panacea common sense or just a label? The value of ISO 14001 environmental management system', *European Management Journal*, **18** (5), 499–510.

Ruiz-Quintanilla, A., Bunge, J., Freeman-Gallant, A. and Cohen-Rosenthal, E. (1996), 'Employee participation in pollution reduction: a socio-technical perspective', *Business Strategy and the Environment*, **5** (3), 137–44.

Schahn, J. (1993), 'Psychologische Maflnahmen zur Mülltrennung und -vermeidung', in Schahn, J. and Giesinger, Th. (eds), *Psychologie für den Umweltschutz*, Weinheim: Belzt Psychologie Verlags Union, pp. 123–32.

Schein, E.H. (1985), *Organizational Culture and Leadership*, San Francisco: Jossey-Bass.

Schinnenburg, H. and Funck, D. (2000), 'Ökologische Personalentwicklung im Handel – eine verhaltentheoretische Analyse', in Trommsdorf, V. (ed.), *Handelsforschung 1999/00, Verhalten im Handel und gegenüber dem Handel*, Annual Report for Forschungsstelle für den Handel Berlin (FfH), Wiesbaden: Gabler, pp. 81–105.

Schreiner, M. (1991), *Umweltmanagement in 22 Lektionen*, 2, revised edition, Wiesbaden: Gabler.
Schreyögg, G. (1996), *Organisation. Grundlagen moderner Organisationsgestaltung*, Wiesbaden: Gabler.
Schumann, J. (1997), 'Umweltbewusstsein und Unternehmenskultur: Entwicklung eines Fragebogens zur Erfassung der Bedingungen für umweltgerechtes Verhalten im Unternehmen', unpublished thesis, University of Hamburg, Department of Psychology.
Seidl, I. (1993), *Ökologie und Innovationen: die Rolle der Unternehmenskultur in der Agrachemie*, Bern: Haupt.
Semmer, N. (1984), *Stressbezogene Tätigkeitsanalyse: psychologische Untersuchung zur Analyse von Stress am Arbeitsplatz*, Weinheim, Basel: Beltz.
Sharma, S. (2000), 'Managerial interpretations and organizational context as predictors of corporate choice of environmental strategy', *Academy of Management Journal*, **43** (4), 681–97.
Sharma, S., Pablo, A. and Vredenburg, H. (1999), 'Corporate environmental responsiveness strategies: the importance of issue interpretation and organizational context', *Journal of Applied Behavioral Science*, **35** (1), 87–108.
Sharma, S. and Vredenburg, H. (1998), 'Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities', *Strategic Management Journal*, **19**, 729–53.
Spada, H. (1990), 'Umweltbewusste Einstellung und Verhalten', in Kurse, L., Graumann, C.F. and Lantermann. E.-D. (eds), *Ökologische Psychologie*, Munich: Psychologische Verlagsunion, pp. 623–31.
Starik, M. and Markus, A. (2000), 'Special research forum on the management of organizations in the natural environment', *Academy of Management Journal*, **43**, 539–46.
Steinheider, B., Fay, D., Hilburger, T., Hust, I., Prinz, L., Vogelsang, F. and Hormuth, S.E. (1999), 'Soziale Normen als Prädiktoren von umweltbezogenem Handeln', *Zeitschrift für Sozialpsychologie*, **30** (1), 40–56.
Taylor, S. and Todd, P. (1995), 'Understanding household garbage reduction behaviour: a test of an integrated model', *Journal of Public Policy and Marketing*, **14** (2), 192–205.
Theyel, G. (2000), 'Management practices for environmental innovation and performance', *International Journal of Operations and Production Management*, **20** (2), 249–66.
Tiebler, P. (1992), 'Unwelttrends im Konsumentenverhalten' in Steger, E. (ed.), *Handbuch des Umweltmanagements: Anforderungs- und Leistungsprofile von Unternehmen und Gesellschaft*, Munich, Beck.
Udris, I. and Alioth, A. (1980), 'Fragebogen zur "subjektiven Arbeitsanalyse" (SAA)', in Martin, E., Ackermann-Liebrich, U., Udris, I. and Oegerli, K. (eds), *Monotonie in der Industrie*, Bern: Hans Huber, pp. 61–8 and 204–7.
UNC–ELI (University of North Carolina and Environmental Law Institute) (2001), *Drivers, Designs and Consequences of Environmental Management System*, Washington, DC: Environmental Law Institute.
UNI and ASU (1997), *Öko-Audit in der mittelständischen Praxis*, Evaluation and Means to Improve Efficiency in Practice, Bonn: Unternehmerinstitut e.V./Arbeitsgemeinschaft Selbständiger Unternehmer.
Van Dyne, L., Cummings, L.L. and McLean Parks, J. (1995), 'Extrarole behaviours: in pursuit of construct and definitional clarity', in Cummings, L.L. and Staw,

B.M. (eds), *Research in Organizational Behaviour*, 17, Greenwich, CT: JAI Press, pp. 215–85.

von Rosenstiel, L. (1999), 'Mitunternehmertum – Unterstützung durch unternehmerische Kulturgestaltung', in Wunderer, R. (1999), *Mitarbeiter als Mitunternehmer*, Neuwied: Luchterhand, pp. 107–21.

Walker, L.R. and Thomas, K.W. (1982), 'Beyond expectancy theory: an integrative motivational model from health care', *Academy of Management Review*, **7** (2), 187–94.

Wall, S. (1995), 'Barriers to individual environmental action: the influence of attitudes and social experiences', *Canadian Review of Sociology and Anthropology*, **32**, 465–89.

Walley, L. and Stubbs, M. (1999), 'Greenjacking – a Tactic for the Toolbag of Environmental Champions? Reflections on an SME Success Story', *Eco-Management and Auditing*, **6** (1) 26–33.

Wehrmeyer, W. (ed.) (1996), *Greening People, Human Resources and Environmental Management*, Sheffield: Greenleaf.

Wehrmeyer, W. and Parker, K.T. (1996), 'Identification and relevance of environmental corporate cultures as part of a coherent environmental policy', in Wehrmeyer (ed.), pp. 163–84.

Weiner, B. (1986), *An Attributional Theory of Motivation and Emotion*, New York: Springer.

Wella, L. (1998), 'Innovation als Prinzip – Partizipation als Modell', in Rubelt, J. and Wayß, E. (eds), *Öko-Audit auch für kleine und mittelständische Unternehmen? Chancen, Probleme, Lösungen*, Berlin: TU Berlin, pp. 49–59.

Wiendieck, G. and Franke, I. (1993), 'Umweltschutz: Aufgabe aller Führungskräfte', *Personalführung*, **10**, 817–57.

Witte, E. (1973), *Organisation für Innovationsentscheidungen, das Promotorenmodell*, Göttingen: Otto Schwatz & Co.

Wittmann, S. (1994), 'Mehr Effizienz im Umweltmanagement: Ökologisches Empowerment', *Management-Zeitschrift IO*, **9**, 70–5.

Wright, P.M., Gardner, T.M. and Moynihan, L.M. (2003), 'The impact of HR practices on the performance of business units', *Human Resource Management Journal*, **13** (3), 21–36.

Wunderer, R. (2001), 'Employees as co-intrapreneurs? A transformation concept', *Leadership and Organization Development Journal*, **22** (5), 193–211.

Wunderer, R. and Jaritz, A. (1999), *Unternehmerisches Personalcontrolling – Evaluation der Wertschöpfung im Personalmanagement*, Neuwied: Luchterhand.

APPENDIX 7A1

Table 7A1.1 Ecopreneurship items (construct no. 1)

Items of the 'active environmental working behaviour – ecopreneurship' Cronbach's Alpha: Survey Round 1 ($N = 231$) 0.7031; Round 2 ($N = 239$) 0.7039; Round 3 ($N = 251$) 0.6195
E 10: How often did you inform yourself about environmental activities within your company during the last 6 months? (e.g., notice board, environmental manager) .... times
E 12: During the last year I made suggestions for environmental improvements in our company (e.g., Saving water or energy, reducing waste) ○ no ○ yes, namely: a)........................b)........................c)........................
E 14: During the last year I made contact with colleagues to engage in environmental activities (e.g., with other teams, other divisions, the environmental manager) ○ at least 4 times ○ 3 times ○ 2 times ○ 1 time ○ 0 times
E 19: During the last year I created options for environmental improvement at my own workplace (e.g., changes in work procedures, optimization of machine settings) ○ no ○ yes, namely: a)........................b)........................c)........................

Table 7A1.2 Items for contextual and individual antecedents of ecopreneurship

Factor dimension	Variable	Items	Cronbach's Alpha		
			Round 1, $N = 231$	Round 2, $N = 239$	Round 3, $N = 251$
		Scale: from 1 = absolutely right to 6 = not right at all:			
Resources	Appropriateness of equipment	• The working equipment I can use in this company (e.g., detergent, machines) hinders pro-environmental behaviour	Not applicable, just one item		
	Availability of extra money	• Pro-environmental suggestions fail in this company because of a lack of money • Pro-environmental activities are rejected in this company for reasons of economy	0.557	0.486	0.702
Organizational climate	Management offers of information	• In this company I get all the information I need to realize pro-environmental behaviour • We are well informed about pro-environmental activities in this company • In this company clear guidelines exist for environmental protection	0.821	0.815	0.851
	Job feedback	• In this company you get to know about the consequences of pro-environmental suggestions	Not applicable, just one item		
	Time availability	• In this company one will always find time for pro-environmental activities	Not applicable, just one item		
	Transparency of corporate environmental management	• I get a response from my supervisor or other employees of this company about the quality of my pro-environmental activities • At work I can see myself which environmental	0.745	0.782	0.809

	activities	consequences it has (e.g., energy consumption, waste, effluent) • I know what my collegues do for environmental protection • I also know what is done for environmental protection in other departments			
	Participation/ coordination	• In our company all employees can participate in teams that deal with environmental protection • Our management is willing to consider pro-environmental suggestions of employees • In this company we can exchange experiences about pro-environmental activities with other employees	0.775	0.792	0.792
	Incentives	• Pro-environmental suggestions earn material rewards (e.g., awards, gifts, a share of the savings etc.) • In our company pro-environmental activities are praised (e.g., on the pinboard, in the internal journal, at work meetings)	0.647	0.659	0.726
	Executives' own pro-environmental behaviour	• The environmental conscience of my supervisors is exemplary • I think our management exemplifies pro-environmental activities through their behaviour	0.771	0.781	0.820
		Scale: from 1 = very helpful to 6 = not helpful at all until 7 = not participated:			
Training	General soft-skill training	• I participated in individual development, training e.g., how to confidently table a proposal	0.900	0.902	0.868

Table 7A1.2 (continued)

Factor dimension	Variable	Items	Cronbach's Alpha		
			Round 1, $N = 231$	Round 2, $N = 239$	Round 3, $N = 251$
		• I participated in training where we learned to work together in teams (e.g., for problem solving or work on a complex task) • Part of the training was how to deal with interpersonal problems (e.g., settle a conflict, motivate other employees) • Part of the training was learning about ourselves, e.g., dealing with responsibility			
	Ecospecific training	• I participated in training where the environmental protection policy of our company was explained • There was training about what to do and not to do regarding environmental protection at my workplace • Part of the training was testing pro-environmental behaviour patterns (e.g., expressing environmental demands for other teams; making suggestions; changing work patterns) • During training I practised techniques for pro-environmental activities (e.g., pro-environmental debate, pro-environmental working techniques)	0.832	0.840	0.862

		Scale: from 1 = absolutely right to 6 = not right at all:			
Ecospecific motivation	Expectation of eco-success	• By myself I can't do anything for environmental protection at work • It doesn't really matter if I behave pro-environmentally, because many colleagues don't	0.629	0.623	0.665
	Valence of nature and environment	• I think environmental problems are not as serious as often declared • I am not concerned about the environmental consequences of our products	0.522	0.612	0.515
	Knowledge of environmental work duties	• I know what I can do at my workplace for environmental protection	Not applicable, just one item		
General motivation	self-efficacy	• I can decide about the order of my working steps myself • I have influence on the type of work I am doing • I can decide about the accomplishment of my work duties • At my workplace employees like me have many opportunities to make a point • I decide about my working life, not my supervisor	0.834	0.820	0.839
	Extrinsic motivation	• Primarily, I work here to earn money and not because of the interesting work • If another company were to offer me more, I would change companies immediately	Last question not part of the statistics	0.421	0.519

APPENDIX 7A2

Table 7A2.1 Hypotheses 1a and 1b concerning correlation of contextual and individual antecedents and ecopreneurship

	Hypothesis 1a: The following variables are positively and significantly related to ecopreneurship	Test results: ✓ confirmed × not confirmed		Hypothesis 1b: The following variables are negatively and significantly related to ecopreneurship	Test results: ✓ confirmed × not confirmed
1a1	Appropriateness of equipment	×	1b1	Incentives	×
1a2	Availability of extra money	×	1b2	Extrinsic motivation	✓
1a3	Management offers of information	✓			
1a4	Job feedback	✓			
1a5	Time availability	✓			
1a6	Transparency of corporate environmental management activities	✓			
1a7	Participation/coordination	✓			
1a8	Executives' own pro-environmental behaviour	✓			
1a9	Soft-skill training	✓			
1a10	Ecospecific training	✓			
1a11	Expectation of eco-success	✓			
1a12	Valence of nature and environment	✓			
1a13	Knowledge of environmental work duties	✓			
1a14	Self-efficacy	✓			

Table 7A2.2 Hypotheses 3a–f concerning assessment of contextual and individual antecedents according to EMS status

	Variables of hypotheses	H3a: The assessment is significantly better the longer a company works with an EMS	H3c: After the two years of research, the assessment improves significantly in companies that worked with an EMS	H3d: In the company without an EMS the assessment does not improve significantly
1	Appropriateness of equipment	✓	×	✓
2	Availability of extra money	×	×	✓
3	Management offers of information	✓	✓	✓
4	Job feedback	✓	×	✓
5	Time availability	✓	✓	✓
6	Transparency of corporate environmental management activities	✓	✓	✓
7	Participation/coordination	✓	✓	✓
8	Incentives	✓	×	✓
9	Executives' own pro-environmental behaviour	✓	×	✓
10	Soft-skill training	✓	×	✓
11	Ecospecific training	✓	×	✓
12	Expectation of eco-success	✓	×	✓
13	Valence of nature and environment	✓	×	✓
14	Knowledge about environmental work duties	Not determined	Not determined	Not determined
15	Self-efficacy	×	×	✓

Table 7A2.2 (continued)

Variables of hypotheses	Test results
H3b: The assessment of extrinsic motivation is not significantly better, the longer a company works with an EMS	×
H3e: The assessment of extrinsic motivation does not improve significantly during the two years of research in companies with an EMS	✓
H3f: The assessment of extrinsic motivation does not improve significantly during the two years of research in the company without an EMS	×

Note: Test results: ✓ confirmed; × not confirmed.

APPENDIX 7A3

Table 7A3.1 Comparison of the assessment of ecopreneurship and its antecedents according to EMS status, Round 1 (means)

Factor dimension	Round 1, $N = 231$ Antecedents: 1 = very good; 6 = very bad Ecopreneurship: the higher the Z-scores = the more active	EMS experienced (tofu), $N = 23$	EMS beginners (Electroplating, components, metal processing), $N = 144$	Control company (lamps), $N = 64$	Significance of means' difference
Resources	Appropriateness of equipment	2.47	3.17	3.35	0.051
	Availability of extra money	2.36	2.47	2.42	n.s.
Organizational climate	Management offers of information	1.84	3.45	4.21	0
	Job feedback	3.00	3.23	4.98	0
	Time availability	3.08	3.90	4.51	0
	Transparency of corporate environmental management activities	3.05	4.07	4.66	0
	Participation/coordination	1.69	3.76	4.77	0
	Incentives	4.47	3.64	5.60	0
	Executives' own pro-environmental behaviour	2.59	3.30	4.32	0

Table 7A3.1 (continued)

Factor dimension	Round 1, $N = 231$ Antecedents: 1 = very good; 6 = very bad Ecopreneurship: the higher the Z-scores = the more active	EMS experienced (tofu), $N = 23$	EMS beginners (Electroplating, components, metal processing), $N = 144$	Control company (lamps), $N = 64$	Significance of means' difference
Training	Soft-skill training	5.11	5.39	6.74	0
	Ecospecific training	4.78	5.85	6.87	0
Ecospecific motivation	Expectation of eco-success	1.62	2.42	2.51	0.003
	Valence of nature and environment	1.82	2.50	2.80	0.002
	Knowledge of environmental work duties	Not determined	Not determined	Not determined	Not determined
General motivation	Self-efficacy	3.00	3.38	3.65	n.s.
	Extrinsic motivation	4.82	3.91	3.87	0.051
Ecopreneurship, z-standardized		0.9097	−0.0316	−0.2559	0

Note: n.s. = not significant.

Table 7A3.2 Comparison of the assessment of ecopreneurship and its antecedents according to EMS status, Round 2 (means)

Factor dimension	Round 2, $N = 239$ Antecedents: 1 = very good; 6 = very bad Ecopreneurship: the higher the Z-scores = the more active	EMS experienced (tofu), $N = 48$	EMS beginners (electroplating, components, metal processing), $N = 132$	Control company (lamps), $N = 59$	Significance of means' difference
Resources	Appropriateness of equipment	2.59	3.35	3.44	0.009
	Availability of extra money	2.47	2.31	2.59	n.s.
Organizational climate	Management offers of information	1.93	3.05	3.74	0
	Job feedback	2.50	3.25	4.87	0
	Time availability	3.13	3.68	4.58	0
	Transparency of corporate environmental management activities	2.98	3.91	4.38	0
	Participation/coordination	1.97	3.48	4.27	0
	Incentives	3.14	3.74	5.20	0
	Executives' own pro-environmental behaviour	2.57	3.31	3.92	0
Training	Soft-skill training	4.69	5.42	6.55	0
	Ecospecific training	4.92	5.83	6.72	0

Table 7A3.2 (continued)

Factor dimension	Round 2, $N = 239$ Antecedents: 1 = very good; 6 = very bad Ecopreneurship: the higher the Z-scores = the more active	EMS experienced (tofu), $N = 48$	EMS beginners (electroplating, components, metal processing), $N = 132$	Control company (lamps), $N = 59$	Significance of means' difference
Ecospecific motivation	Expectation of eco-success	1.84	2.63	2.70	0
	Valence of nature and environment	2.39	2.32	2.99	0.001
	Knowledge of environmental work duties	Not determined	Not determined	Not determined	No conclusion
General motivation	Self-efficacy	3.14	3.47	3.37	n.s.
	Extrinsic motivation	3.81	3.73	3.35	n.s.
Ecopreneurship, z-standardized		0.5043	−0.1112	−0.2068	0

Note: n.s. = not significant.

Table 7A3.3 Comparison of the assessment of ecopreneurship and its antecedents according to EMS status, Round 3 (means)

Factor dimension	Round 3, $N = 251$ Antecedents: 1 = very good; 6 = very bad Ecopreneurship: the higher the Z-scores = the more active	EMS experienced (tofu), $N = 57$	EMS beginners (electroplating, components, metal processing), $N = 144$	Control company (lamps), $N = 49$	Significance of means' difference
Resources	Appropriateness of equipment	2.77	2.94	2.81	n.s.
	Availability of extra money	2.74	2.28	2.63	0.026
Organizational climate	Management offers of information	2.17	2.87	4.13	0
	Job feedback	2.35	3.56	4.75	0
	Time availability	2.80	3.34	4.80	0
	Transparency of corporate environmental management activities	2.99	3.65	4.57	0
	Participation/coordination	1.91	3.33	4.69	0
	Incentives	2.66	3.75	5.67	0
	Executives' own pro-environmental behaviour	2.61	3.07	4.21	0
Training	Soft-skill training	4.87	5.55	6.86	0
	Ecospecific training	5.36	5.81	6.89	0

Table 7A3.3 (continued)

Factor dimension	Round 3, $N = 251$ Antecedents: 1 = very good; 6 = very bad Ecopreneurship: the higher the Z-scores = the more active	EMS experienced (tofu), $N = 57$	EMS beginners (electroplating, components, metal processing), $N = 144$	Control company (lamps), $N = 49$	Significance of means' difference
Ecospecific motivation	Expectation of eco-success	1.94	2.47	2.62	0.003
	Valence of nature and environment	2.41	2.61	2.70	n.s.
	Knowledge of environmental work duties	2.24	2.31	2.72	n.s.
General motivation	Self-efficacy	3.33	3.45	3.66	n.s.
	Extrinsic motivation	3.78	3.52	3.09	n.s.
Ecopreneurship, z-standardized		0.2647	−0.0581	−0.2908	0

Note: n.s. = not significant.

8. The relationship between high performance work systems and proactive environmental management

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Firms can play a role in the improvement of the serious imbalances that humans cause to the world's natural cycles (Shrivastava, 1995a) by implementing proactive environmental management.[2] For this to happen, they must develop environmental strategies that go beyond mere regulatory compliance (Aragón-Correa, 1998). Early literature on firms and environmental management highlighted the positive role of technology (Shrivastava, 1995b) and the possible negative effect of proactive environmental management on financial profitability (for example, Walley and Whitehead, 1994). The resource-based view (RBV), however, suggested that proactive policies might actually improve firm profitability (for example, Hart, 1995; Russo and Fouts, 1997; Marcus and Geffen, 1998; Aragón-Correa and Sharma, 2003), but only if the firm developed internal environment-related capabilities such as employee participation and involvement (for example, Hart, 1995; Wehrmeyer, 1996; Sharma and Vredenburg, 1998; Klassen and Whybark, 1999; Marcus and Nichols, 1999; Bansal, 2005). Despite the view that these internally generated capabilities are important, few works have specifically analysed them. Ramus and Steger (2000) concluded that certain organizational practices such as intensive training, communication facilitation and participation, and rewarding and acknowledging workers' good performance can generate environmental improvement. Similarly, Egri and Herman (2000) showed that organizations concerned about the environment must have flexible structures, be open to the outside world, and be orientated towards employee values. But few other studies have actually specified organizational practices that are related to environmental change and improvement. The way in which certain aspects of human resource (HR) management can influence environmental developments is not well understood. Thus, this research identifies specific HR practices that yield proactive environmental management within an organization. More precisely, it indicates the potential of a 'high performance work system' (HPWS) for inducing positive environmental change.

An HPWS (Arthur, 1994; Huselid, 1995; MacDuffie, 1995; Becker and Huselid, 1998) has been defined as a synergic set of interrelated HR practices that are applied jointly to develop, retain and motivate employees (Way, 2002: 767). To date, the literature has primarily focused on the potential for an HPWS to improve an organization's financial performance (for example, Huselid, 1995; MacDuffie, 1995; Delaney and Huselid, 1996; Bae and Lawler, 2000). After reviewing some of the main characteristics of an HPWS, we shall propose that these same practices are suitable for the development of proactive environmental management and argue that if a firm really wants to develop proactive environmental management, it may need to review the HR practices it is using in order to facilitate this environmental development.[3] We control for the possible moderating effect of perceived uncertainty in the firm, in accordance with contingency approaches (for example, Burns and Stalker, 1961; Lawrence and Lorsch, 1967), giving the RBV a contingency touch (Brush and Artz, 1999; Aragón-Correa and Sharma, 2003).

Our analysis uses data from face-to-face interviews with the managers of a sample of 145 firms from within the food sector. This study makes contributions in at least three different ways. First, from a general perspective, it reinforces the literature about the RBV, showing the importance of developments based on a firm's human resources. Second, it makes a notable contribution to the literature about the natural environment and organizations, discussing and describing the specific HR practices that help consolidate and advance proactive environmental strategies. Finally, the possible influence of the external environment on the relationships analysed is explored.

This chapter is organized as follows. In the next section, we review the literature that has used the RBV to analyse a firm's environmental strategy. We then show the progress that other studies have made in relation to HPWSs and environmental proactivity. In the following section, we establish our hypotheses, after which we proceed to explain the methodology used. The last three sections are dedicated to showing the main results obtained, to discussing them, and finally to highlighting the implications and limitations of our study.

THEORETICAL BACKGROUND

The RBV considers the personnel of a firm to be one of its key assets (for example, Prahalad and Hamel, 1990; Barney, 1991). Many of the arguments are rooted in ideas about human resources (for example, employee skills, knowledge, behaviour) or organizational resources (for example, control systems, routines, learning mechanisms) generated over time by means of path-dependent, and therefore not easily reproducible structures (Colbert, 2004: 343).

Human resources and, above all, an appropriate capacity to manage them, can perfectly fulfil the four requirements of this perspective to generate a competitive advantage (Barney, 1986, 1991) in as much as they are rare, valuable, inimitable and difficult to replace. Using complex human resource management (HRM) functions (above all, through selection, training and involvement), HRM systems focused on constructing and encouraging creativity and adaptability inside the organization (Colbert, 2004) are valuable to the firm. Assuming skill distribution normality, people with high levels of skill are rare by definition (Wright et al., 1994). Imitation, or substitution, requires a thorough understanding of the way in which each of these mechanisms intervene and how the process works (Becker and Gerhart, 1996), a particularly difficult undertaking given the socially complex and ambiguous nature of causality in human relationships.

In recent years, the HRM literature has dedicated a large number of works to the study of practices that can be classified as proactive and as more innovative than traditionally used practices (Ichniowski et al., 1996). These practices can be combined to form interactive systems that jointly produce synergic effects on organizational performance (MacDuffie, 1995). For this reason the name given to such combinations is 'high performance work systems'. Although there is no explicit agreement on the precise definition of an HPWS, according to Becker and Huselid (1998: 55), there are some common elements in all of them. They are internally consistent work systems which include rigorous recruitment and selection procedures, performance-contingent incentive compensation systems, management development and training activities linked to the needs of a business, and a significant commitment to employee involvement. The unifying common element is that an HPWS is designed to become the basis for the acquisition, motivation and development of a set of intellectual assets, which can become a permanent source of competitive advantage.

Different papers have tried to clarify and specify which practices should be considered to be part of an HPWS (for example, MacDuffie, 1995; Delaney and Huselid, 1996; Ichniowski et al., 1997; Pfeffer, 1998a; Appelbaum et al., 2000; Bae and Lawler, 2000; Guthrie, 2001; Whitener, 2001; Way, 2002). Most studies agree that at least the following practices can be included within the most effective HPWSs: the use of programmes meant to improve internal communication within the firm; the establishment of specific (effective and fast) conflict resolution procedures; the guarantee of job stability (indefinite versus temporary contracts); internal promotion systems (based on merit and/or on the employee's potential); broad job design (and job rotation); flatter organizational structures; the existence of work teams; contingent pay (based on performance) and participation in the firm's profit-sharing programme; involvement in decision-making processes; selection and recruitment of staff according to their potential; and (extensive, potential-based) worker training.

Various researchers have demonstrated the positive influence exerted by an HPWS on different firm performance modalities, for example, financial performance (Huselid, 1995; Delaney and Huselid, 1996; Becker and Huselid, 1998; Bae and Lawler, 2000), production performance (Ichniowski et al., 1997; Ichniowski and Shaw, 1999; Guthrie, 2001; Bartel, 2004), new product launch efficiency (Ahmad and Schroeder, 2003), and even achievement of higher motivation and commitment levels among a firm's workers (Arthur, 1994; Tsui et al., 1997; Whitener, 2001; Gould-Williams, 2003). Delaney and Huselid (1996) and Becker and Huselid (1998) concluded that HR practices affect employees' abilities to perform their jobs, their motivation and the job structure itself, which in turn produces better firm performance levels. We believe that proactive environmental management needs to focus on motivational aspects as well as on ensuring enough flexibility to develop ad hoc teamwork practices. These factors lead us to believe that an HPWS can be very useful in achieving a firm's environmental aims.

HYPOTHESES

HPWSs and Proactive Environmental Management

The literature has shown that environmental policies and practices are horizontally integrated into all of a firm's functional areas (Starik and Rands, 1995). Hence, environmental strategy needs to be developed with the full support of a firm's employees, taking into account HR practices which can affect the organization's environmental possibilities.

Pioneering works in the study of the environmental management/HRM connection emphasized the need for the two to cooperate in order to achieve improvements in an organization's environmental performance (for example, Wehrmeyer, 1996). Hart (1995) specifically pointed out that proactive environmental management requires extensive employee involvement for continuous improvement in the reduction of emission levels and depends on the intangible skills developed by personnel through their involvement with the firm. Later, other studies demonstrated that pollution prevention, rather than pollution control, requires the involvement and commitment of employees (for example, Aragón-Correa, 1998; Bansal, 2005; Sharma and Vredenburg, 1998; Klassen and Whybark, 1999; Marcus and Nichols, 1999). Bunge et al. (1996) and Ruiz-Quintanilla et al. (1996) showed that firms that counted on the participation and involvement of their employees through formal practices had triple the reduction in (pollutant) emissions compared with those firms which had not developed such participation systems. According to these studies, employees need to believe that the organization is truly making an effort to involve them in environmental decision making with the intent of reducing the firm's environmental impact.

Both the contribution of each organization member and the systems and structures that permit members to interact with one another play an exceptionally important role in achieving environmental improvement (Hostager et al., 1998). Regarding organizational structure, Egri and Herman showed that firms concerned about the environment are 'adaptable and change-oriented, have task systems focused on establishing relationships with external constituencies and on creating a strong commitment to the firm's values and beliefs among all organization members, within informal and fluent structures' (2000: 595–6).

The most recent studies about organizations and the natural environment have been orientated towards specific aspects of HRM, showing the close link between HRM and practices and environmental performance. Thus, Russo and Harrison (2005) studied the relationship between the environmental performance of plants or industrial units and organizational aspects such as the pay system for environmental managers at the plant. Although these authors did not manage to validate their hypothesis, which stated that greater emission reductions would be found in firms where the environmental managers' salaries are linked to environmental performance, they insisted on the need to explore pay systems in relation to the environmental variable. In this respect, Lothe et al. (1999) suggested a method for designing the most suitable pay system for managers, taking into account the correlation between the firm's short- and long-term economic and environmental objectives.

