A Sustainability and Eco-Innovation Framework for Manufacturing SMEs

In one volume

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Submitted for the Degree of Doctor of Philosophy

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November 2014

Declaration

I hereby declare that the work presented in this thesis is my own, except where duly acknowledged and that it has not been used to obtain a degree in this institute or elsewhere.

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ABSTRACT- A Sustainability and Eco-Innovation (SEco) Framework for Manufacturing Small and Medium Enterprises (SMEs)

Since the industrial revolution, manufacturing has been a major contributor to environmental damage, through pollution, the depletion of resources and the consumption of energy and the related burning of fossil fuels (IPCC, 2007). There is strong evidence that the situation will worsen, and there is a global call for urgent action to mitigate the accelerating damage (Füssel, et al., 2012; IPCC, 2014). Sustainable economic development needs to consider the impact of Small and Medium Enterprises (SMEs), which make up 99% of businesses in Europe (European Commission, 2008; Audretsch, et al., 2009). SMEs cumulatively cause 64% of total industrial pollution in Europe, and contribute approximately 60-70% of the total industrial waste (Constantinos, et al., 2010).

While large companies are showing improvements in environmental performance, the same is not true of SMEs. Only 24% of SMEs in Europe are currently acting to reduce their environmental impact (Constantinos, et al., 2010). SME owner-mangers do not have the time or resources to learn and apply sustainability principles, and are often not aware that their business operations have a negative impact. There are supports available, but many are not adequately designed for the majority of SMEs.

There is limited research in the area of SMEs and sustainability, and previous studies have not sufficiently considered the role of owner-managers. This research was carried out as part of a European FP7 project called *FutureSME; involving a* 26 partner consortium, 13 of which were manufacturing SMEs. This allowed access to SME owner-managers over four years. They contributed to the development, piloting and testing of SME-suitable tools and methodologies to improve sustainability maturity levels in manufacturing SMEs. In this study, 'Sustainability Maturity' is defined as '*the capability of an SME owner-manager to manage the environmental sustainability of a business, including sustainability practices, knowledge of how the business impacts the environment, and awareness of how sustainability can be of business benefit*'.

A Sustainability and Eco-Innovation Framework (SEco Framework) to support manufacturing SMEs was developed. It integrated existing methods, together with new ones, and aligned with an overall goal to guide and support SME owner-managers to incrementally improve the sustainability of their businesses. The Framework is a four-step process of (1) diagnosis, (2) identification of sustainability or eco-innovation opportunity projects, (3) selection and implementation of projects identified and (4) a review with the SME owner-manager. The process is supported by a comprehensive toolkit that can be easily applied in any small business. The study showed that the SEco Framework improved the sustainability maturity in SMEs, when it was tested in two small, Irish manufacturing companies.

The findings of the research identified that an initial SEco Pilot Framework, which was an online self-led methodology, did not engage SMEs, despite being designed for and approved by end-users. It led to the conclusion that the majority of SMEs need the assistance of an external advisor to help them get started, and guide them through a step-by-step process. One particular tool, the Sustainability Report, played a key role in the company's acceptance of the SEco Framework.

The two key research contributions include new insights into SMEs and a novel Sustainability and Eco-Innovation Framework for SMEs to enable change and advancement in sustainability maturity in manufacturing SMEs.

Publications associated with this research

Mitchell, S., Lalui, A., & Kearney, D. (2012). The FutureSME Framework for Transformation . InterTradeIreland, All-Island Innovation Programme, 2012 Annual Conference. Galway

Mitchell, S., Dimache, A., & O'Dowd, P. Roche, T. (2011). The Issue of waste in European Manufacturing SMEs. 13th International Waste Management and Landfill Symposium. Cagliari. (Awarded the Luigi Mendi award for "*Best Paper in the theme of waste policy and legislation*").

Dimache, A., Mitchell, S., & O'Dowd, P. (2011). Business Sustainability Methodology for European Manufacturing SMEs. 1st International Conference on Sustainable Intelligent Manufacturing. Leiria, Portugal.

Mitchell, S., (2011). European SMEs, eLearning and the Knowledge Economy, a Literature Review. Galway: Instiutes of Technology Institute (submitted as part of a post-gradute certificate in Research Practice).

Mitchell, S., O'Dowd, P., & Dimache, A. (2010). Environmental challenges and opportunities for European manufacturing SMEs. International Manufacturing Conference 27. Galway: GMIT.

Dimache, A., Mitchell, S., & O'Dowd, P. (2010). TRAPSS (Transition along the product-service system route) - a smart solution for manufacturing SMEs. International Manufacturing Conference 27. Galway: GMIT.

Dimache, A., Mitchell, S., O'Dowd, P., & Harvey, N. (2009) 'Future Industrial Models for SMEs'. Posterfest, Athlone Institute of Technology.

Foreword

This research was carried out as part of FutureSME project (www.futuresme.eu) funded by the European Commission under the Seventh Framework Programme (FP7). The primary aim of the project was to develop a set of tools and methodologies for manufacturing SMEs in Europe, which can enable them to adapt to the changing economic environment and lead them towards a sustainable business model.

The research in this thesis evolved through interdependent experiences on the FutureSME project and beyond the work carried out on the futureSME project. The researcher would like to acknowledge the research work carried out the futureSME consortium during the pilot toolkit development. Dr. Aurora Dimache worked in collaboration on the design and development of the individual tools of SEco Pilot Framework on the FutureSME research project team; she contributed to the design and build of many of the excel tools and eLearning modules, in particular the LCA, LCC and DfE tools. The PSS module was heavily based on her colleagues PhD thesis, "*A Decision Methodology to Support the Transition along the Product-Service System Continuum*" (Dimache, 2009).

Quotation

Business is the force of change. Business is essential to solving the climate crisis, because this is what business is best at: innovating, changing, addressing risks, searching for opportunities. There is no more vital task."

Richard Branson, entrepreneur. (Reynolds, 2012)

Acknowledgements

My biggest thank you goes to Fearghal, who was there for the good times and the bad times and supported me through it all. I could not have done this without you. You are amazing.

Thanks to Mary and Svetlana for being such great friends, for all the lunches and always making me laugh even when you both had your own struggles. Thanks to Jackie for always listening, and giving me a new perspective and encouraging me to keep going. Thanks to Jean for all the support, inspiration, collegiality, talks and thoughts about designing a more sustainable world. Thanks to Simrn for sharing PhD moments together, and keeping me sane. Thanks to Cathy for always saying the right thing at the right time, and understanding me. Thanks to Nially and Jason for listening to me and housing me on many many occasions. Thanks to Ruaidhrí for the coffees, the crepes, the chats, and the beers. Thanks to Attracta for sharing your amazing depth of knowledge, and perspective, helping me understand that I "need to give birth to each sentence" and for bringing colour to the world. Thanks to Siobhán for your amazing philosophical mind, having a laugh and joining me in trying to solve the world's problems while we were supposed to be working on our PhD. Thanks to Angela and all the Caffreys of Breaghmore who have also been so great. Thanks to Sheila for inviting me to share my research findings in the Kemmy Business School in UL, and chats and guidance on Corporate Social Responsibility. Thanks to all my proofreaders, in particular at the last stages from Gerry and Maebh.

Thanks to all my family for putting up with my PhD 'excuses' for not being at gatherings on many occasions. Thanks to mam and dad for the nights in Loughrea and that the bacon and cabbage was always magically there for me. Thanks to Verona and Ciara for being the best sisters ever. Believe it or not it's done and you will never have to hear about it again! I promise I will never take on anything like this again!

Thanks to all on the FutureSME project. The team in Stratchclyde University, and Chalmers in particular at the early stages. A special thanks to Aylin, Catherine, Ian and Marcus for PhD advice, and all the SMEs that participated at various stages of the way. Thanks to all the SME owner-managers who participated in the development and testing throughout the project. Your frankness was much appreciated and this project could not have happened without it!

Thanks to all my amazing new colleagues in Business in the Community for all your support and encouragement in the final year.

Thanks to my colleagues in GMIT. Thanks to Aurora for sharing the room with no windows for so long, being a superwhizz on excel and an expert on LCAs and PSSs. Thanks to my supervisors Paul and Tom for expert guidance throughout the years. Your input kept me on my toes.

A special dedication to my baby in my belly – you gave me the inspiration to keep going and most importantly to finish a few months before your arrival.

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Table of Abbreviations

Acronym	Full Term
BATs	Best Available Technologies
BER	Building Energy Rating
CGGP	Cleaner Greener Production Plan
CSR	Corporate Social Responsibility
DfE	Design for Environment
ECAP	Environmental Compliance Assistance Programme
EEE	Electrical and Electronic Equipment
EEN	Enterprise Europe Network
EI	Enterprise Ireland
EMAS	Eco-Management and Audit System
EMS	Environmental Management System
EPA	Environmental Protection Agency
ETAP	Environmental Technologies Action Plan
ETS	Emissions Trading Scheme
FDI	Foreign Direct Investment
FS	Functional Specification
GDP	Gross Domestic Product
GMIT	Galway-Mayo Institute of Technology
GPP	Green Public Procurement
IDA	Industrial Development Authority
IOTI	Institutes of Technology Ireland
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LCM	Life Cycle Management
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PSS	Product Service Systems
REACH	Registration, Evaluation, Authorisation and Restriction of Chemical substances
SEAI	Sustainable Energy Authority of Ireland
SEco	Sustainability and Eco-Innovation (Framework)
SETAC	Society of Environmental Toxicology and Chemistry
SME	Small and Medium Enterprise
SWOT	Strengths, Weaknesses, Opportunities and Threats
UN	United Nations
UNEP	United Nations Environment Programme
UNFCC	UN Framework Convention on Climate Change
URS	User Requirements Specification
VOC	Volatile Organic Compounds
WWF	World Wildlife Fund

1 Introduction

1.1 Background

1.2 Research Environment

1.3 Research Objectives

1.4 Research Questions

1.5 Contribution of the Research

1.6 Thesis Structure

1.7 Summary of Chapter 1

1.1 Background

Protection of our environment is considered one of the most important issues facing mankind (IPCC, 2007; European Commission, 2009-b; Reddy & Assenza, 2009; United Nations, 2010). The critical need for industry to address global environmental issues is well documented (IPCC, 2007; Reddy & Assenza, 2009). Public discourse frequently cites the damaging activities of large organisations but smaller organisations are rarely, if ever, featured. This is despite the fact that Small and Medium Enterprises (SMEs) are large contributors to environmental damage, causing 64% of total industrial pollution, and contributing approximately 60-70% of the total industrial waste in the EU (Constantinos, et al., 2010).

SMEs play an important role in our economy and society (Nooteboom, 1988). Not only do they provide many of our essential goods and services, but also they make up 99% of all businesses operating in the EU (European Commission, 2005-c; Madrid-Guijarro, et al., 2009). SMEs are also responsible for 67% of total EU employment and contribute 85% to EU Gross Domestic Product (Ayyagari, et al., 2003; European Commission, 2005-c; Audretsch, et al., 2009). SMEs in Ireland represent 99% of all enterprises and have suffered more than larger enterprises since the global financial crisis in 2008; the Irish SME sector has experienced a total loss of 128,000 jobs since 2008, but it continues to provide 67% of total employment, which is aligned with the broader EU metrics (European Commission, 2011).

When compared with their larger counterparts, SMEs encounter many difficulties, which are predominantly related to finance and limited resources (time, capacity and human resources) (Jones & Tilley, 2003). For instance, the administrative burden of an SME is (relatively) ten times greater than that of a larger organisation. They struggle in accessing appropriate information and often lack the necessary skills to be competitive in a global marketplace (Boswell, 1973; Nooteboom, 1988; Edmunds & Morris, 2000; Hassid, 2002; Eppler & Mengis, 2002; Fliess & Busquets, 2006; Hunt, 2007; Aragón-Correa, et al., 2008; European Commission, 2008-c; Audretsch, et al., 2009) (Wooi & Zailani, 2010; Predescu, et al., 2010; Ma & Lin, 2010).

Although SMEs contribute significantly to environmental damage, most managers are not aware that their business operations do so (Hillary, 2000; NetRegs, 2010). Few are acting to reduce their impact (Constantinos, et al., 2010) and supports designed for SMEs do not meet their needs (Mitchell, et al., 2010; Arbačiauskas, et al., 2010; Romero-Martinez, et al., 2010).

Moreover, SMEs are missing out on benefits that good environmental management can bring to their businesses (Jones & Tilley, 2003; Mitchell, et al., 2010). The links between better business performance and sustainability is well documented (Côté, et al., 2006; Carrillo-Hermosilla, et al., 2010; Lin, et al., 2011). However, many SME businesses fail to take advantage of these. In contrast, larger enterprises have more developed sustainability practices than smaller ones due mainly to the availability of specialised environmental management roles within larger firms (Côté, et al., 2006; Fernández-Viñé, et al., 2010). To promote sustainable economic development, the role of manufacturing SMEs needs to be considered (Hillary, 2004) and supports should be developed to meet the needs of the wider SME community, to include small and micro companies.

The literature on effective solutions to support sustainability in SMEs is sparse. Researchers need to look more closely at small and micro firms in a regional and sector-specific manner which considers

the view of the owner-managers (Hillary, 2004). Gaps remain in the research to go beyond '*easy-to-reach' SMEs*[1]. This research project aims to move towards a solution for this group.

Supports and toolkits from various agencies have been developed for SMEs and manufacturing industries, such as the European Commission, the OECD and on a national level. The Sustainability and Eco-Innovation (SEco) Framework proposed in this document addresses the gaps that are present in the supports that are currently available. It adopts a systems view of SMEs and designs a solution with them in mind from the outset.

1.2 Research Environment

This research was carried out as part of a four year multidisciplinary project, FutureSME (www.futuresme.eu), funded by the European Union under the Seventh Framework Programme (FP7) and led by Professor Umit Bititci, University of Strathclyde. The FutureSME project spanned nine European countries, with 26 partner organisations. The primary aim of the project was to develop a set of tools and methodologies for manufacturing SMEs in Europe to help them to adapt to the changing economic environment and lead them towards sustainable business models.

The researcher furthered her learning and experience through participation in all phases of the FutureSME project. Working as a postgraduate researcher in Galway-Mayo Institute of Technology (GMIT), she was involved in many project activities, particularly: the research and development of an environmental toolset; as a member of the futureSME Technology Board contributing to monthly meetings; attendance at bi-annual all-partner meetings; and dissemination events for varied audiences (for more details on the FutureSME project see Appendix A). This created the enabling environment to carry out her research (see Figure 1.1 for an outline of the broader FutureSME project).

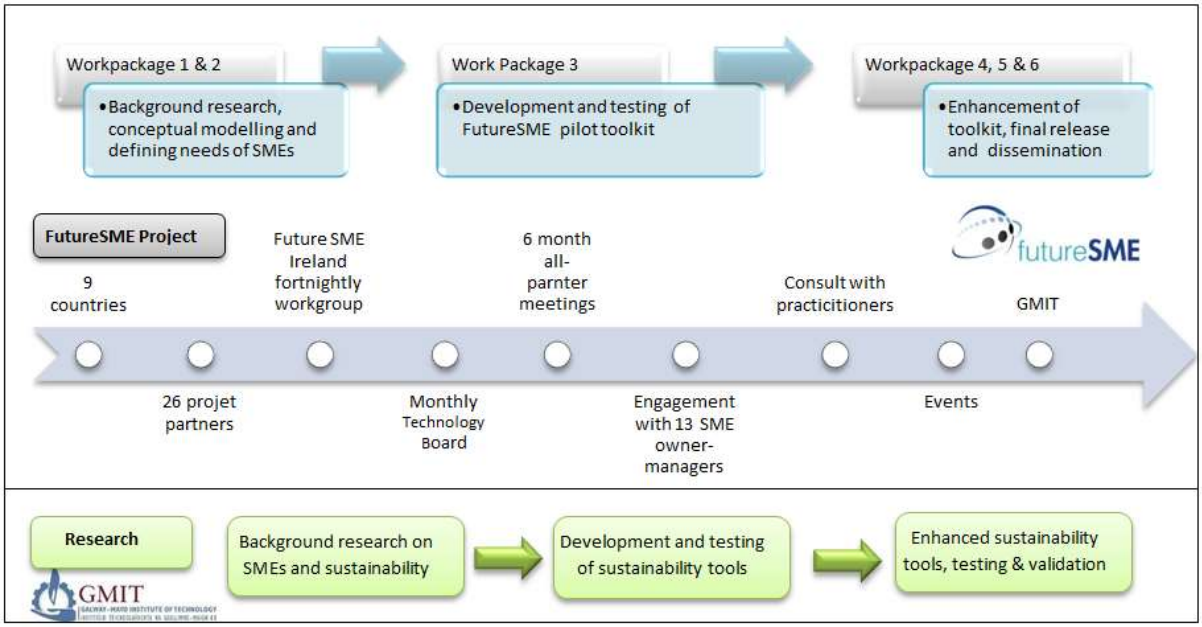


Figure 1.1: Research enabling environment, in the context of the FutureSME project

The theoretical approach chosen by the researcher was a *critical realist* epistemology with a *systems view* and an *action research* approach. To begin with, the researcher focused mainly on the

[1] "easy-to-reach" includes SMEs businesses offering green products or services, whose owners have a personal interest in environmental management and/or are well established and have

development of a set of simple SME-friendly engineering tools and methodologies to allow the owner-managers to improve their environmental management performance unaided. Through the involvement of research conducted in this area and the wider research project (involving over one hundred manufacturing SMEs in total), the researcher developed deeper insights into the practices of SME owner-managers. For instance, the mere existence and free availability of tools and supports (in any area from strategy to operations) did not lead to their use and application by the SME owner-managers. This was despite the fact that these tools were designed for SMEs. One of the main findings from the overall FutureSME project was that an SME needs to develop capabilities to adapt to the ever-changing business environment (Bititci, et al., 2010). This finding promotes a holistic view of the company when trying to improve a company's performance and the consideration of the systems within which SMEs are embedded.

A *Sustainability and Eco-Innovation (SEco) Framework* for manufacturing SMEs was developed resulting from consultations with the owners and managers of 26 SMEs in total, 13 of which were FutureSME partners and were consulted with throughout. The researcher also engaged with representatives from 27 different organisations including consultancies, support organisations, academia and the European Commission during the research process (see Appendix B for a list SMEs and other organisations involved).

To investigate sustainability and SMEs, it is important to understand the system in which SMEs operate and then to look for the leverage required to change the system towards better environmental performance. SMEs have common structures and characteristics that produce typical behaviours (discussed in Chapter 2) and research shows that sustainability performance improvement is possible within SMEs (Klewitz & Hansen, 2011; Seidel, 2011). This study focused specifically at one segment of SME, a '*manufacturing SME*'. For the purposes of this study, a '*manufacturing SME'* is defined as any SME company involved in manufacturing, including industrial production activities from design, to manufacturing, to end-of life (e.g. reuse, repair, remanufacturing and recycling and after-sales services). The tools and methodologies needed to support an improvement in manufacturing SMEs are the subject within the context of sustainability, of this investigation. As a result, the researcher positioned her research topic in the area of sustainability and manufacturing SMEs as depicted below in Figure 1.2.

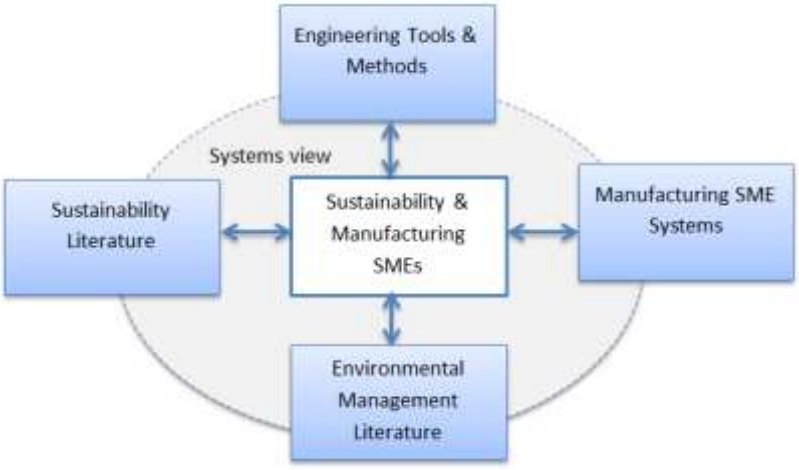


Figure 1.2: Locating SME Sustainability within a systems perspective as a subject

1.3 Research Objectives

The initial investigation into the relevant literature highlights the factors contributing to the research problem, *the slow uptake of sustainability practices in SMEs.* These factors include a lack of awareness, a lack of knowledge, a shortage of resources, negative perception, insufficient support and limited research (discussed in more detail in the literature review, Chapter 2).

In light of the identified gaps, the key objective of this study is to deepen the understanding of, and to develop new insights into the uptake and practices of sustainability and eco-innovation in manufacturing SMEs. It will explore sustainability practices in SMEs and develop solutions that will lead to improved '*sustainability maturity*' in SMEs. This is defined in this study as '*the capability of an SME owner-manager to manage the environmental sustainability of a business, including sustainability practices, knowledge of how the business impacts the environment and awareness of how sustainability can be of business benefit*'. To achieve this, a set of appropriate engineering tools and methodologies are proposed, embedded within a framework to support the complex requirements and needs of SMEs and tested within the context of manufacturing SMEs.

The research integrates past research and literature with current mechanisms used to support SMEs to improve their sustainability performance. It links the theoretical foundation of sustainability principles with practices in manufacturing SMEs and explores the viewpoints of SME owner-managers in implementing such principles and practices. It contributes to the sparse, but growing, body of knowledge in the area.

1.4 Research Questions

To address the problem, the researcher poses three critical research questions:

Research Question 1 *What factors influence positive environmental behaviour in manufacturing SMEs and why?* This broad research question aims to form the theoretical foundation and the basis for overcoming the barriers that are preventing SMEs from adopting sustainability principles.

Research Question 2 *What engineering solutions are needed to create sustainability- and eco-innovation-supports that meet the needs of manufacturing SMEs?* The goal of this question is to comprehend the appropriate suite of tools necessary and explore what makes tools suitable or not to the needs of SMEs.

Research Question 3 How w*ill the supports affect the environmental sustainability maturity in the firm?* This research question aims to shed light on whether the solutions developed effected any change and what part of the overall process had a positive (or negative) effect.

1.5 Contribution of the Research

This research contributes to knowledge in the area of SMEs and sustainability by addressing the factors causative to the research problem and by answering the research questions.

The research contribution is:

- The development of a novel Framework for SMEs:
    - The Sustainability and Eco-Innovation (SEco) Framework is a methodology for manufacturing SMEs that advances sustainability maturity by guiding the SME owner-manager through a 4-step process.

- New insights into SMEs including the main barriers to sustainability, SME owner-manager behaviour, sustainability maturity and how to improve it:
    - derivation of the headline issues and the barriers SMEs face in relation to sustainability;
    - derivation of the design criteria for tools appropriate for European/Irish manufacturing SMEs;
    - evidence that a self-led framework is not sufficient - SMEs need an advisor to guide them;
    - recommendations on how best to engage with SME owner-managers.

These contributions are discussed in more detail in Chapter 7 Conclusions.

1.6 Thesis structure

This thesis is structured in seven chapters. Each chapter begins with a brief introduction to remind the reader what the section aims to accomplish and its relevance to the topic under investigation. The end of each chapter provides a summary to review critical messages emerging. A brief synopsis of each chapter is provided below (see Figure 1.3).

Chapter 1: Introduction This chapter introduces the reader to the broad context for the research; the research questions, the overall objective, its expected contribution and the thesis structure.

Chapter 2: Literature Review This chapter outlines the previous literature pertaining to the primary theme, sustainability and SMEs, spanning academic sources as well as the most recent European Commission and government research and policies. This chapter intends to clarify the urgent need for environmental change and the business case for sustainability. Furthermore, it illustrates that SMEs lag behind larger organisations in environmental performance despite the supports available to them. This chapter also documents and analyses the tools and methodologies that have been identified as best practice to manage sustainability within organisations.

Chapter 3: Research Methodology This chapter presents the research design and discusses the research methods chosen. It outlines the research paradigms through to the collection and measurement of the data. The researcher discusses the appropriateness of a mixed methods approach to accumulate the various data, with testing case studies being the instrument used for validating the framework.

Chapter 4: Development of the SEco Pilot Framework This chapter describes the development of the Sustainability & Eco-Innovation (SEco) Pilot Framework. It takes SME characteristics into consideration and aims to overcome the barriers faced in adopting sustainability practices (as highlighted in chapter 2). The development maps user-needs and specifications, leading to a pilot framework to equip SME owner-managers with a set of tools and methodologies appropriate to their requirements. Testing of the individual SEco Pilot Framework and potential gaps are identified.

Chapter 5: The enhanced SEco Framework. This chapter describes the enhanced SEco pilot Framework by addressing the gaps identified in Chapter 4. It examines the literature on maturity frameworks in relation to sustainability. The resulting SEco Framework is a four-step iterative guided process which assesses the SME, explores the opportunities available to them and leads to actions and improvements in sustainability maturity.

Chapter 6: **Test and validation of the SEco Framework** This chapter documents two testing case studies of the SEco Framework implementation. It details how the Framework is applied in practice. It confirms that the process works and how it addresses the barriers to sustainability in SMEs through a systems analysis of the test companies, and the application of a validation framework.

Chapter 7: Conclusions In this chapter, the research objectives are revisited and answers to the research questions are proposed. The key findings are revealed and the similarities with and differences from previous and current research are highlighted, and limitations of the research stated. The significance of the work carried out towards improving sustainability practices, its implications for SME research, learning, policy and practice are then highlighted. This chapter concludes with a condensed insight emerging in the context of the manufacturing SME and the role it plays in overall sustainability improvements.

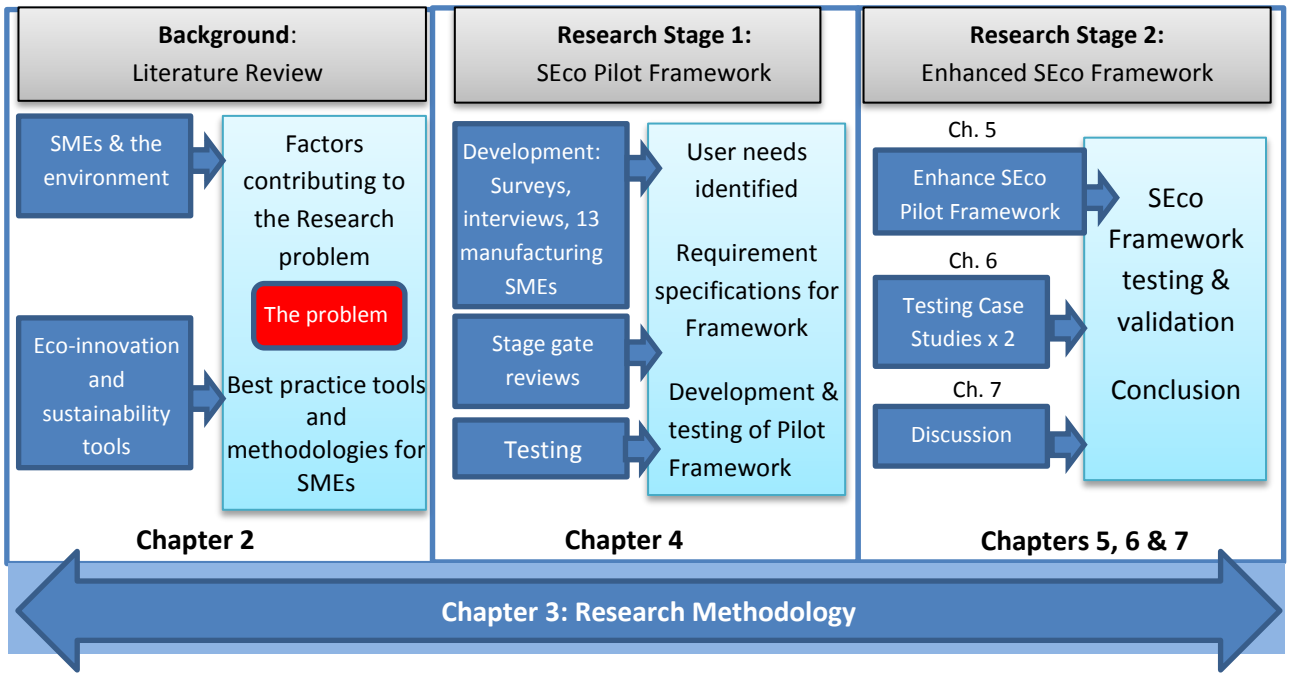


Figure 1.3: Thesis Structure

1.7 Summary of Chapter 1

This chapter introduced the research topic and set out the motivation for the research. It described the context in which it was undertaken and outlined the thesis structure.

This research will now address the research questions identified in this chapter by identifying and discussing the factors contributing to the research problem.

The next chapter will provide a widespread review of the literature pertaining to the practices and concerns on the research area, that is, sustainability in manufacturing SMEs and the use of engineering tools to support sustainability and eco-innovation.

2 Literature Review

2.1 Introduction

2.2 The Environment in Crisis

2.3. Small and Medium Enterprises (SMEs)

2.4 The Business Case for Sustainability

2.5 The Research Problem

2.6 Sustainability and Eco-Innovation Solutions

2.7 Life-Cycle Management (LCM) tools

2.8 Design for Environment (DfE) Strategies and Methods

2.9 Environmental Management Systems (EMS)

2.10 Sustainability Reporting

2.11 Product Services Systems (PSS)

2.12 Auditing Tools

2.13 Legislation Assistance

2.14 Eco-innovation and Sustainability Training

2.15 Measuring Sustainability - Definition of Sustainability Maturity

2.16 Conclusions of the Literature Review

2.1 Introduction

This chapter presents a synthesis of the literature on SMEs, the environment, and where they intersect (see Figure 2.1).

Firstly, the literature review presents the global environmental threats caused by the impact of industrial activity. It explores the characteristics of SMEs, their importance to the economy and society, as well as their impact on the environment. It examines the difficulties that SMEs experience compared to their larger counterparts and the reasons why many SMEs do not apply good environmental practices. It highlights the opportunities that they can avail of when environmental issues are considered and incorporated into their businesses.

The research problem is defined and the factors contributing to the problem are outlined.

The chapter then reviews the tools, methodologies and frameworks for environmental management and conducts an analysis to ensure suitability to the SME context. Sustainability Maturity is introduced as measure of sustainability.

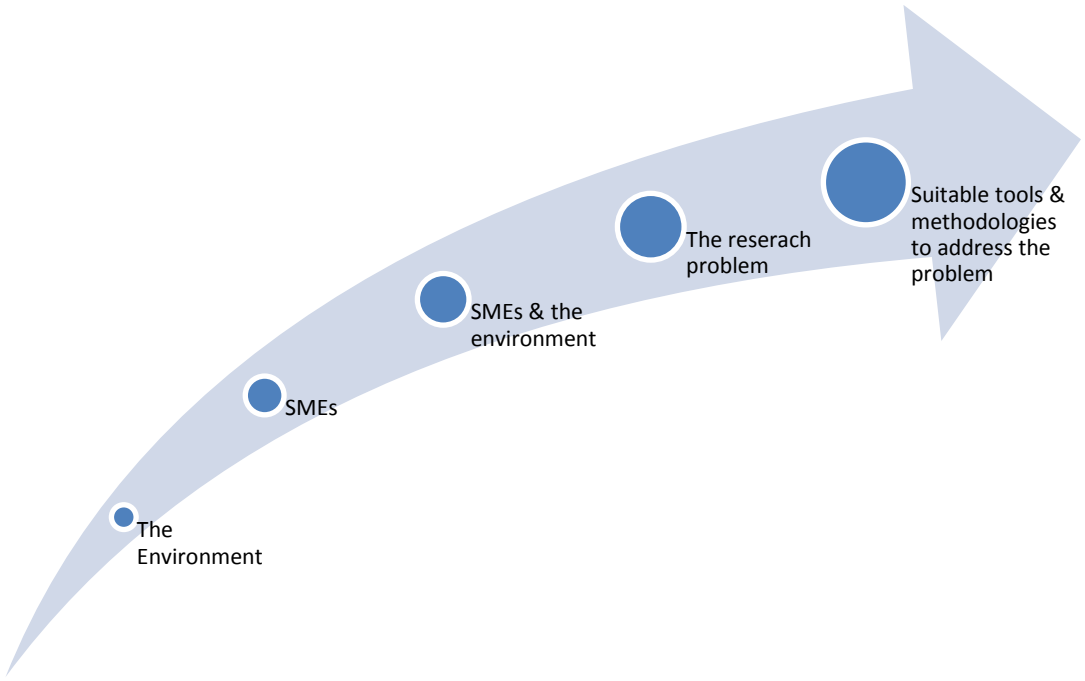


Figure 2.1: Chapter 2 outline

2.2 The Environment in Crisis

Preservation of our environment is imperative to the future of life on our planet and is one of the most important issues facing mankind (IPCC, 2007; Braungart & McDonough, 2009; European Commission, 2009-b; United Nations, 2010)[1]. Environmental damage and the unsustainable use of earth's resources affects the security and price of our food, the availability of clean water, our health and the eco-systems on which we all depend (Beg, et al., 2002; IPCC, 2007; Heltberg, et al., 2009). Scientific evidence points toward human influence, caused by mass production and industrialisation, being responsible for these damaging trends; and in particular since the mid-20th century (IPCC, 2014). The consequential effect of climate change is evident in events such as the increased occurrence of hurricanes, thinning glaciers and melting polar icecaps (IPCC, 2007). The most recent report from the IPPC presents strong evidence that the situation is predicted to worsen, and it is calling for urgent action to mitigate the damage (IPCC, 2014).

Environmental issues also affect the fabric of our society. Our planet does not have enough resources for us to continue living a consumerist lifestyle (Ryan, 2009). Mass industrialisation and production of goods for human consumption cause a significant effect on the planet (IPCC, 2007; IPCC, 2014). Environmental damage is escalating the levels of social inequalities worldwide and is resulting in the exploitation of people, land and eco-systems in the less powerful, poorer nations (Beg, et al., 2002; Ryan, 2009). For global development to be sustainable, humanity needs "*to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs"* (World Commission on Environment and Development, 1987). Global economies continue to focus on a growth model, yet the earth's capacity is already overextended (Meadows, et al., 2012). This continued capability of the human race to meet the needs of future generations is under threat (Willard, 2012). The current rate of depletion of the earth's natural resources is unsustainable (Leonard, 2010; European Environment Agency, 2010; Meadows, et al., 2012; IPCC, 2014). The more we consume, the bigger the resulting impact on the planet's future resource security (Beg, et al., 2002). We need materials to function as a society, but in the last 30 years alone we have used up one third of the earth's natural resources (Leonard, 2010; European Environment Agency, 2010).

Concerted responses to limit and reverse the damaging trends of environmental degradation have come mainly from the UN and Europe. The UN Framework Convention on Climate Change (UNFCCC) was established at the *Rio Summit* in 1992. This led to the first legally binding commitment by industrialised nations to reduce Greenhouse Gas (GHG) emissions: in 1997 the *Kyoto Protocol* set targets to reduce these by at least 5% below 1990 levels (Sampei & Aoyagi-Usui, 2009). The UNFCCC *Copenhagen Accord* in 2009 failed in its call for developing countries to significantly reduce their emissions (UNFCCC, 2009). However, the most recent convention, *Rio +20*, brought life-cycle management of manufactured products to the fore (UNEP, 2012-b). Meanwhile in Europe, the *EU2020* agreement has been put in place for 80% of EU member countries to cut their emissions by a more stringent 20% of 1990 levels by 2020, which aims to address the majority of the environmental issues in the region (Beg, et al., 2002; European Union, 2010).

[1] The Intergovernmental Panel on Climate Change (IPCC), created by the United Nations Environment Programme (UNEP), is the principal body worldwide on climate change evaluation and dissemination.

Despite the consensus on the damage that human activity is causing to our planet, our use of resources (particularly fossil fuel) is intensifying. The International Energy Agency (IEA) estimates the use of coal may increase by 60% (or more) in the next 20 years because of population growth (Warr & Orsato, 2008).

Since the industrial revolution, manufacturing has been a major contributor to the environmental crisis through the depletion of resources and the over-dependence on energy (particularly fossil fuels), the generation of waste, emissions to air, soil and water sources (IPCC, 2007). The issue is particularly relevant to manufacturing, as it consumes large amounts of energy and raw materials (Heltberg, et al., 2009; Williamson, et al., 2006). The scarcity of resources in manufacturing is reflected in the growing value of waste as a primary raw material (Braungart & McDonough, 2009; Rx3, 2011). *"The use of material resources and the generation of waste are two sides of the same coin"*, as the more we consume, the more waste we produce (European Environment Agency, 2010). We are recycling more than ever before, and it is possible that this waste that may end up as new products (European Environment Agency, 2010). However, recycling activities can be just as damaging to the environment, or even more so than the original materials, because the materials were not originally designed for this purpose (Braungart & McDonough, 2009; European Environment Agency, 2010).

Industry must play a central role in addressing the environmental crisis through better practices and resource efficiencies. To reverse the effects of climate change, businesses need to reduce their emissions by 50-80%[2] by 2050 (Hoskin, 2011; IPCC, 2007). Industrialised nations account for 70% of the damaging effects (IPCC, 2014). Government policies need to address a number of related issues to facilitate the change. This includes the allocation of rights related to emissions; controlling the negative impact on the economy; the provision of suitable information to allow businesses and people to address their consumption levels and the minimisation of the impact to society as a whole (European Commission, 2009-c). The current action plan by European Union Sustainable Development Strategy (EU SDS) aims to prevent and reduce environmental pollution and promote sustainable consumption and production (Nash, 2008).

There is an on-going debate on the cost of curbing environmental damage and increasing sustainability (Hart, 2002; Paltsev, et al., 2009). However, there is a growing acceptance by economists that environmental sustainability and economic growth are inter-dependent (Bawden, 2013). The World Economic Forum believes that 'greening' of the global economy is the only way to satisfy the needs of our growing population, drive development and wellbeing, while simultaneously decreasing greenhouse gas emissions and improving the productivity of natural resources (Bawden, 2013).