In addition to employee pay systems, we must also consider other complementary HR practices to take advantage of the synergic effects resulting from the implementation of mutually coherent practices. Fernández (2003) explained how certain aspects of HRM, such as employee involvement and participation, training and motivation, along with other aspects indirectly related to the organizational culture, have an impact on environmental management.

Various researchers have shown specific connections between environmental and HR issues. Among these, Bansal (2003) analysed the ways in which the values of the individuals working for a firm, both managers and employees, are related to the firm's specific responses to environmental issues. This author shows how important it is to enhance employee ecological awareness through training and education and other HR practices, such as staff selection, in order to achieve a more environmentally committed management.

One way for environmental aspects to be incorporated into daily work is through employee participation and involvement. Based on a case study of NUMMI, Rothenberg (2003) discovered the critical importance of employee participation in the implementation of an environmental management programme. According to Zobel and Burman (2004: 25), employee participation and involvement along with the competence levels of staff dealing with environmental issues need to be improved when implementing an environmental management system. And Rothenberg et al. (2001) demonstrated the importance of worker participation in improving environmental efficiency. To that end, some models have been put forward in which managers are told how to achieve greater employee motivation and involvement (for example, Hostager et al., 1998; Epstein and Roy, 2001).

However, production research has clearly verified how HR practices contribute to improving a firm's environmental performance. This literature insists on the training of employees to achieve reduction in a firm's emissions (Daily and Huang, 2001), a fluent, open communication in both directions (Gupta and Sharma, 1996; Kitazawa and Sarkis, 2000), the participation and involvement of workers in the development of preventive environmental practices (Chinander, 2001; Daily and Huang, 2001; Rothenberg et al., 2001), and the decentralization of activities (Azzone and Noci, 1998) or the creation of work teams (Hanna et al., 2000).

From a broad perspective, Ramus (2001) summarized these HR approaches, showing which promote or facilitate innovation and arguing that they are generally the same as those which facilitate environmental innovation.[4] Innovative firms tend to adopt a set of interrelated innovative practices such as self-managed teams or the participation of workers in both decision-making processes and quality management, all of which produce environmental improvements (Ramus and Steger, 2000; Florida and Davison, 2001; Ramus, 2001). Ramus and Steger (2000) offered a particularly exhaustive description of how certain organizational practices associated with progressive HRM (support for innovation, support for training, facilitation of communication–participation, dissemination of information among employees, acknowledgement and rewarding of employees' good performance, or involvement of employees in decision-making processes) help employees generate more 'ecoinitiatives'.[5]

The HR practices that facilitate the implementation of proactive environmental management, according to the reviewed literature, seem to largely coincide with those which configure an HPWS. This equivalence suggests that HPWSs include HR practices that can positively affect the development of proactive environmental management. Although some of these relationships have already been analysed in the literature, as shown above, our contribution displays that this positive influence on environmental management is reinforced by the existence of a system of HR practices that are in tune with the HPWS philosophy, regardless of the presence – or absence – of a specific practice. Therefore, our hypothesis reads as follows:

Hypothesis 1: The use of HPWSs is positively and significantly related to the implementation of proactive environmental management.

Moderating Effect of Perceived Environmental Uncertainty

A new trend in the RBV is to incorporate exogenous aspects of the firm, in response to criticism that the RBV did not previously acknowledge the importance of considering the business environment (for example, Barney, 2001; Priem and Butler, 2001a, b). Some studies have already started to show the utility of this approach (for example, Maijoor and Van Witteloostuijn, 1996; Miller and Shamsie, 1999; Zajac et al., 2000). Aragón-Correa and Sharma (2003: 73) maintained that 'uncertainty influences a firm's strategy but does not determine it in a mechanical way' and suggested ways to incorporate the contingency aspect into the RBV for the analysis of proactive environmental management.

As shown previously, certain HR practices can be a source of competitive advantage, but the degree of uncertainty in the general competitive environment can play a big role in how these practices (such as an HPWS) might influence other variables. Some studies have started to analyse how the general environment can influence how HR practices affect other variables (for example, Lengnick-Hall and Lengnick-Hall, 1988; Pagell et al., 2000). Additionally, Aragón-Correa and Sharma (2003) have pointed out how different types of general environment may influence the relationship between a firm's resources and capabilities and its environmental proactivity.

Guided by the evidence and recommendations in these previous studies, we propose to determine the role played by uncertainty in our first hypothesis. We understand uncertainty to be the extent to which an environment is dynamic (the degree of variability in elements and the extent to which it can be predicted), complex (the heterogeneity and diversity of the elements present in the general environment), and hostile (the importance and degree of availability of resources for the rest of the elements in the general environment) (Miller and Friesen, 1983; Tan and Litschert, 1994).

The Moderating Effect of Uncertainty on the Relationship between the Use of an HPWS and Proactive Environmental Management

The preceding sections have justified the positive relationship between HPWSs and environmental proactivity. We shall now analyse the extent to which the relationship between an HPWS and environmental proactivity depends on the level of uncertainty. In other words, we think it is appropriate to check whether an HPWS can make a firm more or less environmentally proactive under different levels of uncertainty.

Under uncertainty, a firm's resources and capabilities are particularly critical to its business success (Amit and Schoemaker, 1993). This is why firms that find themselves in uncertain situations tend to maintain and improve their abilities to respond to future changes (Harrigan, 1984). In this sense, it can be argued that the influence is positive because, under uncertainty, the potential capabilities of an HPWS can more easily lead to innovations and breakthroughs. In situations of uncertainty, an environmentally proactive firm will have the ability to anticipate these unknown changes thanks to the implementation of an HPWS. A firm that wants to be environmentally proactive will need knowledge and skills to take advantage of the uncertain elements present in the general environment, such as, for instance, future environmental legislation. An environmentally proactive firm could anticipate and transform something that could pose a threat into an opportunity, thus achieving a corresponding competitive advantage. In other words, under uncertain conditions, an HPWS would better help in developing proactive environmental management.

These systems can provide a firm with the capabilities it needs to adapt to changes (Verdu-Jover et al., 2005), making it easier to reduce the response time needed to adapt (Jackson and Wall, 1991). This is so because the firm's employees, being more competent, are more willing to learn how to respond to new situations when an HPWS is in place (Jaikumar, 1986) or when at least one of their practices is used; for instance, the establishment of a bonus linked to performance (for example, Jerez-Gomez et al., 2005). We expect an HPWS to be particularly effective under conditions of extreme uncertainty, as others have shown (for example, Bae et al., 2003).

Basing its attempts to achieve environmental proactivity on HR strategies may turn out to be critical for a firm when it faces an uncertain environment. Integration has been identified by the literature as a key factor for a firm to develop the capabilities required to face uncertainty. Some empirical studies confirm that the learning rate in the area of new product development increases after the adoption of functional integration mechanisms within an organization (Clark and Fujimoto, 1991; Clark and Wheelwright, 1992). Russo and Fouts (1997) underlined the importance of the functional integration capability to generate innovations in the field of pollution prevention. Similarly, Sharma et al. (1999) found that the flow of information related to environmental innovations required formal and informal mechanisms so that knowledge could be shared by line managers and top managers. These mechanisms may prove to be particularly critical for firms that operate in uncertain environments.

Although the literature has not specifically examined this relationship, we believe that uncertainty intensifies the link existing between the capabilities generated by an HPWS and proactive environmental management. Therefore, we propose the following hypothesis:

Hypothesis 2: Uncertainty intensifies the relationship between HPWSs and the development of proactive environmental management.

METHODOLOGY

Sample

In order to meet the objectives of this study, we chose a single geographically delimited manufacturing sector as our population. In our case, the fact that we focused on food sector firms operating in Spain removed the possible disturbing influences exerted by specific peculiarities of different sectors and the biases that various regulations or national aid and subsidy policies could introduce.

We decided that the food sector suited our research requirements for two main reasons. First, the relevance of this sector gave us the chance of having a sufficiently large enough population with some previously defined characteristics.[6] Second, because these firms are usually labour intensive, human resource and environmental management practices stand out among the issues that receive preferential attention.

In short, our target population was formed by firms located in Spain and belonging to the food sector and was drawn from the Dun and Bradstreet (D&B) database at the end of 2004. The population included 1,556 firms. The sample, made up of 145 organizations (10 per cent of the target population), was obtained using the random sampling method.

Questionnaire

Multiple instruments were used to obtain the data we needed for our research. First and foremost, a questionnaire was used which included questions about the degree of development of environmental practices, the degree of use of certain HR practices, and the degree of uncertainty. In addition, we compared the data obtained through this questionnaire (such as the size of the company or the manager's name) with that available through the D&B and Amadeus databases, which allowed us to validate and control certain items of information and relationships. Finally, when possible, we resorted to the information published by the firms themselves on their own Web pages, which helped us better understand some of the practices and approaches related to this study.

In order to construct and refine the questionnaire, we carried out a series of interviews and pretests with the firm managers, environmental managers and HR managers of six firms belonging to the food sector (these executives were not included in the final sampling). The coordinated development of this project in collaboration with a group of 12 researchers from three universities made possible a large number of working sessions in which the suitability of the questionnaire was examined with the help of experts and scholars specialized in the issues under analysis. After incorporating suggestions for its improvement, which we tried to do to ensure the validity of its contents, we generated the final questionnaire.

The questionnaire was completed by the chief executive officer (CEO) of each firm during a personal interview carried out by a survey company in December 2004 and January 2005. This procedure was followed with the 145 firms initially selected and, when a firm was not interested or available, with those randomly designated in advance as substitutes. Although we are aware of the advantages and disadvantages of the practice of obtaining information from a single source, we chose the CEO for two main reasons: our questionnaire contained items about a wide range of firm areas (environmental issues, human resources and uncertainty), for which a company's CEO is the most knowledgeable person (Tomaskovic-Devey et al., 1994), and this practice is consistent with much of the work in the organizational arena (Podsakoff and Organ, 1986).

While use of a single source is typical in this research and among studies of small firms, it does present threats of bias arising from common-method variance. Previous works (for example, Crampton and Wagner, 1994) have demonstrated that measures of micro-organizational practices (for example, HR practices data or environmental practices) are relatively free of effect-size inflation. However, in order to check on possible response bias, we followed the recommendations of Podsakoff and Organ (1986), applying a principal component analysis, Harman's one-factor test,[7] using an eigenvalue greater than one as cutoff criteria. From this analysis we obtained 10 different factors, all but two containing items from the same scale (for example, HPWS, uncertainty and environmental management). These results suggest that common-method bias is an inadequate explanation for the study results.

Variable Measurement

Firm proactive environmental management

We adopted the items used by Aragón-Correa (1998) to measure environmental proactivity and added some new items that, in our opinion, could help us measure firm environmental management within the food manufacturing sector. We eventually constructed an 18-item scale (see Appendix 8A) to evaluate firm environmental proactivity. A seven-point Likert scale was used in which interviewees were asked to assess the degree of development of their firms in relation to the environmental activities mentioned and compared to their competitors. In this way, they analysed the implementation of proactive environmental management within their respective organizations.

An exploratory analysis was run on the 18 items and, after varimax rotation, the analysis showed that proactive environmental management contained four dimensions. We labelled the first 'environmental organization', which includes different organizational factors contributing to proactive environmental management (for example, total quality management (TQM), integrating environmental aspects, and programmes of environmental training for employees or managers). The second was named 'environmental operations' and includes more traditional factors usually linked to production (for example, filters and controls to avoid smog or noise). The third contains items related to environmental sponsorship and environmental education for customers or distributors, so it was called 'external activities of environmental strategy'. And finally, the fourth contains items related to recycling activities and was labelled 'recycling'. A confirmatory analysis using LISREL 8.50 showed a single factor model fitting the data well ($\chi^2 = 164.74$, df $= 131$, $p = 0.024$; RMSEA $= 0.044$, NNFI $= 0.98$, CFI $= 0.99$). Consequently, these four components were treated as indicators of proactive environmental management. The final value of the environmental proactivity of a firm was calculated using the mean of these 18 items. The Cronbach alpha for this scale was 0.915.

Measurement of a high performance work system

The objective pursued in the design of these items was to make sure they represented implementation intensity rather than being a dichotomous indicator of presence or absence. This allowed us to collect more complete qualitative information and at the same time made it easier for the interviewees to describe the specific situations of their firms in an accurate way. We decided to take the items that measure the use of HR systems in the firm from the scale constructed by Huselid (1995) in his well-known synthesis article on HPWSs. He used 13 items based on the scale used by Delaney et al. (1989) and by the US Department of Labor (1993).

We used this scale, adapting it as much as possible to the peculiarities of the territorial and sectoral context under analysis and trying to facilitate the understanding and answering process of the CEOs. To be sure that this scale was appropriate for Spain, we conducted an exploratory principal components analysis with varimax rotation of the HR practices. This analysis suggested that the 13 items represented three sets of HR practices; each factor's eigenvalue exceeded 1.00. The first set contains formal HR practices, such as formal training, evaluation and job analysis, which might be called 'administrative HR practices'. The second contains HR practices linked to performance management, including salary decision-making, promotions, and merit-based evaluations. Finally, the third has HR practices orientated to increase the job satisfaction of the workers, such as participation in the firm's profit-sharing programme and participation in firm decision-making processes. The degree to which these three components represented a latent HPWS factor was tested using LISREL 8.50. The single factor model fit the data well ($\chi^2 = 129.26$, df $= 62$, $p = 0.00$; RMSEA $= 0.085$; NNFI $= 0.99$; CFI $= 1.00$). Consequently, these three components were treated as indicators of a general HPWS construct in the analyses described below. The use of a single HPWS system index is supported by arguments made by Becker and Huselid (1998) and is consistent with the approach used in previous works (for example, Guest et al., 2003; Datta et al., 2005). The Cronbach alpha for this scale was 0.83.

Measurement of the uncertainty perceived in the firm's competitive environment

Our questionnaire asked executives to offer their perceptions of the uncertainty in their firms' competitive environments. This subjective measurement was in tune with the usual approaches found in the strategic literature (for example, Miller and Lee, 2001; Tan and Tan, 2005), which highlight the importance of the decision makers' perceptions.

With the purpose of measuring the perception of environmental uncertainty, our questionnaire was completed with four items adapted from the scale used by Tan and Litschert (1994), in which the interviewees were asked to express their degree of agreement or disagreement with respect to the different aspects or statements proposed using a seven-point Likert scale (see Appendix 8A). The Cronbach alpha was 0.76.

Control variables

We chose firm size and firm age as control variables because they can greatly influence the volume of resources that an organization can dedicate to its environmental management as well as to the development of certain HR practices. Various works in the literature show the relevance these variables can acquire in studies about human resources and firm environmental proactivity, respectively (for example, Arthur, 1994; Huselid, 1995; Judge and Douglas, 1998; Way, 2002). Firm size can be assessed according to diverse criteria or parameters. We decided to use the number of full-time employees as a proxy variable for firm size because it better represents the resources used by a firm, as opposed to pure intermediation activity, and made it easier to compare firms.

Another reason for deciding to control for the age of the firm was because experience can play a role in the way a firm is managed (for example, Way, 2002). The age of the firm was calculated using the founding year of the sample firms. These data were drawn from the latest D&B database and then transformed through the calculation of its natural logarithm in order to fulfil the condition of normality required by the methodology that we were going to use.

RESULTS

Table 8.1 shows the basic data and correlations between all the variables used in our study. The methodology used to try to verify the hypotheses proposed was hierarchical multiple regression. We previously verified the starting assumptions for this model (linearity, variance consistency and variable normality). In the regression, variables were introduced step by step: first, we incorporated control variables (model 1), then we added in independent

Table 8.1 Correlation matrix and main descriptive statistics of the study variables

	N	Mean	Std dev.	1	2	3	4	5
1. Size[a]	143	3.199	1.243	1.00				
2. Age[a]	145	3.332	0.6993	0.370***	1.00			
3. Uncertainty	144	3.891	1.288	−0.001	−0.044	1.00		
4. HPWS	143	3.147	1.243	0.001	−0.152	0.139	1.00	
5. Environmental proactivity	125	3.597	1.349	0.258**	0.028	0.089	0.216*	1.00

Note: [a] Ln; *** $p<0.001$; ** $p<0.01$; * $p<0.05$; † $p<0.10$.

Table 8.2 Regression analysis results[a]

Variable	Model 1		Model 2		Model 3		Model 4	
Constant	3.047***	(0.578)	2.628***	(0.679)	1.797**	(0.534)	1.612*	(0.548)
Size[b]	0.265***	(0.104)	0.261**	(0.104)	0.250**	(0.102)	0.262**	(0.092)
Age[b]	−0.061	(0.186)	−0.058	(185)	−0.024	(0.183)	−0.030	(0.182)
Uncertainty			0.104	(0.089)	0.082	(0.087)	0.122	(0.090)
HPWS					0.215**	(0.095)	0.227**	(0.094)
HPWS × Uncertainty							−0.143	(0.073)
R^2	0.060		0.071		0.116		0.134	
Change in R^2	0.060**		0.011		0.045**		0.018	
F	3.859**		3.040*		3.870***		3.633***	

Notes:
[a] Environmental proactivity is the dependent variable.
[b] Ln.
The values represent the regression coefficients with the standard errors in brackets.
*** $p<0.01$; ** $p<0.01$; *$p<0.05$; $p<0.10$.

variables (models 2 and 3), and finally, we introduced the uncertainty's moderating effect (model 4). To avoid the problem of multicollinearity with the introduction of the moderating effect (multiplication between the variables involved), we mean-centred both independent and moderator variables prior to creating the interaction term (Cronbach, 1987; Jaccard et al., 1990). The results of the regression are found in Table 8.2.

The R^2 in model 1 indicates that firm size accounts for 5.7 per cent of the variance, with the value of F also being significant. This seems to suggest the existence of a correlation between firm size and the development of proactive practices in the organization, hence the greater the firm size, the greater the likelihood of implementing environmentally proactive practices. This correlation remains positive and significant in the other models.

In model 2, the value of R^2 does not increase significantly when the uncertainty level is introduced, meaning that the uncertainty does not influence the degree of environmental proactivity of the firm. In model 3, HPWS use is introduced and has a significant influence on the firm's environmental proactivity, which is completely independent of the level of uncertainty perceived by the organization. Thanks to the beta coefficients, we can say that a one-point increase in the degree of use of an HPWS is associated with a 0.287-point increase in the implementation of proactive environmental practices.

Finally, we introduced the moderating effect of uncertainty in model 4. Both the change in R^2 and the beta coefficient of this moderating effect confirm that uncertainty does not seem to play a moderating role in the relationship between environmental proactivity and the degree of use of an HPWS. In other words, we cannot validate Hypothesis 2, which held that a moderating effect was present in this relationship.

DISCUSSION

In this section, we review the results linked to the different hypotheses formulated in our research study. The results show the existence of a significant positive relationship between the implementation of an HPWS and the development of proactive environmental management, supporting Hypothesis 1 and fully agreeing with the literature's references for the need to consider the importance of human resources in environmental performance (for example, Hart, 1995; Russo and Harrison, 2005).

Environmental strategies have been linked to technology/machinery by engineers, and even management literature is especially consistent in dealing with environmental challenges from a technological perspective (for example, Shrivastava, 1995c; Fiksel, 2003; Todd et al., 2003). Although management literature has often cautioned about the role of employees in the implementation of proactive environmental strategies (for example, Fernández et al., 2003; Florida and Davison, 2001; Hart, 1995; Ramus and Steger, 2000), almost no empirical papers have focused on this particular relationship. We wanted to test whether HR practices are important in developing proactive environmental management because we consider that such management may be more dependent on employee qualifications and motivation than on technology. Our view here is consistent with the logic of the RBV (Barney, 1991; Amit and Schoemaker, 1993), assuming that technology is readily available in the marketplace and that it might 'only' generate financial restrictions. Employee abilities and motivation, however, are intangible aspects and related capabilities are not directly available in the marketplace; a firm has to configure them over time and, for this reason, obtaining them may be less demanding from a financial perspective than purchasing technology.

Moreover, the adoption of an HPWS in firms would cover some of the gaps existing in this area of study, thus facilitating the appropriate development of an environmental management strategy. Several studies (Handfield et al., 2001; Del Brío and Junquera, 2003) have argued that a lack of training, employee motivation and involvement in processes hinders and prevents the development of a firm's environmental strategy.

Although few studies have established a link between the use of an HPWS and environmental proactivity, our results are consistent with some of the conclusions reached by Bunge et al. (1996), Ruiz-Quintanilla et al. (1998), Ramus and Steger (2000), Rothenberg (2003) and Zobel and Burman (2004), among others, particularly regarding the need for achieving employee participation in order to succeed in implementing and developing environmental practices within an organization.

Our results are in line with the well-known relationship between prospector business strategies and proactive environmental approaches, which many works have pointed out (for example, Aragón-Correa, 1998). It is not surprising that HPWSs have been classified as a proactive approach within the field of HRM (for example, MacDuffie, 1995; Koch and McGrath, 1996), and both proactive environmental management and HPWSs could be consistent with the prospector strategy of Miles and Snow (1978). To check the role of a firm's general proactivity in the relationship between HPWSs and proactive environmental management would be an interesting future study, which would be necessary to complete in order to fully understand the above-mentioned relationship. That, however, goes beyond the aims of this research.

Our results also indicate, as has already been demonstrated by other studies (for example, Aragón-Correa, 1998), that the control variable 'firm size' could positively and significantly account for the degree of environmental proactivity achieved by a firm. It seems logical to assume that larger-sized firms would find it easier to implement proactive environmental management. It must be remembered in this respect that this implementation is usually very costly, particularly when dealing with standardized, well-known management systems (Bansal, 2002).

The Influence of Uncertainty: The Moderating Effect

We shall now pay specific attention to the results corresponding to the potential moderating influence exerted by uncertainty on the relationship analysed. The results drawn from model 4 could not confirm the existence of a significant effect of the moderating variable on the relationship between an HPWS and proactive environmental management. The literature has established the moderating role exerted by uncertainty on the link between proactive environmental management and financial performance (Aragón-Correa and Sharma, 2003), and some works have demonstrated it for specific sectors (for example, Russo and Fouts, 1997; Marcus and Geffen, 1998).

The results obtained therefore admit various interpretations that should be examined in future studies. First, we must clarify that the data tell us only that the moderating effect of uncertainty is not significant in a linear relationship. It would be interesting to check on the existence of a moderating effect on nonlinear relationships, such as exponential or logarithmic, as we believe that, although uncertainty does not completely determine the actions undertaken by a firm, it does influence them.

Second, the moderation effect could be reduced because the degree of use of an HPWS has a significant influence on a firm's environmental proactivity, but the firm's environmental proactivity is independent from the perceived uncertainty level. The results referring to the lack of linear moderation thus seem to support all of the approaches in the literature, which highlight the essential role played by human resources in the environmental strategy process (for example, Hart, 1995; Ramus and Steger, 2000; Florida and Davison, 2001; Ramus, 2001; Fernández et al., 2003; Rothenberg, 2003; Zobel and Burman, 2004).

Nevertheless, we must be cautious when interpreting the independence of the relationship between an HPWS and environmental management with respect to the perception of the uncertainty level. We must recognize that the regulatory effect is very strong in this sector and, therefore, given the uniform environmental framework that these firms have to face, it is difficult to detect important disparities regarding such areas as human resources, which have traditionally exerted a considerable influence on environmental proactivity (Marcus and Geffen, 1998; Majumdar and Marcus, 2001).

From another point of view, this could imply the possibility of the uncertainty perception variance not being wide enough to allow the detection of potential differentiating influences derived from that variance. This is why we have to insist once again on the possibility that the moderation introduced by uncertainty could have a nonlinear effect not covered by the tests carried out through our model.

MANAGEMENT IMPLICATIONS AND LIMITATIONS

This study demonstrates that HR practices such as an HPWS can be a valid and useful tool to achieve improvement in the development of proactive environmental management. If employees are not informed, trained, motivated and encouraged to carry out certain actions related to a firm's objectives – such as proactive environmental management – it will prove more complicated to develop and achieve those aims, something that has also been illustrated by other studies (for example, Handfield et al., 2001; Del Brío and Junquera, 2003).

If a company really wants to develop proactive environmental management, it will have to take into consideration its HR practices to help get it there. That is, the firm's management has to be more conscious of the role of HR practices in achieving the firm's natural-environment objectives. Thus, the consideration of human resources as a strategic area should be one of the principles of proactivity in business today, as has been repeatedly demonstrated (for example, Pfeffer, 1994, 1998b; Becker et al., 2001). There are a growing number of studies that emphasize the importance of human resources in developing environmental proactivity (for example, Hart, 1995; Wehrmeyer, 1996; Sharma and Vredenburg, 1998; Klassen and Whybark, 1999; Marcus and Nichols, 1999; Bansal, 2005), but only a few have tested the relationship between them (for example, Hostager et al., 1998; Hanna et al., 2000; Kitazawa and Sarkis, 2000; Ramus and Steger, 2000; Chinander, 2001; Daily and Huang, 2001; Epstein and Roy, 2001), and so far none has studied the relationship between a set of concrete HR practices, as an HPWS, and the development of firm's proactive environmental management.

Of course, this study also has limitations that must be considered along with its results and conclusions. First, the conclusions reached can be generalized only to the context studied, namely firms located in Spain and belonging to the food sector. Second, we checked the influence relationship using a methodology that only serves to contrast the existence of linear relationships. Third, the measurement of variables was carried out using the perceptions of the interviewees themselves, though the absence of published data about the implementation of an HPWS and proactive environmental practices makes this the only possible way to collect information. Fourth, we considered an HPWS only as a determining factor in the shaping of proactive environmental management. However, the literature has paid attention to other complex capabilities on which the development of proactive environmental management depends. Our intention with this study was not to completely explain the different causes and influences on environmental proactivity but to focus our analysis on checking for the existence of (and, if so, the intensity of) the relationships between certain HR practices and environmental proactivity. Finally, this is a transversal study, which prevents us from analysing the evolution of the different variables mentioned in our research; we can check the relationships between the variables but cannot explain the causality in the relationship studied. From a practitioner point of view, our research cautions against focusing environmental management decisions on purely technical solutions and instead recommends an approach that integrates technology and human capabilities. Such an approach might help a firm better leverage its resources, avoiding expensive yet unproductive investments in technology, while achieving real gains in environmental proactivity.

NOTES

1. We would like to thank all those managers of our sample who contributed their time and ideas to this study. This research was partially funded by Andalucia Regional Administration (Junta de Andalucia), Research Group SEJ014 and Project SEJ2007-67833 (European Commission).

2. We use the term 'environment' to refer to the natural environment, the term 'environmental strategy' to refer to a firm's strategy to manage the interface between its business and the natural environment, and the term 'uncertainty' to refer to the general, business or competitive environment of the firm.
3. This does not mean that an HPWS automatically implies proactive environmental strategies, but instead that it can help to develop an environmental proactivity in the firm.
4. With the exception of environmental dissemination, according to Ramus (2001: 102). This can be due to the fact that a large part of this information has a technical character, is not relevant, and does not help to improve performance or the generation of environmental initiatives by employees.
5. An 'ecoinitiative' is an action carried out by an employee in the belief that this action will improve the firm's environmental performance (Ramus and Steger, 2000).
6. The food sector is the principal contributor to GNP in both the EU and the USA.
7. This analysis begins with a factor analysis of all the items of the variables of interest and then examines the number of emerged factors. If a single factor emerges or accounts for a majority of the variance extracted, there is a good chance that the data suffer from common-method bias.

REFERENCES

Ahmad, S. and Schroeder, R.G. (2003), 'The impact of human resource management practices on operational performance: recognizing country and industry differences', *Journal of Operations Management*, **21**: 19–43.

Amit, R. and Schoemaker, P.J.H. (1993), 'Strategic asset and organizational rent', *Strategic Management Journal*, **14**: 33–46.

Appelbaum, E., Bailey, T., Berg, P. and Kalleberg, A. (2000), *Manufacturing Competitive Advantage: The Effects of High Performance Work Systems on Plant Performance and Company Outcomes*, Ithaca, NY: Cornell University Press.

Aragón-Correa, J.A. (1998), 'Strategic proactivity and firm approach to the natural environment', *Academy of Management Journal*, **41**: 556–67.

Aragón-Correa, J.A. and Sharma, S. (2003), 'A contingent resource-based view of proactive corporate environmental strategy', *Academy of Management Review*, **28**: 71–88.

Arthur, J.B. (1994), 'Effects of human resource systems on manufacturing performance and turnover', *Academy of Management Journal*, **37**: 670–87.

Azzone, G. and Noci, G. (1998), 'Seeing ecology and green innovations as a source of change', *Journal of Organizational Change Management*, **11**: 94–111.

Bae, J., Chen, S.J., Wan, T.W.D., Lawler, J.J. and Walumbwa, F.O. (2003), 'Human resource strategy and firm performance in Pacific Rim countries', *International Journal of Human Resource Management*, **14**: 1308–32.

Bae, J. and Lawler, J.J. (2000), 'Organizational and HRM strategies in Korea: impact on firm performance in an emerging economy', *Academy of Management Journal*, **43**: 502–17.

Bansal, P. (2002), 'The corporate challenges of sustainable development', *Academy of Management Executive*, **16**(2): 122–31.

Bansal, P. (2003), 'From issues to actions: the importance of individual concerns and organizational values in responding to natural environmental issues', *Organization Science*, **14**: 510–27.

Bansal, P. (2005), 'Evolving sustainably: a longitudinal study of corporate sustainable development', *Strategic Management Journal*, **26**: 197–218.

Barney, J.B. (1986), 'Types of competition and the theory of strategy: toward an integrative framework', *Academy Management Review*, **11**: 791–800.

Barney, J.B. (1991), 'Firm resources and sustained competitive advantage', *Journal of Management*, **17**: 99–120.

Barney, J.B. (2001), 'Is the resource-based "view" a useful perspective for strategic management? Yes', *Academy of Management Review*, **26**: 41–56.

Bartel, A.P. (2004), 'Human resource management and organizational performance: evidence from retail banking', *Industrial and Labor Relations Review*, **57**: 181–203.