In Ireland, radical changes and rigorous controls are necessary to limit damaging trends. Industry-related emissions in Ireland decreased by over 10% in 2011 (EPA, 2012-b). However, this reduction can be attributed to the economic recession and reduction in commercial activity (EPA, 2012-b). In 2007, at the height of Ireland's economic boom, 53 tonnes of natural resources per inhabitant were being consumed here, compared to 16 tonnes for the average EU citizen (European Environment

[2] Measured from levels industry produced in 2000

Agency, 2010). The *EU15*[3] countries are collectively predicted to meet targets set by *Kyoto* (European Commission, 2012). Emissions from Irish industries are rising and are set to increase by 4.1%, even if current measures are implemented. However, Ireland will meet its *Kyoto* reduction targets by purchasing carbon credits and/or allowances from the European Union's Emissions Trading Scheme[4] (EPA, 2012-d). Ireland has also committed to the more stringent EC targets to reduce emissions by 20% by 2020 (Curtin & Hanrahan, 2012). Ireland is predicted to break this agreement (EPA, 2012-c).

2.3 Small and Medium Enterprises (SMES)

Small and Medium Enterprises (SMEs) are defined as independent businesses involved in the delivery of goods and services in a wide variety of industries and sectors (Hillary, 2000; Ayyagari, et al., 2003). The term "*SME*" is used to group together businesses based on their size. This is measured financially and/or by the number of people employed in the business (Hillary, 2000; Ayyagari, et al., 2003; European Commission, 2005-a). The definition varies from country to country. For example, the maximum headcount for an SME in Mexico is 100, whereas in Denmark it is 500 employees (Hillary, 2000).

For the purpose of this document, the EC definition is applied i.e. for a company to qualify as an SME it must have less than 250 employees. SMEs include subsets of *micro*, *small* and *medium* sized enterprises (see Figure 2.2). A *micro* enterprise is categorised by the headcount being less than 10, and the annual turnover being no more than €2million. A *small* enterprise has fewer than 50 employees, or no more than a €10 million turnover or balance sheet figure. A *medium* enterprise has between 50 and 250 employees, whose turnover is no more than €50 million or a balance sheet figure not exceeding €43 million (European Commission, 2005-a). In fact, the majority of SMEs in Europe fall into the *micro* or *small* category; less than 1% of SMEs are medium sized (Daddia, et al., 2010).

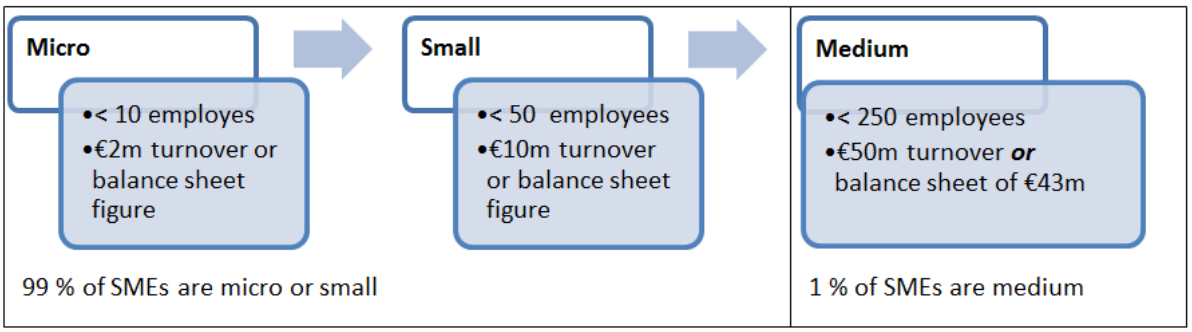


Figure 2.2: SME definition defined by headcount and turnover (European Commission, 2005-a)

SMEs are *'the backbone of Europe's economy'* and the *'key to its competitiveness'* (European Commission, 2005-b). There is widespread recognition of the importance of incentivising industry, entrepreneurship and nurturing small businesses (European Commission, 2013-c; European

[3] The EU15 are the original EU countries that signed up to the Kyoto Protocol which includes Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, Sweden, United Kingdom.

[4] The Europe's Emissions Trading Scheme (EU ETS) is a mechanism within the European Union which works on a "Cap and Trade" system for greenhouse gas emissions. Its aim is to reduce emissions through financial trading of these allowances and credits (European Commission, 2013-d).

Commission, 2005-a). SMEs are good innovators and play an ever-increasing role in commercial activity (Madrid-Guijarro, et al., 2009; Predescu, et al., 2010; de Kok, et al., 2011). The 23 million SMEs that operate within the EU play a vital economic and social role, acting as incubators of entrepreneurial culture and providing 100 million jobs (European Commission, 2005-c). In Europe, SMEs make up 99% of the millions of businesses that are operating within the member countries, and account for 67% of total employment (de Kok, et al., 2011; Audretsch, et al., 2009). The employment that an SME provides to its employees may not allow for significant career advancement. However, the diverse set of skills required to work in an SME is good for job quality and satisfaction (Nooteboom, 1988).

In recognition of their importance, industrial policy in the EC has become more centred on SMEs in recent years. SMEs need to be supported to expand into new markets, increase revenue and create more employment to maintain their contribution to the economy (Predescu, et al., 2010). The importance of SMEs is generally measured by their contribution to Gross Domestic Product[5] (GDP) and employment, which varies across countries and regions (Ayyagari, et al., 2003; European Commission, 2003-a). For example, SMEs in Belarus and Ukraine contribute less than 5% of the formal economy to GDP, compared to 80% in Chile and Thailand. In Europe, the GDP contribution from SMEs averages 58% overall, but can range from 9% in Switzerland to 80% in Greece (Ayyagari, et al., 2003). . Ireland's 230,000 SMEs provide jobs for more than 900,000 people, are dominant in Irish life in towns, cities and rural areas and generate around €10 billion to the Exchequer annually as they also represent 99% of all businesses (McHugh, 2010).

2.3.1 Characteristics of SMEs

The numerical definition of an SME is used and accepted widely. Numbers are useful for the standardisation of data collection within the EU, but they do not give much insight into the characteristics or diversity of SMEs (Nooteboom, 1988; Hillary, 2000). SMEs are not a homogenous group. The standardised description can obscure their diverse characteristics. Hillary (2000) believes that there is no single correct definition of an SME and that "*a more sensitive method needs to be developed*". She suggests that SMEs should be defined more by their sub-groups, *micro*, *small* and *medium*, or by their sector (Hillary, 2000). This research is focused specifically on one sub-group of "*manufacturing SMEs*".

The literature endeavours to characterise SMEs by comparing them to larger enterprises. Some common SME features emerge (but may not be present in all SMEs) - summarised in Table 2.1.

[5] GDP is defined as the total market value of the goods and services produced by a nation's economy during a specific period of time. It includes all final goods and services—that is, those that are produced by the economic resources located in that nation regardless of their ownership and that are not resold in any form (Britannica, 2011).

SME Characteristic	Details	Literature Source
The owner-manager controls the strategy	The owner-manager has the most significant influence on the strategic direction of the enterprise. Strategy is less formal and fewer procedures are in place to develop and communicate strategic developments.	(Mandl & Dorr, 2005; Seidel, et al., 2009; Ates & Bititici, 2009)
Simple management structure	There is no highly structured management hierarchy present in an SME. The owner or a small team, who are its major decision makers, usually manages the business.	(Ricketts Gaskill, et al., 1993; Storey, 2000; Hillary, 2000; Ayyagari, et al., 2003; European Commission, 2005-a; Storey, 2000)
Personalised	An SME is a wholly independent enterprise that is privately owned and managed in a personalised way rather than engaging in corporate structures and procedures.	(Hillary, 2000; Ayyagari, et al., 2003; European Commission, 2005-c)
Independence seeking	The owner-manager has chosen to set up a business to become his or her own boss rather than being primarily motivated by profit.	(Nooteboom, 1988; Hillary, 2000)
Entrepreneurial	An entrepreneur has set up the business. In particular, first generation business owners are entrepreneurial and prone to risk taking. This can lead to SMEs that are more intensely motivated to perform tasks or goals than larger companies.	(Nooteboom, 1988; Ricketts Gaskill, et al., 1993; Storey, 2000)
Small market share	SMEs typically have a small market share in the sector in which they operate.	(Hillary, 2000)
Self-financing	The owner-manager(s) has/have usually risked his or her own money on the venture. Financing is limited to business operations and personal guarantees are often required to fund the company when limited liability is present.	(Hillary, 2000; Storey, 2000)
The business is the main income	Archetypal SME owner-managers have undiversified financial portfolios as the personal wealth of the owner-manager is mostly invested in the business	(Storey, 2000)
Flexible	SMEs adapt well to the changing external environment. They find it easier to adapt to changes quickly, which is important when competing with larger companies.	(Romero-Martinez, et al., 2010)
Sector influence	An SME's behaviour and activity is influenced by other companies that are operating in similar industries	(Ricketts Gaskill, et al., 1993; Hillary, 2000; Seidel, et al., 2009)

Table 2.1: Characteristics of SMEs

2.3.2 Difficulties experienced by SMEs

When competing with larger organisations, SMEs face many difficulties. The primary difference between SMEs and large companies is their limited resources. This means that a small business cannot be managed in the same way as a larger one (Welsh & White, 1981). Figure 2.3 has been developed to highlight these difficulties and show how they overlap. Each of the sections e.g. *finance*, *information*, *the environment* etc. will now be discussed.

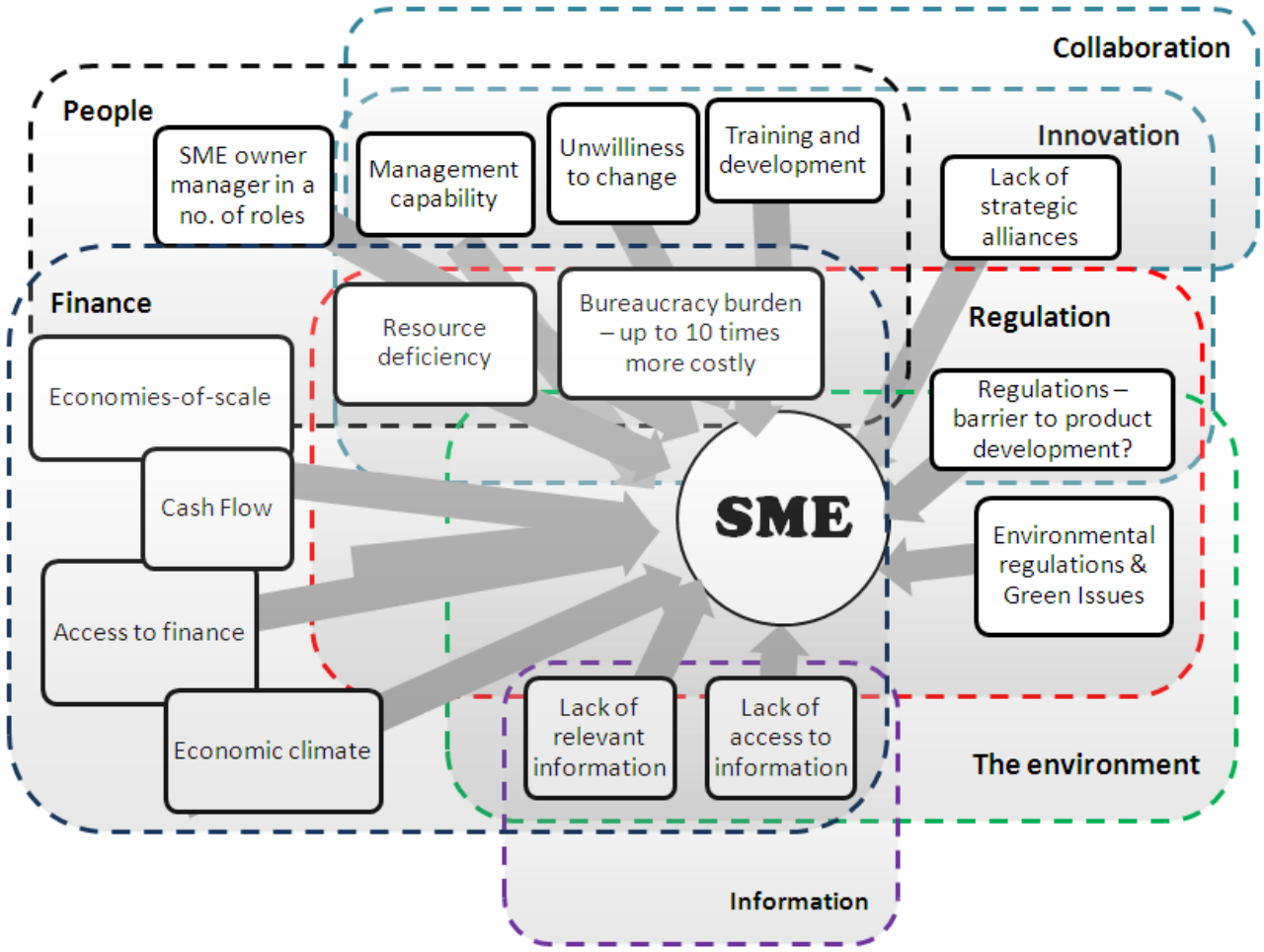


Figure 2.3: Summary of Interlinked difficulties faced by SMEs

- Most of the difficulties that SMEs face are related to *finance* (which occupies the larger space in Figure 2.3). However, the small scale of a small business does not translate to smaller costs (Welsh & White, 1981; Storey, 2000). *Economies-of-scale* is also a major advantage for larger companies. Corporates have greater buying power, reduced production costs and bigger discounts (Nooteboom, 1988; Predescu, et al., 2010). *Access to finance* is a barrier which is limiting the survival and growth of SMEs. Twenty five percent of SMEs fail as a result of late payments which affects their *cash flow.* A large company has the capacity to absorb similar debts (Predescu, et al., 2010). This research was carried out shortly after the global economic downturn of 2008, which led to a particularly difficult *economic climate* and a slowdown in trading in general in the following years (Ma & Lin, 2010). This resulted in limited finance available to fund the start-up and growth of small enterprises (Audretsch, et al., 2009; Doern, 2009).

- *People* issues and limited human resources have a major impact on the performance of SMEs (Fliess & Busquets, 2006; European Commission, 2008-c). Typically, an owner-manager controls all aspects of the business, and consequently plays many roles. However, the owner-manager may not have the necessary skills (Nooteboom, 1988). *Management capability* is an essential condition for the success of an SME (Freel, 2000; Heraty, 2005). SME managers are often unable to carry out effective strategic planning and the capacity to respond to external factors (Ricketts Gaskill, et al., 1993; Hassid, 2002). An SME needs a skilled workforce that is continually learning and adapting to changes. A lack of appropriate *training and development* can affect competitiveness (Hunt, 2007). Despite being characterised as flexible, an *unwillingness to change* is a common problem for the management of a smaller firm. Instead of looking at change positively, many owner-managers of SMEs fear change and what it might bring (Storey, 2000; Romero-Martinez, et al., 2010; Wooi & Zailani, 2010).
- *Regulations* contribute to the administrative burden of an enterprise, which can be up to ten times more costly when carrying out identical tasks in larger companies: SMEs need to process the same amount of red tape, despite their smaller size (Boswell, 1973; Predescu, et al., 2010).
- For small companies to profit and survive, they must continue to be *innovative* (Nooteboom, 1988; Freel, 2000; Romero-Martinez, et al., 2010). Low levels of investment in innovation in the manufacturing sector have restricted the internationalisation of small companies (Madrid-Guijarro, et al., 2009). The main barriers are a lack of finance, management skills, appropriate information, regulation, strategic alliances and a lack of skilled labour (marketing skills in particular) (Freel, 2000). Because innovation is considered high risk to investors and funders, this means that more innovative SMEs are less successful than non-innovative ones when attempting to access finance (Freel, 2000; Madrid-Guijarro, et al., 2009).
- Lack of direct *access to information* limits an SME's effective operation, and it is an extra burden on resources (Eppler & Mengis, 2002; Wooi & Zailani, 2010). The volume of information available (online, in print and other media) can be daunting when an SME is seeking precise details. This can lead to a feeling of losing control and stress (Edmunds & Morris, 2000). Access to the *relevant information* is important in relation the prioritisation of information gathered. Relevant information can be vital to the success or failure of a business (Eppler & Mengis, 2002). If one key piece of information is missed or misjudged as unimportant, such as a new law or regulation, the success of the company could be at risk (Edmunds & Morris, 2000).
- SMEs need to *collaborate* to become more competitive within the global marketplace. There are presently no numbers available to say how many alliances are formed, or what percentages of SMEs are active in *strategic alliances* (Hassid, 2002). However, these alliances are difficult, due to a lack of trust and an inability to find suitable partners (Freel, 2000).
- The *environmental* responsibilities of a manufacturing SME (such as environmental legislation) are growing. Many SMEs are not experts in this area, which can be a barrier to product development (Hillary, 2000). The funds and resources that are required to

implement standards (such as ISO 14001 or EMAS[6]) can limit an SME's market potential. Many customers require this rigorous compliance, and a small business is far less likely to become certified than a large company (European Commission, 2008-c). This issue with be dealt with in section 2.4.1, as it is the main consideration of this research.

Despite the many difficulties SMEs face, there are business benefits to addressing sustainability issues.

2.4 The Business Case for Sustainability

Sustainability in industry will play a significant role in limiting the current trends of environmental damage (United Nations, 2010). Sustainability is the practice of maintaining the balance between fulfilling the requirements of today (such as material resources and clean water), without compromising future generations (EPA, 2011). The current over-dependence on business models focused on economic growth and cheap fossil fuels must end (Willard, 2012). Sustainability within an organisation is often defined in terms of its social, environmental and economic practices (Burke & Gaughran, 2007). Traditional models of sustainability are depicted as the balance between the economy, environment and society as shown in Figure 2.4,also known as the "*the Triple Bottom Line*", or the three P's of Planet, Profit and People (Elkington, 1997) (see Figure 2.4).

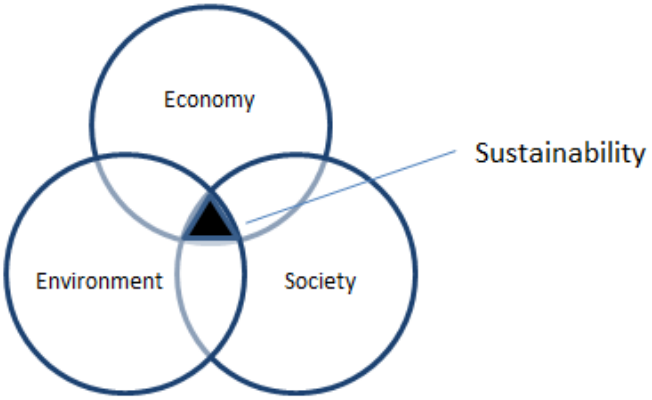


Figure 2.4: Sustainability as the balance of economy, environment and society, or the Triple Bottom Line (Elkington, 1997)

This model has been has criticised for not telling a more complete story. Willard sees the economy, the environment and society as co-dependant as shown in Figure 2.5. This model shows that the environment provides natural resources, without which we could not survive (such as water, clean air and fertile soil). It shows that the economy could not operate without people, and the society in which we all live (Willard, 2008). This highlights the greater importance of the environment over society and the economy, whereas Elkington's model does not depict these nested dependencies.