Becker, B. and Gerhart, B. (1996), 'The impact of human resource management on organizational performance: progress and prospects', *Academy of Management Journal*, **39**: 779–801.

Becker, B.E. and Huselid, M.A. (1998), 'High performance work systems and firm performance: a synthesis of research and managerial implications', in G.R. Ferris (ed.), *Research in Personnel and Human Resource Management*, Vol. 16, Greenwich, CT: JAI Press, pp. 53–101.

Becker, B., Huselid, M. and Ulrich, D. (2001), *The HR Scorecard: Linking People, Strategy, and Performance*, Boston, MA: Harvard Business School Press.

Brush, T.H. and Artz, K.W. (1999), 'Toward a contingent resource-based theory: the impact of information asymmetry on the value of capabilities in veterinary medicine', *Strategic Management Journal*, **20**: 223–50.

Bunge, J., Cohen-Rosenthal, E. and Ruiz-Quintanilla, A. (1996), 'Employee participation in pollution reduction: preliminary analysis of the Toxics Release Inventory', *Journal of Cleaner Production*, **4**(1): 9–16.

Burns, T. and Stalker, G.M. (1961), *The Management of Innovation*, London: Tavistock Publications.

Chinander, K.R. (2001), 'Aligning accountability and awareness for environmental performance in operations', *Production and Operations Management*, **10**: 276–91.

Clark, K.B. and Fujimoto, T. (1991), *Product Development Performance*, Boston, MA: Harvard Business School Press.

Clark, K.B. and Wheelwright, S.C. (1992), 'Organizing and leading heavyweight development teams', *California Management Review*, **34**(3): 9–28.

Colbert, B.A. (2004), 'The complex resource-based view: implications for theory and practice in strategic human resource management', *Strategic Management Review*, **29**: 341–58.

Crampton, S.M. and Wagner, J.A. (1994), 'Percept–percept inflation in micro-organizational research: an investigation of prevalence and effect', *Journal of Applied Psychology*, **79**: 67–76.

Cronbach, L. (1987), 'Statistical tests for moderator variables: flaws in analysis recently proposed', *Psychological Bulletin*, **102**: 414–17.

Daily, B.F. and Huang, S. (2001), 'Achieving sustainability through attention to human resource factors in environmental management', *International Journal of Operations and Production Management*, **21**: 1539–52.

Datta, D.K., Guthrie, J.P. and Wright, P.M. (2005), 'Human resource management and labor productivity: does industry matter?', *Academy of Management Journal*, **48**: 135–45.

Del Brío, J.A. and Junquera, B. (2003), 'A review of the literature on environmental innovation management in SMEs: implication for public policies', *Technovation*, **23**: 939–48.

Delaney, J.T. and Huselid, M. (1996), 'The impact of human resource management practices on perceptions of organizational performance', *Academy of Management Journal*, **39**: 949–69.

Delaney, J.T., Lewin, D. and Ichniowski, C. (1989), *Human Resource Policies and Practices in American Firms*, US Department of Labor, Washington, DC: US Government Printing Office.

Egri, C.P. and Herman, S. (2000), 'Leadership in the North American environmental sector: values, leadership styles, and contexts of environmental leaders and their organizations', *Academy of Management Journal*, **43**: 571–604.

Epstein, M.J. and Roy, M.J. (2001), 'Sustainability in action: identifying and measuring the key performance drivers', *Long Range Planning*, **34**: 585–604.

Fernández, E., Junquera, B. and Ordiz, M. (2003), 'Organizational culture and human resources in the environmental issue: a review of the literature', *International Journal of Human Resource Management*, **14**: 634–56.

Fiksel, J. (2003), 'Designing resilient, sustainable systems', *Environmental Science and Technology*, **37**: 5330–39.

Florida, R. and Davison, D. (2001), 'Gaining from green management: environmental management systems inside and outside the factory', *California Management Review*, **43**(3): 64–84.

Guest, D.E., Michie, J., Conway, N. and Sheehan: M. (2003), 'Human resource management and corporate performance in the UK', *British Journal of Industrial Relations*, **41**: 291–314.

Gould-Williams, J. (2003), 'The importance of HR practices and workplace trust in achieving superior performance: a study of public-sector organizations', *International Journal of Human Resource Management*, **14**: 28–54.

Gupta, M. and Sharma, K. (1996), 'Environmental operations management: an opportunity for improvement', *Production and Inventory Management Journal*, **37**(3): 40–46.

Guthrie, J.P. (2001), 'High-involvement work practices, turnover, and productivity: evidence from New Zealand', *Academy of Management Journal*, **44**: 180–90.

Handfield, R.B., Melnyk, S.A., Calantone, R.J. and Curkovic, S. (2001), 'Integrating environmental concerns into the design process: the gap between theory and practice', *IEEE Transactions on Engineering Management*, **48**: 189–208.

Hanna, M.D., Newman, W.R. and Johnson, P. (2000), 'Linking operational and environmental improvement through employee involvement', *International Journal of Operations and Production Management*, **20**: 148–65.

Harrigan, K. (1984), 'Formulating vertical integration strategies', *Academy of Management Review*, **9**: 638–52.

Hart, S.L. (1995), 'A natural-resource-based view of the firm', *Academy of Management Review*, **20**: 986–1014.

Hostager, T., Neil, T., Decker, R. and Lorentz, R. (1998), 'Seeing environmental opportunities: effects on intrapreneurial ability, efficacy, motivation, and desirability', *Journal of Organizational Change Management*, **11**: 11–25.

Huselid, M.A. (1995), 'The impact of human resource management practices on turnover, productivity, and corporate performance', *Academy of Management Journal*, **38**: 635–72.

Ichniowski, C., Kochan, T.A., Levine, D., Olson, C. and Strauss, G. (1996), 'What works at work: overview and assessment', *Industrial Relations*, **35**: 299–333.

Ichniowski, C. and Shaw, K. (1999), 'The effects of human resource management systems on economic performance: an international comparison of US and Japanese plants', *Management Science*, **45**: 704–21.

Ichniowski, C., Shaw, K. and Prenushi, G. (1997), 'The effects of human resource management practices on productivity: a study of steel finishing lines', *American Economic Review*, **87**: 291–314.

Jaccard, J., Turrisi, R. and Wan, C.K. (1990), *Interaction Effects in Multiple Regression*, Newbury Park, CA: Sage.

Jackson, P.R. and Wall, T.D. (1991), 'How does operator control enhance performance of advance manufacturing technology?', *Ergonomics*, **34**: 1301–11.

Jaikumar, R. (1986), 'Postindustrial manufacturing', *Harvard Business Review*, **64**(6): 69–76.

Jerez-Gomez, P., Céspedes-Lorente, J. and Valle-Cabrera, R. (2005), 'Organizational learning and compensation strategies: evidence from the Spanish chemical industry', *Human Resource Management*, **44**: 279–99.

Judge, W.Q. Jr and Douglas, T.J. (1998), 'Performance implications of incorporating natural environmental issues into the strategic planning process: an empirical assessment', *Journal of Management Studies*, **35**: 241–62.

Kitazawa, S. and Sarkis, J. (2000), 'The relationship between ISO 14001 and continuous source reduction programs', *International Journal of Operations and Production Management*, **20**: 225–48.

Klassen, R.D. and Whybark, D.C. (1999), 'The impact of environmental technologies on manufacturing performance', *Academy of Management Journal*, **42**: 599–615.

Koch, M.J. and McGrath, R.G. (1996), 'Improving labor productivity: human resource management policies do matter', *Strategic Management Journal*, **17**: 335–54.

Lawrence, P.R. and Lorsch, J. (1967), *Organization and Environment*, Boston, MA: Harvard Business School Press.

Lengnick-Hall, C. and Lengnick-Hall, M. (1988), 'Strategic HRM: a review of the literature and a proposed typology', *Academy of Management Review*, **13**: 454–70.

Lothe, S., Myrtveit, I. and Trapani, T. (1999), 'Compensation systems for improving environmental performance', *Business Strategy and the Environment*, **8**: 313–21.

MacDuffie, J.P. (1995), 'Human resource bundles and manufacturing performance: organizational logic and flexible production systems in the world auto industry', *Industrial and Labor Relations Review*, **48**: 197–221.

Maijoor, S. and Van Witteloostuijn, A. (1996), 'An empirical test of the resource-based theory: strategic regulation in the Dutch audit industry', *Strategic Management Journal*, **17**: 549–69.

Majumdar, S.K. and Marcus, A.A. (2001), 'Rules versus discretion: the productivity consequences of flexible regulation', *Academy of Management Journal*, **44**: 170–79.

Marcus, A. and Geffen, D. (1998), 'The dialectics of competency acquisition: pollution prevention in electric generation', *Strategic Management Journal*, **19**: 1145–68.

Marcus, A.A. and Nichols, M.L. (1999), 'On the edge: heeding the warnings of unusual events', *Organization Science*, **10**: 482–99.

Miles, R.E. and Snow, C.C. (1978), *Organizational Strategy, Structure and Process*, New York: McGraw-Hill.

Miller, D. and Friesen, P.H. (1983), 'Strategy-making and environment: the third link', *Strategic Management Journal*, **4**: 221–5.

Miller, D. and Lee, J. (2001), 'The people make the process: commitment to employees, decision making, and performance', *Journal of Management*, **27**: 163–89.

Miller, D. and Shamsie, J. (1999), 'Strategic responses to three kinds of uncertainty: product line simplicity at the Hollywood film studios', *Journal of Management*, **25**: 97–116.

Pagell, M., Handfield, R.B. and Barber, A.E. (2000), 'Effects of operational employee skills on advanced manufacturing technology performance', *Production and Operation Management*, **9**: 222–38.

Pfeffer, J. (1994), *Competitive Advantage through People: Unleashing the Power of the Workforce*, Boston, MA: Harvard Business School Press.

Pfeffer, J. (1998a), 'Seven practices of successful organizations', *California Management Review*, **40**(2): 96–123.

Pfeffer, J. (1998b), *The Human Equation*, Boston, MA: Harvard Business School Press.

Podsakoff, P.M. and Organ, D.W. (1986), 'Self-reports in organizational research: problems and prospects', *Journal of Management*, **12**: 531–44.

Prahalad, C.K. and Hamel, G. (1990), 'The core competence of the corporation', *Harvard Business Review*, **68**(3): 79–91.

Priem, R.L. and Butler, J.E. (2001a), 'Is the resource-based "view" a useful perspective for strategic management research?', *Academy of Management Review*, **26**: 22–40.

Priem, R.L. and Butler, J.E. (2001b), 'Tautology in the resource-based view and the implications of externally determined resource value: further comments', *Academy of Management Journal*, **26**: 57–66.

Ramus, C.A. (2001), 'Organizational support for employees: encouraging creative ideas for environmental sustainability', *California Management Review*, **43**: 85–105.

Ramus, C.A. and Steger, U. (2000), 'The roles of supervisory support behaviors and environmental policy in employee "ecoinitiatives" at leading-edge European companies', *Academy of Management Journal*, **43**: 605–26.

Rothenberg, S. (2003), 'Knowledge content and worker participation in environmental management at NUMMI', *Journal of Management Studies*, **40**: 1783–802.

Rothenberg, S., Pil, F.K. and Maxwell, J. (2001), 'Lean green, and the quest for superior environmental performance', *Production and Operations Management*, **10**(3): 228–43.

Ruiz-Quintanilla, S.A., Bunge, J., Freeman-Gallant, A. and Cohen-Rosenthal, E. (1996), 'Employee participation in pollution reduction: a socio-technical perspective', *Business Strategy and the Environment*, **5**(3): 137–44.

Russo, M.V. and Fouts, P.A. (1997), 'A resource-based perspective on corporate environmental performance and profitability', *Academy of Management Journal*, **40**: 534–59.

Russo, M.V. and Harrison, N.S. (2005), 'Organizational design and environmental performance: clues from the electronics industry', *Academy of Management Journal*, **48**: 582–93.

Sharma, S., Pablo, A. and Vredenburg, H. (1999), 'Corporate environmental responsiveness strategies: the role of issue interpretation and organizational context', *Journal of Applied Behavioral Science*, **35**: 87–109.

Sharma, S. and Vredenburg, H. (1998), 'Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities', *Strategic Management Journal*, **19**: 729–53.

Shrivastava, P. (1995a), 'The role of corporations in achieving ecological sustainability', *Academy of Management Review*, **20**: 936–60.
Shrivastava, P. (1995b), 'Ecocentric management for a risk society', *Academy of Management Review*, **20**: 118–37.
Shrivastava, P. (1995c), 'Environmental technologies and competitive advantage', *Strategic Management Journal*, **16**(Special Issue): 183–200.
Starik, M. and Rands, G.P. (1995), 'Weaving an integrated web: multilevel and multisystem perspectives of ecologically sustainable organizations', *Academy of Management Review*, **20**: 908–35.
Tan, J.J. and Litschert, R.J. (1994), 'Environment–strategy relationship and its performance implications: an empirical study of the Chinese electronics industry', *Strategic Management Journal*, **15**: 1–20.
Tan, J. and Tan, D. (2005), 'Environment–strategy co-evolution and co-alignment: a staged model of Chinese SOEs under transition', *Strategic Management Journal*, **26**: 141–57.
Todd, J., Brown, E.J.G. and Wells, E. (2003), 'Ecological design applied', *Ecological Engineering*, **20**: 421–40.
Tomaskovic-Devey, D., Leiter, J. and Thompson, S. (1994), 'Organizational survey non-response', *Administrative Science Quarterly*, **39**: 439–57.
Tsui, A.S., Pearce, J.L., Porter, L.W. and Tripoli, A.M. (1997), 'Alternative approaches to the employee–organization relationship: does investment in employees pay off?', *Academy of Management Journal*, **40**: 1089–121.
US Department of Labor (1993), *High Performance Work Practices and Firm Performance*, Washington, DC: US Department of Labor.
Verdu-Jover, A.J., Llorens-Montes, J.F. and Garcia-Morales, V.J. (2005), 'Flexibility, fit and innovative capacity: an empirical examination', *International Journal of Technology Management*, **30**: 131–46.
Walley, N. and Whitehead, B. (1994), 'It's not easy being green', *Harvard Business Review*, **72**(3): 46–52.
Way, S.A. (2002), 'High performance work systems and intermediate indicator of firm performance within the US small business sector', *Journal of Management*, **28**: 765–85.
Wehrmeyer, W. (ed.) (1996), *Greening People: Human Resources and Environmental Management*, Sheffield, UK: Greenleaf.
Whitener, E.M. (2001), 'Do high commitment human resource practices affect employee commitment? A cross-level analysis using hierarchical linear modelling', *Journal of Management*, **27**: 515–35.
Wright, P.M., McMahan, C.G. and McWilliams, A. (1994), 'Human resources and sustained competitive advantage: a resource-based view perspective', *International Journal of Human Resource Management*, **5**: 301–26.
Zajac, E.J., Kraatz, M.S. and Bresser, R.K.F. (2000), 'Modelling dynamics of strategic fit: a normative approach to strategic change', *Strategic Management Journal*, **21**: 429–53.
Zobel, T. and Burman, J.O. (2004), 'Factors of importance in identification and assessment of environmental aspects in an EMS context: experiences in Swedish organizations', *Journal of Cleaner Production*, **12**: 13–27.

APPENDIX 8A QUESTIONNAIRE

I Human Resource Practices in Your Firm

Please answer as accurately as possible the following questions related to human resource practices implemented by your organization in relation to your EMPLOYEES/WORKERS (managers not included) TAKING AS A REFERENCE THE LAST TWO YEARS.

Consider the scale given to you as a guide by *Percentage of employees/ workers who participate*:

Very low						Very high
①	②	③	④	⑤	⑥	⑦
0–15%	16–30%	31–45%	46–54%	55–70%	71–85%	86–100%

	Very low						Very high
1. What percentage of employees get a promotion giving more importance to their performance than to other factors such as seniority, qualifications, skills, etc.?	1	2	3	4	5	6	7
2. What percentage of employees have joined your firm during the last two years?	1	2	3	4	5	6	7
3. What percentage of the total number of employees hired by your firm in one year receive formal training during their first year in your organization?	1	2	3	4	5	6	7
4. What percentage of employees receive formal training after the first year working for your organization?	1	2	3	4	5	6	7
5. What percentage of employees are subject to a formal evaluation of their working performance?	1	2	3	4	5	6	7
6. What percentage of employees receive a pay rise linked to the evaluation of their performance?	1	2	3	4	5	6	7

	Very low						Very high
7. What percentage of employees have jobs where performance evaluation is made using an objective measure (e.g., sales volume, number of requests attended, objective fulfilment, etc.)?	1	2	3	4	5	6	7
8. What percentage of employees have available incentive plans linked to the organization's profits?	1	2	3	4	5	6	7
9. What percentage of employees own shares or stocks of your company?	1	2	3	4	5	6	7
10. What percentage of employees receive formal information (for example, through an information bulletin or regular meetings) about a wide range of issues relevant for the firm and its operations?	1	2	3	4	5	6	7
11. What percentage of employees regularly have to answer a questionnaire about work climate, attitude or satisfaction?	1	2	3	4	5	6	7
12. What percentage of employees have jobs which are subject to a formal analysis of the workplace and its characteristics?	1	2	3	4	5	6	7
13. What percentage of employees are included in some system or programme (e.g., quality circle) in order to be able to participate in the firm's decision-making processes?	1	2	3	4	5	6	7

II Natural Environmental Practices in the Firm

Using a 1 to 7 scale, specify the degree of development of the following activities related to the environment in your firm.

(1: this issue is not developed here and we have no plans to do so in the near future, or even if we would like to, we have no plans to increase respect for the natural environment; 2: we have plans to do so in the long term; 3: we have short-term plans to do so; 4: we have started developing this issue; 5: we have made some progress in this area; 6: we are at a rather advanced stage of development of these practices; 7: we have fully developed this issue and are actually leaders in the application of environmental practices)

1. Internal organization
   - 1.1. Natural environmental aspects in administrative work (paper, toner recycling, etc.) ________
   - 1.2. Periodic natural environmental audits ________
   - 1.3. Recycling of residues and waste produced by the organization ________
   - 1.4. Purchasing manual with ecological guidelines ________
   - 1.5. Natural environmental seminars for executives ________
   - 1.6. Natural environmental training for the firm's employees ________
   - 1.7. Total quality programme including natural environmental aspects ________
   - 1.8. Prevention systems to cover possible environmental accidents and emergencies caused by the organization ________
   - 1.9. Natural environmental management manual for internal use ________

2. Customers/suppliers
   - 2.1. Sponsorship of natural environmental events ________
   - 2.2. Use of natural environmental arguments in marketing ________
   - 2.3. Natural environmental information and training programmes for our distributors and customers ________

3. Manufacturing
   - 3.1. Filters and controls for emissions and discharges ________
   - 3.2. Systematic control of energy consumption so as to reduce the organization's demand ________
   - 3.3. Recycling of the water used by the organization with the purpose of re-using it in other processes and/or before throwing it down the drain ________
   - 3.4. Use of ecological ingredients in the manufacturing of our products ________

4. Design
   4.1. Natural environmental analysis of the product life cycle (PLC) __________
   4.2. Design of products and services according to ecological criteria (eco-design) __________

III General Environment

Identification of the general characteristics of the firm's general environment. Specify the level of agreement or disagreement with each one of the following statements:

	I totally agree					I totally disagree	
1. The environment factors affecting our organization (such as technology, customer preferences, suppliers, regulation, etc.) change very often	1	2	3	4	5	6	7
2. The changes in our business environment affecting the organization make it quite difficult for the organization to obtain positive results	1	2	3	4	5	6	7
3. The business environment factors affecting our firm are numerous	1	2	3	4	5	6	7
4. The business environment factors affecting the operation of our organization are very varied	1	2	3	4	5	6	7

PART III

Customer adoption of and marketing for sustainability innovation

9. Quality, environmental practices and customer satisfaction in services

George I. Kassinis and Andreas C. Soteriou

Studies have pointed out that the implementation of environmental management practices can lead to performance gains in services and manufacturing alike. In services, such performance gains were shown to materialize through cost reduction and resource savings (Goodman, 2000; Schendler, 2001) or through increased customer satisfaction and loyalty (Kassinis and Soteriou, 2003). In this chapter, we examine the link between environmental practices and customer satisfaction within the context of service quality practices, which are critical for a service organization's success. We argue that the established relationship between service quality practices (SQPs) and customer satisfaction may be strengthened if SQPs are 'coupled' with environmental practices. Synergies between environmental and service quality practices can increase the level of customer satisfaction achieved by a service firm – compared to service-quality or environmental practices-only scenarios.

Researchers have stressed that the successful implementation of environmental management practices – specifically pollution prevention – is a complex phenomenon (Aragón-Correa and Sharma, 2003) that is dependent on specific processes (Eisenhardt and Martin, 2000) connected to environmental capabilities such as stakeholder integration, continuous innovation and improvement, and higher-order shared learning (Hart, 1995; Aragón-Correa and Sharma, 2003). These practices and processes are part of proactive environmental strategies that seek to achieve competitive advantages for the firm either through cost advantages or through differentiation advantages targeting green consumers.

At the same time, research has shown that leading service firms focus on strengthening a number of performance drivers such as their generic operations capabilities, quality and human resource management practices. In turn, the complex and highly competitive environments in which such firms operate necessitate the analysis of potential interactions among various practices so that a firm can fully take advantage of their combined impact on its performance.

Here we focus on the potential synergies that exist between environmental and service quality practices, and their combined effect on customer satisfaction. In his seminal paper, Shrivastava (1995) had in fact proposed the integration of quality and environmental considerations by firms in the form of total quality environmental management (TQEM) – a strategic choice that could generate both performance and environmental quality gains for the adopting firm. As Angell and Klassen (1999) and Corbett and Pan (2002) point out, the philosophy that underlies TQEM is that total quality management (TQM) principles and concepts – including continuous improvement, training and empowerment of employees, incentive schemes and quality management systems – apply to environmental improvements as well. Despite its focus on manufacturing, the concept has relevance for services as well. By adopting such a strategic choice, firms could conserve resources by increasing the use of renewable materials, developing ecologically sensitive purchasing policies and inventory management systems, or through product redesign. By focusing on improving the efficiency of production they could minimize waste and reduce costs. Finally, by focusing on product choice and design, they could minimize the life-cycle costs and improve the quality of products and services (Shrivastava, 1995; Angell and Klassen, 1999).

The chapter is organized as follows: in the next section, we provide the conceptual underpinnings of our work and develop our hypotheses; then, we present our methodology, research design, data collection and results; finally, we discuss our findings and conclude.

SERVICE QUALITY, CUSTOMER SATISFACTION AND ENVIRONMENTAL PRACTICES IN SERVICES

Service Quality, Customer Satisfaction and Performance

The belief that better service quality (SQ) pays off is well established in the literature (for example, Anderson et al., 1997 and 2004; Hendricks and Singhal, 2001). Given the importance of service quality, a growing literature has linked operations and marketing concepts (for example, Soteriou and Zenios, 1999) or organizational behaviour and marketing concepts (for example, Heskett et al., 1994) with efforts to improve service quality.

Satisfying customer demands is one of the fundamental notions of the marketing concept. A popular definition of customer satisfaction presented in the literature positions customer satisfaction as an evaluation of the perceived discrepancy between prior expectations – or some other norm of performance – and the actual performance as perceived after the consumption of a good or service by a customer (Oliver, 1993). Moreover, cumulative satisfaction, defined as a customer's overall experience to date with a product or service (Johnson et al., 1995), is considered a fundamental indicator of the firm's past, current and future performance (Anderson et al., 1997).

The literature suggests that customer satisfaction is positively related to customer loyalty (Heskett et al., 1994) with loyalty being linked to increased profits – through enhanced revenues, reduced costs to acquire and serve customers familiar with a firm's service delivery system, and lower customer-price sensitivity (Reichheld and Sasser, 1990; Anderson et al., 2004).

Service Operations, Environmental Management and Customer Satisfaction

Researchers have argued that the effective integration of environmental management practices into operations presents numerous benefits including lower costs and enhanced efficiencies (Hart, 1995; Klassen and Whybark, 1999; King and Lenox, 2002), competitive advantages through product or service differentiation (green products or services), and better servicing of niche markets (customers demanding ecologically friendly products/services) (Shrivastava, 1995; Goodman, 2000).

The majority of empirical studies focus on manufacturing firms, examine the relationship between environmental and financial performance and find a positive correlation between the two (King and Lenox, 2001). Others study the relationship between the implementation of environmental practices and performance and suggest that 'green' firms may also be more efficient and innovative (ibid.) and show that it is pollution prevention measures that yield benefits for adopting firms.

In services, recent studies provide evidence of the benefits of environmental management measures, which include cost reductions, resource savings, customer retention and loyalty, and improved employee morale (Enz and Siguaw, 1999; Foster et al., 2000; Goodman, 2000; Salzman, 2000; Halme, 2001; Schendler, 2001; Kassinis and Soteriou, 2003). With one exception (Kassinis and Soteriou, 2003), these studies base their conclusions on cases or anecdotal evidence – something that may limit their generalizability.

In successfully implementing environmental practices, service firms face unique challenges, which are related to the distinctive characteristics of services *vis-à-vis* goods (Fitzsimmons and Fitzsimmons, 2000; Kassinis and Soteriou, 2003). One such characteristic is the presence of the customer in the system and the resulting simultaneity of service production and consumption. In fact, the impact of customer involvement on the service operating system is one of the most important service idiosyncrasies affecting service performance – especially in high contact service systems, such as hotels and banks, where customer involvement is typically high (Chase, 1981; Chase and Tansik, 1983).

While true that most services require some direct or indirect customer involvement, the physical presence of the customer and his/her role as *co-producer* in high contact service systems create numerous challenges for managers (Soteriou and Chase, 1998). Foster et al. (2000) assert that customer involvement holds potential for influencing environmental actions. Often, certain environmental activities are 'hidden' from the customer as they take place in the back office (for example, in restaurants, where waste disposal or recycling may take place out of customer view). In high contact systems, however, such activities also take place in the front office. An environmentally conscious customer may thus not only apply pressure on management to change company policy (Salzman, 2000) but also be involved, as co-producer, in a firm's environmental practices (for example, energy and water savings practices in hotels). The challenge and at the same time the opportunity for such high contact service firms is to meet customer demands and manage customer involvement without compromising service quality (Goodman, 2000; Schendler, 2001).

Recently, Kassinis and Soteriou (2003) showed that the use of environmental management practices in the hotel industry is positively related to market performance, through the mediating effect of customer satisfaction and loyalty. They argued that environmental practices are a component of a service firm's operations (Angell and Klassen, 1999; Hanna et al., 2000). Environmental practices are, then, built into service design and as such might impact on customer satisfaction and loyalty, and through them firm performance. More specifically, they are integrated within the service concept and alter both its structural and managerial elements, including its service delivery, service encounter, quality and information dimensions (Kassinis and Soteriou, 2003).

Hypotheses

Based on the above we develop hypotheses linking service quality, environmental practices as well as potential interactions between service quality and environmental practices with customer satisfaction. The first hypothesis is intended to reconfirm the established relationship between service quality and satisfaction and serve as a benchmark for identifying potential synergies between service quality and environmental practices.

H1: Higher levels of service quality practices are associated with higher levels of customer satisfaction.

The only other empirical evidence regarding our second hypothesis comes from Kassinis and Soteriou. We test this hypothesis to provide further evidence as to this relationship but also to further establish a baseline against which we can assess potential synergies between environmental practices and service quality towards customer satisfaction. Therefore,

H2: Higher levels of usage of environmental practices are associated with higher levels of customer satisfaction.

Finally, our third hypothesis explores synergies that may exist between service quality and environmental practices towards enhanced customer satisfaction.

H3: Synergies between service quality and environmental practices exist. These manifest themselves in the form of a 'surplus' level of customer satisfaction over that resulting from service quality or environmental practices alone.

METHODOLOGY AND DATA COLLECTION

Controlled Experiments and Video Techniques

To test our hypotheses, we use a controlled experimental procedure that can isolate specific practices and demonstrate their impact on performance (in our study, on customer satisfaction). Controlled experimental methods have been used in the past to isolate and test the effect of various factors (Bitner, 1990; Ogden and Turner, 1997).

A major challenge in designing such experimental procedures involving customers is to provide the respondent with the opportunity to actually 'experience' the various scenarios involved in the design, before responding, while at the same time controlling for extraneous variables. In the past, the use of written scripts and role playing has been used (Bitner, 1990) to describe the 'experience' to respondents, in an attempt to enhance validity and reduce random noise in the experimental setting. In this chapter, we decided to use video technology to further enhance this experience. Its use enables us to better maintain consistency in the various treatments involved. Video technology has been used in the service operations management (Chebat et al., 1995; Kellogg and Chase, 1995; Echeverri, 2005; Seawright and Sampson, 2006) and psychology (Hauenstein, 1992; Sulsky and Day, 1992) literatures.

Specifically, a professional production crew and professional actors were hired to produce four different scenarios for the needs of our experimental design. Each scenario represented a different 'experience' following the various steps involved during the visit of a customer to a 4-star hotel, starting from the reception area where check-in takes place, moving through the hotel to the room and finally to the check-out area. The choice of hotels as the setting of our study was based on the wide variation that exists with respect to levels of service quality and use of environmental practices in this industry (Goodman, 2000; Halme, 2001). A script for each scenario was developed in which the camera, representing the customer, entered the hotel and checked in with a receptionist, a professional actor. After check-in, the camera moved on to other areas of the hotel before arriving and examining the room, and finally checking out.

Each segment of the experience was videotaped more than once, modifying the experience of the customer and providing different visual cues regarding the quality and environmental practices (EPs) present. In one scenario, for example, the camera entered the reception area where pamphlets with environmental content and recycling bins were in view. Those were not present in other scenarios (see Appendix 9A, Table 9A.1 for descriptions of the various scenarios). Professional digital editing was then used to link the various segments together and produce four videoclips of continuous flow, corresponding to the four scenarios required by the needs of our design. Each segment was edited to last exactly the same amount of time. Resulting videoclips were within five seconds of mean length of three minutes.

A Two-way Experimental Design

We followed a 2^2 factorial design that would allow us to explore both main *and* interaction effects of (i) service quality and (ii) environmental practices on customer satisfaction, as shown in Table 9.1.

This design results in four blocks of treatment levels. A two-way (factorial) design can be characterized by the following mathematical model:

Table 9.1 A 2^2 factorial design of service quality and environmental practices on customer satisfaction

		Level of SQ	
		Low	High
Level of EPs	Low	Scenario A	Scenario B
	High	Scenario C	Scenario D

$$y_{tij} = \eta + \tau_t + \beta_i + \omega_{ti} + \varepsilon_{tij}, \tag{9.1}$$

where,

y_{tij}: the response of the jth subject, with the tth and ith treatments of factors A and B, respectively,
η: the sum of a general mean,
τ_t: the mean response increment associated with the tth treatment of factor A (main effect),
β_i: the corresponding increment associated with the ith treatment of factor B (main effect),
ω_{ti}: the interaction effect associated with the tth and ith treatments of factors A and B and
ε_{tij}: error.

Associated with such a model is the decomposition of the observations,

$$y_{tij} = \bar{y}_{ti} + (y_{tij} - \bar{y}_{ti}) \tag{9.2}$$

and

$$\bar{y}_{ti} = \bar{y} + (\bar{y}_t - \bar{y}) + (\bar{y}_i - \bar{y}) + (\bar{y}_{ti} - \bar{y}_t - \bar{y}_i + \bar{y}) \tag{9.3}$$

where,

$\bar{y}$: the grand average,
$\bar{y}_t$: the tth treatment average of factor A and
$\bar{y}_i$: the ith treatment average of factor B.

The simplicity of this design and its ability to capture interaction effects (Box et al., 1978) makes it particularly attractive for the purposes of our study.

Questionnaire Development

To develop our questionnaire, we built on relevant efforts in the marketing and operations management literatures regarding service quality (Zeithaml et al., 1996; Brady and Cronin, 2001), customer satisfaction (Oliver, 1993; Fornell et al., 1996) and service firms' environmental practices (Goodman, 2000; Foster et al., 2000; Schendler, 2001; Kassinis and Soteriou, 2003). We followed the approach described by Froehle and Roth (2004) to create a parsimonious set of survey items that exhibit satisfactory levels of reliability and validity (Pedhazur and Schmelkin, 1991). Respondents were asked to rate the degree of agreement or disagreement with all the statements in the questionnaire, using a seven-point scale, anchored at 'strongly agree' (7) and 'strongly disagree' (1).

We took a number of steps to ensure the reliability and validity of the measurement scales (and items). First, we proceeded with discussions with six hotel managers, whose premises were used for the filming of the videoclips. Based on these discussions we made minor refinements to the initial set of service quality items, in order to capture the uniqueness of the hotel setting of our study and of the videoclips. A number of items were dropped at this stage because of the nature of the videoclips that would not allow the respondents to provide a meaningful response. The questionnaire was also submitted to a pre-test in which 80 students were shown the videoclips and were asked to provide responses along with qualitative comments, in order to enhance the items' and scales' content validity. Based on their comments we dropped a number of additional items and slightly modified others.

We assessed scale reliability using an internal consistency method, where reliability is operationalized as internal consistency or the degree of intercorrelations among the items that constitute a scale (Nunnally, 1988). Scale reliabilities measured by Cronbach's alpha were calculated, with all values examined being consistently similar with those reported by other authors (for example, Parasuraman et al., 1991) and exceeding the minimum requirements. Thus, we are confident that all three scales are internally consistent. We also examined issues of face, content, convergent and discriminant validity (Pedhazur and Schmelkin, 1991) and are confident that the validity of our measures is ensured.

Data Collection

As discussed above, four different videoclips representing the scenarios were developed to match the resulting blocks of the research design. These scenario clips were randomly assigned to 145 business students who were asked to assume that they were the customer visiting the hotel, as shown in the videoclips. Randomization of subject assignment to treatment groups enabled the control of a number of otherwise uncontrollable factors, such as, customer expectations, attitudes and prior experience with the service. After viewing the clip they were asked to complete a questionnaire regarding their experience.

The questionnaire used included items focusing on issues of service quality, environmental practices and customer satisfaction. Measures were drawn from the relevant literatures and finalized during a pilot study (Soteriou and Chase, 1998; Kassinis and Soteriou, 2003). Respondents were asked to rate the degree of agreement or disagreement with statements relating to service quality and environmental practices of the hotel, using a seven-point scale, anchored at 'strongly agree' (7) and 'strongly disagree' (1). Customer satisfaction items were also measured using a seven-point scale, with similar anchors. Sample questions and resulting reliability Cronbach α coefficients are presented in Appendix 9A. Exploratory factor analysis suggested three distinct constructs regarding service quality, satisfaction and environmental practices.

Results

Table 9.2 presents descriptive statistics, including mean customer satisfaction levels obtained from respondents who viewed each of the four clips and responded to the accompanying questions. The mean satisfaction level of the respondents who viewed the 'High service quality' videoclip was 5.23 compared to 2.42 of those who viewed the 'Low service quality' clip, suggesting a main effect of service quality on customer satisfaction. Table 9.2 also points towards a main effect regarding the use of environmental practices on customer satisfaction (mean of 4.11 versus 3.85) although this is not statistically significant ($p < 0.05$).

The same table presents descriptive results regarding two additional dependent variables: perceived service quality and perceived level of environmental practices employed, as obtained from the respondents of each of the four cells in our research design. The results further confirm the choice of the four videoclips. As expected, quality perceptions associated with the 'High service quality' clips were higher than those associated with the 'Low service quality' clips. A similar picture holds true regarding environmental perceptions: those associated with the 'High environmental practices' clips are higher than those associated with the 'Low environmental practices' clips.

This picture is further explored in Table 9.3, where 95 per cent confidence intervals are presented regarding the mean differences across groups. Again, as expected, the difference in the responses regarding environmental practices when moving from the 'Low environmental practices' clip to the 'High environmental practices' clip is statistically significant ($p < 0.05$), while the difference in customer satisfaction levels when environmental practices change from 'Low' to 'High' are only statistically significant when quality levels remain high.

Table 9.3 also suggests a much more interesting finding regarding the existence of a possible interaction effect between service quality and environmental practices, because the mean difference in customer satisfaction varies across the two quality groups. We observe that an increase in the

Table 9.2 Descriptive statistics for the cells of the research design

Customer satisfaction

		Environmental practices		Row totals
		Low Env	High Env	
Service quality	Low SQ	2.6354 (0.99590) $N=32$	2.2121 (0.99589) $N=33$	2.4205 (1.01084) $N=65$
	High SQ	4.7667 (1.37719) $N=42$	5.7586 (1.25807) $N=38$	5.2378 (1.40502) $N=80$
	Column totals	3.8450 (1.61756) $N=74$	4.1102 (2.11267) $N=71$	3.9749 (1.87452) $N=145$

Service quality perceptions

		Environmental practices		Row totals
		Low Env	High Env	
Service quality	Low SQ	1.7293 (0.37052) $N=32$	1.7163 (0.31515) $N=33$	1.7227 (0.34088) $N=65$
	High SQ	3.8518 (0.55557) $N=42$	3.9201 (0.50799) $N=38$	3.8843 (0.53125) $N=80$
	Column Totals	2.9340 (1.16299) $N=74$	2.8958 (1.18629) $N=71$	2.9153 (1.17052) $N=145$

Environmental orientation

		Environmental practices		Row totals
		Low Env	High Env	
Service quality	Low SQ	2.4452 (0.29235) $N=32$	3.0807 (0.41367) $N=33$	2.7678 (0.47904) $N=65$
	High SQ	2.5349 (0.31407) $N=42$	3.4228 (0.28839) $N=38$	2.9566 (0.53781) $N=80$
	Column totals	2.4961 (0.30610) $N=74$	3.2638 (0.38953) $N=71$	2.8720 (0.51918) $N=145$

Table 9.3 Confidence interval means of research design cells

Customer satisfaction

		Mean	Std error	95% Confidence interval	
				Lower bound	Upper bound
High SQ	High Env	5.759	0.193	5.378	6.139
	Low Env	4.767	0.183	4.404	5.129
Low SQ	High Env	2.212	0.207	1.803	2.621
	Low Env	2.635	0.210	2.220	3.050

Service quality perceptions

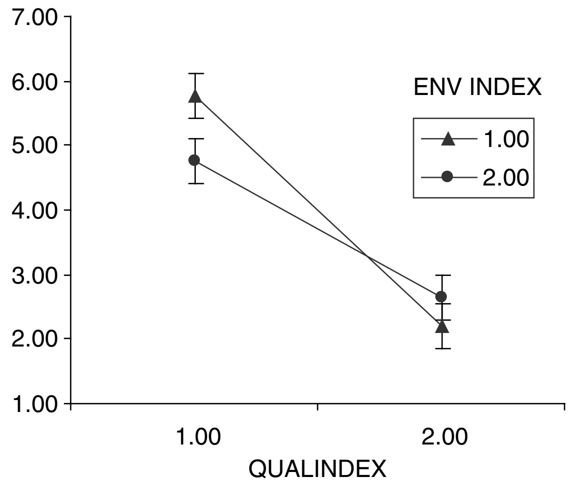
		Mean	Std error	95% Confidence interval	
				Lower bound	Upper bound
High SQ	High Env	3.920	0.074	3.773	4.067
	Low Env	3.852	0.071	3.712	3.992
Low SQ	High Env	1.716	0.080	1.558	1.874
	Low Env	1.729	0.081	1.569	1.890

Environmental orientation

		Mean	Std error	95% Confidence interval	
				Lower bound	Upper bound
High SQ	High Env	3.423	0.053	3.317	3.528
	Low Env	2.535	0.051	2.435	2.635
Low SQ	High Env	3.081	0.057	2.967	3.194
	Low Env	2.445	0.058	2.330	2.560

perceived level of service quality offered is associated with an increase in customer satisfaction from 2.6 to 4.8, while an increase in the perceived level of environmental practices employed leaves customer satisfaction levels virtually unchanged. However, a scenario accompanied by a similar increase in the perceived service quality offered, *combined with* perceived high levels of environmental practices, is associated with customer satisfaction levels of 5.7 – significantly higher than the satisfaction level achieved when the increase was only due to changes in service quality (4.8).

Figure 9.1 provides additional evidence regarding the potential existence of an interaction effect. This is further confirmed by the analysis of variance (ANOVA) tables (Table 9.4). For example, when the dependent



Notes:
1. QUALINDEX: A categorical variable indicating the type of experience, where 1 refers to 'High level of service quality' and 2 to 'Low level of service quality'.
   ENVINDEX: A categorical variable indicating the type of experience, where 1 refers to 'High level of environmental practices' and 2 to 'Low level of environmental practices'.
2. The vertical axis measures mean satisfaction levels.

Figure 9.1 Graph of marginal means of satisfaction

variable is customer satisfaction, this interaction term is statistically significant ($p < 0.05$). The main effect regarding service quality is also statistically significant ($p < 0.05$). On the other hand, the main effect of environmental practices is not statistically significant. What this suggests is that service quality directly influences customer satisfaction. While environmental practices alone do not directly impact on customer satisfaction, this impact becomes significant when combined with quality practices.

The above results lend support to Hypotheses 1 and 3. More particularly, higher levels of service quality are associated with higher levels of customer satisfaction as per Hypothesis 1. Tables 9.2, 9.3 and 9.4 suggest a statistically significant main effect of service quality on customer satisfaction. On the other hand, Hypothesis 2 is not supported. Although according to Table 9.2, higher levels of environmental practices seem to be associated with higher levels of customer satisfaction, this result is not statistically significant. This is clearly shown in Table 9.4, which outlines all the significance levels of all terms in the model. Finally, the results lend support to Hypothesis 3, which suggests the presence of an interaction effect between service quality and environmental management practices ($p < 0.05$).

Table 9.4 ANOVA tables

(Dependent variable: 'Customer satisfaction')

Source	Type III sum of squares	df	Mean square	*F*	Sig.	Partial eta squared
Corrected model	307.183[a]	3	102.394	72.621	0	0.607
Intercept	2116.094	1	2116.094	1500.793	0	0.914
QUALINDEX	288.652	1	288.652	204.720	0	0.592
ENVINDEX	2.895	1	2.895	2.053	0.154	0.014
QUALINDEX × ENVINDEX	17.933	1	17.933	12.719	0	0.083
Error	198.808	141	1.410			
Total	2796.951	145				
Corrected total	505.991	144				

Notes:
[a] $R^2 = 0.607$ (R^2 adj $= 0.599$).
QUALINDEX: A categorical variable indicating the type of experience, where 1 refers to 'High level of service quality' and 2 to 'Low level of service quality'.
ENVINDEX: A categorical variable indicating the type of experience, where 1 refers to 'High level of environmental practices' and 2 to 'Low level of environmental practices'.

DISCUSSION

In this chapter we take a closer look at the relationship between environmental practices and customer satisfaction within the broader context of service quality considerations that are critical for a service firm's success. We find evidence of potential synergies between service quality and environmental management practices that are associated with an increase in customer satisfaction levels. The existence of such synergies provides additional evidence regarding the complexities surrounding the design and implementation of environmental management practices in services. They also point out the potential benefits – in terms of customer satisfaction – of integrating environmental practices within a firm's operating strategy and service delivery system.

The contribution of this work is twofold: (i) we empirically demonstrate the existence of synergies between service quality and environmental practices on customer satisfaction, and (ii) we show how experimental procedures with the help of video technology can be used to provide additional insights on the relationship between environmental management practices and customer satisfaction in services. The use of video technology provides the opportunity to respondents to 'experience' the various scenarios involved in the experimental design. It must be pointed out that the presence of the customer in the system introduces challenges in using experimental designs in service research. However, video technology allows multiple respondents to experience *the same* scenario and thus maintain consistency, a major requirement of experimental designs. As such, the combination of video technology and experimental designs provides us with a powerful tool for empirical research in service settings.

We must note that the observed interaction effect may also be related to what has been known in the literature as the 'halo effect', that is the surplus correlation that exceeds the true correlation of the constructs (Murphy and Jako, 1989). Since Thorndike's (1920) study on supervisors' difficulty in separating independent elements of performance when evaluating subordinates, a number of studies especially in the human resource management literature have focused on this effect (Balzer and Sulsky, 1992). Wirtz and Bateson (1995) examined halo effects on various service attributes leading to customer satisfaction and reported significant halo effects in service attribute evaluation. Our results could also be pointing towards the presence of such an effect in the evaluation of service attributes. While, for example, the presence of specific environmental practices may not be related to customer satisfaction, this may change when such practices are coupled with high levels of service quality.

The study has a number of limitations. First, we need to acknowledge the ongoing debate in the literature between the 'artificiality' of laboratory settings versus the 'realism' of field settings. The controversy is rooted in philosophical and theoretical orientations as well as misconceptions regarding the role of experiments in general and laboratory experiments in particular (see Pedhazur and Schmelkin, 1991, for a discussion on this issue). While some researchers argue against the use of experiments in studying human behaviour (Argyle, 1969) others advocate the use of laboratory experiments as the way to control confounding variables that exist in the real world (Wuebben et al., 1974). As Hutten (1962: 216) summarizes: 'Experimentation allows the scientist to push his hypothesis beyond the realm of everyday things and to advance . . . For the artifact of the laboratory of today becomes the reality of everybody tomorrow'.

While the use of video techniques to help control for confounding variables is attractive, one may question the extent to which the attitude towards a non-interactive videoclip is comparable with that of a real service experience, characterized – among other things – by the simultaneity of production and consumption. A short videoclip may fail to fully capture the complexities of a customer experience. In fact, the nature of the videoclip explains at least in part why a number of service quality items, for example, exhibited low response rates and were dropped from the analysis.

It may also be the case that respondents exhibit a favourable attitude towards the fact that videos are being used which may increase the overall satisfaction level.

Another potential shortcoming of this work relates to the use of a business student sample. While this has been a popular approach followed by a number of researchers, it may limit the generalizability of the results. Larger samples using customers from various service settings should also be considered in future studies. Soteriou and Chase (1998) describe the design of an experimental approach that could help further generalize these findings and provide additional insights.

Overall, our findings on the existence of an interaction effect between service quality and environmental practices are broadly consistent with research that argues that environmental practices need to be integrated within the service concept and alter both its structural and managerial elements (Kassinis and Soteriou, 2003). Moreover, the 'interconnectedness' of service quality and environmental management considerations and their potential interactions are in line with the fact that environmental practices are also a component of a service firm's operating strategy and service delivery system (Heskett et al., 1994). If, then, environmental practices along with quality practices are built into the service design, they could jointly impact on customer satisfaction – hence the observed interaction effect that is over and above their individual effects on customer satisfaction. Such integration is in fact advocated in recent literature, which argues that the environment must be integrated with management's efforts to address the concerns of all stakeholders – with the overarching objective of such efforts being the improvement of customer value (Angell and Klassen, 1999).

The complexities surrounding the design and implementation of environmental management practices in service settings remain. Service managers must continuously strive to meet the demands of environmentally conscious customers and manage their involvement in service production without compromising the quality of services they provide. Further empirical research is thus needed to shed light on how environmental and quality programmes can best be integrated into the service design.

REFERENCES

Anderson, E.W., C. Fornell and S.K. Mazvancheryl (2004), 'Customer satisfaction and shareholder value', *Journal of Marketing*, **68**(4), 172–86.

Anderson, E.W., C. Fornell and R.T. Rust (1997), 'Customer satisfaction, productivity and profitability: differences between goods and services', *Marketing Science*, **16**(2), 129–45.

Angell, L.C. and R.D. Klassen (1999), 'Integrating environmental issues into the mainstream: an agenda for research in operations management', *Journal of Operations Management*, **17**(5), 575–98.
Aragón-Correa, J.A. and S. Sharma (2003), 'A contingent resource-based view of proactive corporate environmental strategy', *Academy of Management Review*, **28**(1), 71–88.
Argyle, M. (1969), *Social Interaction*, Tavistock, London.
Balzer, W.K. and L.M. Sulsky (1992), 'Halo and performance appraisal research: a critical examination', *Journal of Applied Psychology*, **77**(6), 975–85.
Bitner, J.J. (1990), 'Evaluating service encounters: the effects of physical surroundings and employee responses', *Journal of Marketing*, **54**(4), 69–82.
Box, G.E.P., W.G. Hunter and J.S. Hunter (1978), *Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building*, Wiley-Interscience, New York.
Brady, M. and J. Cronin (2001), 'Some new thoughts on conceptualizing perceived service quality: a hierarchical approach', *Journal of Marketing*, **65**, 34–49.
Chase, R.B. (1981), 'The customer contact approach to services: theoretical bases and practical extensions', *Operations Research*, **21**(4), 698–705.
Chase, R.B. and D.A. Tansik (1983), 'The customer conduct model for organizational design', *Management Science*, **29**(9), 1037–50.
Chebat, J.C., P. Filiatrault, C. Gelinas-Chebat and A. Vaninsky (1995), 'Impact of waiting attribution and consumer's mood on perceived quality', *Journal of Business Research*, **34**(3), 191–6.
Corbett, C.J. and J.N. Pan (2002), 'Evaluating environmental performance using statistical process control techniques', *European Journal of Operational Research*, **139**, 68–83.
Echeverri, P. (2005), 'Video-based methodology: capturing real-time perceptions of customer processes', *International Journal of Service Industry Management*, **16**(2), 199–209.
Eisenhardt, K.M. and J.A. Martin (2000), 'Dynamic capabilities: what are they?', *Strategic Management Journal*, **21** (Special Issue), 1105–21.
Enz, C.A. and J.A. Siguaw (1999), 'Best hotel environmental practices', *Cornell Hotel and Restaurant Administration Quarterly*, **40**(5), 72–7.
Fitzsimmons, J.A. and M.J. Fitzsimmons (2000), *Service Management: Operations, Strategy and Information Technology*, 3rd edn, Irwin/McGraw-Hill, Boston, MA.
Fornell, C., M.D. Johnson, W.E. Anderson, J. Cha and B.E. Bryant (1996), 'The American consumer satisfaction index: nature, purpose, and findings', *Journal of Marketing*, **60**, 7–18.
Foster, S., S. Sampson and S. Dunn (2000), 'The impact of customer contact on environmental initiatives for service firms', *International Journal of Operations and Production Management*, **20**(2), 187–203.
Froehle, C.M. and A.V. Roth (2004), 'New measurement scales for evaluating perceptions of the technology-mediated customer service experience', *Journal of Operations Management*, **22**, 1–21.
Goodman, A. (2000), 'Implementing sustainability in service operations in Scandic hotels', *Interfaces*, **30**(3), 202–14.
Halme, M. (2001), 'Learning for sustainable development in tourism networks', *Business Strategy and the Environment*, **10**(2), 100–114.

Hanna, M.D., W.R. Newman and P. Johnson (2000), 'Linking operational and environmental improvement through employee involvement', *International Journal of Operations and Production Management*, **20**(2), 148–65.

Hart, S.L. (1995), 'A natural resource-based view of the firm', *Academy of Management Review*, **20**(4), 986–1014.

Hauenstein, N.M. (1992), 'An information processing approach to leniency in performance judgments', *Journal of Applied Psychology*, **77**(4), 485–93.

Hendricks, K. and V.R. Singhal (2001), 'The long-run stock price performance of firms with effective TQM programs', *Management Science*, **47**(3), 359–68.

Heskett, J., T. Jones, G. Loveman, W. Sasser Jr and L. Schlesinger (1994), 'Putting the service-profit chain to work', *Harvard Business Review*, **72**(2), 164–75.

Hutten, E.H. (1962), *The Origin of Science: An Inquiry into the Foundations of Western Thought*, George Allen & Unwin, London.

Johnson, M.D., E.W. Anderson and C. Fornell (1995), 'Rational and adaptive performance expectations in a customer satisfaction framework', *Journal of Consumer Research*, **21**(4), 695–707.

Kassinis, G. and A. Soteriou (2003), 'Greening the service profit chain: the impact of environmental management practices', *Production and Operations Management*, **12**(3), 386–403.

Kellogg, D.L. and R.B. Chase (1995), 'Constructing an empirically derived measure for customer contact', *Management Science*, **41**(11), 1734–49.

King, A.A. and M.J. Lenox (2001), 'Lean and green? An empirical examination of the relationship between lean production and environmental performance', *Production and Operations Management*, **10**(3), 244–56.

King, A.A. and M.J. Lenox (2002), 'Exploring the locus of profitable pollution reduction', *Management Science*, **48**(2), 289–99.

Klassen, R.D. and D.C. Whybark (1999), 'The impact of environmental technologies on manufacturing performance', *Academy of Management Journal*, **42**(6), 599–615.

Murphy, K.R. and R. Jako (1989), 'Under what conditions are observed intercorrelations greater or smaller than true intercorrelations?', *Journal of Applied Psychology*, **74**(5), 828–30.

Nunnally, J.C. (1988), *Psychometric Theory*, McGraw-Hill, Englewood-Cliffs, NJ.

Ogden, H.J. and R.E. Turner (1997), 'Promises, promises: buyer satisfaction with delivery delays', *Journal of Satisfaction, Dissatisfaction, and Complaining Behavior*, **10**, 26–42.

Oliver, R. (1993), 'Cognitive, affective, and attribute bases of the satisfaction response', *Journal of Consumer Research*, **20**(3), 418–30.

Parasuraman, A., L. Berry and V. Zeithaml (1991), 'Refinement and reassessment of the SERVQUAL scale', *Journal of Retailing*, **67**, 420–50.

Pedhazur, E.J. and L.P. Schmelkin (1991), *Measurement, Design, and Analysis: An Integrated Approach*, Lawrence Erlbaum, Hillsdale, NJ.

Reichheld, F.F. and W.E. Sasser (1990), 'Zero defections: quality comes to services', *Harvard Business Review*, **68**(5), 105–11.

Salzman, J. (2000), 'Environmental protection beyond the smokestack: addressing the impact of the service economy', *Corporate Environmental Strategy*, **7**(1), 20–37.

Schendler, A. (2001), 'Trouble in paradise: the rough road to sustainability in Aspen', *Corporate Environmental Strategy*, **8**(4), 293–9.

Seawright, K.K. and S.E. Sampson (2006), 'A video method for empirically studying wait-perception bias', *Journal of Operations Management*, doi:10.1016/j.jom.2006.10.006.

Shrivastava, P. (1995), 'The role of corporations in achieving ecological sustainability', *Academy of Management Review*, **20**(4), 936–60.
Soteriou, A.C. and R.B. Chase (1998), 'Linking the customer contact model to service quality', *Journal of Operations Management*, **16**(4), 495–508.
Soteriou, A.C. and S.A. Zenios (1999), 'Operations, quality and profitability in the provision of banking services', *Management Science*, **45**(9), 1221–38.
Sulsky, L.M. and D.V. Day (1992), 'Frame of reference training and cognitive categorization: an empirical investigation of rater memory issues', *Journal of Applied Psychology*, **77**(4), 501–10.
Thorndike, E.L. (1920), 'A constant error in psychological ratings', *Journal of Applied Psychology*, **4**, 25–9.
Wirtz, J. and J. Bateson (1995), 'An experimental investigation of halo effects in satisfaction measures of service attributes', *International Journal of Service Industry Management*, **6**(3), 84–102.
Wuebben, P.L., B.C. Straits and G.I. Schulman (1974), 'Traditional objections to experimentation', in Wuebben, Straits and Schulman (eds), *The Experiment as a Social Occasion*, Glendessary Press, Berkeley, CA, pp. 15–19.
Zeithaml, V.A., L.L. Berry and A. Parasuraman (1996), 'The behavioral consequences of service quality', *Journal of Marketing*, **60**, 31–46.

APPENDIX 9A

Table 9A.1 Description of the four scenarios that were shown in separate videoclips

Scenario/ videoclip		Video segment		
		Reception area	Lobby/Aisles	Room
1.	High quality/high EPs	Professionally dressed, polite and courteous receptionist Clean and tidy reception area 'Environmentally friendly' pamphlets in full view Use of recycled paper for check-in information	Lobby and aisle areas clean and well maintained Recycle bins for paper, glass and plastic in full view	Clean, spotless, well-maintained room, with all necessary equipment Signs for water conservation Signs for towel change only on request Electronic faucets for water conservation
2.	Low quality/high EPs	Sloppy receptionist Reception area not professionally maintained 'Environmentally friendly' pamphlets in full view Evidence of recycling through use of recycled paper for check-in/out information	Lobby and aisle areas not well maintained or clean Recycle bins for paper, glass and plastic in full view	Room not in good shape Signs for water conservation Signs for towel changes only on request Electronic faucets for water conservation
3.	High quality/low EPs	Professionally dressed, polite and courteous receptionist Clean and tidy reception area No environmental pamphlets in view No evidence of recycling	Lobby and aisle areas clean, and well maintained No evidence of recycling or other EPs	Clean, spotless, well-maintained room, with all necessary equipment No signs for water conservation No signs for towel changes only on request

Table 9A.1 (continued)

Sceanario/ videoclip		Video segment		
		Reception area	Lobby/Aisles	Room
4.	Low quality/low EPs	Sloppy receptionist Reception area not professionally maintained No environmental pamphlets in view No evidence of recycling	Lobby and aisle areas not well maintained or clean No evidence of recycling or other EPs	Room not in good shape No signs for water conservation No signs for towel change only on request

Sample Items Included in the Questionnaire

Service quality measures (α = 0.953)

1. Employees were friendly
2. Employees had the knowledge to answer questions
3. Employees were courteous
4. Facilities were visually appealing
5. Employees were of neat appearance
6. Pamphlets associated with the service were visually appealing
7. Employees were willing to help
8. Employees were not too busy to respond to requests
9. Employees understood specific needs
10. Employees gave personal attention
11. Employee behaviour instilled confidence

Environmental practice measures (α = 0.927)

1. Extent of recycling usage
2. Water conservation usage
3. Electricity conservation measures
4. Environmental activities are evident
5. Wide spectrum of environmental management practices
6. Hotel being environmentally conscious
7. Hotel cares about the environment

Customer satisfaction measures (α = 0.875)

1. Overall customer satisfaction
2. Customer expectations
3. Deviation from ‘ideal’ hotel

10. The adoption of environmentally friendly products in mature organizational fields

Patrick A.M. Vermeulen and Annekathrin Ellersiek

The growth of the global economy and the total population of our planet combined with increased consumption of fossil fuels and heightened industrial production threaten the future of our natural environment. Over the last decades, environmental issues have become increasingly important for companies' business activities. The publication of the Brundtland Commission Report in 1987 (World Commission on Environment and Development, 1987) has been an accelerator for environmental concerns for both managers and academics. In response to the severe damage of business activities to the natural environment (Shrivastava, 1994), organization theorists and strategists have slowly started to realize the importance of studying the biosphere in relation to organizations (for example, Gladwin et al., 1995; Hart, 1995; Starik and Rands, 1995; Aragón-Correa, 1998; Starik and Marcus, 2000). The appearance of special research forums in the *Academy of Management Review* (1995) and the *Academy of Management Journal* (2000) and the presence of specialized journals such as *Organization and Environment* and *Business Strategy and the Environment* further illustrate the increased academic interest in the natural environment.

Various reasons exist for increased ecological responses, including legislation, stakeholder pressures, ethical motives and economic opportunities (Bansal and Roth, 2000). An important body of environmentally orientated research in the strategic management tradition has focused on the last reason; more specifically, scholars in this stream of research concentrate on the relation between environmental strategies and competitive advantage or superior performance (Porter and van der Linde, 1995; Klassen and McLaughlin, 1996). In most of these studies it is assumed that there is a positive relation between proactive environmental strategies and firm performance (Hart, 1995; Nehrt, 1998). Several studies have shown this relationship empirically (Dean and Brown, 1995; Porter and van der Linde, 1995; Klassen and McLaughlin, 1996; Judge and Douglas, 1998; Sharma and Vredenburg, 1998; Klassen and Whybark, 1999). This positive association has been explained by increased entry barriers, regulatory issues, cost savings, and the development of firm-specific resources and capabilities (Dean and Brown, 1995; Hart, 1995; Russo and Fouts, 1997; Sharma and Vredenburg, 1998; Aragón-Correa and Sharma, 2003).