[6] ISO 140001 is an internationally recognised environmental management system, which requires a significant amount of resources (time and money) to become certified. EMAS is the EU equivalent. Many large organisations require this certification for a company (such as a manufacturing SME) to qualify as their supplier.

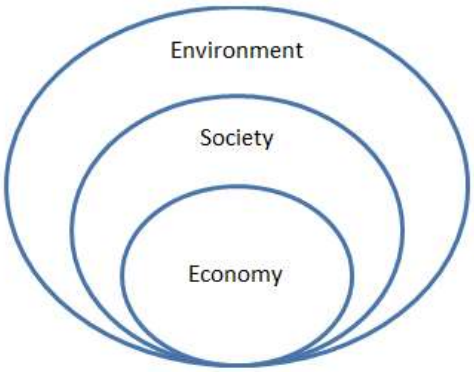


Figure 2.5: Sustainability depicted as nested dependencies (Willard, 2008)

The history of addressing sustainability in organisations dates back to the 1970s, when corporate leaders began to recognise the economic value of good environmental practices (Sanchez, 2009). A recent survey of business leaders claims that sustainability is now part of their value creation (edie.net, 2012). Sustainability is becoming mainstream among large corporations. For example, Wal-Mart, a company viewed as one of the least environmentally friendly companies in the world, has adapted sustainability strategies. Lee Scott, the president and former CEO of Wal-Mart has publicly stated, "*Sustainability is the single biggest business opportunity of the 21st century, and will be the next source of competitive advantage* (Humes, 2011). Wal-Mart's motives are not altruistic. They believe that being greener equates to bigger profits (Sanchez, 2009; Humes, 2011).

Mandatory compliance to legislation is a key instrument driving environmental change (European Commission, 2009-a). Regulation bridges the gap between an organisation's goal to make a profit, and the interest of society at large (Williamson, et al., 2006). Good management of environmental compliance can add value to a business (Enviance, 2012). In developing countries, legislation can be the only driving influence within a company to improve its environmental performance (Fernández-Viñé, et al., 2010). Businesses operating in EU member countries must comply with various environmental regulations and 14 member countries have action plans on corporate responsibility. Ireland's first National Action Plan on Corporate Responsibility was published in 2014. The Government's vision is for Ireland to be recognised as a Centre of Excellence for responsible and sustainable business practices (Department of Jobs, Enterprise and Innovation, 2014). This may have implications for SMEs in Ireland in the future as sustainability is recognised as a key element of competitiveness.

"*Buyer influence*" is another major driver of environmental change. Some consumers are choosing products and services based on sustainability claims and are willing to pay more for these (Sanchez, 2009; European Commission, 2010-e). The increasing influence of the environmental conscious buyer will result in industries having to improve the design of products and manufacturing practices (Braungart & McDonough, 2009). This is also relevant to government agencies throughout Europe. The EC's Green Public Procurement policy (GPP) aims to increase the use of environmentally sound products and services, where businesses tendering must supply sustainability data (European Commission, 2010-e). In 2009, Ireland's government promised to adopt a GPP policy by "*greening*" €8bn of its spending (Gormaly, 2009). However, five years later in 2014, processes to bring this to effect are still in the early consultation stage (Mitchell, 2014).

Sustainable practices in manufacturing industries can equate to higher company value, directly related to reduced costs and increased profits (Carbon Trust, 2008; Sinkin, et al., 2008; Humes, 2011; Lloyds TSB, 2013). For example, waste prevention strategies within organisations can result in resource efficiencies, reduced levels of energy and water use, as well as reduced waste. Being more sustainable is becoming a new model of big business growth and development: seven out of ten large firms view it as a driver of success; and a further three out of ten are embedding sustainability into their business strategy (Willard, 2012). It is "*empowering a virtual second industrial revolution",* because the greener "*efficient, less-wasteful, less polluting way of doing business can also be the most profitable way of doing business"* (Humes, 2011).

Researchers at the Harvard Business School have identified sustainability as the next emerging megatrend (Lubin & Etsy, 2010). Previous business-related megatrends include Q*uality* and *IT* (Lubin & Etsy, 2010). In keeping with the success stories of the other megatrends, improving the environmental performance of a company can help it to gain competitive advantage (Sanchez, 2009). Companies were previously confined to thinking of value in purely financial terms (Porter & Kramer, 2011), but now organisations cannot afford to consider sustainability as a secondary issue because it is linked to greater economic revenues (Sanchez, 2009; Lubin & Etsy, 2010).

Shared value is a related term, and a relatively new concept in business literature. It refers to simultaneously enhancing the competitiveness of a company and improving the economic and social conditions in the communities in which it operates (Porter & Kramer, 2011). "*Business and society have been pitted against each other for too long*" (Porter & Kramer, 2011). The traditional view of a *value chain* is flawed, as it is a based on a take-make-waste system (Unruh, 2010). The *shared value* model recognises that companies need to operate in a world where resources are conserved, and the communities where they operate are not in any economic or environmental distress (Porter & Kramer, 2011). However, there are limitations to the *shared value* model. The critics claim that the model has a closed view of sustainability. Most notably, Elkington (2012) believes this model is mostly about resource efficiency. He claims that capitalism does not conjure value out of nothing but exploits the planet's natural capital that has evolved over millions of years for financial gain. Therefore, *shared value* benefits big business more than society and nature because it focuses only on gradual change rather than a necessary transformational change that is needed to make a significant difference (Elkington, 2012). However, the campaigners for the *shared value* idea state that sustainability and *shared value* overlap and complement each other. One of the main arguments for framing it as *shared value* is that is better in convincing corporate leaders than sustainability alone (Kramer, 2012).

Overall, large companies are leading the way in the environmental improvements. Generally, all businesses continually seek to eliminate waste and reduce their operating costs. Environmental-related actions are seen as an opportunity to do so (Jones & Tilley, 2003). Taking the case of energy alone, the steel industry has improved its energy efficiency levels overall by 167% in the last 20 years and the computer industry by 2.8 million % (Sanchez, 2009). Citigroup have focused on green buildings design to be more energy efficient and are saving an estimated $100 million yearly.

'*Eco-efficiency*' is a relatively new term that dates back to around 1990 (Côté, et al., 2006). It can be defined as "*competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing environmental impacts of goods and resource intensity throughout*

the entire life-cycle, to a level at least in line with the Earth's estimated carrying capacity" (Saur, et al., 2003). The elements of eco-efficiency that have been identified to help a business reduce costs while reducing their environmental impact are as follows (Côté, et al., 2006):

1. Reduction of material intensity;
2. Reduction of energy intensity;
3. Reduction of toxic substances being dispersed;
4. Enhancement of recyclability;
5. Maximisation of renewable resources;
6. Extension of product durability;
7. Increase service intensity.

The concept of eco-efficiency is a win-win from a business perspective. However, there is growing criticism of the limited effect that efficiency alone will have on the overall environmental impact of the manufacturing industry (Braungart, et al., 2007; Braungart & McDonough, 2009). One of the main criticisms is that the major focus is only on making better products with fewer resources, together with recyclability and re-manufacturability in mind. This can make a product more attractive to the consumer who wishes to make an environmentally sound purchasing choice. It does not tackle the growing levels of consumerism. The demands for new and more products continues the irreversible extraction and depletion of natural resources (Côté, et al., 2006). The production of greener products by large companies can increase sales by harnessing this growing consumerism and peoples' tendency to '*buy green'.* For example, GE have increased their sales by producing environmentally sound products, to the value of around $12 billion in 2006 and 2007 combined (Sanchez, 2009). Furthermore, eco-product innovation alone does not necessarily contribute to overall economic growth. New products often simply replace previous versions of other products. This continues to create and encourage waste (Warr & Orsato, 2008).

'*Eco-effectiveness'* can play a part in addressing environmental impacts related to growing consumption levels. Eco-effectiveness goes beyond eco-efficiency because it does not just look at a product and how it is manufactured. For example, it looks at the use of the fossil fuels that go into manufacturing the product. It takes into account, for example, the power plant involved upstream running at efficiency levels of 30% (Côté, et al., 2006). Eco-effectiveness goes beyond the life cycle of the product. It includes the future life cycles of the materials in all product systems. It supports both ecological and economic systems. It aims to eliminate waste and calls for the redesign of industrial systems in a totally sustainable closed loop material flow, called a 'cradle-to-cradle' approach (Braungart, et al., 2007).

'*Eco-innovation'* is a broader term to be used in this study, and it encompasses *eco-efficiency* and *eco-effectiveness*. *Eco-innovation* is a term used to describe improved environmental practices in business collectively. Eco-innovation refers to innovations specific to an organisation which result in environmental improvements (Carrillo-Hermosilla, et al., 2010). Eco-innovation can encompass "*all innovations that have a beneficial effect on the environment, regardless of whether this effect was the main objective of the innovation*" (Bernauer, et al., 2006). New greener products are an example of one type of eco-innovation, which is an important one for businesses: particularly because 72% of European citizens are willing to pay more for environmentally friendly products (Eurobarometer,

2011). There are three main types of eco-innovations (see Figure 2.6), which can be classified as (Carrillo-Hermosilla, et al., 2010):

- **Product innovation** – improvements resulting in lowering the environmental impact during the product life cycle. This can reduce the cost of ownership for the consumer and increase sales for the producer e.g. energy efficient light bulbs.
- **Process innovation** – improvements in production processes which result in lower environmental impact. This is less costly to produce and increases the value to the consumer e.g. a packet of crisps made with a renewable energy source in production leads to a lower carbon footprint, which is more attractive to a consumer.
- **Organisational innovation** – facilitates the implementation of product and process innovations. An organisation can implement eco-innovations in many business functions e.g. the implementation of a paperless office.

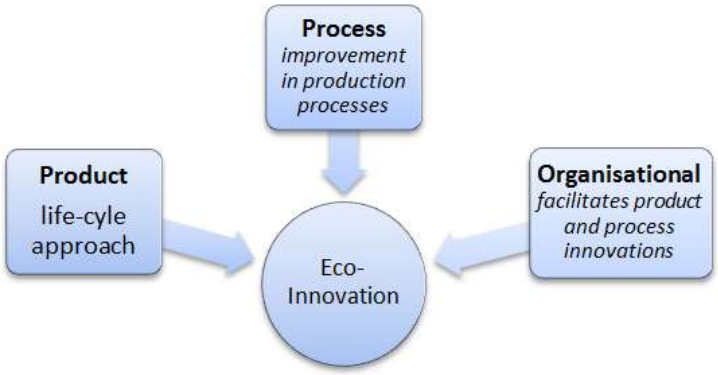


Figure 2.6: Eco- innovations encompass all innovations that have an effect on the environment (Carrillo-Hermosilla, et al., 2010).

Eco-innovation can also be described in terms of *dimensions*, which can involve incremental (gradual change that adds value in existing systems) or radical change (creation of new entire systems to add value). The *dimensions* (summarised in Table 2.2 below) are categorised as: (1) design dimensions, (2) user dimensions, (3) product-service dimensions and (4) governance dimensions. Eco-innovations mainly include a mixture of these four dimensions. The design dimension is the most significant in establishing the environmental impact. The other dimensions are more important for acceptance within its particular context (Carrillo-Hermosilla, et al., 2010).

Dimensions of eco-innovation	
Design dimension	Component addition – incremental changes focused on 'end-of-pipe' solutions, for example carbon capture Sub-system changes –eco-innovative efficiencies such as resource minimisation and waste reduction, which can be incremental yet more radical than component addition System change – eco-effective radical redesign of industrial systems such as closed loop product take-back and remanufacturing
User dimension	The involvement of the user ensures a greater chance of acceptance of products when they reach the marketplace. A clear understanding is necessary for this dimension to be effective and can be challenging
Product service dimension	This involves changing the business model that focuses on providing higher value to the customer through a system of products, services and supporting networks. For example Rolls Royce changed its business from selling jet engines to selling air time for airplanes
Governance dimension	Radical, institutional or complex system-level changes, likely to happen in an evolutionary manner, through gradual adaptations rather than being managed as a whole.

Table 2.2: Dimensions of eco-innovation (Carrillo-Hermosilla, et al., 2010)

2.4.1 SMEs and the environment

SMEs are considered the main target for environmental performance improvements if policy-makers are to make a significant impact in relation to sustainability (Daddia, et al., 2010). SMEs make up 99% of all enterprise activity in Europe, so their impact is substantial. Manufacturing companies, by their nature, consume relatively large amounts of energy and resources. SMEs involved in manufacturing are highly dependent on the earth's resources and contribute significantly to environmental damage (Hillary, 2000).

The total environmental impact of small firms was not aggregated regionally until recently (Hillary, 2004). Claims that SMEs in the EU were causing a large proportion of environmental damage were simply informed estimates (Hillary, 2000; Hillary, 2004; Daddia, et al., 2010; Heras & Arana, 2010). However, a comprehensive study confirmed that SMEs cumulatively cause 64% of total industrial pollution, and contribute approximately 60-70% of the total industrial waste in the EU (Constantinos, et al., 2010).

Companies that consider sustainability can increase the value of their business by up to 80% - through increased revenue, decreased costs and risk minimisation (Carbon Trust, 2008; Lloyds TSB, 2013). Sustainability principles have the potential to increase profits alone by up to 66% in SMEs (Willard, 2008). However, the lack of environmental improvements in SMEs indicates that SMEs don't recognise this potential, or know what to do about it. A recent survey in the UK indicated that 42% of small business admitted to having little or no understanding of sustainability (Stringer, 2013).

As large organisations continue to adapt sustainability principles, it is expected that this will lead to compulsory sustainability requirements for SMEs - in particular those positioned in the supply chains of the larger companies (Burke & Gaughran, 2007; Lubin & Etsy, 2010; Humes, 2011). The metrics that are used to measure and track sustainability in large companies are used very little by SMEs (Côté, et al., 2006). Few manufacturing SMEs are undertaking voluntary actions for the benefits of

wider society (Williamson, et al., 2006; Constantinos, et al., 2010). One of the reasons for this may be that most manufacturing SMEs do not deal directly with the end-users of their products. SMEs are not pressurised by consumer groups to be greener, as are larger global brands (Hoskin, 2011).

2.4.2 Eco-innovation and SMEs

SMEs need to be innovative and sustainable to remain competitive in the marketplace (Côté, et al., 2006; Willard, 2008; Constantinos, et al., 2010; Freel, 2000). SMEs need to change focus away from solely profit-targeted innovation towards environmental eco-innovation and social innovation (Emerald Editor, 2011). It is claimed that eco-innovative practices could improve the environmental impact and profitability of a business through the implementation of eco-efficient and eco-effective practices, or by changing the business's entire operating model (Carrillo-Hermosilla, et al., 2010; Willard, 2008). However, SMEs are less likely than larger organisations to make transformational changes due to their limited resources and influence in their supply chain. A focus on sustainability through eco-innovation is an appropriate approach. SMEs need to manage their financial and environmental performance and develop capabilities and competence for sustainable business management (Lin, et al., 2011; van Kleef & Roome, 2007).

However, there is little existing literature to show evidence of SMEs using eco-innovation to improve their business. In the small number of reported cases where SMEs are involved in eco-innovation, it has been shown that they are responding to a stimulus from outside the firm (see Figure 2.7). This stimulus could be in many forms, for example legislation (Williamson, et al., 2006; Hillary, 2004; Klewitz & Hansen, 2011). This can also be due to involvement with NGOs[7] or an actor in their value chain (Klewitz & Hansen, 2011; Hoskin, 2011). This actor is more than likely to be a larger customer. Better environmental practices are fast becoming *order qualifier* and can be a competitive advantage (Seidel, et al., 2009). Cost is another major stimulus for eco-innovation (Hoskin, 2011). A recent study has shown that the majority of businesses (75%) have seen a dramatic or moderate increase in material costs in recent times, with 87% of businesses expecting even more increases in the next 5-10 years (Gallup, 2011).

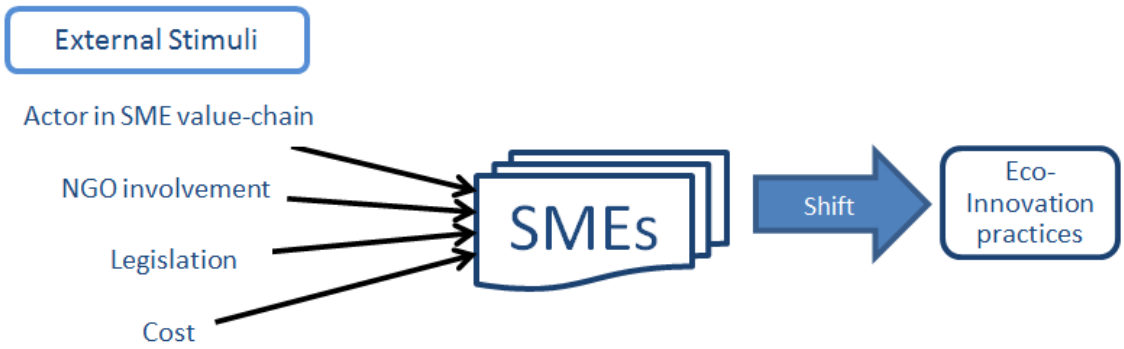


Figure 2.7: External stimuli affecting eco-innovative practices in SMEs

Research has shown that SMEs who engage in low-risk, eco-innovation practices (e.g. better energy management) see further opportunities for improvement (Klewitz & Hansen, 2011). There is evidence that these low-risk changes may result in more radical innovation, such as the adoption of

[7] An NGO is a Non-Governmental Organisation, for example, the World Wildlife Fund (WWF) is currently working with the Coca Cola company to help them improve their environmental performance (Sanchez, 2009).

life-cycle thinking, or in the form of new manufacturing models based around sustainability (Klewitz & Hansen, 2011).

Tackling a strategic issue, such as adopting a new business focus, can be a complex issue for SMEs (Klewitz & Hansen, 2011). The business strategy within SMEs is often emergent, fluctuating based on the immediate needs to be competitive (Ates & Bititici, 2009). Although these practices allow SMEs to be more flexible than their larger counterparts, an emphasis on a short-term perspective can dissuade SME owner-managers from tackling environmental issues (Mitchell, et al., 2010). For an SME to successfully adopt sustainability through eco-innovation, the strategy needs to be explicit, rather than reactive. An external support mechanism is often necessary to do so successfully (Klewitz & Hansen, 2011). This is often in the form of collaboration with actors in their value chain, knowledge institutions and/or government organisations (Klewitz & Hansen, 2011).

2.4.3 Support for SMEs in Europe

SMEs are unlikely to make much progress without support (Seidel, et al., 2009; Hoskin, 2011). Many free supports are available online. For example the OECD Sustainable Manufacturing Toolkit is a 7-step guide in booklet form online to download (OECD, 2011). However, this guide is very generic, a high-level conceptual road-map, and does not have any tools associated with it to implement changes. It has been designed for SMEs, but as it was published in the USA, where SMEs are defined as having fewer than 500 employees. It may be useful for an environmental manager in a company, but not for an SME that lacks the resources to have such an expert available.