Another possibility for firms to increase their competitive position is to develop from first-mover advantages by introducing new innovative products (Cardozo et al., 1993; Noci and Verganti, 1999). However, in order for a firm to be actually gaining this competitive advantage depends on the adoption of the new product by potential customers. Research on the adoption of innovations offers significant contributions to such understanding. Adoption refers to the decision of any individual or organization to make use of an innovation (Rogers, 1995). The literature on innovation adoption is strongly inspired by the work of Rogers, who has described the adoption process as a sequential model in which individual decision makers go through a number of steps.

Studies following this line of reasoning, however valuable they are, are rooted in social psychology (see Arkesteijn and Oerlemans, 2005) and pay little or no attention to the impact of powerful institutional forces on the adoption of new products. Only marginally have broader environmental factors (Rogers, 1995), such as cultural values and community norms, or network externalities (Kraut et al., 1998; Frambach and Schillewaert, 2002) been included in adoption studies. Other institutional forces, such as the position in the organizational field (centre or periphery) and the ties between field constituents, are seldom studied in (strategic management orientated) environmental studies. However, since the adoption of green products often requires fundamental changes at the field level (Hoffman, 1999), we argue that institutional forces are crucial to this process (compare Scott et al., 2000; Reay and Hinings, 2005; Greenwood and Suddaby, 2006).

Hence, in this chapter we use an institutional perspective to describe the dynamics of adoption and non-adoption of 'green' products in a mature organizational field. More specifically we study this process in the light of difficulties that entrepreneurial firms face in their efforts to introduce and disseminate an environmentally friendly product in the concrete industry. Our data show that these firms struggle to survive and have to continuously fight for resources in order to remain viable. This leads us to our central research question: how do institutional factors affect the successful adoption of green products?

In answering this question, the chapter aims to make two contributions. First, it develops an account of an attempt of fundamental transition that leads to field recomposition over time. Not only are different roles in different stages of the transformation described, we also provide insight into the entry and exit of key constituents and the consequences of this migration. Hence, we offer more insight into the role of agency in institutional change. Second, this chapter demonstrates how institutional forces can have a strong impact on the adoption of new products. As such, it contributes to research on the diffusion of innovation.

THEORETICAL ORIENTATION

The adoption and dissemination of new products has received ample attention in the innovation literature (see Rogers, 1995, for an extensive overview of the literature), but mainly from a cognitive perspective. Although some attention has been paid to organizational features and the broad context in which organizations are embedded, most research concentrates on the decision-making process at the end of which adoption is a fact or not. Various elements that contribute to successful adoption have been extensively described (Strang and Soule, 1998). Another stream of literature has focused more on the impact of social networks on the adoption of innovations (among others, Burt, 1987; Abrahamson and Rosenkopf, 1997; Macrì et al., 2001). From a network perspective, two reasons are provided for successful adoption: cohesion and structural equivalents (Burt, 1987). Cohesion refers to the fact that like-minded organizations (members from the network) and the relations these organizations have are important indicators for the likelihood of adoption. Structural equivalents refer to adoption that is determined by competitive pressures instead of direct contact between organizations. The decision to adopt the innovation, however, is dependent on the position of the focal organization compared to its competitors (Redmond, 2004). In both these streams of literature there is a strong rational undertone of how new products are adopted.

Institutional theory is often viewed as a break from rational-actor models (see, for instance, Zucker, 1983, 1991; Scott, 1987, 2001) because it is based on ideas, values, norms and beliefs embedded in the institutional environment. Institutions have a high 'taken-for-granted' degree of current practices that are re-enacted and considered as social facts (Meyer and Rowan, 1977). Although institutional theory has been popularized as being a theory of stability and inertia (Greenwood and Hinings, 1996), there are a growing number of studies focusing on institutional change (see, for instance, the *Academy of Management Journal*'s special issue in 2002). Yet, institutional change is a difficult and lengthy undertaking, as established players may feel threatened and undermine the legitimacy of the new institution through disinformation or the active suppression of alternatives

(Aldrich and Fiol, 1994). The firms in the industry that we choose to study, the concrete industry, are not used to a proactive attitude towards the natural environment and green products. In other words, firms pursuing these strategies deviate from the accepted strategies in the field and may suffer in terms of profitability and legitimacy as a result of this. In a study of environmentalism in the US chemical industry, Hoffman (1999) argued that a firm's individual strategy needs to be defined within the boundaries of the organizational field in order to be accepted. The strong pressures that arise from the field's institutional systems restrict the possibilities for firms in the field to radically alter their strategies and for new constituents to establish their position in the field. We shall especially focus on the evolution of the field over time and the ties between the field's actors, since these have been found crucial in the recomposition of organizational fields (Hoffman, 1999; Reay and Hinings, 2005). We shall briefly describe these two concepts in the remainder of this section.

Organizational Field

At the core of institutional theory lies the notion that a firm's behaviour originates from its organizational field. Fields comprise suppliers, resource and product consumers, regulatory agencies, professional associations as well as organizations that produce similar services or products (DiMaggio and Powell, 1983: 148). Following this diversity of actors, organizational fields are considered to be 'arenas of power relations' (Brint and Karabel, 1991: 355) where each actor tries to protect its own interest, meaning that these fields may resemble institutional war (Hoffman, 1999: 352). Therefore, we argue that organizational fields are not static phenomena, but are constantly changing and evolving. Evolution may occur through the entry of new constituents and exit of established players in the field, because interaction patterns and power balances change or because new inventions are introduced (Hoffman, 1999). Regulatory agencies of the state and professional associations also play an important role in the definition and evolution of organizational fields and their behaviour, since they have the ability to endorse or reject strategies from members of the field (Scott, 2001).

Ties between Actors

When fields evolve, ties between their constituents are simultaneously developed; that is, they coevolve. The existence of such ties often leads to the fact that many incumbents are primarily interested in sustaining the status quo. Baum and Oliver (1991) also studied the effects of inter-organizational relations and demonstrated that such linkages enhance the survival chances of organizations. The advantages from the institutional environment are stability, social support, legitimacy and access to resources. Their study also supports the idea that linkages that correspond to the norms and beliefs of the field reduce mortality rates more than linkages that do not meet the prevailing organizing principles of the field. Lawrence et al. (2002) emphasize that collaborative relationships are based on negotiations between organizations that are different from exchange relations and hierarchical arrangements. Their study focuses on the effect of institutional fields on the *negotiation* and *structuration* of collaborative relationships. These relations are developed by processes of structuration, 'whereby patterns of social action produce and reproduce the institutions and relationships that constitute the field' (ibid.: 282).

RESEARCH CONTEXT[1]

The case study concerns the attempt to expand the high-grade use of granular in construction projects in the Netherlands. Essentially, granular is a recycled substitute for primary materials (sand and gravel). The Dutch concrete industry originates from the early nineteenth century and received an enormous boost after the Second World War; concrete mortar factories were started, research institutes were founded, professional associations appeared, and national and provincial governments formulated laws and regulations. In the four decades following the Second World War, the market for concrete expanded by 550 per cent.

In the 1990s, the government began to promote the high-grade use of granular, but its share of the market remained very low (less then 1 per cent in 2001). The number of newly built houses (the primary target for the high-grade use of granular) grew rapidly in the 1980s and 1990s, reaching 90,000 per year in 1997. The economic recession in the Netherlands led to a drop in new house construction to 60,000 in 2001, but since then the figure has risen to 70,000 and is expected to grow further. In summary, despite its cyclical nature, the market for new houses has increased significantly over time and has proved a stable source of income for the construction industry. Nevertheless, although the possibility for the high-grade use of granular had already been demonstrated in 1983 (see below), the construction industry has resisted using this environmentally friendly alternative to gravel despite the ever-increasing demand for concrete. Our interest is in the institutional factors that constrained the market for high-grade granular from expanding. We are particularly interested in the role of collective mechanisms such as professional associations and corporate actors, which have been found elsewhere to be significant enablers or inhibitors of change (for example, Greenwood et al., 2002; Lounsbury, 2001; Schneiberg and Bartley, 2001).

We first set out to uncover some of the more obvious technical and economic explanations to the limited adoption of granular. In terms of technical requirements, the Center for Civil Engineering Research and Codes (CUR), in close cooperation with a scientific research institute, TNO, has consistently demonstrated that the quality of granular is more than sufficient for substituting 20 per cent of gravel in the production of concrete without loss of quality (CUR, 1983, 1985, 1986, 1996).[2] These studies led to the certification of granular and formulation of clear guidelines and regulations on how (much) and when (in what type of constructions) granular could be used (Ministry of Transport, Public Works and Water Management, 2003a). Furthermore, the CUR studies provide evidence for the economic consequences of using granular. In 1983, CUR argued that granular was not yet economically competitive. Although granular was cheaper than gravel, the additional costs of transportation and technical control made it more expensive. Nevertheless, granular was competitive with gravel in regions where producers of granular are close to the producers of concrete, lowering transportation costs. In 1986, CUR concluded that granular was competitive on a national scale because of its increased quality. In the 1990s, the costs of granular were further reduced because certification made the costs of additional quality controls redundant. In short, despite 'technical' arguments made against granular, the results of independent research studies concluded that granular was higher quality than gravel, and cost-competitive.

DATA COLLECTION[3]

We studied a large number of organizations in order to collect information from various perspectives (Table 10.1). We focused on those organizations that had a central position in the organizational field. We distinguish three clusters of organizations within the supply chain: *producers* of primary (sand and gravel) and secondary (granular) raw materials, *manufacturers* of concrete mortar and concrete products, and *building partners* (construction firms, architects, building contractors, real estate developers and real estate owners). Together, they constitute the entire building process from provision of raw materials to the construction of (for instance) buildings. The field also contains various regulatory agencies: *three* levels of government; and multiple professional associations (72 for the entire field). Finally, there are independent knowledge institutions that provide field constituents with information. The data for this study were collected using qualitative and longitudinal case study procedures.

Table 10.1 Organizations involved in case study research

Type of organization	Number of organizations involved	Number of interviews	Functions of respondents
Research institutions	4	6	Policy maker, technical secretary, project coordinator, project leader, coordinator raw materials, management consultant
Producers of raw materials (including recyclers and demolishers)	15	18	Director (7), plant manager (4), senior manager, vice-director, financial director, commercial manager, manager recycling and purchasing, environmental adviser, coordinator quality & environment
Concrete manufacturers	16	20	Director (7), director technology (2), manager quality services (2), production director, director construction, commercial director, manager development & innovation, manager knowledge & production, concrete technologist, manager execution, plant manager, manager recycling & purchasing
Building partners	14	17	Project leader (4), director (3), manager purchasing (2), plant manager, chief engineering, project developer, quality adviser, technical director, financial director, manager control & maintenance, manager project development
Professional associations	5	8	Chairman (5), cluster manager, secretary, manager policy and regulation
Governmental agencies	8	9	Policy maker (4), senior policy maker (2), technical policy maker, coordinator sustainable development, project leader raw materials
Total	62	78	

The first step was to know the organizational field. We talked to people familiar with granular in 129 organizations, to discover what facts (for example, costs, availability and quality of granular) were available concerning its use in concrete. Furthermore, this initial stage was used to collect information on the structure of the industry, to uncover relations between the organizations in the field and to get acquainted with key players in the field. The second step consisted of the analysis of reports and publications regarding the use of granular in the manufacturing of concrete. These documents were mostly derived from governmental agencies, professional associations and research institutions. Since the use of granular in the production of concrete has been discussed in the Netherlands for about 20 years and because during this period much technological research has taken place, key organizations were easily identified. The information from these two initial research steps served as input for the case study phase.

In the third stage of the research process, interviews were conducted with informants in 62 organizations. In all organizations, at least one expert (identified by senior managers, CEOs or owners) on the use of granular was interviewed. In smaller companies, we often talked to the managing directors. Interviews were semi-structured, and lasted approximately one-and-a-half to two hours during which we tried to obtain in-depth knowledge of the adoption of granular and the major constraints of diffusion in the concrete industry. The scope of these interviews was kept broad in order to discover the most salient issues relevant to our study. We received valuable information on all these issues and in most cases this information was shared with the interviewer spontaneously. Interviews were recorded and transcribed. The transcripts were detailed representations of the interviews. Transcripts were sent back to respondents to provide the opportunity for factual corrections, but respondents were not allowed to change the text. Despite the limits of qualitative research, the relatively large number of interviews and the range of organizations covered give us confidence that the findings reported below are a valid account of the impact of institutional forces on the adoption of green products in mature fields. Besides regular interviews, we were also involved in several meetings with the group of institutional entrepreneurs (see below) and used these meetings to talk to these actors. Extensive memos of these meetings were produced and included in our analysis.

FINDINGS

The results are presented according to three distinct stages that we identified in the documents: 'slumbering giant' (1960–89), 'awakenings and resistance' (1990–99), and 'escape from Alcatraz' (2000–05). We checked these with our respondents, who confirmed the three stages. Although each of the stages will be described below, we shall concentrate on the last two. The actual events that caused upheaval in the concrete industry started in the early 1990s. A summary of the results is presented in Table 10.2.

Stage 1: Slumbering Giant (1960–1989)

In the 1950s, granular was already being used in road construction. The debris from the Second World War was clearly visible; many buildings had been either destroyed in the war or demolished since they were temporary buildings. The waste ('granular') that was left after demolition was perfectly usable as a foundation for new roads. As the country was in need of many new roads, the market for granular was created. Similarly, many new houses were built in the early 1960s, which had a strong effect on the demand for concrete.

Organizational field

The organizational field developed rapidly in the early 1960s as a result of the huge demand for concrete. In the 1958–67 period the production of concrete mortar increased elevenfold. New concrete manufacturers were founded and the existing ones underwent a huge expansion. The number of concrete manufacturers increased almost sixfold (van der vlist, 1998). In the 1970s growth gradually slowed down, and following the second oil crisis in 1978 the demand for concrete plummeted. However, by 1985, the field had recovered, resulting in a steady growth in the years to come. The producers of sand and gravel played an important role, since they provided the two essential raw materials for concrete. Many of these firms were located near the main rivers from where the materials were extracted. The building partners who were in charge of the actual construction processes also became important players in the field. They benefited from the need for new houses and developed 'easy-to-construct' houses of relatively low quality and with a short life cycle, legitimated by the urgent need for new houses.

Ties between actors

By the early 1900s, the first ties between the producers of sand and gravel and the concrete manufacturers were already established. In the period of growth in the 1960s the existing relations were strengthened and many new ones were formed to secure the necessary supplies. In the years to come, many ties were formalized, with alliances and conglomerates being formed between concrete manufacturers and the sand and gravel producers. These cooperative forms dominated the field, and the professional associations that were established earlier mainly served the interests of these dominant

Table 10.2 Summary of results

Stage	Organizational field	Ties between actors
Slumbering giant (1960–1989)	Rapid development in which production of concrete increased elevenfold. New concrete manufacturers entered the field, whereas existing players increased in size. Producers of sand and gravel provided two key raw materials. The building partners also became important players in the field	First ties between the producers of sand and gravel, the concrete manufacturers and building partners were established. In the years to come, many ties were formalized,i.e., alliances and conglomerates were formed between concrete manufactures and the sand and gravel producers
Awakenings and resistance (1990–1999)	The interference of the government in the market for concrete was the most important shift in the organizational field in the second stage. The government imposed legislative impediments on the extraction of primary materials such as such as sand and gravel, which led to the entry of new players. Established firms were still in charge and controlled the market for concrete. The professional associations were clearly directed towards the use of sand and gravel. They used educational programmes to promote the use of primary materials	The ties between the large concrete manufacturers and the producers of sand and gravel became even stronger in the early 1990s. Mainly because of their attitude towards granular, there were few ties with the producers of granular. Furthermore, the producers of granular were not able to establish productive relations with other field constituents. Although there were organizations throughout the value chain that used granular, they did not cooperate with them
Escape from Alcatraz (2000–2005)	The established players still resisted the use of granular and largely controlled the industry. Some organizations did	The ties between the concrete, construction and gravel incumbents still heavily dominated the field. But new initiatives were

Table 10.2 (continued)

Stage	Organizational field	Ties between actors
	consider granular to be a valid alternative for gravel. They realized that the natural environment was suffering from the unlimited extraction of raw materials. However, they lacked the capabilities to mobilize sufficient resources. An 'institutional architect' entered the the field. He tried to mobilize organizations that wanted to use granular and his way of working is best described as providing opportunities for firms to get acquainted	taken. In line with the secondary logic, new ties were formed in the field. The institutional architect led in this effort to join forces. He gathered a group of institutional entrepreneurs concerned with both the environment and the economy, together with representatives from the government, universities and consultancy firms, and started a major project to promote the use of granular

groups because their representatives were involved in their foundation. The professional associations provided their members with information, developed in-company training programmes, workshops and seminars, functioned as an intermediary, conducted research, cooperated closely with professional associations in related industries and attended to the interests of their members. The building partners also established formal relations with the concrete manufacturers, which resulted in even larger building conglomerates. As the field evolved, the ties became stronger and stronger. By the end of the first stage it became clear that most concrete manufacturers no longer looked for alternative suppliers, and consequently the entry barriers in the field were very high.

Stage 2: Awakenings and Fierce Resistance (1990–1999)

In the early 1990s the government began to promote the use of granular as a substitute for gravel. The motivation for favouring granular was a desire to consume primary materials more responsibly, and has been referred to as the 'sustainability principle'. Consistent with this principle, waste from demolished buildings (granular) is recycled so that fewer primary raw materials (sand and gravel) are needed. In 1995, a report entitled *Sustainable Building* was presented to the concrete industry, outlining the government's desire to further strengthen the idea of sustainability in Dutch society. The report was followed by a set of regulations and guidelines that aimed at replacing 20 per cent of the gravel used in the concrete market with granular. In 1995, the Dutch government issued a building material decree containing over 500 procedures related to sustainable building. It required concrete producers to demonstrate that no harmful or damaging materials were being used. Inspection and knowledge institutions initiated multiple research projects in order to clarify the appropriateness of granular as a substitute for gravel. Furthermore, technological and societal developments led new players to enter the concrete market. Producers of granular were then competing with the producers of sand and gravel for some market share. This proved to be difficult because many concrete manufacturers had strong historical ties with the producers of sand and gravel, often in the form of 'mother/daughter' relations.

Organizational field

According to many of our respondents, the involvement of the government in the market for concrete was the most important shift in the organizational field in the second stage. This occurred because the government wanted to replace primary materials by granular, which was considered a necessary development in the supply of raw material. After years of self-regulation, the field was now confronted with government interference in the form of legislative impediments to the extraction of primary materials such as sand and gravel:

> We wanted to replace primary materials used in concrete because our natural resources are scarce these days. We needed to face up to our responsibility to tell the concrete manufacturers that they should use alternative materials that are less harmful to our environment. (Ministry of Transport, Public Works and Water Management)

> The government has imposed a restriction on primary raw materials. I think they finally got the message and tried to establish a change in the industry. (Senior manager of granular producer)

Instead of enforcing a command-and-control regulation, however, the government decided to use voluntary agreements to leave as much decision making to the market as possible. It did, however, offer incentives and subsidies to organizations that planned to recycle. At first the field seemed to react positively to the formulated policies. This paved the way for new players to enter the field: the producers of granular, who offered an environmentally friendly alternative to gravel. Although not all of the granular producers attempted to compete with the producers of gravel in the market for concrete, several tried to offer an alternative:

> We can deliver an alternative for gravel that is of high quality, is better for our environment and does not cost a cent more. And of course we know that the government is keen on recycling these days and offers various incentives. (CEO of granular producer)

The conditions at this time were favourable to the creation of a new market for more environmentally friendly concrete; however, it soon became clear that the market was not willing to adopt the new product. There was little confidence in it in terms of cost, quality and availability, even when the producers of granular guaranteed these. However, it was also apparent that the constituent ingredients of concrete were very much taken for granted and manufacturers could not imagine an alternative:

> It's very simple. We do not think that the quality of granular is sufficient for our concrete. It is also more expensive and we can never get it from our suppliers. So there is a big risk involved in producing concrete using granular. In the end, we are responsible for the constructions that are built of concrete. (Director of construction of large concrete manufacturer)

> Concrete is made out of sand, gravel, water and cement. That is the way it has been for the last 100 years. Why should we change anything if we have the best product available? I just don't think that concrete with this granular stuff is real concrete. If we buy a ton of granular, there is just so much junk included. We will not accept this as a valid alternative. (Director of concrete manufacturer)

Therefore most of the concrete manufacturers did not use the new material, and thus had no intention of complying with the voluntary agreements they signed, which called for a 20 per cent replacement of gravel. It was evident that the field's players from the first stage were still in charge and controlled the market.

The professional associations in the field were also clearly orientated towards the use of traditional primary materials. These associations exercise control by perpetuating collective taken-for-granted beliefs through training and education, by carefully managing relations with the state and by ministering to the needs of their members (see Greenwood et al., 2002). Our empirical investigation clearly shows that these associations have a strong impact on the entire field:

> After receiving the award in 1997, I hoped that the product would catch on in the concrete industry. However, the concrete industry completely ignored the

> award and the leading professional association even announced on the same day that we received the award that [granular] was not available. It all depends on the producers of sand and gravel and the cement industry. They all know what the characteristics of granular are and that the quality is excellent. Yet, they are controlled by the professional associations of the concrete manufacturers who control the market and push it in their direction. These guys are everywhere. When the government investigates the possibilities for granular in a certain project, they contact these same professional associations who claim that granular is just a piece of junk. So, how are we ever going to be successful? (Director of granular and concrete producer)

Ties between actors

The ties between the large concrete manufacturers and the producers of sand and gravel became even stronger in the early 1990s. In their search for expansion, these companies further merged into large conglomerates. In their attempts to block the market from granular, they worked together even more closely than before. They closed ranks to avoid the new entrants from becoming successful, and tried to maintain control over the industry. The concrete manufacturers have often argued that it is not just the historical ties that cause them to refuse to adopt granular. Yet, there are few granular producers who actually believe the arguments (too expensive, poor quality and low availability) that are put forward by the incumbents, because there are various successful examples of smaller firms that have produced concrete using granular, without loss of quality or higher costs:

> There is a very strong connection between the producers of sand and gravel and the concrete manufacturers. They all belong to the same small group who control the industry. (Policy maker, provincial government)

> They mainly provide non-arguments for why granular cannot be used satisfactorily . . . an important reason for this behaviour is related to the historical ties that these firms have with the producers of sand and gravel. (Director of granular producer)

Heavily sponsored by the established organizations, the professional associations use educational programmes to promote the use of primary materials that are taken for granted by most organizations in the field, despite the government's preference for secondary materials. They do so because they are 'captured' by incumbent firms who use the associations as vehicles to promote their interests while suppressing those of organizations more favourable to granular. Backed up by an institutional setting in which it is accepted that incumbent firms are the key representatives in the field, they are able to negotiate their interests with the government. In these meetings the possibilities for a more sustainable future are discussed. However, the information that is shared with the government is rather one-sided since there is no enthusiasm for granular on behalf of the industry representatives.

The producers of granular have not been able to establish productive relations with other actors in the field. Some organizations throughout the value chain have used granular, but they do not cooperate with the new entrants. The main reason for this put forward in the interviews was that because of the fragmented attempts in the field to apply granular, the various actors do not know each other. However, this is only partly true: in some cases, our respondents did know which other firms were interested in working with granular, but still did not manage to organize any kind of cooperation: 'I am not sure why it does not work, it just doesn't'.

Stage 3: Escape from Alcatraz (2000–2005)

The Dutch government now plays an active role in stimulating innovations in the field of construction, promoting and specifying environmentally friendly policies. Although the adoption of granular has increased, it is still a mere fraction of the amounts of sand and gravel used for making concrete. Over 75 per cent of all the sand and 70 per cent of all the gravel extracted is used in concrete, whereas only 1.5 per cent of all the granular used is used in concrete (Ministry of Transport, Public Works and Water Management, 2003b). Some concrete manufacturers have started to adopt granular, but it has only been used in (successful) pilot projects and has hardly been accepted by the market. However, in the light of recent developments (such as the liberalization of the market for extracting primary raw materials) granular producers have started their own mobile concrete producing plants, causing upheaval in the consensus of the prevailing norms and values in the industry. Several parties in the organizational field have found new ways of creating value as a result of these developments, which have disturbed the routines and habits of the industry.

Organizational field

At first sight, it appears that not much has changed in the constituency of the field. The established players still resist the use of granular and largely control the industry. The professional associations are equally resistant in adopting granular. The industry in general is reluctant to change and will only respond in the case of a major crisis:

> You see that firms in this industry only react when the bomb has exploded. So, they don't react when certain threats appear until they are right under their noses and it is too late. (Chairman of professional association)

Yet, some have changed their production processes in order to be able to use granular. These organizations consider granular to be a valid alternative for gravel. They have realized that the natural environment is suffering from the unlimited extraction of raw materials and argue that the industries' conservatism is key in resisting granular. Together with the granular producers who have recently entered the market for concrete, these organizations are trying to create a market for granular. However, they are still outnumbered by the incumbents and they lack sufficient power to achieve a real breakthrough. Besides the lack of power on the one hand, those companies in favour of using granular lack the capabilities needed to mobilize sufficient resources. Having battled against the established players for a long time, they seem to lack the energy and capabilities to once more organize collective action. The high degree of fragmentation is also of importance here, since this makes it difficult to trace them:

> I have been fighting for years and I am tired of it. They [referring to the established players] have always tried to block me from entering the industry. An outsider may be able to make it work because he is not directly involved. I also find it difficult to identify relevant players, since these smaller organizations are spread out all over the country. I do not have the time and the resources to do this; I have a business to run. (Director of granular producer)

But another actor has entered the field: an independent consultant who has expressed a desire to protect the environment and subsequently wants to make the use of granular more widespread. He was not directly related to any existing organization in the field, nor had he a direct interest in granular; we define his role as 'institutional architect'. The institutional architect tried to design an ideal situation of a market in which granular would be used as a substitute for gravel since this would benefit the environment. As such, he tried to mobilize the players in the field who wanted to use granular, and his way of working is best described as providing opportunities for firms to get acquainted. He constantly talked to people in the field and tried to bring together the proponents of granular, always from his initial ideal design:

> Well, you know him [referring to the consultant] by now. He has this way of talking to people and getting things done. I don't know what it is, but it's a certain style of how you react to people at first sight. He has this casual, nonchalant, friendly, openness . . . I don't really know how to explain it. But this opens doors for him that will be shut for others. He is highly sensitive to people. (Director of granular producer)

> I had a certain idea in mind of what should happen in this industry and what that would look like and tried to realize that by bringing together key players

> from the entire value chain, and other actors that I considered important for facilitating this process. (Institutional architect)

Research projects were initiated and meetings were organized to discuss the results. Although he was an 'outsider' to the field, he managed to be seen as a legitimate actor and was therefore capable of mobilizing a group of institutional entrepreneurs that together tried to break away from the established players in the field. The institutional architect attempted to set the agenda for the dominated firms and could understand the intricacies of their position. He was able to convince organizations that were traditionally related to the incumbents, that a shift towards granular was actually in their best interest since it would bring more market share. Furthermore, he invested heavily in brokering between actors and he refrained from focusing on his personal gain. Besides mobilizing actors and trying to establish collaboration between them, it was emphasized that controlling the entire value chain was crucial for success:

> There are two things you need to do when you have identified and mobilized actors. First, you need them to work together. This requires a lot of energy since they are not used to this. And then they also have to try to keep it together. Someone needs to be in charge so to speak to have a good grip on the entire building process.

Having organizations in all steps of the value chain would secure a long-term viability for granular as a (niche) market. This, however, requires control at the field level. Ultimately this is the responsibility of the organizations involved, yet on the level of the field rather than that of the individual firm.

Ties between actors

The field is still heavily dominated by the ties between the concrete, construction and gravel incumbents. These firms cooperate together and are often legally related to one another. Together they control the professional associations. Despite the support for sand and gravel by the dominant professional associations, new initiatives have been taken and new ties have been formed in the field. The institutional architect was instrumental in this effort to join forces. He gathered together a group of institutional entrepreneurs concerned with both the environment and the economy, with representatives from the government, universities and consultancy firms, and started a major project to promote the use of granular. One of the primary activities of this group is to bring together firms from across the entire supply chain and to promote the use of granular through the lobbying of governmental agencies:

> What we try to do is to get a group of people together who are willing to make a change. There are enough organizations that participate and the entire supply chain is represented in this group. We need to create the conditions for them to start collaborating on a more sustainable basis. Hopefully this will be a trigger that will lead to the diffusion of granular as a key component of concrete. (Policy maker, governmental environmental agency)

> We can only do this together. We have representatives from firms representing each part of the chain of relevant activities; from granular producers, concrete manufacturers and building partners. Each of these firms has tried to achieve something, but has failed. We need to start collective processes; this is the only way to do this. We need to start searching for them and mobilize these firms to join us. (Participant from the group)

The group aims to demonstrate that there is an alternative to the traditional use of gravel in concrete. They have no formal position in the industry yet, but serious efforts are being made to ensure that the use of granular is increased by collectively searching for opportunities to start new projects, mobilize organizations that are interested and willing to participate and subsequently establish collaborative ties between them. Members of this group are primarily institutional entrepreneurs who see market potential for granular combined with a feeling of responsibility for the future. Their interests are currently not served by any of the traditional professional associations.

It is not yet known whether this parallel system will develop successfully. However, the first projects are being started and there seems to be a fruitful basis for the future. The exact outcome of this process remains to be seen, but it is likely that a niche market is viable. More important is the fact that a group of firms have found a way to escape from the iron cage. What is also interesting is that some of the leading established firms have recently started talking about their responsibility to the environment as well, which may function as a snowball effect for the entire field. One of the key reasons for the established firms to change their thinking seems to be related to economic motives. They realize that the new mobilization initiatives may actually take away some of their market share. The leading professional association has posted information on their website about a large number of pilot projects using granular, which has triggered responses from their members:

> I think that something is happening. We see some of our members getting a bit nervous. They wonder if these new initiatives that are mentioned on our website will catch on. If they do nothing they are probably too late to respond and will lose market share. This is something they don't like. So, they are thinking about using it [granular] for the first time. (Chairman of professional association)

DISCUSSION AND CONCLUSION

The aim of this chapter was to explore the impact of institutional forces on the adoption of an environmentally friendly product. To reach this goal we have explored this issue in a mature industry, in which new entrants tried to introduce a new product. Whereas the literature on innovation adoption has mainly stressed a more rational approach in which actors independently decide on whether to adopt new products, our study demonstrates that new product adoption is not just a matter of rational considerations. The evolution of the organizational field and the co-evolution of strong ties between incumbent firms led to routine and taken-for-granted behaviour with respect to the use of raw materials needed to produce concrete. It is unimaginable for many firms that concrete does not consist of just sand, water and gravel. As such, these firms have, for a long time, successfully blocked the adoption and subsequent dissemination of granular. Even though this product has been found to be technically equivalent, no more costly, amply available and environmentally friendly, the strong symbolic value of normative and cognitive institutional forces (Scott, 2001) has contributed to the difficulties that confront new entrants.

We argue that the successful adoption of green products strongly depends on the maturity of the field and the power of incumbents and their subsequent interest in maintaining the status quo (see Beckert, 1999). It is argued that when these powerful constituents have sufficient resources to resist changes, and thus prevent the overthrow of established institutional practices, changes will not come about. In our case we have seen the incumbent firms actively resist changes in order to maintain the field in its current form. However, it is not very likely that powerful groups will remain powerful in the situation of persistent foreclosure of other constituents. In this study we have identified a group of institutional entrepreneurs who have tried to escape from the control of the powerful incumbents.

The entrepreneurs in this study are institutional challengers (Hensmans, 2003) operating in the periphery of an established field (see Leblebici et al., 1991). These entrepreneurs are 'marginalized or less powerful participants within the existing institutional arrangements' (Seo and Creed, 2002: 236). In order to be successful, they require social skills to be able to elicit cooperation from other actors (Fligstein, 1997). A single individual will often not be capable of disseminating an innovation throughout an entire field. Instead, a group of actors is needed (see Colomy, 1998). By crystallizing broad symbolic orientations in new ways and articulating specific goals, such groups work to persuade other players to adopt the innovation. In these circumstances, creating a niche market requires joint capabilities. In mature organizational fields, such as the concrete industry described in this chapter, joint capabilities are needed with respect to mobilization, collaboration and chain control. Mobilization is aimed at actually bringing together like-minded firms, which is similar to the process of leverage (Dorado, 2005). In particular, those actors that lack resources will be capable of achieving their goals only when mobilizing other interested actors (McAdam, 1996). Subsequently, ideas about potential collaboration should be developed, which involves processes of recognizing the complementarities of the organizations involved and developing collaborative arrangements (see Dorado, 2005). We argue, however, that the eventual success of such efforts also depends on a process of chain control. The entire chain of firms involved in, in our case, the building process, needs to be controlled. Chain control is meant to develop strong ties between firms in order to remain viable as a group (or niche). Only when a sufficient degree of control and power is developed over time, will the niche players be able to resist the incumbents.

However, we claim that peripheral players are not always capable of mobilization activities. This is mainly the result of the high degree of uncoordinated actions. Whether these may have an effect on the field, highly fragmented efforts are also fairly easy to resist. This was clearly the case in our study. The institutional entrepreneurs were simply resisted. The sheer magnitude of incumbent firms and accompanying logics, the central position in the field and their ties make it almost impossible to break into the market. Many of the entrepreneurs did not have the time or the energy to invest heavily in mobilizing like-minded organizations. They were tired of fighting the incumbents for a small piece of the market and indicated that they also lacked the resources to continue doing this. We identified the role of an institutional architect as being crucial to start a phase of mobilizing other actors. Like-minded organizations needed to be mobilized to enhance the viability of the niche. However, unlike the central actors in Maguire et al.'s (2004) study in the emerging field of HIV/AIDS treatment, who were able to obtain legitimacy only when they were part of the gay community or HIV-positive, this architect was a relative outsider to the field. Yet, he possessed some of the essential social skills needed to trigger change in a mature field (see Fligstein, 1997). The institutional architect may be similar to Dorado's (2005) description of conveners. A central feature of these agents is that they have envisaged a 'design' of some sort and continuously act upon that. The architect is a 'broker' who tries to bridge gaps between fragmented actions of a variety of institutional entrepreneurs and designs these actions into a coherent whole.

In this chapter we aimed to better understand how institutional factors affect the adoption of green products by incumbent firms. We used institutional theory to add alternative explanations to the adoption literature. The position in the organizational field and historically developed relationships were strong determinants for the limited adoption of a new green product. As with most studies, our study also has some limitations. We have only started to explore some of the issues raised in this chapter.

Although we have collected a substantial amount of rich qualitative data, we studied only one specific sector in one country. Although the concrete industry is distinct from many other industries, other examples of established fields with low ambitions for radical change and innovation exist in the literature. In the forestry industry, for instance, we have also seen strong resistance to more sustainable ways of logging. MacMillan Bloedel, the largest forest company in British Columbia at the time, had long resisted major innovations and decided to stick to its old logging methods for as long as possible (Zietsma and Winn, 2005). In a different setting, Reay and Hinings (2005) described a radical change in the Alberta health system. Again, we see established players resisting change. They argue that key actors must continuously use their power to act upon the changes needed for change. And even when key actors manage to successfully change the field, established players will support the old logic. In established fields, endogenous innovation and change will come about only when key actors are dissatisfied with the current situation (Greenwood and Hinings, 1996). Hence, our results are transferable to other established industries, especially those with oligopolistic supply structures. More research is needed, however, on emerging fields where the institutional logic is still developing. It would be especially interesting to uncover the mechanisms by which new products become adopted or not in newly developing fields.

NOTES

1. The description of the research context is partly derived from Vermeulen et al. (2007).
2. These studies have even been able to demonstrate that for certain types of concrete (dependent on the strength needed) gravel could be totally replaced without any loss of quality.
3. The description of the data collection is partly derived from Vermeulen et al. (2007).

REFERENCES

Abrahamson, E. and Rosenkopf, L. (1997), 'Social network effects on the extent of innovation diffusion: a computer simulation', *Organization Science*, **8**(3), 289–309.

Aldrich, H. and Fiol, C.M. (1994), 'Fools rush in? The institutional context of industry creation', *Academy of Management Review*, **19**(4), 645–70.

Aragón-Correa, J.A. (1998), 'Strategic proactivity and firm approach to the natural environment', *Academy of Management Journal*, **41**, 556–67.

Aragón-Correa, J.A. and Sharma, S. (2003), 'A contingent resource-based view of proactive corporate environmental strategy', *Academy of Management Review*, **28**, 71–88.

Arkesteijn, K. and Oerlemans, L. (2005), 'The early adoption of green power by Dutch households. An empirical exploration of factors influencing the early adoption of green electricity for domestic purposes', *Energy Policy*, **33**, 183–96.

Bansal, P. and Roth, K. (2000), 'Why companies go green: a model of ecological responsiveness', *Academy of Management Journal*, **43**(4), 717–36.

Baum, J.A.C. and Oliver, C. (1991), 'Institutional linkages and organizational mortality', *Administrative Science Quarterly*, **36**, 187–218.

Beckert, J. (1999), 'Agency, entrepreneurs, and institutional change. The role of strategic choice and institutionalized practices in organizations', *Organization Studies*, **20**, 777–99.

Brint, S. and Karabel, J. (1991), 'Institutional origins and transformations: the case of American community colleges', in W.W. Powell and P.J. DiMaggio (eds), *The New Institutionalism in Organizational Analysis*, Chicago: University of Chicago Press, pp. 337–60.

Burt, R.S. (1987), 'Social contagion and innovation, cohesion versus structural equivalence', *American Journal of Sociology*, **92**, 1287–335.

Cardozo, R., McLaughlin, K., Harmon, B., Reynolds, P. and Miller, B. (1993), 'Product-market choices and growth of new businesses', *Journal of Product Innovation Management*, **10**, 331–40.

Colomy, P. (1998), 'Neofunctionalism and neoinstitutionalism: human agency and interest in institutional change', *Sociological Forum*, **13**(2), 265–98.

CUR (1983), *Granulaat van beton en metselwerkpuin als toeslagmateriaal voor beton* (in Dutch) (Granular from concrete and bricklaying debris as secondary material for concrete), Research report C83-1, Gouda: CUR.

CUR (1985), *Beton en metselwerkpuingranulaat. Technisch-economische evaluatie* (in Dutch) (Concrete and bricklaying debris granular: technical-economic evaluation), Research report C85-3, Gouda: CUR.

CUR (1986), *Betonpuingranulaat en metselwerkpuingranulaat als toeslagmateriaal voor beton* (in Dutch) (Concrete debris granular and bricklaying debris granular as secondary material for concrete), Research Report C125, Gouda: CUR.

CUR (1996), *Secundaire toeslagmaterialen in beton* (in Dutch) (Secondary building material in concrete), Research report C185, Gouda: CUR.

Dean, T.J. and Brown, R.L. (1995), 'Pollution regulation as a barrier to new firm entry: initial evidence and implications for future research', *Academy of Management Journal*, **38**, 288–303.

DiMaggio, P. and Powell, W.W. (1983), 'The iron cage revisited: institutional isomorphism and collective rationality in organisational fields', *American Sociological Review*, **48**(2), 147–60.

Dorado, S. (2005), 'Institutional entrepreneurship, partaking, and convening', *Organization Studies*, **26**(3), 383–413.

Fligstein, N. (1997), 'Social skill and institutional theory', *American Behavioral Scientist*, **40**, 397–405.

Frambach, R. and Schillewaert, N. (2002), 'Organizational innovation adoption. A multi-level framework of determinants and opportunities for future research', *Journal of Business Research*, **55**, 163–76.

Gladwin, T.N., Kennelly, J.J. and Krause, T.S. (1995), 'Shifting paradigms for sustainable development: implications for management theory and research', *Academy of Management Review*, **20**, 874–907.

Greenwood, R. and Hinings, C.R. (1996), 'Understanding radical organisational change: bringing together the old and new institutionalism', *Academy of Management Review*, **21**, 1022–54.

Greenwood, R. and Suddaby, R. (2006), 'Institutional entrepreneurship by elite firms in mature fields: the big five accounting firms', *Academy of Management Journal*, **49**(1), 27–48.

Greenwood, R., Suddaby, R. and Hinings, C.R. (2002), 'Theorizing change: the role of professional associations in the transformation of institutionalized fields', *Academy of Management Journal*, **45**, 58–80.

Hart, S.L. (1995), 'A natural-resource-based view of the firm', *Academy of Management Review*, **20**, 874–907.

Hensmans, M. (2003), 'Social movement organizations: a metaphor for strategic actors in institutional fields', *Organization Studies*, **24**(3), 355–81.

Hoffman, A. (1999), 'Institutional evolution and change: environmentalism and the U.S. chemical industry', *Academy of Management Journal*, **42**(4), 351–71.

Judge, W.Q. and Douglas, T.J. (1998), 'Performance implications of incorporation natural environmental issues into the strategic planning process: an empirical assessment', *Journal of Management Studies*, **35**, 241–62.

Klassen, R.D. and McLaughlin, C.P. (1996), 'The impact of environmental management on firm performance', *Management Science*, **42**, 1199–214.

Klassen, R.D. and Whybark, D.C. (1999), 'The impact of environmental technologies on manufacturing performance', *Academy of Management Journal*, **42**, 599–615.

Kraut, R., Rice, R., Cool, C. and Fish, R. (1998), 'Varieties of social influence: the role of utility and norms in the success of a new communication medium', *Organization Science*, **9**, 437–53.

Lawrence, T.B., Hardy, C. and Phillips, N. (2002), 'Institutional effects of interorganizational collaboration: the emergence of proto-institutions', *Academy of Management Journal*, **45**, 281–90.

Leblebici, H., Salancik, G.R., Copay, A. and King, T. (1991), 'Institutional change and the transformation of interorganizational fields: an organizational history of the U.S. radio broadcasting industry', *Administrative Science Quarterly*, **36**(3), 333–63.

Lounsbury, M. (2001), 'Institutional sources of practice variation: staffing college and university recycling programs', *Administrative Science Quarterly*, **46**, 29–56.

Macrì, D.M., Tagliaventi, M.R. and Bertolotti, F. (2001), 'Sociometric location and innovation: how the social network intervenes between the structural position of early adopters and changes in the power map', *Technovation*, **21**, 1–13.

Maguire, S., Hardy, C. and Lawrence, T.B. (2004), 'Institutional entrepreneurship in emerging fields: HIV/AIDS treatment advocacy in Canada', *Academy of Management Journal*, **47**(5), 657–79.

McAdam, D. (1996), 'The framing function of movement tactics: strategic dramaturgy in the American Civil Rights Movement', in McAdam, D., McCarthy, John D. and Zald, Mayer N. (eds), *Comparative Perspectives on Social Movements: Political Opportunities, Mobilizing Structures, and Cultural Framings*, Cambridge/New York: Cambridge University Press, pp. 338–55.

Meyer, J.W. and Rowan, B. (1977), 'Institutionalized organizations: formal structure as myth and ceremony', *American Journal of Sociology*, **83**(2), 340–63.

Ministry of Transport, Public Works and Water Management (2003a), *Verbruik van beton- en metselzand en (gebroken) grind 2001*: *Stand van het Zand VII/Lint aan het Grind V* (Use of sand and gravel 2001), Publicatiereeks Grondstoffen, The Hague: VROM.

Ministry of Transport, Public Works and Water Management (2003b), *Hoeveelheden bouw- en sloopafval en bouw- en sloopafvalproducten 2000 en 2001* (Amounts of construction and demolition waste and products), Publicatiereeks Grondstoffen, The Hague: VROM.

Nehrt, C. (1998), 'Maintainability of first mover advantages when environmental regulations differ between countries', *Academy of Management Review*, **23**, 77–97.

Noci, G. and Verganti, R. (1999), 'Managing "green" product innovation in small firms', *R&D Management*, **29**(1), 3–15.

Porter, M.E. and Linde, C. van der (1995), 'Green and competitive: ending the stalemate', *Harvard Business Review*, **73**(5), 120–34.

Reay, T. and Hinings, C.R. (2005), 'The recomposition of an organizational field: health care in Alberta', *Organization Studies*, **26**(3), 351–84.

Redmond, W.H. (2004), 'Interconnectivity in diffusion of innovations and market competition', *Journal of Business Research*, **57**, 1295–302.

Rogers, E.M. (1995), *Diffusion of Innovations*, New York: Free Press.

Russo, M.V. and Fouts, P.A. (1997), 'A resource-based perspective on corporate environmental performance and profitability', *Academy of Management Journal*, **40**, 534–59.

Schneiberg, M. and Bartley, T. (2001), 'Regulating American industries: markets, politics, and the institutional determinants of fire insurance regulations', *American Journal of Sociology*, **107**, 101–46.

Scott, W.R. (1987), 'The adolescence of institutional theory', *Administrative Science Quarterly*, **32**, 493–511.

Scott, W.R. (2001), *Institutions and Organizations*, 2nd edn, Thousand Oaks, CA: Sage.

Scott, W.R., Ruef, M., Mendel, P.J. and Caronna, C.A. (2000), *Institutional Change and Healthcare Organizations: From Professional Dominance to Managed Care*, Chicago: University of Chicago Press.

Seo, M.G. and Creed, W.E.D. (2002), 'Institutional contradictions, praxis, and institutional change: a dialectical perspective', *Academy of Management Review*, **27**(2), 222–47.

Sharma, S. and Vredenburg, H. (1998), 'Proactive corporate environmental strategy and the development of competitively valuable organizational capabilities', *Strategic Management Journal*, **19**, 729–53.

Shrivastava, P. (1994), 'CASTRATED environment: GREENING organization studies', *Organization Studies*, **15**, 701–20.

Starik, M. and Marcus, A.A. (2000), 'Introduction to the special research forum on the management of organizations in the natural environment: a field emerging from multiple paths, with many challenges ahead', *Academy of Management Journal*, **43**(4), 539–46.

Starik, M. and Rands, G.P. (1995), 'Weaving an integrated web: multilevel and multisystem perspectives of ecologically sustainable organizations', *Academy of Management Review*, **20**, 908–35.

Strang, D. and Soule, S.A. (1998), 'Diffusion in organizations and social movements: from hybrid corn to poison pills', *Annual Review of Sociology*, **24**, 265–90.

van der Vlist, A.A. (1998), *Tussen cement, zand en grind . . . en beton; 50 jaar betonmortelindustrie in Nederland 1948–1998* (Between cement, sand and gravel . . . and concrete. 50 years of concrete industry in the Netherlands), Driebergen: VOBN.

Vermeulen, P.A.M., Buch, R. and Greenwood, R. (2007), 'The impact of governmental policies in institutional fields: the case of innovation in the Dutch concrete industry', *Organization Studies*, **28**(4): 515–40.

World Commission on Environment and Development (1987), *Our Common Future*, Oxford: Oxford University Press.

Zietsma, C. and Winn, M. (2005), 'The war of the woods: a forestry giant seeks peace', *Greener Management International*, **48**, 21–37.

Zucker, L.G. (1983), 'Organizations as institutions', in S.B. Bacharach (ed.), *Advances in Organizational Theory and Research*, New York: JAI Press, pp. 1–47.

Zucker, L.G. (1991), 'The role of institutionalization in cultural persistence', in W.W. Powell and P.J. DiMaggio (eds), *The New Institutionalism in Organizational Analysis*, Chicago: University of Chicago Press, pp. 83–107.

PART IV

Investors and policy

11. Is the European Pollutant Emission Register an effective instrument for disciplining companies?

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Market-based environmental regulation instruments attempt to encourage a certain type of behaviour through market signals, rather than through explicit directives regarding pollution control levels or methods (Stavins, 2003). Within the limits of this definition we find what Tietenberg (1998), Tietenberg and Wheeler (2001), Cohen (2002) and others have called the 'third wave' of environmental regulation, based on the use of quasi-regulatory instruments such as the disclosure of information to the public about the pollution generated by each individual firm.

Environmental information disclosure strategies consist of 'public and/or private attempts to increase the availability of information on pollution to workers, consumers, shareholders and the public at large' (Tietenberg and Wheeler, 2001: 87). The normative basis of this instrument of environmental regulation is the 'right to know', the right of all citizens to know to what extent they are affected by risks derived from environmental pollution (Cohen, 2001, 2002).

The best-known example of this environmental information disclosure requirement is the Toxic Release Inventory (TRI) database promoted in the USA by the Emergency Planning and Community Right to Know Act of 1986. First published in 1989, information on the emission of up to 300 toxic chemical compounds by each of the affected firms was made available under the programme.

In the European context, public access to an inventory of toxic emissions was originally put forward in European Council Directive 96/61/EC, concerning Integrated Pollution Prevention and Control (IPPC). Among other obligations, all the plants affected by this directive must provide the European Pollutant Emission Register (EPER) with their pollutant volume figures.

Subsequently, the register only publishes this information for plants in which emissions exceed the thresholds specified in Decision 2000/479/EC for individual substances. These thresholds are not emission limit values, so the data published do not necessarily mean non-compliance with environmental legislation. However, the establishment of these thresholds reveals which industrial plants exceed certain levels of pollution within their sectors. Indeed, the EPER could be seen as a 'black list' of the firms producing the greatest pollution.

The effectiveness of the TRI as an environmental regulation instrument has been studied from both a practical and a theoretical perspective. The publication of the TRI did have a relevant impact in the mass media in the form of numerous articles and reports by environmentalist groups (Khanna et al., 1998). The publication of the emissions inventory had a negative effect on the market value of the companies involved and this resulted in private initiatives to reduce pollution (Hamilton, 1995; Konar and Cohen, 1997; Khanna et al., 1998; Cohen, 2001). The US Environmental Protection Agency (2001) estimates that the TRI helped reduce toxic emissions by 45.5 per cent between 1988 and 1999.

The aim of this chapter is to analyse the effectiveness of the most recent EPER data published in February 2004. We therefore conducted an event study to verify whether the publication of the EPER in Spain had a negative effect on the market value of the affected firms. Based on papers evaluating the repercussion of the publication of the TRI in the US we first used traditional event methodology consisting of estimating a market model. We then used a portfolio model and a multivariate regression model to correct the contemporary correlation problem derived from traditional methodology when the date of the event is the same for all the firms.

This chapter is structured as follows: the next section covers the theoretical arguments and results obtained from the literature published on the subject; then the research methodology and design will be explained, followed by a section on the empirical analysis and the results obtained; the final section will summarize the main conclusions that have been drawn from the study.

ENVIRONMENTAL INFORMATION DISCLOSURE AND MARKET VALUE OF COMPANIES

There are a number of studies showing that environmental information disclosure has a significant effect on the behaviour of companies (Maxwell et al., 2000; Cohen, 2002; Berthelot et al., 2003; Hasseldine et al., 2005; Joshi et al., 2005). The explanation of this effect can be found in institutional theory, which studies the influence of social and cultural pressure on the activities and practices of organizations. Institutional theory establishes that conforming to social expectations determines the survival and organizational success of businesses (Carroll and Hannan, 1989; Baum and Oliver, 1991). Organizations tend to homogenize their conduct as a response to coercive forces within their field, and this imposes a certain standardization (DiMaggio and Powell, 1983; Scott, 1992). In relation to environmental behaviour, the establishment of regulations based on the imposition of standards was originally the most relevant controlling factor (Hart, 1995; Jaffe et al., 1995; Henriques and Sadorsky, 1999). In the last few years, however, two other controlling forces have come into play: market and social pressures. Market pressure is concerned with the environmental information available to consumers, companies and investors (Bowen et al., 1983; Konar and Cohen, 1997). Social pressures reflect the expectations of environmentalist groups, the mass media and so on (Henriques and Sadorsky, 1999; Hoffman, 2000).

Regulation mechanisms based on the disclosure of information use both pressure factors to alter the conduct of firms. Disclosure of information about pollutant emissions, therefore, makes the community an active participant in the regulation process (Tietenberg and Wheeler, 2001). Such disclosure encourages different stakeholders (consumers, environmentalist groups, financial institutions, insurance companies and investors) to bring disciplinary pressure to bear on the behaviour of companies (Lanoie et al., 1998; Maxwell et al., 2000; Cohen, 1999, 2001). This is precisely the objective of these disclosure strategies: to enlist market forces in the quest for efficient pollution control (Tietenberg and Wheeler, 2001). The absence of information means that investors perceive environmental risk to be the same for all companies (Toms, 2002).

The right to know therefore allows investors to appropriately adjust their expectations about the value of companies in relation to perceived environmental risk (Feldman et al., 1996). This means that investors have new elements to consider when selecting their portfolio and this, in turn, imposes disciplinary pressure on companies (Konar and Cohen, 1997). In addition, satisfying the right to know allows, for example, for the adjustment of the premiums demanded by insurance companies (Delmas, 2001), and financial institutions (Donaldson et al., 2001). So when data on emissions are made public, repercussions for the companies with the highest pollution levels are not limited to a possible sanction, but may also include an increase in costs and a possible decline in reputation, sales or market value (Hamilton, 1995; Lanoie et al., 1998).

Investor reaction to environmental information disclosure and its effect on the market value of the firm has been one of the most fruitful research areas in relation to this third wave of environmental regulation (for a full review, see Berthelot et al., 2003).

Shane and Spicer (1983) found that the market value of companies in four industries in the US was adversely affected by the disclosure of environmental results by the Council of Economic Priorities (CEP).[2] More recently, after the publication of the TRI in 1989, a number of studies have analysed investor reaction to the release of such information. For example, Hamilton (1995) found a mean decline of 0.3 per cent in the trading value of the firms affected by the first publication of the TRI database. Hamilton argues that these negative abnormal returns reflect the effect that the TRI had on modifying the expectations of the financial community related to company pollution costs – costs derived from sanctions, new equipment expenses, loss of reputation and so on.

Konar and Cohen (1997) provided new evidence on the effectiveness of the TRI by studying toxic emissions from 1989 to 1992 in order to analyse the response of firms to the public disclosure of environmental information. Using Hamilton's (1995) work as a reference, they concluded that the significant reductions in share prices provoked by the TRI resulted in significant reductions in toxic emissions. Market reaction informs management that this is now an important criterion for investors, and managers thus attempt to reduce TRI emissions in subsequent periods. Specifically, the top 40 firms affected by the largest negative abnormal returns in 1989 as a result of TRI publication lowered their TRI per cent emissions in 1988–90 and 1991–92. Likewise, they reduced their average volume of oil and chemical spills per dollar of sales for the same periods.

Khanna et al. (1998) also looked at the reaction of investors to TRI publications in the period from 1989 to 1994, but limited their study to a sample of firms from the chemical industry. Their empirical results did not show a significant change in the market value of the firms as a consequence for the first TRI publication in 1989.[3] There was, however, a significant negative effect in the following years, especially for the firms in which environmental results worsened in relation to those of their competitors.

Based on these arguments, we contemplate the following hypothesis:

Research hypothesis: The publication of emission data in the EPER produces negative abnormal returns in the trading price of the affected firms.

RESEARCH DESIGN

Methodology

An event study was performed to evaluate investor reactions with respect to pollution levels generated by the firms listed on the EPER. According to the efficient market hypothesis, the information received by investors is continuously evaluated and reflected in the share price which represents the most accurate estimation of the current value of future discounted cash flows (Fama, 1970). Event study is therefore appropriate for evaluating the efficiency of a regulatory instrument aimed at altering the behaviour of firms through disclosure of new information (Hamilton, 1995).

An event study can make use of different techniques and market models. In this case, we started by applying traditional methodology according to Brown and Warner (1985). This methodology was used with similar objectives by Hamilton (1995), Konar and Cohen (1997) and Khanna et al. (1998) in relation to the TRI. It is based on the following market model:

$$R_{it} = \alpha_i + \beta_i R_{mt} + u_{it}, \qquad \text{with } i = 1, \ldots, N;\ t = 1, \ldots, T, \qquad (11.1)$$

where R_{it} is the observed return of the title i on the day t; R_{mt} is the return of market index and u_{it} is the random disturbance. Thus, as suggested by Fama et al. (1969), the abnormal returns are calculated as the residual estimates of equation (11.1).

This method assumes that the residuals are independent and identically distributed among the firms. This requirement, however, is not verified when the information that becomes available on the market is the same for all firms. This could give rise to contemporary correlation problems and, therefore, dependency between the residuals.

One way to solve these dependency problems is through the portfolio model (Izan, 1978). In this case, the dependent variable in the equation is the mean return on the portfolio weighted by the value of each firm on t (R_{pt}):

$$R_{pt} = \alpha_p + \beta_p R_{mt} + \sum_{a=1}^{A} \gamma_{pa} D_{at} + u_{pt}, \qquad \text{with } t = 1, \ldots, T, \qquad (11.2)$$

where R_{mt} is the return of market index on the day t, D_{at} is a dummy variable that takes the value of 1 on the day of the event a and zero in the contrary case[4] and γ_{pa} is the abnormal return of the portfolio on the date of the event a.

This enables the portfolio return to contemplate dependency between the firms and increases the model's explanatory power (Schwert, 1981; Collins and Dent, 1984; Bernard, 1987; Shane, 1995).

This kind of analysis, however, can cause confusion when it comes to the interpretation of results (Lamdin, 2001). An abnormal non-significant return of the portfolio could be due to compensation between the positive and negative effects of the firms in the portfolio, or the fact that the said return does not exist. Therefore, the estimation of the abnormal return based on equation (11.2) would not be an appropriate procedure when the abnormal returns have different signs among the firms in the sample (Binder, 1998).

This limitation of the previous model can be avoided by breaking down the portfolio model (11.2) into a system of equations, establishing one equation for each of the N firms (titles) affected by the different events (McKinlay, 1997; Binder, 1998). The multivariate regression model (MVRM) was developed by Schipper and Thompson (1983), Collins and Dent (1984) and Binder (1985a, b, 1998), and can be represented as follows:

$$R_{1t} = \alpha_1 + \beta_1 R_{mt} + \sum_{a=1}^{A} \gamma_{1a} D_{at} + u_{1t}, \qquad \text{with } t = 1, \ldots, T$$

$$R_{2t} = \alpha_2 + \beta_2 R_{mt} + \sum_{a=1}^{A} \gamma_{2a} D_{at} + u_{2t}, \qquad \text{with } t = 1, \ldots, T$$

$$\ldots$$

$$R_{Nt} = \alpha_N + \beta_N R_{mt} + \sum_{a=1}^{A} \gamma_{Na} D_{at} + u_{Nt}, \qquad \text{with } t = 1, \ldots, T, \quad (11.3)$$

where R_{it} is the observed return of title i on the day t; R_{mt} is the market return at day t; D_{at} is a dummy variable that takes the value 1 on the day a of the event window and 0 in the contrary case; γ_{ia} reflects the abnormal return of title i on the day of the event a and u_{it} is the random term.

This system of equations is jointly resolved with the use of generalized least squares (GLS). The MVRM has three main advantages over the traditional methodology. First, it explicitly incorporates the heteroscedasticity between equations and the dependency derived from the contemporaneous nature of the dates of the events in the hypotheses tests. Second, it allows abnormal returns to be differentiated not only between firms but also by sign – something that does not happen when portfolio returns are aggregated (Binder, 1985a, b). Finally, MVRM methodology has the advantage of allowing us to test the joint hypothesis on accumulated abnormal return when the event window is made up of more than one day.

In this study, average abnormal return was accumulated in the window included in the interval $(-1, +1)$, around the date of the publication of the EPER (day 0). This allows us to consider the possibility of advance knowledge of the information on the market as well as allowing for a certain delayed reaction. In short, it allows us to test whether $\Sigma_{a=-1}^{+1}\gamma_{ia} = 0$. The rejection of this hypothesis implies accepting that the event contains relevant information which is significantly reflected by share price.