To assist SMEs in adopting green practices, support structures have been developed throughout the EU (European Commission, 2005-c). Some of these are not SME specific[8], but the S*mall Business Act*, the *SME portal* and *Environmental Compliance Assistance Programme* (ECAP) have been designed specifically for SMEs. This section will discuss the current supports available (see Figure 2.8)[9].

[8] *Environmental Technologies Action Plan (ET*AP) and Enterprise Europe Network (EEN) are not SME specific
[9] A new support called the Green Action Plan for SMEs is due to be announced in late 2014 (European Commission, 2014-e).

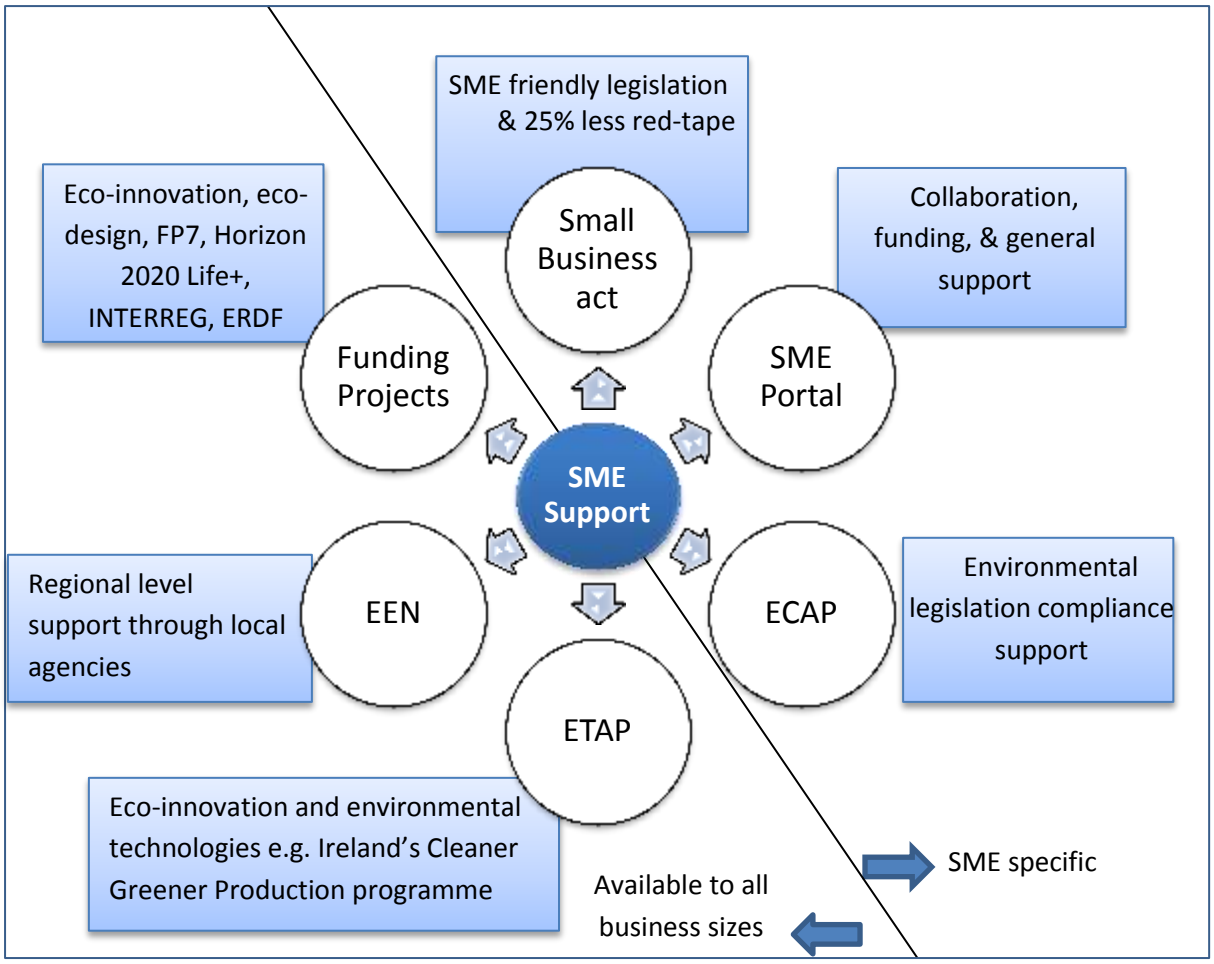


Figure 2.8: Summary of supports available to SMEs in the EU

- The *EU Small Business Act* is an attempt to make business operations less bureaucratic (European Commission, 2008-c). It has committed to make the administrative load for small business lighter by writing new regulations in an easy-to-understand manner (European Commission, 2005-a; Predescu, et al., 2010).
- The EC has developed the *SME portal* to give guidance on funding opportunities, Europe-wide news and events, as well as assistance on finding suitable collaborative partners (European Commission, 2010-d). The portal is not specifically about environmental issues, but it is easy to for SMEs to navigate to environmental issues and supports (European Commission, 2010-d).
- The *European Compliance Assistance Programme (ECAP)* is the main EU support to promote environmental legislation compliance in SMEs. Its objective is to be a one-stop-shop for environmental management assistance (ECAP, 2010). By encouraging compliance among SMEs, ECAP aims to reduce the impact the SME sector has on the environment (European Commission, 2009-a). ECAP recommends that the best way to be compliant is through an Environmental Management System (EMS) (Heras & Arana, 2010). The most widely recognised systems are ISO 14001 and the equivalent European standard, EMAS (Environmental Management Assessment System) (Cleaver, 2001).
- The objective of the *Environmental Technologies Action Plan (ETAP)* is to improve competitiveness in the area of eco-innovation and environmental technologies in Europe. It

displays eco-innovation projects on its website and provides incentives to encourage markets to use environmental products and services (European Commission, 2010-a). ETAP is rolled out in EC member countries in schemes such as *The Cleaner Green Production Plan* in Ireland, in the hope that eco-efficient practices will eventually become the norm (CGPP, 2010).

- The *Enterprise Europe Network (EEN)* is the main high-level enterprise support agency in Europe. It comprises 570 partner organisations in a support network throughout the EU. The partners consist of support agencies such as chambers of commerce and regional development organisations, research institutes, technology centres and innovation centres. These partners are placed at a local level in communities and regions across member states, and aim to provide targeted, local information on legislation and other issues to the millions of European SMEs (Enterprise Europe Network, 2010). Although the EEN is not solely focused on environmental issues, it does provide easier access to finance, towards boosting innovation in support of the triple bottom line (European Commission, 2008-a; European Commission, 2008-b).
- *Funding projects* include grant-aided opportunities for eco-design or general assistance for SMEs to participate in various multi-disciplinary projects. The most recent initiatives are been offered under the Horizon 2020 Programme (European Commission, 2014-c), replacing the *7th Framework Programme (FP7) for Research and Technological Development* (European Commission, 2010-b). Life+ is the EU's main funding that is focused on environmental policy implementation and few SMEs have benefited from it (European Commission, 2010-a). SPIN (Sustainable Production through Innovation in SMEs), is an example of an EU INTERREG Programme directly focused on SMEs and eco-innovation. Its aim is to give assistance to SMEs with their innovations as well as with their legal responsibilities (Arbačiauskas, et al., 2010).

2.4.4 SMEs are Slow to Access Supports

Only 24% of SMEs are currently acting to reduce their environmental impact (Constantinos, et al., 2010) and most SMEs do not see environmental issues within the context of their core business activities (ECOTEC , 2000; ECAP, 2010). The resources involved in implementing environmentally sound practices, and the lack of influence a manufacturing SME has within a supply chain can make it more difficult for smaller business in practical terms (Wooi & Zailani, 2010). Furthermore, there has been little evaluation of the effectiveness of the supports that are currently available (Romero-Martinez, et al., 2010).

Even though there are supports available, most manufacturing SMEs are still not dealing with environmental issues, and are failing to see the importance of sustainability (Mitchell, et al., 2010). The support funding available in the EU is not being accessed; in 2009 only 20% of the EU structural funds available to SMEs for eco-innovation were accessed (Romero-Martinez, et al., 2010; Arbačiauskas, et al., 2010). The lack of uptake in innovation-related funding has particular implementation problems. The main obstacle for SMEs to get support is their lack of awareness of the available support (Côté, et al., 2006). The common reasons cited in the literature for the lack of uptake of the available funding are summarised in Table 2.3:

Reason for lack up uptake of supports		Author(s)
A lack of awareness that their business activities are damaging the environment	A recent study in the UK showed that the majority of businesses operating there believed that their business had no effect on the environment. When questioned further on more specific issues, 46% actually carried out activities that were harmful to the environment.	(Fernández-Viñé, et al., 2010; NetRegs, 2010; ECAP, 2010)
A lack of awareness of the available support	The main obstacle for SMEs to get support is their lack of awareness of the available support.	(Côté, et al., 2006)
A lack of resources	SMEs have a short-term economic outlook and there is difficulty in obtaining financing related to environmental issues. Regulatory compliance and capabilities to build networks are important activities that SMEs do not have the resources to implement effectively.	(Côté, et al., 2006)
Perceived cost	SMEs lack the appropriate information on the effectiveness of green issues and associate environmental issues with costs.	(Côté, et al., 2006; Wooi & Zailani, 2010)
Perceived lack of competitive advantage	SMEs do not perceive green practices as giving a competitive advantage.	(Seidel, et al., 2009; Wooi & Zailani, 2010)
Support is not sector specific	Customised services are not available to different SME sectors.	(Shearlock, et al., 2001)
No supply chain pressure	Although this may change in the near future, there are currently little pressures within the supply-chain to have good green credentials.	(Fernández-Viñé, et al., 2010)
A lack of training	There is limited training of staff and a lack of managerial expertise on the issues.	(Côté, et al., 2006)
Not for everyone	Supports have been aimed mainly towards the high-tech sector.	(Predescu, et al., 2010)
There is no local support	A UK study showed that less than a third of business support agencies provided support related to environmental issues.	(Shearlock, et al., 2001)
Confusion	The SMEs cannot understand the options available when they seek support.	(Romero-Martinez, et al., 2010)
Perceived loss of control (innovation-related funding)	There is a perception that some control of their company may be lost, which can inhibit an SME accessing supports.	(Romero-Martinez, et al., 2010; Arbačiauskas, et al., 2010)
Seeking funds too early (innovation-related funding)	Innovations are not developed to a far enough level, in order to access the funding.	(Arbačiauskas, et al., 2010)

Table 2.3: Reason for lack of uptake of environmental supports by SMEs

The EC attempts to improve awareness of supports through the Enterprise Europe Network (EEN). This network is represented in all EU member countries, mainly through Chambers of Commerce - membership of which is mostly compulsory in the EU to operate a business (Enterprise Europe Network, 2010). In Ireland, however, the 'Chambers of Commerce' is not comparable to its other

European Chamber counterparts. Chambers Ireland is the largest business network in Ireland, but larger companies dominate it, and membership is voluntary (Chambers Ireland, 2011). Furthermore the EEN is only represented in four of the sixty chambers branches in Ireland (Enterprise Europe Network, 2010).

The main initiatives to assist businesses in Ireland are formed around the government's *Green Business Initiative*. This involves four agencies, the EPA, SEAI, Enterprise Ireland and the IDA (EPA, 2012-a). Table 2.4 summarises the supports available and their suitability for manufacturing SMEs.

Agency	Nature of Service	Support Programme	Suitable for SMEs?	Reason
SEAI	Energy Management Energy Efficiency Energy Alternatives	Large Industry Network	No	For large companies only
		Energy Efficiency Fund	No	Competitive application
		Accelerated Capital Allowances & Triple E	No	Competitive application
		Advice Mentoring & Assessment	Some	Competitive application
		SEAI Website	**Yes**	**Simple downloadable tools**
EPA	Eco-Efficiency	Cleaner Greener Production/ Green Enterprise Programme	Some	Competitive application process (less complex)
		Green Hospitality Award Programme	No	For hospitality businesses only (not specifically SMEs)
		Local Authority Prevention Programme	Some	Local supports designed for SMEs (limited reach)
		Green Retail	No	For retail business only
		GreenBusiness.ie	Some	Designed for SMEs, but not accessed by many
EI	Clean Technology	Research Development & Innovation Support	Some	Need to be an EI client
	Clean Technology, EMS, Eco-labelling, Carbon management	Green Offer	Some	Need to be an EI client
	Online information/ advice	EnviroCentre.ie	**Yes**	**Free repository of guidance**
IDA	Clean Technology & Eco-Efficiency	Research, Development & innovation Support	No	Only for FDI companies
		Capital & Training Grant	No	
		Clean Tech Support	No	
SMILE Resource Exchange	Waste prevention	Resource Exchange via Networking Events and online	Some	Free events and online site to exchange resources (only in Munster & Dublin)

Table 2.4: Environmental Supports in Ireland for business highlighting SME suitability

Many of these supports are not suitable to SMEs. Many of them target large corporations, such as the IDA and the SEAI's Large Industry Network. Other supports do not have a direct access route and involve a competitive application process, which does not guarantee provision. To access many of the Enterprise Ireland (EI) supports, a business must qualify with certain criteria, such as being export led, high tech and/or have high growth potential (Enterprise Ireland, 2014). The supports that are suited to a wide range of SMEs include the EnviroCentre.ie website and the SMILE Resource Exchange.

Business Support Agencies are having limited success in assisting SMEs in addressing their environmental impact, and SMEs are reported to be difficult to engage with in relation to environmental issues (Côté, et al., 2006). SMEs are not accessing supports in Ireland (European Environment Agency, 2011). The main support in Ireland aimed at SMEs (GreenBusiness.ie) has not been successful in reaching them (Hogan, 2012). One significant reason for this is that small businesses are often overlooked as a group that is too expensive to reach: it is much easier to develop supports for, and reach large businesses (Seidel, et al., 2008). Some of these supports have been successful in highlighting the issues, but the bespoke services that SMEs need have not been forthcoming (Shearlock, et al., 2001). Despite this, support organisations can be key to manufacturing SMEs being more compliant, more cost effective and more sustainable (Côté, et al., 2006).

In contrast to the support approach, legislation is cited as a key instrument to drive environmental change (Hillary, 2000; Fernández-Viñé, et al., 2010; ECAP, 2010). EU legislation is implemented through member states, which can have a major impact on SMEs. There are a number of areas of EU environmental legislation of relevance to SMEs (European Commission, 2014-b) synthesised in Table 2.5 below.

However, environmental legislation is constantly being updated, and SMEs continue to experience compliance problems such as:

- The *lack of awareness* of the existence of the legislation, and in turn what must be done to be in compliance (ECAP, 2010).
- The *lack of policing* the legislation (Fernández-Viñé, et al., 2010).
- A *lack of expertise* in most small firms (Fernández-Viñé, et al., 2010).
- The *lack of time* to figure it out. Environmental issues (and related legislation) are viewed as secondary to their main business activities, so give little time to the issue (ECAP, 2010).

Notwithstanding the slow uptake in environmental funding and support, and that the majority of SMEs are currently not acting to reduce their environmental impact; SME owner-managers claim to want to act in a more environmentally friendly way (Mitchell, et al., 2011). Compared to larger organisations, small business owners are reported to have a higher level of ethics and moral accountability (Mandl & Dorr, 2005). Despite this, a company is still more likely to be sustainable if it is a larger firm (Uhlaner, et al., 2010).

Legislation Type	What it covers	Industrial activity affected	Potential Impact for SMEs
Air Quality, Emissions trading and Noise	-Emissions to air -Volatile organic compounds (VOCs)	-Use of organic solvents -Manufacturer or use of decorative paints or materials containing VOCs -Storage, load and transportation of petrol -High polluting industries such as energy, metals, chemicals, waste management of livestock.	-Emissions need to be measured and controlled -Products or processes may need redesigning -Investment needed in Best Available Technologies (BATs) to reduce emissions
	-Industrial Plants	-Industrial installations	
	-Emissions trading	-Combustion plans such as oil refineries, iron, steel, cement, glass, ceramics	
	-Noise reduction -General motor vehicles -Health and safety	-General motor vehicles and motorcycles -Aircrafts -Compressors, excavator-loaders, saws, mixers, lawnmowers etc.	-Conform with noise level -Labelling of equipment -Re-design of products to meet the targets
Chemicals	-REACH (Registration, Evaluation, Authorisation and Restriction of Chemical substances)	-Manufacturers and importers that use chemical substances (oils, lubricants, electronic components)	-Access to chemical database required -To avoid use of certain substances redesign may be needed
Energy	-Energy markets -Energy efficiency -Renewable energy -Nuclear energy	-All industries must reduce energy consumption and greenhouse gas emissions by at least 20% by 2020	-Access to information on renewable energy sources -Access to energy technologies
Greener products	-(GPP) Green public procurement	-Public purchasers, such as local authorities or hospitals	-Procurement process may be overly bureaucratic
	-Integrated product policy (IPP) considers life cycle impact	-Various businesses: designers, manufacturers, marketing and retailers, consumers	-Tools needed to estimate life cycle impacts
	-Eco-design and energy use	-Producers of energy-using products such as electrical and electronic devices or heating equipment	-Eco-Design tools needed
Waste	-Batteries	-Producers and consumers of batteries,	-Tools needed to identify alternative substances
	-Packaging	-All industries	-Design opportunities for packaging tools is needed
	-(EEE) Electrical and electronic equipment	-Producers of electrical and electronic equipment, consumers	-Design opportunities for identifying alternative solutions
	-Oils	-Any business producing, collecting and/or disposing of waste oil	
	-End-of-life vehicles	-Producers and suppliers of vehicles	
Water	-Urban wastewater -Discharges of substances -Pollution from industrial plants and agriculture	-Food and drink production, agriculture and animal products (e.g. leather, glue)	-Investment in installations, processes for safe disposal of sewage and environment protection
Soil	-Soil protection	-Landfilling of waste, extractive industries and agriculture	-Investment to prevent soil contamination

Table 2.5: Synthesis of EU environmental legislation affecting SMEs

Recalling that SMEs are not just miniature versions of larger ones (as discussed in section 2.3.2) (Welsh & White, 1981), the reason they are failing at living up to their higher moral code in the area of sustainability lies with a lack of tailored support to meet their needs (Uhlaner, et al., 2010).

Taking the issue of waste management as an example, various barriers exist that inhibit good practices in SMEs, such as the lack of services available and the practicality of finding suitable solutions (Banga & Freestone, 2011; Mitchell, et al., 2011). More awareness of the environmental practices in companies has resulted in their adapting their practices positively (Hoffmann, et al., 2009). The use of appropriate tools and methodologies suited to their particular needs can effect change in SMEs (Côté, et al., 2006; ECAP, 2010).

It is clear the particular characteristics of SMEs need a different approach than those designed for larger enterprises (Seidel, et al., 2009).

After extensively discussing the literature on SMEs and sustainability in SMEs, the research problem is identified in the next section.

2.5 The Research Problem

The consensus between scientists, economists and businesses is clear - irreversible damage to the eco-system, caused by human activity, is increasing at a rate that is unsustainable and threatens the future of the human race. (World Commission on Environment and Development, 1987; Bradley, 2000; Beg, et al., 2002; IPCC, 2007; Monni & Rase, 2008; Heltberg, et al., 2009; European Union, 2010; Meadows, et al., 2012; European Commission, 2005-c; Bawden, 2013). Furthermore, Ireland is not on track to meet emission reduction obligations (EPA, 2012-c).

The issues under investigation in this thesis may be summarised as follows (see Figure 2.9):

1.	The cumulative activities of SMEs are contributing significantly to environmental damage.	(Vesterdorf, 2005; Daddia, et al., 2010; Constantinos, et al., 2010)
2.	It is particularly relevant to manufacturing SMEs.	(Leonard, 2010; European Environment Agency, 2010)
3.	SMEs need to improve their environmental performance in line with EU targets.	(European Union, 2010; ACCA, 2013)
4.	There is a slow uptake of sustainable environmental practices within SMEs, despite the fact that there are many tools and supports widely available cumulative.	(European Commission, 2005-c; European Commission, 2005-a; European Commission, 2008-c; BMW Regional Assembly, 2008; European Commission, 2009-a; Enterprise Europe Network, 2010; European Commission, 2010-d; Arbačiauskas, et al., 2010)

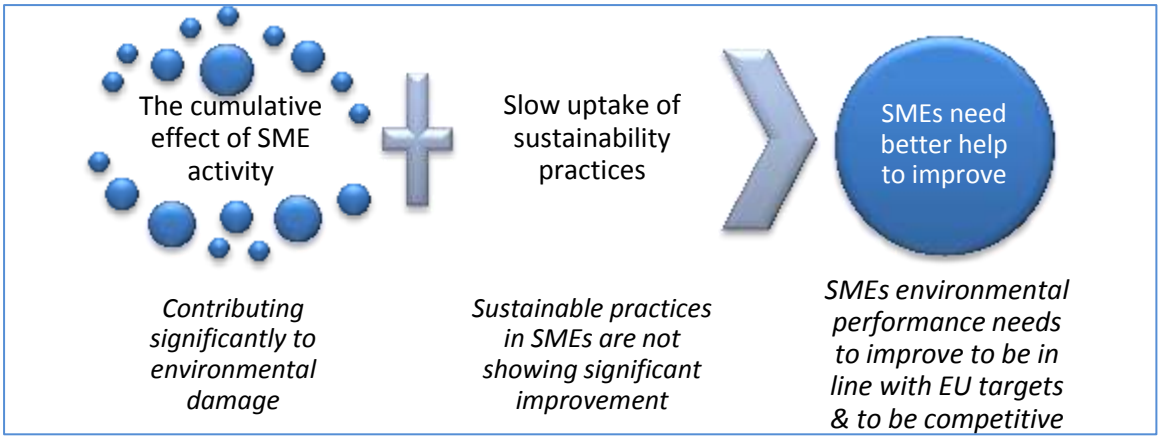


Figure 2.9: The issues under investigation

SMEs are of significant importance to economies and society in general, yet they encounter many difficulties (European Commission, 2005-b; European Commission, 2005-c; European Commission, 2005-a; European Commission, 2003-a) (European Commission, 2013-c; European Commission, 2005-a; Ayyagari, et al., 2003; McHugh, 2010; Nooteboom, 1988; Constantinos, et al., 2010).

Being more sustainable simultaneously offers a major opportunity for SMEs and benefits the environment. The researcher has identified the six main factors that contribute to the problem of the slow uptake of sustainable environmental practices (see Figure 2.10 below):

(1) A *lack of awareness* of the impact their actions have on the environment (ECAP, 2010) (NetRegs, 2010);
(2) A *lack of knowledge* of sustainability including the legislation pertaining to environmental issues (Côté, et al., 2006; ECAP, 2010; Fernández-Viñé, et al., 2010) ;
(3) A *shortage of resources*, both financial and human resources, to address the issues (Fliess & Busquets, 2006; Aragón-Correa, et al., 2008);
(4) The *negative perception* that there is no immediate benefit to their organisation (Wooi & Zailani, 2010);
(5) *Insufficient supports and tools* to affect change (Arbačiauskas, et al., 2010; Romero-Martinez, et al., 2010);
(6) *Limited research* in the area of SMEs and the environment (Labonne, 2006; Daddia, et al., 2010; ACCA, 2013).

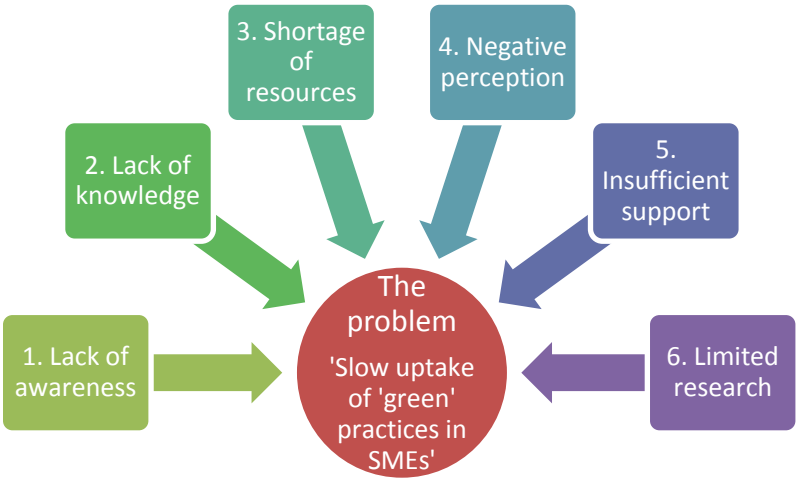


Figure 2.10: The Research Problem and contributing factors

Sustainability has previously been ignored as being a competitive advantage in manufacturing (Shahbazpour & Seidel, 2006). The issue of sustainability in SMEs has also been largely ignored, which has led to a lack of research in the area (ACCA, 2013; Labonne, 2006). There is a lack of data available on environment performance in SMEs (Daddia, et al., 2010). Therefore, it is clear that more research needs to be done. Suitable tools and methodologies need to be developed in order to influence SMEs in their environmental performance and behaviour.

Sustainable business practices and eco-innovation tactics (including product, process or organisational innovation) could play a part in addressing the issue from the business (ECAP, 2010; Klewitz & Hansen, 2011). This will be discussed in the next sections.

2.6 Sustainability and Eco-innovation Solutions

The desire for, and examination of, better and more sustainable manufacturing began in the 1980s, primarily in a bid to reduce waste and prevent pollution. This has moved towards energy and resource efficiency in recent times (Stone, 2006; Seidel, 2011). The motivation for change originally stemmed from public concerns over environmental degradation caused mainly by well-known, large manufacturing organisations (van Hemel & Cramer, 2002). These drivers are still present today; the practices of large multinational corporations continue to generate worldwide media interest and are of on-going civic concern. Conversely, headline news on environmental degradation caused by smaller businesses is virtually non-existent and there is no public pressure for SMEs to be greener (Mitchell, et al., 2011). This is despite the fact that SMEs cumulatively cause more environmental damage and produce more waste than all larger organisations combined in Europe (Constantinos, et al., 2010) as was highlighted in Section 2.4.

Consequently, the history of environmental improvements in industry practices began in large companies, not SMEs. Considering that the majority (99%) of businesses in Europe are SMEs, they should, and can, play a big part in this development, but the main impetus to improve is not present in SMEs. Particular attention should be paid to their effective implementation within smaller SMEs, because *small* and *micro* enterprises account for the majority of all SMEs in Europe (Russo & Tencati, 2009).

EU policy is designed to encourage voluntary environmental management practices in SMEs (Williamson, et al., 2006). However, this chapter has indicated that suitable environmental management supports for SMEs have not yet been forthcoming (Shearlock, et al., 2001; Dimache, et al., 2011). To put sustainability into practice, one of the strategies recommended by the United Nations Environmental Programme (UNEP) is the development of greener products, services and business models (UNEP, 2011-a).

An abundance of tools and methodologies has already been developed for environmental improvements, and many available for no cost online. However, SME owner-managers are often not aware that such tools exist or that they could help their business. Furthermore, due to the lack of time and resources within SMEs, the majority do not seek out these tools and methodologies, or have time to decipher what is suitable their particular situation. To address this, a *one-stop-shop* approach is recommended as best practice by the European Commission to reach a bigger audience (ECAP, 2010). However, the heterogeneous nature of SMEs, in size and industry sector, makes it difficult to provide a *one-size-fits-all* solution (Hillary, 2004). Therefore, a support framework should comprise of a broad range of elements, which can be useful across industry sectors, which can be used by micro and small SMEs, as well as mediums ones.

Section 2.4.2 discussed the suitability of eco-innovation as an approach to generate environmental improvements in manufacturing SMEs. The *design* dimension of eco-innovation was highlighted as being the most significant dimension in establishing the environmental impact, with the other dimensions (governance, product service and user) being important for acceptance within its particular context (Carrillo-Hermosilla, et al., 2010). The most appropriate tools and methodologies that can help eco-innovations were selected. These are presented in the following section (see Table 2.6).

	Eco-innovation Dimensions			
	Design	**Governance**	**Product service**	**User**
This dimension addresses	Environmental impact	Acceptance within its particular context		
Applicable Tools , training and methodologies	• Life Cycle Management (LCM) • Design for Environment (DfE)	• Environmental Management System (EMS) • Sustainability Reporting	• Product Service Systems	• Auditing tools • Legislation tools

Table 2.6: Tools to support better environmental performance through eco-innovation

Each of these applicable tools, training and methodologies will now be discussed and linked to the Eco-Innovation design dimension it addresses.

2.7 Life Cycle Management Tools – 'Design' Dimension

Life Cycle Management (LCM) tools are the most comprehensive methods to measure the environmental impact of products and services. They fit within the 'design' dimension of eco-innovations they help decision makers to design and manufacture in a more sustainable manner (UNEP, 2011-a). Sustainable solutions are increasingly taking into account the whole life cycle of a

product or services (Westkämper, et al., 2000). LCM tools that may be useful for SMEs[10] include Life Cycle Assessment, Life Cycle Costing and Carbon Footprinting.

2.7.1 Life Cycle Assessment (LCA)

The International Organisation for Standardisation (ISO) defines a Life Cycle Assessment, or LCA[11], as a "*compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life-cycle*" (ISO, 2006). An LCA is the most objective, comprehensive and robust environmental methodology. It was originally developed by the Society of Environmental Toxicology and Chemistry (SETAC)[12] (UNEP, 2011-b). It is the only internationally accepted methodology to assess the environmental performance of a product, service or activity (SETAC, 1993; Kloepffer, 2008; UNEP, 2011-b).

LCA has been standardised within the ISO14000 framework (ISO 14040 series) to support management decision-making in the design phase of a product or service (ISO, 2006). An LCA methodology is implemented in an iterative manner. The ISO14040 defines the framework in four stages (see Figure 2.11) (ISO, 2006) which are (see Figure 2.11):

1. *Goal and scope definition* – the purpose and, assumptions of the system are set down and boundary conditions are defined.
2. *Inventory analysis* –the inputs (resources used) and outputs (environmental effects) of the system are quantified.
3. *Impact assessment* – all inputs and outputs are classified, characterised and evaluated.
4. *Interpretation* – evaluation and reporting to assess opportunities to reduce impacts.

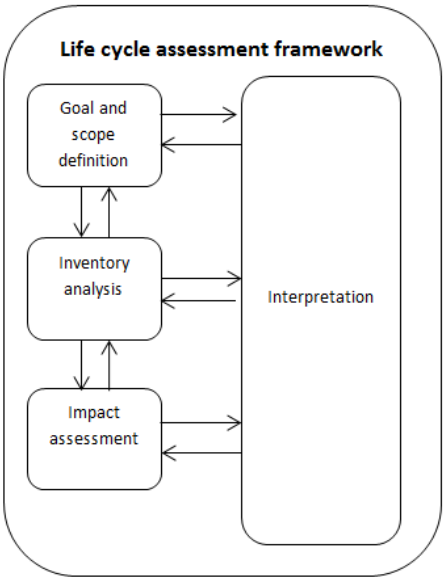


Figure 2.11: LCA Stages (ISO, 2006)

[10] There are other Life cycle methodologies evaluation, Design for Life Cycle, Life Time Management, Product Life Cycle Management, Logistics and Life Cycle (Dimache, 2009)
[11] Life Cycle Assessment (LCA) is also known as Life Cycle Analysis.
[12] The Society of Environmental Toxicology and Chemistry (SETAC) is a world-wide science-based organisation that uses a multidisciplinary objective approach to solving environmental problems to balance business, academia and government (SETAC, 1993).

LCA is increasingly important to manufacturers because environmental legislation and EU policy are attempting to encourage greener, more sustainable products and services (European Commission, 2013-b). France is leading the way. Trials involving labelling of a life-cycle rating on a sample of high volume consumer goods have taken place there, supported by "*Grenelle de l'Environment'* legislation" (French Environment and Energy Management Agency, 2014). The European Commission has also been involved in piloting options to communicate greener products and opportunities to converge methods for a "*Single Market for Green Products Initiative*" (European Commission, 2014-a).

LCA techniques exemplify *systems thinking* because they evaluate the environmental impact of a *product system*[13] throughout its entire life. The assessment goes beyond what is happening in the production facility, to identify the true sources of environmental impacts along the supply chain (UNEP, 2011-b).

The main life-cycle phases of a product system are illustrated in Figure 2.12; these include the extraction and treatment of raw materials; the design and production phase; packaging and distribution; use and maintenance phase; disposal and end-of-life, reuse and recycling. Decisions made in manufacturing companies affect the efficacy of products, therefore playing a key role in resource usage by society during the use phase (Hillary, 2004). For example, the largest environmental impact of clothing occurs during the use phase (from electricity usage and water consumption) rather than the raw materials, distribution or manufacturing phases (Allwood, et al., 2008).

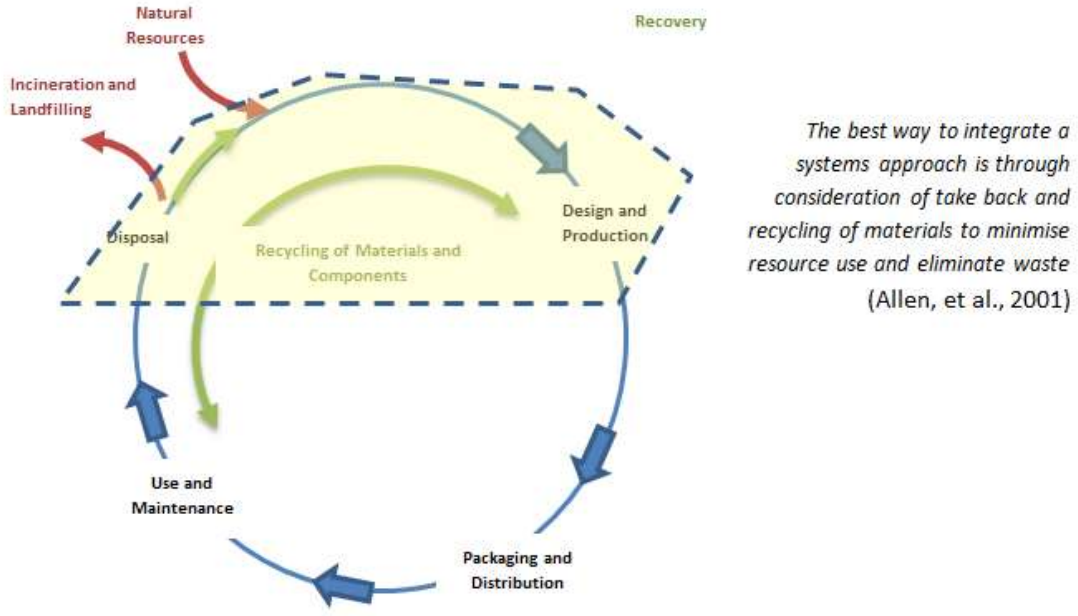


Figure 2.12: Product Life Cycle Stages -where a systems approach should be applied (UNEP, 2011-b)

The best way to integrate a *systems* approach is to design the product with the consideration of the *take back* and *recycling* phase of a product cycle (Allen, et al., 2001). This will minimise the use of

[13] The process of designing and manufacturing products and services can be viewed as a *product system.*

natural resources and waste going to landfill or incineration. However, closed loop systems are not good if the processes or materials used are toxic (McDonough & Braungart, 2013).

Intelligently designed products do not need to compromise, and should allow for "*abundance, endless reuse, and pleasure*" (McDonough & Braungart, 2013). For example *OrangeBox*, a medium sized office furniture manufacturer in the UK, has redesigned its *Ara* office chair to allow the chair to be collected and taken back after its use phase (see Figure 2.13). It uses 98% recyclable plastic materials in its *cradle-to-cradle certified*[14] *product*, ensuring the raw materials remain in a closed loop production cycle, that the materials and processes have minimal environmental impact, and do not lose their value and at the end of the chairs useful life (Orangebox, 2013).

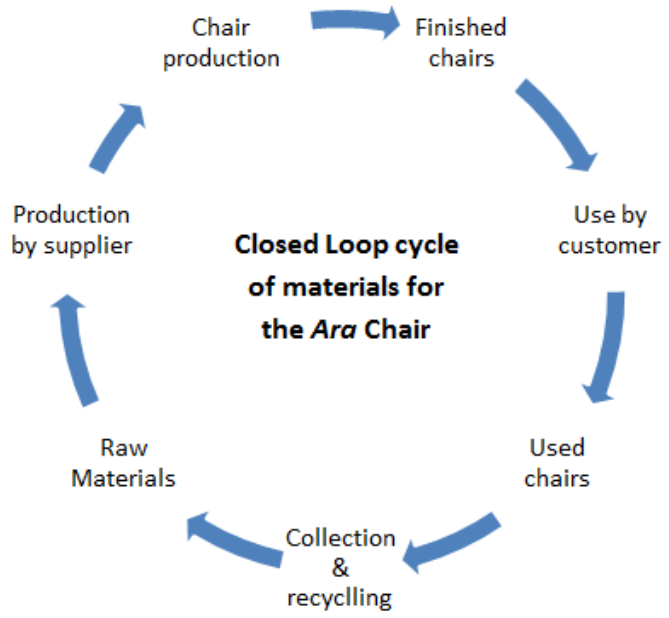


Figure 2.13: Closed Loop of Orangebox's *Ara* chair (Orangebox, 2013)

However, the use of LCA methodologies is not widespread. An LCA can be quite difficult to perform, even for large companies (Allen, et al., 2001). Undertaking a *full* LCA method is not suitable for SMEs, as it is too costly and time-intensive (de Haes & van Rooijen, 2005; Dimache, et al., 2009). *Abridged* LCA methods are less rigorous, but can highlight where significant environmental impacts occur, to help decision making in the design process (Dimache, et al., 2009).