Sample Selection and Sources of Information

The EPER provides data on pollution exceeding the individual thresholds specified in Decision 2000/479/EC for 50 classes of substances which pollute air and water. The EPER was published on 24 February 2004, and contains information corresponding to emissions generated in 2001, individually specified for each facility affected by Directive 96/61/EC. In the case of Spain, the EPER included information on the 1,414 plants which were under the obligation to notify emissions of one or more of the classified substances (of a total of 4,983 facilities affected by the IPPC directive).

The first step in the process of selecting the first sample was to choose, from among the 1,414 Spanish industrial facilities listed in the EPER, those which were owned by firms trading on the Madrid Stock Exchange's Continuous Trading Market. The information published in the register included details of the parent company for each of the industrial installations. Eighty-seven facilities were thus identified, belonging to 31 different companies. The second step was to eliminate the facilities for which their market value could have been affected by events other than the publication of the EPER on the analysis dates; in order to do this, a review of all leading newspapers and news media was carried out to find events which could have affected the share price of any of the firms in our sample. The eliminated firms were affected by contemporaneous news such as announced dividend payments or increased profits. We were left with a study sample comprising 80 plants belonging to 28 different companies operating in nine different industrial sectors (see Table 11.1). Although the sample may appear small, it represents approximately 13.5 per cent of all the plants in sectors for which information is available.[5]

The daily returns for a 269-day period, from 25 February 2003 to 22 March 2004, were compiled for each of the firms in the sample. These daily returns were used to estimate the MVRM parameters. The value of the General Index of the Madrid Stock Exchange was likewise compiled for each day in the studied period. Share price and index data were obtained from the Madrid Stock Exchange.

The date of the event (day 0) was taken as 24 February 2004, the first day on which the information related to the new EPER appeared in the press (national newspapers and specialized economic journals). The event window

Table 11.1 Sample distribution by sector (CNAE-93 classification)

Sector	Number of facilities on the Spanish EPER	Number of facilities in sample	Number of firms in sample
Agriculture and livestock	801	0	0
Food, drink and tobacco	41	8	2
Textiles	13	1	1
Paper and wood	40	4	3
Petrochemicals	128	17	6
Cement, glass and ceramics	139	5	2
Metallurgy and manufacturing of metal articles	103	13	5
Mechanical engineering, electrics and electronics	29	4	3
Energy production and distribution	61	19	5
Public health activities	41	9	1
Others	18	0	0
Total	1414	80	28

Note: We have used the official Spanish sector classification – the CNAE (*Clasificación Nacional de Actividades Económicas*).

was considered as the day before publication to the day after (−1, +1), enabling control of the effect of both advance notice and a delayed reaction to the news by the market. This choice and size of window is regularly used in the literature using event studies.

Model Specification

Considering that the event window is three days, that the number of firms in the sample is 28 and that the number of analysed days is 269, each of the proposed models is specified as follows:

Traditional market model:

$$R_{it} = \alpha_i + \beta_i R_{mt} + u_{it}, \qquad \text{with } i = 1, \ldots, 28;\ t = 1, \ldots, 269.$$

Portfolio model:

$$R_{pt} = \alpha_p + \beta_p R_{mt} + \sum_{a=1}^{3} \gamma_{pa} D_{at} + u_{pt}, \qquad \text{with } t = 1, \ldots, 269.$$

MVRM:

$$R_{1t} = \alpha_1 + \beta_1 R_{mt} + \sum_{a=1}^{3} \gamma_{1a} D_{at} + u_{1t}, \qquad \text{with } t = 1, \ldots, 269,$$

$$R_{2t} = \alpha_2 + \beta_2 R_{mt} + \sum_{a=1}^{3} \gamma_{2a} D_{at} + u_{2t}, \qquad \text{with } t = 1, \ldots, 269,$$

$$R_{28t} = \alpha_{28} + \beta_{28} R_{mt} + \sum_{a=1}^{3} \gamma_{28a} D_{at} + u_{28t}, \quad \text{with } t = 1, \ldots, 269.$$

ANALYSIS OF RESULTS

The results obtained from the event studies using the traditional market model, the portfolio model and the MVRM are shown in Tables 2, 3 and 4, respectively.

Table 11.2 shows the mean value of the abnormal returns on each day in the window and overall (accumulated), together with the significance tests of individual and accumulated returns according to the traditional market model. The estimated abnormal returns are negligible, as none of the tests is significant.

Table 11.3 shows the average value of abnormal returns, γ_{ia}, estimated for each of the days in the event window the total obtained for the three days, using the portfolio model. It also shows the results of the testing of model hypotheses, both individual (H_0: abnormal event return on the day analysed is equal to zero), and joint (H_0: the sum of the abnormal event return on the days of the window is equal to zero). These results are no different from those obtained with the traditional market model. In other words, no significant results are obtained in any of the cases (individual and cumulative returns).

As in the previous table, Table 11.4 shows the average value of abnormal returns, γ_{ia}, estimated for each of the days of the event window and the total

Table 11.2 Abnormal returns and individual and joint testing of hypotheses (traditional market model)

Day	Date	Average abnormal return (%)	*t*-test
−1	23/02/2004	−0.007	−0.015
0	24/02/2004	0.25	0.578
+1	25/02/2004	−0.28	−0.637
Window	–	Cumulative average abnormal return (%)	*t*-test
(−1, +1)	–	0.04	0.063

Table 11.3 Abnormal returns and individual and joint testing of hypotheses (portfolio model)

Day	Date	Average abnormal return (%)	Test H_0: $\gamma_{ia} = 0\ \forall a = -1, +1$
−1	23/02/2004	0.04	$F(1, 263) = 0.01$
0	24/02/2004	0.25	$F(1, 263) = 0.35$
+1	25/02/2004	−0.25	$F(1, 263) = 0.37$
Window	–	Cumulative average abnormal return (%)	Test H_0: $\Sigma_{a=-1}^{+1} \gamma_{ia} = 0$
(−1, +1)	–	−0.16	$F(1, 263) = 0.00$

Table 11.4 Abnormal returns and individual and joint testing of hypotheses (MVRM)

Day	Date	Average abnormal return (%)	Test H_0: $\gamma_{ia} = 0\ \forall a = -1, +1$
−1	23/02/2004	−0.14	$F(28, 263) = 0.99$
0	24/02/2004	0.26	$F(28, 263) = 0.99$
+1	25/02/2004	−0.28	$F(28, 263) = 1.60$***
Window	–	Cumulative average abnormal return (%)	Test H_0: $\Sigma_{a=-1}^{+1} \gamma_{ia} = 0$
(−1, +1)	–	−0.16	$F(1, 263) = 0.00$

Note: *** p-value < 1%.

obtained for the three days, this time using the MVRM. The table also shows the results of testing the model hypotheses, both individual (H_0: abnormal event return on the day analysed is equal to zero), and joint (H_0: the sum of the abnormal event return on the days of the window is equal to zero).

According to the results obtained with the MVRM, the abnormal returns are not statistically significant in the first two days (−1 and 0) of the event window ($F(28, 263) = 0.99$; $F(28, 263) = 0.99$, respectively). The result for accumulated abnormal returns was also not significant for the window period (−1, + 1). Nevertheless, the contrast for day + 1 indicates significant and negative abnormal returns of 0.28 per cent ($F(28, 263) = 1.60$***).

The results obtained from estimating the market model (Table 11.2) and the portfolio model (Table 11.3) do not confirm the research hypothesis concerning the repercussion of the EPER on the market value of listed firms. However, we find a possible explanation for these results in the estimation methods used which, as we explained in the methodology section, are not the most appropriate in certain conditions. The first of these conditions refers to the fact that the event analysed occurs on the same date for all the firms. The second refers to the differences in the sign of the abnormal returns estimated for different firms. Both conditions are found here and we therefore believe that the results obtained from the MVRM are the most accurate.

The MVRM results confirm the hypothesis that the publication of the EPER produced negative abnormal returns in the share price of affected firms. Specifically, the share price of the firms shows that environmental results published by the register fell by an average of 0.28 per cent on the following day. This result is similar to that obtained by Hamilton (1995), who found a fall of 0.3 per cent in the share price of firms affected by the first publication of the TRI in the United States. The delay of one day in the appearance of negative abnormal results can be explained as a consequence of the time needed by investors to aggregate and compare the published data.[6] In this respect, the results are consistent with those established by Khanna et al. (1998), who observed that the publication of the TRI implied a significant loss of value for the firms concerned on day + 1, after its first publication.

The results obtained from this research represent the first evidence of the effectiveness of the EPER in Spain, and also in the European Union, as a regulatory instrument based on information disclosure. These results confirm the disciplinary capacity of the EPER as a regulatory instrument. In fact, being listed on the EPER determines investor reactions to the new challenge to firms to adapt to the demands of IPPC regulations. In short, the empirical evidence indicates that investors anticipate higher costs for adapting to IPPC requirements in firms listed on the EPER. These costs are due to the need to invest in machinery and equipment in order to reduce pollution levels or the possible loss of market position resulting from the decline in the firm's reputation and image.

CONCLUSIONS

The publication of the EPER in February, 2004, is the first European experience in the use of environmental control mechanisms based on the disclosure of information about firms' pollution emissions. This information is revealed so that stakeholders will bring pressure to bear for disciplining environmental conduct. This study therefore provides empirical evidence of the effectiveness of this environmental regulation instrument in Spain.

Event study methods are used, following the research analysing the impact of the publication of the TRI in the US.

The event study was shown to be an effective method for testing an instrument that aims to discipline firms by disclosing information to stakeholders, including affected investors. Considering that businesses trading on the stock exchange are particularly vulnerable to new information, as they rely on the capital market for finance (Gibbins et al., 1990; Frankel et al., 1995), the effect of the publication of the EPER has been measured through a sample of firms listed on the Continuous Trading Market of the Madrid Stock Exchange.

The event study can be based on different models. Here it is applied to three: the traditional market model, the portfolio model and the MVRM. They attempt to estimate the abnormal returns derived from the publication of the EPER on the share price of the listed firms.

No significant results are obtained with the traditional market and portfolio models. However, we obtain significant negative abnormal returns on the day after the publication of the EPER with the MVRM. On the one hand, this method of estimation corrects the contemporary correlation problem generated with the traditional events method based on the estimation of a market model and, on the other, unlike the portfolio model, the MVRM distinguishes between the positive and negative abnormal returns of the firms concerned. Therefore, the MVRM estimation adds value to this research, relative to the papers evaluating the effect of the publication of the TRI, by means of event studies.

The negative abnormal returns obtained show that new information on pollution has a significant negative impact on the market value of the firms exceeding the threshold limits established by legislation.

This result proves the effectiveness in Spain of this new instrument of environmental regulation. Thus, the market uses the new information as a determining element when selecting an investment portfolio, a fact which proves its success as a disciplinary measure.

The confirmation that the publication of firms' pollution levels has a significant effect on their financial results confirms that the EPER is an effective external environmental control instrument. The disclosure of information provides stakeholders with an idea of a firm's future competitiveness. This could provide an incentive for firms to voluntarily reduce their emissions.

NOTES

1. This chapter was developed under the objectives of the CREVALOR Research Group (DGA-Spain). It was financed by the MEC-FEDER Research Project SEJ2005-07341.
2. The CEP is an independent, public-interest research organization dedicated to accurate and impartial analysis of the social and environmental records of corporations.

3. Khanna et al. (1998) explain the difference between their results and those of Hamilton (1995) and Konar and Cohen (1997) as being due to differences in the samples of companies that were analysed.
4. Legislative processes usually involve various public announcements or events so a dummy event was established for each of the identified events.
5. Almost 57 per cent of the installations are in the agriculture and livestock sector. These firms are not quoted on the stock exchange due to their small size; they are not therefore included in our sample.
6. Although the EPER publishes all necessary information for comparing the environmental results of the firms, it is difficult to make comparisons before the development of a pollution index capable of correcting differences in the toxicity levels of the different substances and the different sizes and activities of the firms. After the publication of the TRI in the USA, some environmental pressure groups attempted to make the information easily comparable; they developed a ranking of firms that was based on their levels of pollution and published in the mass media.

REFERENCES

Baum, J. and Oliver, C. (1991), 'Institutional linkages and organizational mortality', *Administrative Science Quaterly*, **36**: 187–218.

Bernard, V. (1987), 'Cross sectional dependence and problems in inference in market based accounting research', *Journal of Accounting Research*, **25**: 1–48.

Berthelot, S., Cormier, D. and Magnan, M. (2003), 'Environmental disclosure research: review and synthesis', *Journal of Accounting Literature*, **22**: 1–44.

Binder, J. (1985a), 'Measuring the effects of regulation with stock price data', *Rand Journal of Economics*, **16** (2): 167–83.

Binder, J. (1985b), 'On the use of the multivariate regression model in event studies', *Journal of Accounting Research*, **23** (1): 370–83.

Binder, J. (1998), 'The event study methodology since 1969', *Review of Quantitative Finance and Accounting*, **11** (1): 1–137.

Bowen, R., Castanias, R. and Daley, L. (1983), 'Intra-industry effects of the accident at Three Mile Island', *Journal of Financial and Quantitative Analysis*, **18** (1): 87–111.

Brown, S. and Warner, J. (1985), 'Using daily stock returns. The case of event studies', *Journal of Financial Economics*, **14**: 3–31.

Carroll, G. and Hannan, M. (1989), 'Density dependence in the evolution of population of newspapers', *American Sociological Review*, **54**: 524–41.

Cohen, M.A. (1999), 'Monitoring and enforcement of environmental policy', in T. Tietenberg and H. Folmer (eds), *International Yearbook of Environmental and Resource Economics*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 44–106.

Cohen, M.A. (2001), 'Information as a policy instrument in protecting the environment: what have we learned?', *Environmental Law Reporter*, **31**: 10425–34.

Cohen, M.A. (2002), 'Transparency after 9/11: balancing the "right-to-know" with the need for security', *Corporate Environmental Strategy*, **9**: 368–78.

Collins, D. and Dent, W. (1984), 'A comparison of alternative testing methodologies used in capital market research', *Journal of Accounting Research*, Spring: 48–84.

Delmas, M. (2001), 'Stakeholders and competitive advantage: the case of ISO 14001', *Production and Operations Management*, **10** (3): 343–58.

DiMaggio, P.W. and Powell, W. (1983), 'The iron cage revisited: institutional isomorphism and collective rationality in organizational fields', *American Sociological Review*, **48**: 147–60.

Donaldson, T., Werhane, P. and Cording, M. (2001), '*Ethical Issues in Business: A Philosophical Approach*, 7th edn, Upper Saddle River, NJ: Prentice-Hall.

Fama, E. (1970), 'Efficient capital markets: a review of theory and empirical work', *Journal of Finance*, **25**: 385–417.

Fama, E., Fisher, L., Jensen, M. and Roll, R. (1969), 'The adjustment of stock prices to new information', *International Economic Review*, **10**, February: 1–21.

Feldman, S.J., Soyka, P. and Ameer, P. (1996), 'Does improving a firm's environmental management system and environmental performance result in a higher stock price?', *Journal of Investing*, **6** (4): 87–97.

Frankel, R., McNichols, M. and Wilson, G. (1995), 'Discretionary disclosure and external financing', *The Accounting Review*, **70** (1): 135–50.

Gibbins, M., Richardson, A. and Waterhouse, J. (1990), 'The management of corporate social disclosures: opportunism, ritualism, policies and processes', *Journal of Accounting Research*, **28**, Spring: 121–43.

Hamilton, J.T. (1995), 'Pollution as news: media and stock market reactions to the toxics release inventory data', *Journal of Environmental Economic and Management*, **28**: 98–113.

Hart, S. (1995), 'A natural resource based view of the firm', *Academy of Management Review*, **20**: 986–1014.

Hasseldine, J., Salama, A.I. and Toms, J.S. (2005), 'Quantity versus quality: the impact of environmental disclosures on the reputations of UK plcs', *The British Accounting Review*, **37**: 231–48.

Henriques, I. and Sadorsky, P. (1999), 'The relationship between environmental commitment and managerial perceptions of stakeholder importance', *Academy of Management Journal*, **42** (1): 87–99.

Hoffman, A. (2000), *Competitive Environmental Strategy: A Guide to Changing Business Landscape*, Washington, DC: Island Press.

Izan, H.Y. (1978), 'An empirical analysis of the economic effects of mandatory government audit requirements', PhD dissertation, University of Chicago.

Jaffe, A., Peterson, S., Portney, P. and Stavins, R. (1995), 'Environmental regulation and the competitiveness of U.S. manufacturing: what does the evidence tell us?', *Journal of Economic Literature*, **23** (1): 132–63.

Joshi, S., Khanna, M. and Sidique, S. (2005), 'Effect of environmental management systems on investor reactions to emission information', Academy of Management Best Conference Paper, 2005.

Khanna, M., Quimio, W. and Bojilova, D. (1998), 'Toxic release information: a policy tool for environmental protection', *Journal of Environmental Economics and Management*, **36**: 243–66.

Konar, S. and Cohen, M.A. (1997), 'Information as regulation: the effect of community right to know laws on toxic emissions', *Journal of Environmental Economics and Management*, **32**: 109–24.

Lamdin, D.J. (2001), 'Implementing and interpreting event studies of regulatory changes', *Journal of Economics and Business*, **52**: 171–83.

Lanoie, P., Laplante, B. and Roy, M. (1998), 'Can capital markets create incentives for pollution control?', *Ecological Economics*, **26** (1): 31–41.

MacKinlay, A. (1997), 'Event studies in economics and finance', *Journal of Economic Literature*, **34**: 13–39.

Maxwell, J.W., Lyon, T.P. and Hackett, S.C. (2000), 'Self-regulation and social welfare: the political economy of corporate environmentalism', *Journal of Law and Economics*, **43** (2): 583–617.

Schipper, K. and Thompson, R. (1983), 'The impact of merger-related regulations on the shareholders of acquiring firms', *Journal of Accounting Research*, **21**, Spring: 184–221.

Schwert, G. (1981), 'Using financial data to measure effects of regulation', *Journal of Law and Economics*, **24**: 121–58.

Scott, W.R. (1992), *Organizations: Rational, Natural, and Open Systems*, Englewood Cliffs, NJ: Prentice-Hall.

Shane, A. (1995), 'An investigation of shareholder wealth effects of environmental regulation', *Journal of Accounting*, *Auditing and Finance*, **10** (3): 485–520.

Shane, P.B. and Spicer, B.H. (1983), 'Market response to environmental information produced outside the firm', *The Accounting Review*, **58** (3): 521–38.

Stavins, R.N. (2003), 'Experience with market-based environmental policy instruments', in L.G. Mäler and J.R. Vincent (eds), *Environmental Degradation and Institutional Responses: Handbook of Environmental Economics*, Vol 1, Amsterdam: North-Holland, pp. 355–435.

Tietenberg, T. (1998), 'Disclosure strategies for pollution control', *Environmental and Resource Economics*, **11** (3–4): 587–602.

Tietenberg, T. and Wheeler, D. (2001), '*Empowering the Community: Information Strategies for Pollution Control*, in H. Folmer, H.L. Gabel, S. Gerking and A. Rose (eds), *Frontiers of Environmental Economics*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar, pp. 85–120.

Toms, J.S. (2002), 'Firms resources, quality signals and the determinants of corporate environmental reputation: some UK evidence', *British Accounting Review*, **34**: 257–82.

US Environmental Protection Agency (2001), *Toxic Release Inventory (1999): Executive Summary*, www.epa.gov/tri/tri99/press/execsummary_final.pdf.

12. Cleantech venture investors and energy policy risk: an exploratory analysis of regulatory risk management strategies

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Venture capital (VC) investments are an important source of financing for innovative entrepreneurial firms. The largest share of VC has traditionally been invested in a few sectors such as information and communication technology (ICT) or biotechnology. More recently, cleantech ventures are attracting increasing amounts of capital, with a particular focus on clean energy technology ventures. VC investments in clean energy can significantly accelerate the market diffusion of climate-friendly technologies such as solar energy or clean biomass. While exhibiting strong growth rates and a surge in media attention in the most recent past (see Figure 12.1), these investments still represent a small percentage of the overall VC market.

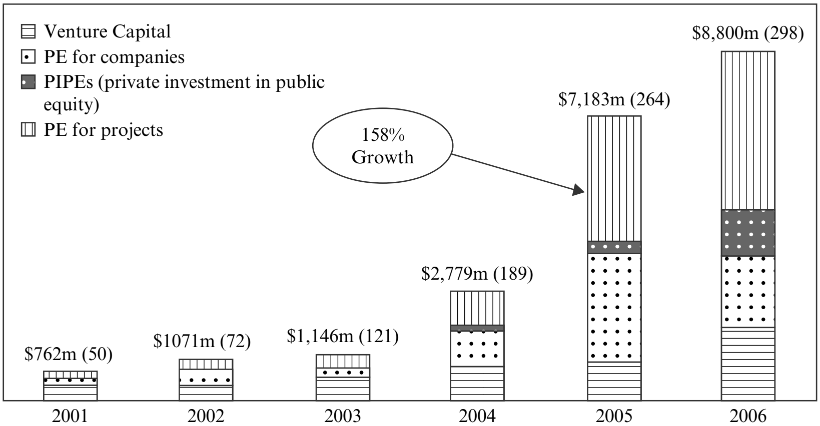
In previous research (Wüstenhagen and Teppo, 2006), we identified a number of sector-specific risks as a potential barrier to increasing levels of clean energy VC investments. Given the important role of regulatory drivers for sustainability in the energy sector, it is particularly important for government to understand investors' perceptions of the risks (and opportunities) associated with energy and climate policies and how they manage these risks.

LITERATURE REVIEW

Regulatory Influences on VC Investments

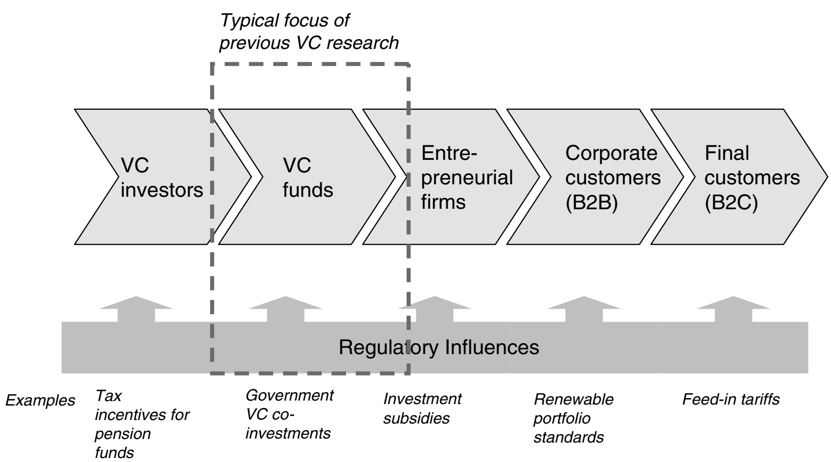
Regulatory influences can be identified on various stages of the VC investment value chain (see Figure 12.2).

Traditionally, research on the linkage between government policy and the VC market has had a relatively narrow perspective on one particular



Source: Liebreich (2006).

Figure 12.1 Estimated global clean energy private equity investment, 2001–2006



Note: B2B = business to business; B2C = business to customer.

Figure 12.2 Regulatory risk at different stages of the VC investment value chain

stage of the value chain, namely how government can support VC funds (Baygan and Freudenberg, 2000; Jeng and Wells, 2000; Rigau, 2002; Dubocage and Rivaud-Danset, 2004; OECD, 2004). The focus typically is on tax incentives and other forms of direct investment support. The

2004 OECD report surveyed five policy areas which are conducive to increasing the supply of venture capital: investment regulations, taxation, public equity programmes, business angel networks and second-tier stock markets.

To get a more comprehensive understanding of the links between regulation and the level of VC investing in a certain sector or country, it is important to also look up and down the value chain. As several authors have noted, the emergence of a healthy VC market requires a whole 'ecosystem' of innovation, which includes sufficient levels of entrepreneurial activity, as well as sufficient capital allocation from investors. Black and Gilson (1998), in their attempt to explain differences in the development of VC markets between the US and other countries, concur that critical institutions, such as experienced venture capitalists and investment bankers experienced in taking early-stage companies public, will not develop quickly. They conclude that a 'strong venture capital market thus reflects an equilibrium of a number of interdependent factors' (p. 272). Kuemmerle (2001), in his comparison of the evolution of VC industries in the US, Germany and Japan, points out that 'an active venture capital industry is arguably . . . difficult to create . . . because it typically requires not just a functioning financial system, but a fertile technology system and a climate conducive to entrepreneurship'.

If the emergence of a healthy VC industry depends on other institutions and actors along the value chain, we can conclude that regulatory policies to support the VC market should also be targeting those players, for example, investors such as pension funds, or entrepreneurial firms as the venture capitalists' 'customers'. An often-quoted best-practice example is the Small Business Innovation Research (SBIR) programme that was designed to assist small technology-based firms to commercialize their products beyond early-stage research and development (R&D) (US EPA, 1994; Lerner, 1999). This policy has indirectly supported the VC industry by providing funding to early-stage entrepreneurial firms and thereby broadening the universe of investable companies for venture capitalists later on.

Yet even looking at investors, venture capitalists and entrepreneurs will not yet lead to a complete picture of regulatory influences on the VC market. The success of VC investments ultimately depends on customers' decisions to prefer the entrepreneurial firm's products over existing products. With sustainability innovation being characterized by a strong societal (rather than private) value as described above, regulation is a strong factor influencing demand. Several policies have been developed that influence demand for sustainable energy, such as the UK renewables obligation, where electric utilities are mandated to buy a certain share of their power from renewable energy, or the German Electricity Feed-in Law (StrEG), which was introduced in 1991 (Wüstenhagen and Bilharz, 2006). This legislation guaranteed all renewable energy producers a preferred rate for selling the electricity that they generated over 20 years (CEC, 2004). These demand-driven policies have arguably indirectly contributed more to successful VC investments in the German renewable energy sector than many of the measures discussed above that aimed at directly supporting VC funds, and yet they constitute a surprising gap in the literature on regulatory influences on VC.

The view that these policies are indeed important for understanding VC investments in the sustainability sector is underlined by LoGerfo et al. (2005), who find that a number of macro trends will support cleantech as a viable venture investment category for some years to come; for example, local and national policy initiatives such as renewable energy portfolio standards for utilities, subsidies for wind and solar power systems, and 'green building' and environmental procurement requirements for government agencies that create demand for cleantech solutions and kick start the virtuous cycle of 'volume increase cost reduction'. Not much literature exists, however, on the impact of energy and climate policy on the VC industry. One of the few exceptions is an exploratory study by Kasemir et al. (2000) using a policy exercise methodology to survey European venture capitalists' views on climate policies. Among other things, they concluded that European venture capitalists would welcome stricter climate policies on the EU level, even if they were to be introduced unilaterally, as a means to foster innovation in the energy sector and hence support entrepreneurial activity in this sector.

Concluding our review of previous research about regulatory influences on VC investments, while many forms of possible government support for venture capital are being discussed, most of them focus on a relatively narrow stage of the VC value chain. In particular, the one form of government support that is most prevalent in the sustainable energy sector, namely incentives for the venture's final markets, is surprisingly absent in current research. Therefore further research is needed to develop a comprehensive model of regulatory risk in the context of sustainability-related VC investments.

Perception of Risk and VC Investment Decisions

Understanding the decision process of venture capitalists, and in particular the relative importance of multiple decision criteria (or risk factors), has been an important theme in VC research. Early empirical studies by Tyebjee and Bruno (1984) and MacMillan et al. (1987) described the factors that venture capitalists use in assessing an investment opportunity.

Tyebjee and Bruno summarized their findings in a set of five underlying dimensions that venture capitalists consider (market attractiveness, product differentiation, managerial capabilities, environmental threat resistance and cash-out potential), which they in turn summarized as describing expected return and perceived risk. Riquelme and Rickards (1992), in an exploratory study of 13 venture capitalists, investigated the inherent trade-offs between various factors and their relative importance in the decision process. Muzyka et al. (1996) surveyed 73 European venture capitalists to assess the relative importance of 35 individual criteria, concluding that the leadership potential of the entrepreneur and four other management team criteria (leadership potential of management team, industry expertise, track record of entrepreneur, track record of management team) were consistently of highest importance to European VCs, while product-market and deal-related criteria were less important. They identified three clusters of VC investors that differed in their perception of the importance of criteria.

While research on VC decision has traditionally followed a rationalist paradigm, recent contributions are increasingly shifting towards a behavioural paradigm and point to the importance of perceptional factors. The importance of behavioural aspects was first highlighted by Amos Tversky and Daniel Kahneman (1974) who demonstrated that decisions under uncertainty exhibit significant deviations from the rationality assumptions in conventional economic and financial theory. They showed that such decisions are governed by intuition more than reasoning (Kahneman, 2003) and are characterized by a number of cognitive biases (McFadden, 2001) such as anchoring-and-adjustment, availability and status quo biases (Samuelson and Zeckhauser, 1988). In sum, a significant effect of these biases is that they lead to conservatism in adjusting to new information (Tversky and Kahneman, 1974; Kahneman, 2003). In another important contribution, Kahneman and Tversky (1979) drew attention to anomalies in choices under risky prospects, demonstrating that losses are weighted differently from gains, and that expected losses and gains, rather than final assets, explain investor behaviour. This marked the starting-point of research in behavioural finance which analyses investment decisions that are based on heuristics and biases. Empirical evidence for the theoretical phenomena described by Kahneman and Tversky and the stream of behavioural economic research built on their insights has been found in various areas, including investor behaviour in stock markets (Lakonishok et al., 1994; Jordan and Kaas, 2002; Chan and Lakonishok, 2004), currency speculation (Bikhchandani et al., 1992; Froot et al., 1992; Bikchandani and Sharma, 2001), and managerial decision making (McNamara and Bromiley, 1999). More recently, scholars in entrepreneurship and VC research have taken up the theme (for example, special issue of the *Journal of Business Venturing* (2004) on cognitive perspectives in entrepreneurship research; Levesque and Schade, 2005). In the context of venture capital, Shepherd (1999) and Zacharakis and Shepherd (2001) found evidence for overconfidence and availability bias among a set of Australian and US venture capitalists, respectively, and Shepherd et al. (2003) indicated that decision accuracy of venture capitalists as a function of their experience appeared to decrease, rather than increase beyond a certain point. Lange et al. (2004) investigated cultural influences on the perception of venture risk attributes and the consequent willingness to invest in family businesses. They found some early indications that there are in fact differences in mental definitions and perceptions of risk among specific investor groups. Baum and Silverman (2004) investigated Canadian biotechnology venture capitalists and concluded that they tend to overemphasize human capital-related factors for the success of new ventures, and pointed to the need for further research on cognitive biases in VC investment decisions. In a survey of German venture capitalists by Weber and Dierkes (2002), 44 per cent of venture capitalists stated that 'personal chemistry' is very important for their investment decision.