LCAs are rarely carried out by small organisations. More accessible tools need to be developed for manufacturing SMEs. LCAs are limited by the fact that it takes a lot of effort and resources[15] to collect and analyse the data to carry out the assessment. Also, the potential impacts measured may not reflect reality[16]. Although an LCA is the best tool to measure and compare environmental

[14] This certification is an eco-label focused on materials that are safe to use and recycling processes for future, assessing products in five areas (material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness) (c2ccertified.org, 2014)

[15] Such as access to databases and time spent on the analysis

[16] For example information on what happens when policies and standard procedures are not followed are not considered

impacts, much simpler LCM tools that may be more suitable to SMEs are Life Cycle Costing, or Carbon Footprinting.

2.7.2 Life Cycle Costing

Life Cycle Costing (LCC) is used to *economically* evaluate the environmental cost of a product or service over its entire life cycle (Norris, 2001), and is a 'logical counterpart' for LCA (Kloepffer, 2008). This is particularly helpful at the design stage, as around 70% of life cycle costs are committed at this stage (Asiedu & Gu, 1998; Layer & al, 2002) (see Figure 2.14 below).

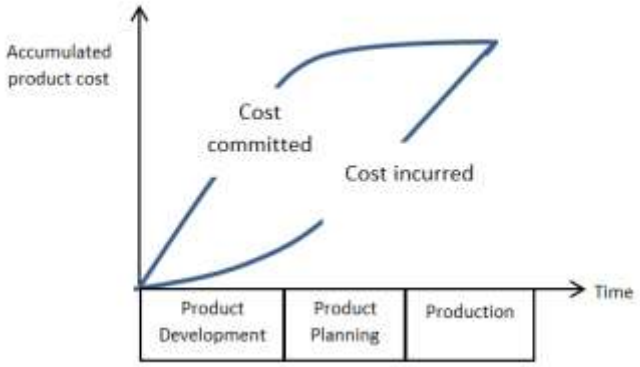


Figure 2.14: Cost of product development (Layer & al, 2002)

The initial cost from a user's perspective should consider the 'whole iceberg of costs' for a more complete picture of design cost as seen below in Figure 2.15. The purchase price should consider other costs such as; transportation and installation; start-up and training; maintenance; operating cost of energy, materials, wages and service; and disposal cost (Ehrlenspiel, et al., 2007).

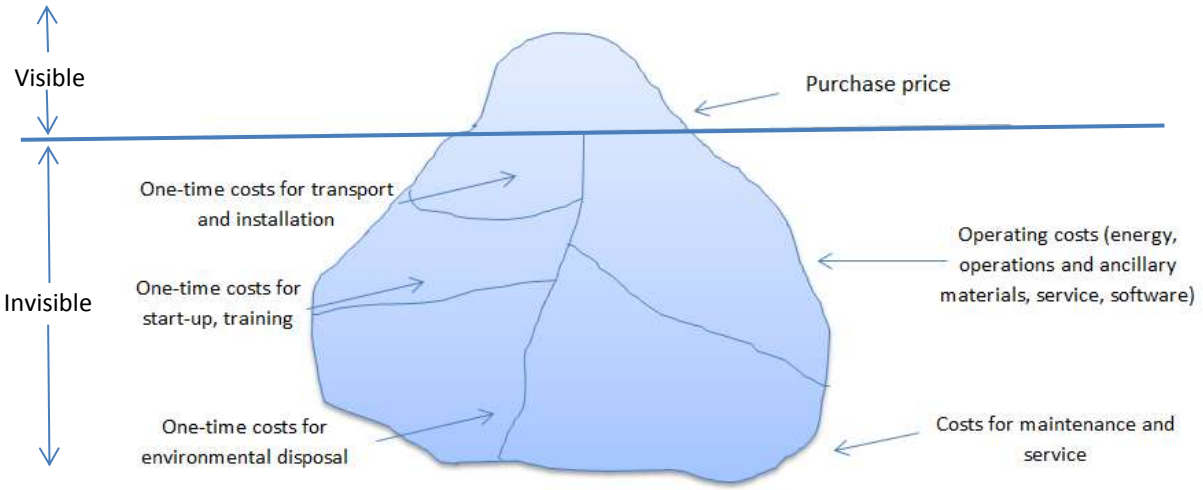


Figure 2.15: Iceberg of life cycle cost from user's perspective after (Ehrlenspiel, et al., 2007)

A simplified LCC methodology would be useful to manufacturing SMEs, before committing to life cycle costs associated with purchasing of significant items, such as manufacturing equipment and

commercial vehicles. It can be especially useful at the design stage to explore costs of manufacturing products and related services (Asiedu & Gu, 1998; Dimache, 2009).

2.7.3 Carbon Footprinting

Carbon measurement is becoming the '*new language*' in environmental impact, with carbon footprinting being recommended as a means of reducing emissions from manufactured goods (Messem, 2012). A *footprint* is "*a quantitative measurement describing the appropriation of natural resources by humans*" (Cucek, et al., 2012). Carbon footprinting is a limited LCA. It converts greenhouse gas (GHG) emissions associated with a product or an activity into a carbon dioxide equivalent (written as CO_2E). It is the most widely used method of sustainability measurement worldwide (UNEP, 2011-a; Cucek, et al., 2012).

Voluntary carbon measurement and reporting is gaining in popularity worldwide, with businesses reporting to agencies such as the carbon disclosure project, and the carbon trust (Messem, 2012; Carbon Disclosure Project, 2008). In 2013, the UK introduced compulsory carbon reporting for publicly listed businesses. It currently remains voluntary for all other business entities (DEFRA, 2013). Many large companies in Ireland are already measuring their direct emissions (Business in the Community Ireland, 2009).

SMEs can gain a competitive edge by being ahead of the crowd in adopting carbon footprinting. The benefits of carbon measurement outweigh the costs (Carbon Disclosure Project, 2008) . Carbon Footprinting is a term that is used in everyday language, which may make it easier to gain acceptance within SMEs as a performance measurement tool.

2.8 Design for the Environment (DfE) Strategies and Methods –'Design' Dimension

Manufacturing enterprises are aware that it is less efficient and more costly to be wasteful, but even world-leading companies like Volvo find it difficult to integrate sustainability and eco-innovation into their businesses (Allen, et al., 2001). The best opportunity to do so is at the design stage of a product (Westkämper, et al., 2000; Allen, et al., 2001). Sustainable solutions need to focus more on the environmental impact during the design stage of products and processes. A sustainable design approach at company level can help enable sustainable development and tackle global issues such as over-production and excessive consumption (Tukker, et al., 2008). Eco-design is an element within the sustainable design paradigm, which encompasses environmental aspects as seen below in Figure 2.16. and fits within the 'design' dimension of eco-innovation.

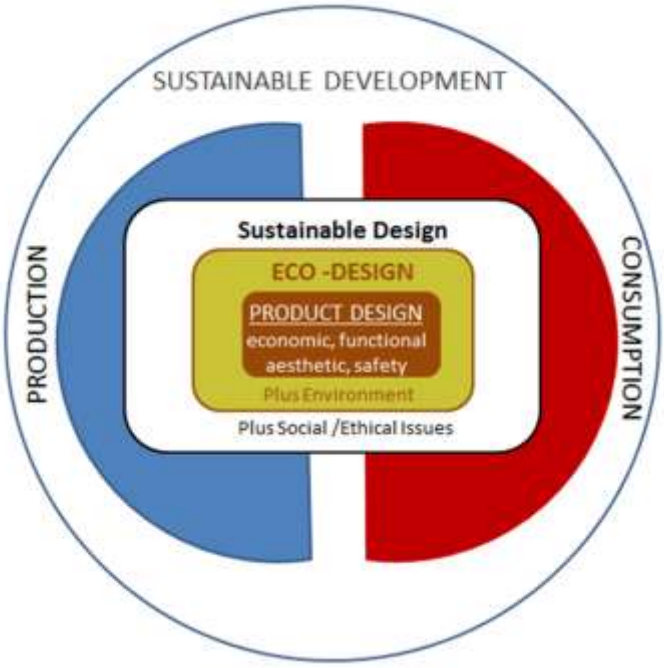


Figure 2.16: The Sustainable Design Process (Fuery, 2013)

Although an LCA is the most comprehensive tool to measure environmental impacts, *Design for Environment* methodologies can provide a simpler alternative solution for SMEs wishing to reduce their environmental impact.

Design for Environment (DfE) is defined as "*the systematic consideration, during new production and process development, of design issues associated with environmental safety and health over the full product life cycle*" (Fiskel & Wapman, 1994).

DfE provides an organised structure for companies to integrate sustainability practices (eco-efficiency, pollution prevention and clean production). DfE provides criteria for evaluating designs, based on materials, production techniques, finishing technologies, and packaging methods (Dimache, et al., 2009). The strategies and tools offered by DfE can help companies to be more environmentally responsible, while at the same time driving innovation and competitiveness (Dimache, et al., 2009). DfE can also stimulate partnerships with suppliers/distributor/recyclers, open up new market areas and increase product quality (Dimache, et al., 2009).

DfE strategies include:

- Design for product reuse
- Design for disassembly
- Design for remanufacturing
- Design for recycling
- Design for safer incineration

However, the processes for designing for the environment within companies are not clearly defined in practice (Pigosso , et al., 2013), which makes it difficult to reproduce them extensively. DfE is not usually pursued within SMEs if the benefits are seen to be purely environmental (van Hemel & Cramer, 2002).

The van Hemel & Cramer (2002) eco-design wheel identifies 33 strategies throughout the life-cycle of a product. The most succcessful are (van Hemel & Cramer, 2002):

- recycling of materials
- high reliability/durability
- recycled materials
- low energy consumption
- remanufacturing/refurbishing
- less production waste
- clean production techniques
- reduction in weight
- clean materials
- less/clean/reusable packaging.

Some studies carried out in manufacturing SMEs in Europe have seen the firms engage well with consultants on eco-design, but as soon as the support is removed, so too is the focus on environmental issues (Allen, et al., 2001).

DfE strategies and tools can give manufacturing SMEs a competitive advantage in two ways. DfE can offer a complete design-manufacturing solution to meet customer requirements. Secondly, for SMEs without design autonomy[17], DfE strategies can play a role in product innovation by advising customers on issues ranging from material selection to legislative compliance process. DfE can provide guidance on product and process design to enhance the environmental performance of a product or service, as well as providing a design input into material selection, influencing recyclability and remanufacturing.

2.9 Environmental Management Systems (EMS) – 'Governance' Dimension

The most widely recognised Environmental Management Systems (EMS)[18] are the international ISO 14001 and the equivalent European standard, EMAS (Environmental Management Assessment System) (Cleaver, 2001; Ählström, et al., 2007; EMAS, 2013; ISO, 2014). An EMS framework can be implemented within any organisation. It results in a structured management system, which can be externally audited and certified for compliance, and therefore it fits within the 'governance' dimension of eco-innovation.

The EC endorses an EMS as the most effective methodology to reduce environmental impacts within SMEs (Heras & Arana, 2010; ECAP, 2010). However, Ählström, et al., (2007) emphasised that such certification systems are not a truly objective measure of sustainability in today's globalised supply chains. The principle of visibility is not guaranteed to be upheld, because the original source of natural resources used in manufacturing is often not known at the top tier of the supply chain. This makes it very difficult to measure the true impact of the natural environment or social systems at the source (Ählström, et al., 2007). For SMEs, it is even more challenging due to their level of influence over their upstream supply chains. The United Nations recognise that an SME has limited resources to carry out in-depth analyses, but recommends that SMEs should be as vigilant as possible within their capabilities (Killian, 2012).

[17] Manufacturing SMEs are primarily situated within the supply chains of larger organisations
[18] EMSs were introduced in Chapter 2

Despite the drive from the EC to implement an EMS, there is little evidence of implementation of EMSs in SMEs. An implementation level of 6% has been recorded in Italy (ECAP, 2010), and 4% in the UK (NetRegs, 2010). In fact, only 0.4% of SMEs throughout Europe are actively involved in implementing an EMS (Constantinos, et al., 2010). The most likely reason for the slow uptake is that SMEs will not implement an EMS without some support (Chittock & Hughey, 2010; ECAP, 2010). There is a sparse (but growing) body of literature exploring the effectiveness of an EMS on a company's actual environmental performance and the research so far has been inconclusive (Heras & Arana, 2010). Another barrier to uptake is that implementing an EMS can take considerable time (Heras & Arana, 2010). Chittock & Hughey, identify nine factors related to the success of the implementation of an EMS (Chittock & Hughey, 2010):

1. adequate and consistent funding
2. collaborative relationship with industry
3. single sector programme focus
4. setting credible goals
5. info-regulation and resources available
6. threat of credible enforcement
7. regular and credible monitoring
8. visible participant benefits
9. transparent provision of programme results.

In reality, an EMS is not common in SMEs (NetRegs, 2010; Constantinos, et al., 2010; ECAP, 2010). There is an awareness among EC policy makers that there is a '*fear*' among the SME sector of EMSs, as SMEs consider them too costly and difficult to implement (ECAP, 2010; Heras & Arana, 2010). *EMAS-easy* is an EMS that has been developed specifically considering an SME's needs and resource constraints. It is intended to address the 'fear', and is described as a 'light but serious' method to implement an EMS (EMAS-easy, 2013). An EMS is most suited to medium and larger SMEs, as it is too burdensome for very small SMEs (ECAP, 2010).

2.10 Sustainability Reporting – 'Governance' Dimension

The international flow of capital, goods and services, namely globalisation, is relatively new. It has altered the scope and influence of organisations (Blowfield & Murray, 2011). Products and services have become geographically diverse in their resources, manufacturing and packaging operations, usage and end-of-life (UNEP, 2011-a). There are benefits to globalisation such as economic growth and increased employment opportunities in developing economies (Blowfield & Murray, 2011). However, there is a lack of global governance to minimise problems associated with globalisation, namely; environmental degradation, human rights violations, poverty, inequality and the universalisation of norms, values and culture (Blowfield & Murray, 2011). However, the growing access to information by consumers is increasing pressure by various interest groups on organisations to be more responsible and transparent.

Corporate Social Responsibility (CSR) can help businesses to deal with the results of globalisation. CSR is broadly defined as a firm's responsibility that extends beyond legal requirements (Blowfield & Murray, 2011; Killian, 2012). Recent times have seen the exponential growth of CSR or *sustainability reporting* among large corporations (Killian, 2012), as social impact is becoming increasingly important for competitiveness. CSR is leading to a new era of transparency in business (Kloepffer,

2008) and fits within the 'governance' dimension of eco-innovation. Critics of CSR view such self-reporting activities as purely part of a corporate marketing strategy. However, Killian (2012) argues that the motivations behind CSR activities are irrelevant if it results in responsible behaviour.

Small firms can gain advantages from CSR initiatives (Russo & Tencati, 2009). The business and moral arguments for CSR are seldom in conflict. For example, environmental improvements work in parallel with economic savings. However, s*ustainability reporting* is rare in SMEs, and they do not have the resources to assess their activities and report on them (Killian, 2012; Hohnen, 2007; Russo & Tencati, 2009).

SMEs can be exposed to economic losses if they adopt formal CSR practices (Russo & Tencati, 2009). Quantifying relevant reporting data can be difficult (Kloepffer, 2008) and burdensome in SMEs. Support systems target larger organisations, rather than SMEs (Killian, 2012) as SMEs tend to have a lower public profile than their larger counterparts (Hohnen, 2007).

The responsible behaviours of SMEs can be transformed into business opportunities (Russo & Tencati, 2009). It is best to focus on what the SME is already active in, and communicate it effectively. The earlier sections of this chapter discussed the enormous contribution SMEs make to society and the economy in Ireland, and responsible business practices are at the heart of their success.

2.11 Product Service Systems (PSS) – 'Product service' dimension

Researchers in business management and sustainability have discussed the advantages of the paradigm shift from a product system, to a *Product Service System*[19] (PSS) for many years (Allen, et al., 2001). It is a concept whereby products are *servitised*, and customers receive all the benefits of a product without having to purchase or own the product, and comes under the 'product service' dimension of eco-innovation. A PSS business model can be environmentally beneficial, even though sustainability is not built in automatically (Tukker & Tischner, 2006). The burden of ownership (including performance and maintenance) lies with the manufacturer. Therefore, it can it can lead to the design of more durable and reliable products, minimising waste and extending the life cycle of a product.

Ray Anderson, CEO of *Interface,* created a PSS model by leasing carpets instead of selling them, thereby changing the nature of supply from goods to services. The company transformed a pollution- and waste-heavy industry into an environmentally sustainable one. Based on *materials parsimony*[20] and *DfE* strategies, they created a closed-loop production model, by ensuring materials were designed for durability, remanufacture, waste minimisation and recycling (Unruh, 2010; Killian, 2012).

However, the transition from a product system, to a product-service system is a multifaceted process (Dimache, 2009). Research has reported success in high-cost products such as the Xerox photocopying model (Allen, et al., 2001) and Rolls Royce 'per hour' service for jet engines (Baines & Lightfoot, 2007). A PSS may be less accessible to the majority of SMEs, as they are often situated

[19] Product Service Systems (PSS) is also known as a *leasing product*, an *extended enterprise* and *inverse manufacturing*.

[20] *Materials Parsimony* is about minimising the types of materials used in products by using materials that can be recycled economically and safely (Unruh, 2010).

within the value chain of larger organisations, and provide products and services to other firms, who are in direct contact with the consumer. They have less influence within the supply chains and less resources to risk on reinventing their business model. Nonetheless, it is an opportunity to look for new opportunities along the product service system paradigm in an ever-increasingly servitised world, as smaller manufacturing organisations are evolving to act as outsourced services to larger companies.

2.12 Auditing Tools – 'user' dimension

SMEs can access other eco-innovation opportunities from the 'user' dimension of eco-innovaiotn through simple behaviours and techniques for minimising costs. For example, energy management can promote economic productivity, yet such efficiency improvements are not widely capitalised upon (Warr & Orsato, 2008).

SMEs have limited resources. A focus on cost related tools, such as energy, water and waste management are key to driving change. Feedback information is a key part of systems dynamics (Bertalanffy, 1950). The act of measuring and monitoring manufacturing data gives it visibility in an industrial setting. This highlights trends in the data, which directly affect activity, leading to behavioural changes (Deming, 1986). Behaviour change plays a major part in environmental improvements (Warr & Orsato, 2008). Environmental auditing tools can help SMEs manage this data and promote eco-innovation.

As SMEs have limited resources, a focus on cost-related tools, such as energy, water and waste management are key to driving change through effective feedback.

2.13 Legislation Assistance – 'user' dimension

As highlighted in section 2.3.2, compliance costs are relatively higher in SMEs than in larger organisations (Boswell, 1973; Predescu, et al., 2010). Similarly, SMEs bear a larger administrative burden from monitoring and evaluation of environmental legislative requirements (ECAP, 2010). The largest regulation impacts are on waste, water and REACH[21] (ECAP, 2010).

SME owner-managers acknowledge the necessity of legislation, but lack knowledge regarding specific environmental legislation affecting them (ECAP, 2010; Mitchell, et al., 2010). SMEs need simple eco-innovative ways from the 'user' dimension to keep up to date with their environmental legislation requirements.