While insightful in many respects to extend VC research beyond narrow rationality assumptions, none of these studies has explicitly focused on the perception of regulatory risk by venture capitalists, partly because sustainability-related VC investments are a relatively recent empirical phenomenon and this aspect may be less prevalent in other sectors. A particular insight from previous research is that it points to cultural and experience effects, which can cause venture capitalists to deviate from what would be purely rational investment behaviour. With regulatory risk being subject to many uncertainties and cultural interpretations, one might expect to see interesting evidence for such biases in the area of clean energy VC investments.

Venture Capitalists' Risk Management Strategies

As VC investing is a risky undertaking in many respects, a good part of the literature deals with risk management strategies. A distinction can be made between two fundamental options, namely 'actively managing risks', and 'passively diversifying risk'.

With regard to actively managing risks, there is extensive literature about how venture capitalists manage the inherent risks of their investments, mainly focusing on the risks resulting from principal–agent problems between the venture capitalist and the entrepreneur (see, for example, Kaplan and Strömberg, 2001a, 2001b; Hellmann, 2004). Gompers (1995) maintains that three risk management mechanisms are common to almost all VC investments: (i) the use of financial contracting (most commonly by financing through convertible securities), (ii) syndication of investment, and (iii) staged financing. Since regulatory risk is not rooted in the venture capitalist–entrepreneur relationship, but rather in the business–government relationship, one may question whether there is scope for active risk management at all. However, there is some evidence that active regulatory risk management is not foreign to VC practitioners. Consider, for example, the statement of this venture capitalist quoted in Wüstenhagen and Teppo (2006: 73): 'VCs need to have competence in lobbying if they want to succeed in the energy sector, just like the big American mainstream [venture capitalists] have their guys in Washington DC'.

This quotation demonstrates that actively managing risks must take different forms when it comes to regulatory risk. Venture capitalists may manage these risks either on an individual firm level or by taking collective action (also referred to as 'structural political action of firms' by Schneidewind, 1998, or as 'policy development strategies' by Dyllick et al., 1997) to influence the regulatory framework for some or all of their portfolio companies. While the idea of actively managing regulatory risk is relatively well established in the corporate sustainability literature, it is largely neglected in VC research.

Portfolio diversification (also referred to as 'passive risk management' in the finance literature) is another important aspect of managing risk. Smolarski et al. (2005) point out that VC portfolio theories and management have not received significant attention in the literature and are not well understood. This can be explained by the fact that portfolio theories have traditionally been developed in public equity markets where stocks can be bought and sold every day, and risk and return data can be determined on a daily basis. For VC investments, in contrast, investments are illiquid over several years, and short-term returns and prices are non-observable. While there are periodic revaluations of VC and private equity holdings, these are often subjective. Traditional measures of risk may therefore be inappropriate for measuring risk and return of VC investments (Chiampou and Kallett, 1989). Looking at regulatory risk from a portfolio diversification perspective is somewhat unusual, since political or regulatory frameworks are often considered to be non-diversifiable (or systematic) risks, while the term 'diversifiable' (or unsystematic) risk is more frequently associated with firm-internal aspects (because they can be diversified away by investing in a portfolio of companies). At the same time, in a sector such as clean energy, where regulatory drivers are ubiquitous, it may be worthwhile to look at the regulatory framework as a form of diversifiable risk and think about diversification strategies. Finally, diversification of regulatory risk may apply not only to a venture capitalist's portfolio as a whole, but also to a single portfolio company if it manages to diversify its business activities across international markets (and hence get exposure to different regulatory environments).

DATA AND METHODS

The purpose of our research project was to develop a robust model of regulatory risk management strategies applied by cleantech VC investors. To reach this exploratory objective and develop theory that is empirically grounded, an inductive approach is most appropriate (Glaser and Strauss, 1967; Eisenhardt, 1989; Yin, 1994).

Based on a review of the existing literature and a preliminary understanding of the research context, we designed an interview guideline that we applied in three forms, namely telephone interviews, an online questionnaire[2] and an abbreviated paper-and-pencil version of that online questionnaire, all directed at VC and private equity (PE) investors with an exposure to the clean energy technology sector. Our empirical data collection took place between October 2006 and April 2007. Online surveys were mostly undertaken between January 2007 and February 2007. Survey respondents were principals or investment managers in VC and private equity funds. In the full version of the questionnaire, 30 questions were asked about (i) the fund's investments in clean energy, (ii) preferences with regard to various energy and innovation policies, and (iii) regulatory risk management strategies. In the surveys and interviews, information was also collected on a number of basic characteristics of the funds, management practices and skills, as well as clean energy views and preferences. Investors were asked about major drivers for clean energy investment, hindering factors for more clean energy investment, their investment criteria for clean energy deals, their typical time to exit for clean energy deals, various fund characteristics (size of clean energy funding, size of all VC or PE funding, fund type, firm type and so on), and various factors which are relevant to how they manage their funds. For example, funds were asked about their most influential sources of information, how much exposure and interaction they tend to have with policy makers and portfolio companies, what backgrounds their investment teams tend to have and so on. Other policy perception questions were about international climate policy, nuclear energy and clean energy industry regulatory issues. Perceptions on policy were generally based on a 5-scale rating. Depending on their availability and preferences, the respondents replied to the questionnaire either online, in written form, or in an interview. Interviews allowed for further qualitative information to be gathered, such as the investors' views on why the clean energy sector has attracted so much interest in recent years. However, in some cases interviewees did not have enough time to complete the full interview and only a subset of questions were asked of them in such cases. Participant observation at two major international industry conferences of cleantech venture capitalists and web searches of fund websites complemented our data collection. The respondents to the interviews and surveys had been assured of 100 per cent confidentiality in the reporting of the results.

The sample is considered to be representative of the general investment actors in the VC and private equity investment space in the clean energy sector. Further details about the various characteristics of the sample of funds used for the empirical data analysis are discussed in Bürer (2007).

The survey was first sent to 200 investment companies in the private equity field which were located around the world, but mostly in Europe. Emails were directed to the managing director or a similarly senior position in each company. It was later estimated that about 100 of the funds reached were effectively involved or interested in the clean energy sector. Therefore, a more focused list of these 100 funds was used in a second electronic mailing to invite participants to utilize the online software to complete the survey. A thorough research of relevant people at each fund was conducted in order to increase the response rate among this set. Initially, the response rate was not high enough after this mailing, so follow-up emails were sent to select groups of investors which were considered to be the most important players in the field. In some cases, the fund managers who were contacted were invited to participate in a quick interview of 10–15 minutes only, in order to increase the response rate among this busy and important set of funds. Although the data have been compiled via three different methods and with varying completeness, in this manner it was possible to reach a response rate of approximately 60 per cent among the funds which were deemed to be the most important players in the field. Considering the time availability of venture capitalists for academic research of this type, this can be considered to be a relatively high overall response rate. Sixty fund managers from Europe and North America took part in the survey, of which 80 per cent had already invested in a clean energy deal. Out of the 60 fund managers, about one-third completed the web-based questionnaire, another third returned the shorter paper-and-pencil version and another third responded either face to face or via the telephone. However, not all questions were answered by all respondents. For example, only 30 out of the 60 participating firms answered the question on regulatory risk management in the questionnaire, because only those participating in the longer survey or interviews could answer these questions.

Finally, in order to understand what drives investors to invest in clean energy today, it was also considered of interest to interview a number of investors in the clean energy field that were not in the category of VC and PE fund managers. Therefore, a few additional interviews were conducted to supplement the qualitative research in this chapter with the following types of investors: (i) institutional investors who invest in clean energy funds (one pension fund, three banks, and one fund of fund), (ii) project financiers (three PE investors for projects in the clean energy sector), and finally (iii) a few advisory firms in the PE and VC space for clean energy technology ventures.

REGULATORY RISK MANAGEMENT STRATEGIES OF CLEAN ENERGY VENTURE INVESTORS

Based on our findings from the interviews and surveys, we developed the conceptual model of regulatory risk management strategies shown in Figure 12.3. We find that investors use both active and passive risk management strategies. The results demonstrated that 22 fund managers had an active risk management strategy as their primary approach, while eight had a passive (diversification) strategy. For active risk management strategies, we distinguish inbound and outbound risk management, where inbound means strengthening a venture's policy expertise by hiring people with relevant expertise, and outbound means actively influencing the regulatory environment. Thirteen of the 22 fund managers in the active category had an inbound approach, as their primary approach. As for passive risk management strategies, we distinguish diversification on the portfolio (or fund)

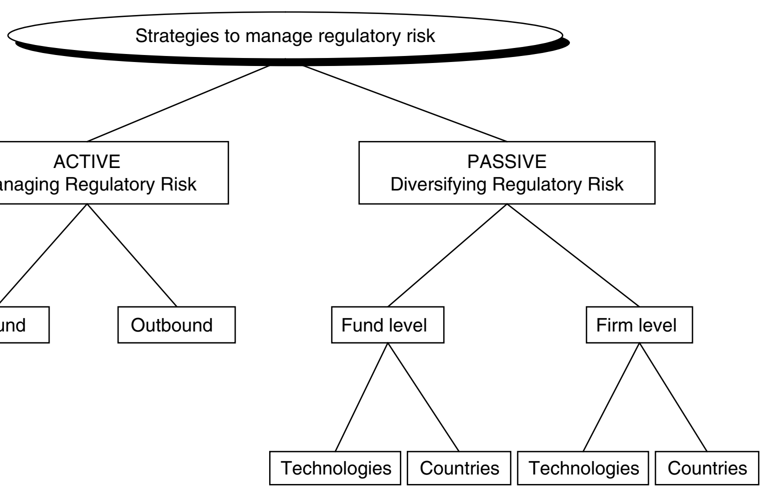


Figure 12.3 Typology of venture investors' regulatory risk management strategies

level and on the firm level, as well as diversification across technologies and across countries. Of this category, the strategies primarily used by respondents were quite evenly divided among fund- and firm-level diversification approaches. Some fund managers applied two strategies or more in parallel. We shall elaborate more on each of these strategies below, and illustrate them with direct quotations from our interviews and survey responses.

Active Regulatory Risk Management Strategies

Active risk management, inbound

The rationale behind the first form of actively managing regulatory risk is to strengthen the ties with relevant policy makers and increase the capacity of the firm to react quickly to newly emerging regulatory opportunities and challenges by recruiting people with specialized policy skills. This may include setting up a dedicated function for regulatory affairs management, or – more likely in an earlier stage of the company – giving board seats to people with a strong policy background:

> We create a strong advisory board for the portfolio company, preferably with leads into the large corporates and utilities in the energy space. (Venture capitalist C12)

> The key is being aware of and responding to policy drivers. (Venture capitalist D09)

Active risk management, outbound

The second form of actively managing regulatory risk is in a sense even more proactive, in that the VC fund actively gets involved in the regulatory process and tries to influence decision making in the policy arena in a way that benefits its portfolio companies:

> We have several people working in groups that are involved in defining new regulations. We actively manage regulatory risks. We are politically active as investors. We ask for harmonization of the most effective policies in Europe. (Venture capitalist D05)

> Also, one partner [in our fund] is involved in a political party. (Venture capitalist D12)

> Regulatory risk – we try to . . . influence the policy development getting as much information as we can and also talking to the regulators themselves. We meet twice a year with policy makers in the countries we invest in. (Venture capitalist D08)

In the context of this approach of active, outbound regulatory risk management, we asked how often investors actually meet with policy makers.

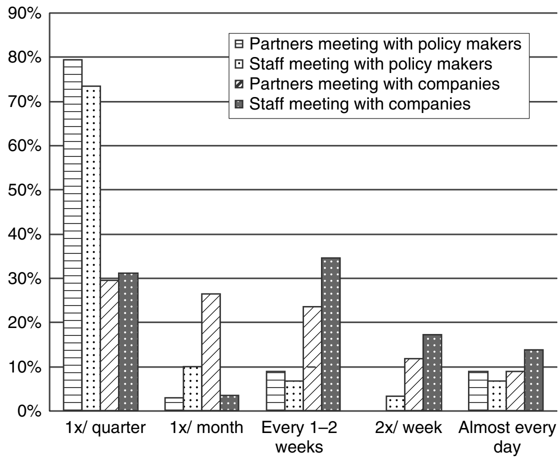


*Figure 12.4 Frequency of direct interactions between venture capitalists and policy makers versus portfolio companies (*N = *30)*

Figure 12.4 shows the results of this question, and uses the frequency of interaction with the portfolio firms for comparison (see also Appendix 12A). It turns out that most venture capitalists have rather rare direct interactions (including meetings at industry conferences) with policy makers. About three-quarters of them meet with policy makers once a quarter or less. On the other end of the spectrum, almost 10 per cent of investors indicated that they interact with policy makers more than once a week or even almost every day. An interesting finding with regard to these results is that the one type of fund which meets with policy makers more often than they meet with portfolio companies are funds that invest in late-stage clean energy deals.

Diversification – Passive Regulatory Risk Management Strategies

Fund level, across technology

As for passive risk management strategies (or diversification), the first option is to deal with regulatory risk on the fund level and invest in a portfolio of companies that represent different technology segments. An example may be to invest in several clean energy technologies, including solar, wind, biomass and fuel cells, which differ in the way that they are dependent on policy support:

> Our portfolio companies are active . . . in different areas and technologies, so this reduces the regulatory risk. (Venture capitalist D01)

While there seemed to be widespread support for the idea of diversifying portfolios across technologies among the funds that we interviewed, there were also some exceptions, that is, funds that were focusing on just a small subset of clean energy technologies. However, these more focused funds acknowledged the inherent higher level of (regulatory) risk that they were taking:

> Our fund concentrates on solar and wind. We make big bets because our investors want us to take the risks. (Venture capitalist C09)

Fund level, across countries

Another approach to diversification of regulatory risk is to invest in a portfolio of ventures in different countries. As clean energy policies still differ significantly from country to country, and also the timing of legislative decisions with regard to, for example, introducing or changing renewable energy support policies varies, having a portfolio of companies acting in different jurisdictions is a good hedge for regulatory risk:

> You can follow policy making from Japan to California and that goes back to the team and initial investment. You might have 3–4 countries where you are betting on CO_2 emissions policy in Europe and the United States (e.g., California). (Venture capitalist C11)

> Our portfolio companies are active in different countries . . . so this reduces the regulatory risk. (Venture capitalist D01)

Firm level, across technology

A similar distinction with regard to diversification across technologies versus countries can be made on the firm level. Of these two options, diversification across technologies on the firm level is more rare, especially in the case of early-stage ventures that tend to be focused on a single technology. In a later stage of firm development, diversification across technologies does become a possibility, for example in the case of photovoltaics companies acquiring solar thermal energy businesses, or wind energy project developers moving into biomass projects.

Firm level, across countries

The more common form of diversification on the firm level is cross-country diversification, or internationalization:

> Unless you are very comfortable about a particular legislation, you would probably shy away from investing in a company that is 100% dependent on policy in one country. (Venture capitalist D01)

Again, internationalization will typically occur in a later stage of company development. However, there are also examples of very early internationalization, as for example in the case of the VC-backed wave energy company Ocean Power Delivery, headquartered in Scotland, but selling first commercial products to Portugal due to the more favourable policy environment.

Further Observations on Regulatory Risk Management Strategies

Adaptation to policy changes

Interview partners highlighted the fact that a particularly important dimension of regulatory risk with regard to clean energy VC investments is the risk of *changes* in policy. While anticipating (or even preventing) policy changes may often be beyond a fund's (or firm's) control, investors pointed out that some firms may be better positioned than others to cope with these risks. Especially in the case of solar energy, which currently has high policy support levels in Germany, but where changes to this regulation might raise challenges to the financial performance of German solar companies, the ability of a firm's management to adapt to these changes may be very important:

> We can manage the policy, but we can't manage the changes in policy. . . . Also you need to have confidence in the venture's management team (that they can make the necessary changes in the company if policy changes). (Venture capitalist C11)

> This is the approach assuming that the regulatory risk will change over the period of time you are investing (e.g., it may change much less in the first year, but in years 2–5 you don't know how it will change). If the management team lowers cost, increasing efficiency in the technology (e.g., solar), you can win despite changes in regulatory issues. (Venture capitalist D06)

Relative importance of regulatory drivers versus market drivers

Another important aspect of regulatory risk management, particularly with regard to clean energies where demand for a venture's product is often driven by government incentives or regulations, is to find the right balance between government-driven demand and 'voluntary' customer demand. In other words, investors can manage regulatory risk by selecting firms whose product has a clear path to consumer adoption and whose success is therefore not 100 per cent dependent on policy:

> As for regulatory risk management, you hopefully made an investment where the policy is additive, but not the totality of what you are betting on. (Venture capitalist C11)

> Our investments do not rely on subsidy supports, or at least they rely very little on them. (Venture capitalist D11)

CONCLUSIONS

Government policies affect venture capital investment at various stages of the VC value chain. Previous literature has mainly focused on direct policies aimed at increasing the amount of capital available to venture capitalists in a particular country, or altering the risk-return equation for investors by, for example, providing tax incentives for venture capitalists. Our findings suggest that regulatory influences on VC investments are more multifaceted, and include policies that influence VC investors indirectly, for example by creating attractive markets for VC-backed companies. We also show that the relationship between regulation and VC investments is not a one-way street as the literature on government VC policies tends to suggest. Rather, we demonstrate that venture capitalists can (and do) also influence policies, and that there are ways for them to manage regulatory risk.

Our findings extend the literature on VC decision making by highlighting the importance of regulation as a risk factor in assessing investment opportunities. Much of the previous VC literature focuses on traditional forms of investment risk such as market and technology risks and neglects regulatory risk as a factor seemingly outside the scope of VC influence. Especially for a sector with obvious political influence as in the case of the energy industry, this narrow view on investment risk neglects important risk factors, but may also lead to missed opportunities. Our findings also link to the emerging discussion in entrepreneurship and VC literature about rationalist versus behavioural perspectives on decision making, in that we highlight the striking differences in venture capitalists' perceptions of regulatory risk. Energy policies that some actors seem to be seeing as a risk are perceived as an opportunity by others.

Our research makes an important contribution to the literature of risk management strategies by developing a conceptual framework for strategies of VC investors to manage regulatory risk. We distinguish active strategies for managing regulatory risk from passive ways of diversifying regulatory risk. Active risk management strategies can take two forms, inbound and outbound. Passive strategies can be applied at firm or at portfolio level, and diversification can be achieved across technologies or across countries. Apart from this conceptual contribution, we also demonstrate empirically that clean energy venture investors actually apply a range of different strategies at the same time to manage regulatory risk, from among the various forms of active and passive risk management that we discussed. Our typology of regulatory risk management strategies sheds light on the diversity of approaches, and allows for a systematic categorization of those strategies.

In a broader sense, this chapter contributes to the literature on non-market strategies of companies by extending the perspective from corporate political activity of large incumbent firms to the interplay between policy and small entrepreneurial firms. It also highlights the role that investors in those firms, particularly venture capitalists, play in mediating the firm–policy relationship.

LIMITATIONS AND FURTHER RESEARCH

The conceptual model developed from our exploratory research is based on a limited number of qualitative interviews with venture capitalists. Further research with a larger sample can help to assess the relative importance of the identified strategies. Investors were also the main source of information for our categorization of regulatory risk management strategies on the firm level. Surveying the management teams of entrepreneurial firms would be a valuable extension of our research and could help to add to the venture's perspective. Finally, a selected number of longitudinal case studies may be useful to assess the success of certain regulatory risk management strategies in coping with unexpected changes in the policy environment.

NOTES

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2. For a full version of the survey instrument, see Bürer (2007, Annex 1).

REFERENCES

Baum, J.A.C. and Silverman, B.S. (2004), 'Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups', *Journal of Business Venturing*, **19**, 411–36.

Baygan, G. and Freudenberg, M. (2000), 'The internationalisation of venture capital activity in OECD countries: implications for measurement and policy', OECD Science, Technology and Industry Working Papers, 2000/7, doi:10.1787/084236411045.

Bikhchandani, S., Hirshleifer, D. and Welch, I. (1992), 'A theory of fads, fashions, customs and cultural change as informational cascades', *Journal of Political Economy*, **100**, 992–1026.

Bikhchandani, S. and Sharma, S. (2001), 'Herd behavior in financial markets', *IMF Staff Papers*, **47** (3).

Black, B.S. and Gilson, R.J. (1998), 'Venture capital and the structure of capital markets: banks versus stock markets', *Journal of Financial Economics*, **47**, 243–77.

Bürer, M.J. (2007), 'Public policy and clean energy private equity investment', University of St. Gallen: PhD dissertation (forthcoming).

CEC (2004), *Status Report 2004: Energy End-use Efficiency and Electricity from Biomass, Wind and Photovoltaics and in The European Union*, August; Authors: Paolo Bertoldi, Thomas Huld, Niina Kautto, Harald Scholz, Ewan Dunlop, Arnulf Jäger-Waldau, Andrew Machirant, Marcel Suri; Editor: Arnulf Jäger-Waldau.

Chan, L.K.C. and Lakonishok, J. (2004), 'Value and growth investing: review and update', *Financial Analysts Journal*, **60** (1), 71–86.

Chiampou, G.F. and Kallett, J.L. (1989), 'Risk/return profile of venture capital', *Journal of Business Venturing*, **4**, 1–10.

Dubocage, E. and Rivaud-Danset, D. (2004), 'The development of venture capital in Europe: the role of public policy', in *Capital Market Development and the Economy*, Tokyo Club Papers, No. 16, 76–117, Tokyo Club Foundation for Global Studies, www.tcf.or.jp/data/20021203-04_Frederique_Sachwald__Dorothee_Rivaud-Danset.pdf.

Dyllick, T., Belz, F. and Schneidewind, U. (1997), *Ökologie und Wettbewerbsfähigkeit* (Environment and Competitiveness), Munich/Vienna: Carl Hanser and Zurich: Verlag Neue Zürcher Zeitung.

Eisenhardt, K.M. (1989), 'Building theories from case study research', *Academy of Management Review*, **14** (4), 532–50.

Froot, K., Scharfstein, D. and Stein, J. (1992), 'Herd on the street: informational efficiencies in a market with short-term speculation', *Journal of Finance*, **47**, 1461–84.

Glaser, B.G. and Strauss, A.L. (1967), *The Discovery of Grounded Theory*, Chicago: Aldine.

Gompers, P. (1995), 'Optimal investment, monitoring and the staging of venture capital', *Journal of Finance*, **50**, 1461–89.

Hellmann, T. (2004), 'IPOs, acquisitions and the use of convertible securities in venture capital', Working paper 1702, Stanford Graduate School of Business, January, http://strategy.sauder.ubc.ca/hellmann/pdfs/xit04.pdf.

Jeng, L.A. and Wells, P.C. (2000), 'The determinants of venture capital funding: evidence across countries', *Journal of Corporate Finance*, **6**, 241–89.

Jordan, J. and Kaas, K.P. (2002), 'Advertising in the mutual fund business: the role of judgmental heuristics in private investors' evaluation of risk and return', *Journal of Financial Services Marketing*, **7** (2), 129–40.

Kahneman, D. (2003), 'Maps of bounded rationality: psychology for behavioral economics', *American Economic Review*, **93** (5), 1449–75.

Kahneman, D. and Tversky, A. (1979), 'Prospect theory: an analysis of decisions under risk', *Econometrica*, **47** (2), 263–91.

Kaplan, S. and Strömberg, P. (2001a), 'Venture capitalists as principals: contracting, screening, and monitoring', *American Economic Review*, **91**, 426–30.

Kaplan, S. and Strömberg, P. (2001b), 'Financial contracting theory meets the real world: an empirical analysis of venture capital contracts', Working paper, University of Chicago, September.

Kasemir, B., Toth, F. and Masing, V. (2000), 'Climate policy, venture capital, and European integration', *Journal of Common Market Studies*, **38** (5), 891–903.

Kuemmerle, W. (2001), 'Comparing catalysts of change: evolution and institutional differences in the venture capital industries in the U.S., Japan and Germany', in Chesbrough, H. and Burgelman, R.A. (eds), *Comparative Studies of Technological Evolution*, Vol. 7, Amsterdam: Elsevier, 227–61.

Lakonishok, J., Shleifer, A. and Vishny, R.W. (1994), 'Contrarian investment, extrapolation, and risk', *Journal of Finance*, **49** (5), 1541–78.
Lange, J., Leleux, B. and Muzyka, D. (2004), 'New ventures and attitudes to risk: a multi-country empirical analysis', in Zahra, S. et al. (eds), *Frontiers of Entrepreneurship Research 2004*, Proceedings of the Twenty-Fourth Annual Entrepreneurship Research Conference, Babson Park, MA: Babson College.
Lerner, J. (1999), 'The government as venture capitalist: the long-run impact of the SBIR program', *Journal of Business*, **72** (3), 285–318.
Levesque, M. and Schade, C. (2005), 'Intuitive optimizing: experimental findings on time allocation decisions with newly formed ventures', *Journal of Business Venturing*, **20**, 313–42.
Liebreich, M. (2006), 'European energy investment trends', presentation at the European Energy Venture Fair, 11 September, Rüschlikon, Zurich (Switzerland), www.energyvcfair.com/download_06/session1_michael_liebreich.pdf.
LoGerfo, J., Parker, N. and Propper de Callejon, D. (2005), *Cleantech Venture Investing: Patterns and Performance*, March, Cleantech Venture Network LLC, http://cleantechnetwork.com/Publications/CleantechPatternsandPerformanceFlyer.pdf.
MacMillan, I.C., Zemann, L. and Subba Narasimha, P.N. (1987), 'Criteria distinguishing successful from unsuccessful ventures in the venture screening process', *Journal of Business Venturing*, **2** (2), 123–38.
McFadden, D. (2001), 'Economic choices', *American Economic Review*, **91** (3), 351–78.
McNamara, G. and Bromiley, P. (1999), 'Risk and return in organization decision making', *Academy of Management Journal*, **42** (3), 330–39.
Muzyka, D., Birley, S. and Leleux, B. (1996), 'Trade-offs in the investment decisions of European venture capitalists', *Journal of Business Venturing*, **11**, 273–87.
OECD (2004), 'Venture capital: trends and policy recommendations', Synthesis paper of country peer reviews on venture capital to analyse recent market trends and the policy framework in selected OECD countries, as part of the OECD project on Growth Follow-up: Micro-Policies for Growth and Productivity.
Rigau, A. (2002), 'The development of venture capital fundraising in Europe. Evidence across countries, prospects and policy issues', thesis for European Economic Studies, Economic Department, College of Europe, Bruges.
Riquelme, H. and Rickards, T. (1992), 'Hybrid conjoint analysis: an estimation probe in new venture decisions', *Journal of Business Venturing*, **7** (6), 505–18.
Samuelson, W. and Zeckhauser, R. (1988), 'Status quo bias in decision making', *Journal of Risk and Uncertainty*, **1** (1), 7–59.
Schneidewind, U. (1998), *Die Unternehmung als strukturpolitischer Akteur* (Firms as political actors), Marburg: Metropolis.
Shepherd, D.A. (1999), 'Venture capitalists' assessment of new venture survival', *Management Science*, **45** (5), 621–32.
Shepherd, D.A., Zacharakis, A. and Baron, R.A. (2003), 'VCs' decision processes: evidence suggesting more experience may not always be better', *Journal of Business Venturing*, **18**, 381–401.
Smolarski, J., Verick, H., Foxen, S. and Kut, C. (2005), 'Risk management in indian venture capital and private equity firms: a comparative study', *Thunderbird International Business Review*, **47** (4), July–August, 469–88.
Tyebjee, T.T. and Bruno, A.V. (1984), 'A model of venture capitalist investment activity', *Management Science*, **30** (9), 1051–66.

US EPA (1994), *Bridging The Valley of Death: Financing Technology for a Sustainable Future*, Prepared by the US Small Business Administration for the US Environmental Protection Agency, December.

Weber, C. and Dierkes, M. (2002), *Risikokapitalgeber in Deutschland – Strukturmerkmale, Entscheidungskriterien, Selbstverständnis* (Venture Capitalists in Germany – Characteristics, Decision Criteria, Self-Image), Berlin: edition sigma.

Wüstenhagen, R. and Bilharz, M. (2006), 'Green energy market development in Germany: effective public policy and emerging customer demand', *Energy Policy*, **34**, 1681–96.

Wüstenhagen, R. and Teppo, T. (2006), 'Do venture capitalists really invest in good industries? Risk-return perceptions and path dependence in the emerging European energy VC market', *International Journal of Technology Management*, **34** (1/2), 63–87.

Yin, R. (1994), *Case Study Research: Design and Methods*, 2nd edn, Beverly Hills, CA: Sage.

Zacharakis, A.L. and Shepherd, D.A. (2001), 'The nature of information and overconfidence on venture capitalists' decision making', *Journal of Business Venturing*, **16**, 311–32.

APPENDIX 12A SAMPLE QUESTION FROM THE QUESTIONNAIRE (BASIS FOR FIGURE 12.4)

Question 19: How often does your firm interact with the following?

	1× / quarter, or less	About 1×/ month	Every 1–2 weeks	2 × a week	Almost every day	N/A
Partners meeting with policy makers	O	O	O	O	O	O
Staff meeting with policy makers	O	O	O	O	O	O
Partners meeting with typical clean energy company	O	O	O	O	O	O
Staff meeting with typical clean energy company	O	O	O	O	O	O

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