2.14 Eco-innovation and Sustainability Training

While there has been a recent shift in larger organisations from a focus on *training* to a focus on *learning* (Sambrook, 2003), "*the training culture within SMEs is not well developed and relies heavily on traditional training methods*" (Hamburg & Hall, 2008). Most European SMEs don't have long-term vocational action plans (Hamburg & Hall, 2008), whereas large companies have time and resources to support their long-term strategic outlook (McPhearson, 2008). SMEs may not have departmentalised management structures in place, which leads to a lack of focus on developing a training strategy aligned to the objectives of the company (SIMPEL, 2008).

[21] Companies that produce or use chemicals must comply to REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), including manufacturers that import substances over one tonne per year

Since the 1990s, eLearning has been adopted by larger companies in a bid to reduce the cost of staff training (McPhearson, 2008) and it could play a part in a similar process within SMEs. To be globally competitive, an SME needs an accomplished workforce that is continually learning and adapting to change and to new technology (Sambrook, 2003; Hunt, 2007). eLearning could increase SMEs' participation in the knowledge economy[22] and allow them to manage their training better and more inexpensively (Hamburg & Hall, 2008).

Many advantages have been attributed to eLearning, the most obvious being its accessibility and flexibility. It can be made available to anyone, at any time, in any place and its material can be adapted, modified and updated to suit particular organisations, whether large, medium or small. (SIMPEL, 2008). The specific business related benefits of eLearning can include the cultivation of better business processes, the improvement of relationships with business partners and the increase in employee related efficiencies and enthusiasm. It can result in knowledgeable staff at less expense, as travel costs and staff downtime are not as great as external courses (McPhearson, 2008). It is also important to note that when SMEs support any kind of training, regardless of its relevance to the job, they are, in effect, building a learning culture and participating in the future-friendly knowledge economy (Antwell, 2003).

Although eLearning is assumed the perfect low-cost, flexible solution for the '*resource poor*' SME, there is little research on the application of eLearning within SMEs. Very few case studies of good practice have been reported (McPhearson, 2008; SIMPEL, 2008). There has been a good uptake in larger organisations (Hamburg & Hall, 2008; SIMPEL, 2008), because the finances and human resources for staff training are more affordable, and the eLearning options more efficient due to the economies of scale. There is also currently no clear proof that eLearning improves innovation or creativity skills which are vital to ensuring an SME's competitiveness (McPhearson, 2008).

However, eLearning has the potential to benefit SMEs (Mitchell, 2011). eLearning providers often do not develop or tailor content to SME needs because the design is influenced by traditional methods (Hamburg & Hall, 2008). SMEs need skills training that can be directly applied to the business (McPhearson, 2008). When eLearning is designed well and the value is evident to the SME audience, it could be a useful tool to support eco-innovation.

Now that the business case for sustainability and tools to manage sustainability has been discussed, the next section will look at how sustainability can be measured within an organisation.

2.15 Measuring Sustainability- Definition of Sustainability Maturity

Many agencies and programmes worldwide promote environmental sustainability, but there is no globally accepted measure of sustainability within a business. The most well-known methodologies include ISO14001, EMAS and the Carbon Trust (International Organization for Standardization, 2014; European Commission, 2014-d; The Carbon Trust, 2014). There are also 447 eco-label schemes in 197 countries, throughout 25 different industry sectors (Ecolabel Index, 2014).

In Ireland, the Business Working Responsibly Mark is a new standard based on ISO26000, incorporating environmental standards, but this is only suited to large companies (Business in the

[22] The 'knowledge economy' is a term used to describe the economy of a country where growth is no longer solely focused on the production of goods and services, but on the quantity, quality, and accessibility of information (Oxford Dictionaries, 2010).

Community Ireland, 2014). If an SME wishes to implement any of these programmes, significant resources would be required.

Some authors are critical of the objective measure of such certifications. Ählström, et al., (2007) argue that most companies infringe on the principle of visibility, in particular those with global supply chains. The primary source of the natural resources used in manufacturing is often unknown, which makes it difficult to measure the true impact (Ählström, et al., 2007). Furthermore, Parker, et al. (2009) propose that sustainability definitions should be measured in terms of improvements in *current* practices, which avoids the argument of acceptable levels of improvement.

The Global Reporting Initiative (GRI) is not a measure of sustainability, but it is the programme closest to achieving global acceptance. Meeting the reporting criteria could be viewed as a form of sustainability maturity. The GRI is a standard of sustainability reporting, and is shaping the trend of transparency and equality in organisations (particularly large ones) through standardised sustainability reporting and indicators of environmental and social impact (Global Reporting Initiative, 2012). The new GRI 4.0 guidelines place a major emphasis on stakeholder engagement and supply chains (Global Reporting Initiative, 2014).

There is an SME version[23] of the GRI guidelines, but it is often necessary for a trained expert to carry out the process, as an SME manager does not typically have the time to implement it. Considering the 'global' claims of the GRI, there is still a very small percentage of SMEs participating (7% of organisations reporting). The number of European SMEs submitting GRI reports is growing, and in 2013, the number reached a high of 237 companies (Global Reporting Initiative, 2014).

The arguments against standardisation of sustainability measurements claim that such prescribed metrics can limit the possibilities available to an organisation (Ählström, et al., 2007). The focus on sustainability improvements being "less-bad" is not an appropriate system, claims McDonough & Braungart (2013) and that "[*eco*-] *innovation by definition cannot be benchmarked*".

A summary of existing conceptual models of sustainability maturity, in Table 2.7 below, is mapped to the initial SEco Pilot Framework. These models attempt to describe a level of maturity, graduating from a low maturity level at a "defensive" stage, to higher levels reaching and "integrated" maturity in their business. Kolk & Mauser (2002) and Seidel (2011), argue that maturity levels may differ internally (across functions). This has been articulated in some models. Furthermore, consideration should be paid to the industry sector, market base, organisational goals, competitors, and the marketplace (Shahbazpour & Seidel, 2006; Acur, et al., 2003). For example, a manufacturing company operating in the German market may view sustainability as simply a hygiene factor or an *order qualifier* (Seidel, et al., 2009). However, in New Zealand manufacturers do not give as much weight in the marketplace to sustainability (Seidel, 2011). The model by Zadek (2004) is based on the case of Nike's corporate responsibility evolution since the 1990s. The highest "civil" level is attained when the company moves beyond the business case, sharing its expertise within its industry, without leveraging this practice to win new business through promotion of its respnsible business practices. These abstract models fail to illustrate complex organisational systems. However, despite

[23] The GRI 4.0 includes a "Comprehensive" set of required indicators, while the "Core" is more suited to SMEs, requiring a less detailed level of reporting for compliance.

the limitations, a staged description is a convenient technique to assess the evolution of sustainability within organisations and thereby communicate it effectively.

Sustainability Maturity Models					
Low Level of Maturity ----------→				**High level of Maturity**	
Legitimation		Moral responsibility		Competitive	(Bansal & Roth, 2000)
Sanitise		Control		Integration	(Keijzers, 2002)
Defensive	Proactive	Managed		Integrated	(Kolk & Mauser, 2002)
Defensive	Compliance	Managerial	Strategic	Civil	(Zadek, 2004)
Introverted	Extroverted	Conservative		Visionary	(Baumgartner & Ebner, 2010)
Elementary	Engaged	Innovative	Integrated	Transforming	(Mirvis & Googins, 2010)
Defensive	Proactive	Managed		Integrated	(Seidel, 2011)
Save Costs	**Be Compliant**		**Gain a Competitive advantage**	**New business model**	**Pilot Framework (Chapter 4)** (Dimache, Mitchell & O'Dowd, 2011)

Table 2.7: Summary of sustainability maturity models in the literature

Mirvis & Googins (2010) provide a detailed framework of maturity levels. There are six dimensions in each maturity stage to describe an organisation (see Table 2.8). For example, an organisation might be *elementary* in relation to its *Strategic Intent*, by being focused mainly on legal compliance. However, it may be *engaged* by being involved in some form of *Philanthropy or environmental protection*, moving towards Stage 2.

Dimensions	Stage 1: Elementary	Stage 2: Engaged	Stage 3: Innovative	Stage 4: Integrated	Stage 5: Transforming
Citizenship Concept	Jobs, Profits& Taxes	Philanthropy, Environmental Protection	Stakeholder Management	Sustainability or Triple Bottom Line	Change the Game
Strategic Intent	Legal Compliance	License to Operate	Business Case	Value Proposition	Market Creation or Social Change
Leadership	Lip Service, Out of T/ouch	Supporter, In the Loop	Steward, On Top of It	Champion, In Front of It	Visionary, Ahead of the Pack
Structure	Marginal: Staff Driven	Functional Ownership	Cross-Functional Coordination	Organizational Alignment	Mainstream: Business Driven
Issues Management	Defensive	Reactive, Policies	Responsive, Programs	Pro-Active, Systems	Defining
Stakeholder Relationships	Unilateral	Interactive	Mutual Influence	Partnership Alliance	Multi-Organization
Transparency	Flank Protection	Public Relations	Public Reporting	Assurance	Full Disclosure

Table 2.8: Stages of Corporate Citizenship ((Mirvis & Googins, 2010) emphasis added

In this study, Sustainability Maturity is defined as '*the capability of an SME owner-manager to manage the environmental sustainability of a business, including sustainability practices, knowledge of how the business impacts the environment, and awareness of how sustainability can be of business benefit*'. This is discussed further in Chapter 5 (Sections 5.2.3 and 5.2.4).

2.16 Conclusions of the Literature Review

Preserving our environment is the biggest issue facing mankind (IPCC, 2007; European Commission, 2009-b; United Nations, 2010; Braungart & McDonough, 2009). Manufacturing activities are causing catastrophic environmental problems with implications for the future life of the planet, such as the depletion of resources, emissions to the air, soil and water causing widespread pollution and climate change (Beg, et al., 2002; Braungart, et al., 2007; Reddy & Assenza, 2009; Heltberg, et al., 2009).

SMEs account for 99% of all businesses in Europe. They are "the backbone of Europe's economy" (European Commission, 2005-c) and important for society as a whole (Nooteboom, 1988; Madrid-Guijarro, et al., 2009). They employ 67% of Europe's workforce (Audretsch, et al., 2009). The activities of SMEs are contributing significantly to environmental problems (Hillary, 2000; Vesterdorf, 2005; Daddia, et al., 2010), cumulatively causing 70% of all industry related damage and producing 67% of waste within the EU (Constantinos, et al., 2010). EU countries are legally bound to reduce their emissions (European Union, 2010) and SMEs are being targeted by policy makers for improvements to be made (Daddia, et al., 2010). SMEs face many difficulties in general such as:

- Their *administrative burden* in comparison with larger enterprises (Boswell, 1973; Predescu, et al., 2010);
- *Financial issues*, for instance cash flow and access to finance, (Doern, 2009; Predescu, et al., 2010; Audretsch, et al., 2009; Ma & Lin, 2010);
- *Limited resources* (Fliess & Busquets, 2006; Aragón-Correa, et al., 2008; European Commission, 2008-c);
- *Access to appropriate information* (Edmunds & Morris, 2000; Eppler & Mengis, 2002; Wooi & Zailani, 2010);
- *Deficiencies in skills* (Nooteboom, 1988; Hassid, 2002; Hunt, 2007; Fernández-Viñé, et al., 2010).

There are certain instruments that are driving better sustainability behaviour in general, such as consumer influence (Sanchez, 2009; European Commission, 2010-e), compliance with legislation (Fernández-Viñé, et al., 2010) and the related business benefits (Sinkin, et al., 2008; Seidel, et al., 2009).

There is a strong and growing case for SMEs to embrace sustainability principles (Jones & Tilley, 2003; Saur, et al., 2003; Côté, et al., 2006; Willard, 2008; Sanchez, 2009; Fernández-Viñé, et al., 2010; Lubin & Etsy, 2010; Humes, 2011; Seidel, et al., 2009).

However, only 0.4% of SMEs have a system in place to manage their environmental performance (Constantinos, et al., 2010), and only 24% are improving their environmental performance (Tukker & Tischner, 2006). SMEs are not addressing environmental issues. They have a short-term economic and strategic outlook (Côté, et al., 2006; Ates & Bititici, 2009). There is a lack of awareness of the effect manufacturing activities have on the environment (NetRegs, 2010). SMEs consider these environmental impacts external to their business are not convinced that being green is good for

their business (ECAP, 2010; Wooi & Zailani, 2010). Environmental compliance is confusing and SMEs don't have the expertise to address it themselves (Côté, et al., 2006; ECAP, 2010), and the appropriate relevant information is not readily available (Côté, et al., 2006; Wooi & Zailani, 2010).

The result of this literature synthesis will guide the development of a solution to the research problem, *a slow uptake in sustainability practices in SMEs*. Six main factors contribute to the problem of the slow uptake of sustainable environmental practices:

(1) A *lack of awareness* of the impact their actions have on the environment (ECAP, 2010) (NetRegs, 2010);
(2) A *lack of knowledge* of sustainability including the legislation pertaining to environmental issues (Côté, et al., 2006; ECAP, 2010; Fernández-Viñé, et al., 2010) ;
(3) A *shortage of resources*, both financial and human resources, to address the issues (Fliess & Busquets, 2006; Aragón-Correa, et al., 2008);
(4) The *negative perception* that there is no immediate benefit to their organisation (Wooi & Zailani, 2010);
(5) *Insufficient supports and tools* to affect change (Arbačiauskas, et al., 2010; Romero-Martinez, et al., 2010);
(6) *Limited research* in the area of SMEs and the environment (Labonne, 2006; Daddia, et al., 2010; ACCA, 2013).

SMEs need to be supported (Predescu, et al., 2010) and these supports should be tailored for them (ECAP, 2010; ACCA, 2013). The current supports are inadequate:

- There are many supports already available for SMEs to address their environmental impact. Many are aimed only at the high-tech sectors (European Commission, 2005-c; European Commission, 2005-a; European Commission, 2008-c; BMW Regional Assembly, 2008; European Commission, 2009-a; Enterprise Europe Network, 2010; European Commission, 2010-d; Arbačiauskas, et al., 2010; Predescu, et al., 2010).
- There is little evidence indicating the effectiveness of the supports available (Romero-Martinez, et al., 2010) (Arbačiauskas, et al., 2010) and many of the funds are not being used up (Arbačiauskas, et al., 2010).

The literature review has also examined the most suitable tools and training to equip SME business owner-managers to improve environmental management practices. These should include:

- Life Cycle Management (LCM) tools, to measure environmental impact of products, services and activities (LCA, LCC and Carbon Footprinting);
- Design for Environment methods (DfE) to guide the design process towards more sustainable products, services and processes;
- Environmental Management Systems (EMS) to provide a framework to guide and implement best practice environmental management;
- Corporate Social Responsibility (CSR) assessment and reporting tools to create awareness of the benefits and gain a competitive advantage by articulating sustainable business practices;
- Product service systems (PSS) tools to explore new business models;
- Tools to audit and measure environmental indicators (waste, water and energy);
- Tools to support environmental legislation compliance;

- Eco-Innovation and sustainability training to support all of the above.

Finally, the measurement of sustainability within organisations was discussed, which concluded with a definition of sustainability maturity.

To address the problem, the researcher poses three critical research questions:

- **Research Question 1** *What factors influence positive environmental behaviour in manufacturing SMEs and why?*
- **Research Question 2** *What engineering solutions are needed to create sustainability- and eco-innovation-supports that meet the needs of manufacturing SMEs?*
- **Research Question 3** *How will the supports affect the sustainability maturity in the firm?*

The research design to address the research problem and answer the research questions, will be discussed in the next chapter.

3 Research Methodology

3.1 Introduction

3.2. The Epistemology Adopted for the Research

3.3. The Research Approach

3.4 Research Methods

3.5 The Research Design

3.6 Limitations of the Research

3.7 Conclusion of Chapter 3

3.1 Introduction

The aim of this research is to deepen the understanding of and to develop new insights into the practices of sustainability and eco-innovation in manufacturing SMEs. It involves the development and testing of a framework to improve levels of *sustainability maturity* (defined in section 1.3) within these organisations. The broad themes under investigation span various fields (namely engineering, business and management).

This chapter describes the researcher's philosophical stance, and describes how the research was designed and executed.

3.2 The Epistemology Adopted for the Research

All research is influenced by fundamental assumptions about knowledge and how it is acquired, which form the foundations for the *research paradigm* (Institutes of Technology Ireland, 2010). The research design is formed from the layers within this paradigm (as depicted in Figure 3.1). Starting with the outermost layer, the ontological considerations refer to the nature of reality. At one extreme, ontology can be *objective*, which asserts a position that reality exists independent of the researcher observing the social phenomena under investigation. At the other extreme, reality is considered socially constructed, and a researcher's *subjectivity* influences the construction of reality (Bryman, 2008). An objective ontology is the preferred ontology for this research, as it allows the researcher to focus on facts rather than meanings. Epistemological considerations are concerned with the generation of '*acceptable knowledge*' in a discipline (Bryman, 2008). The researcher's philosophical stance, or *epistemology*, is embedded within the research paradigm; which in turn influences the research approach, the methods chosen and the insights gained by the researcher (Saunders, et al., 2003; Institutes of Technology Ireland, 2010).

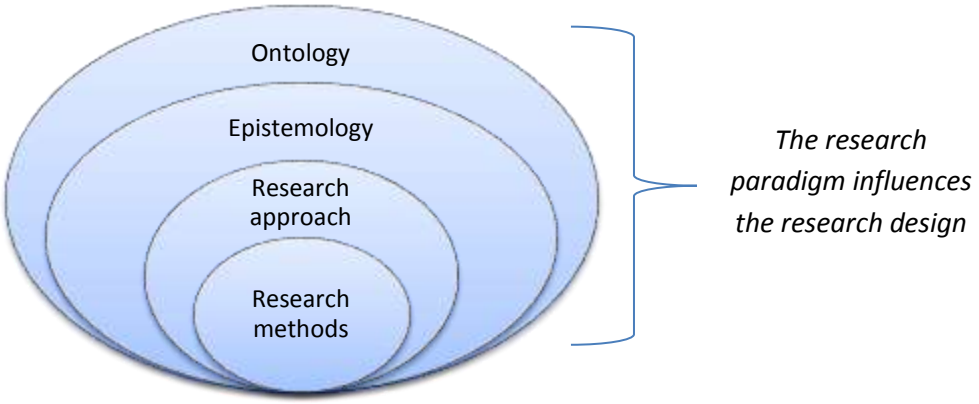


Figure 3.1: Layered description of the research paradigm (adopted from Saunders et al ((2003))

The natural sciences traditionally take a *positivist* stance in the generation of new knowledge. *Positivism* refers to the epistemological perspective which generally employs quantitative methods and claims to provide objective evidence through empirical data to test hypotheses (Burgess, et al., 2006; Bryman, 2008). *Post-positivism* may be considered more appropriate in an organisational setting (such as an SME), as it is less rigid. It accepts that society is not fluid or without fault, and that it is problematic to establish absolutes. It allows for the belief that knowledge is gained through human conjecture, yet still strives for *objectivity* (Burgess, et al., 2006).

While sustainability and environmental management research does incorporate a scientific and engineering foundation, the research setting (an organisation) precludes it from being a purely scientific (positivist) investigation. Moreover, *positivism* has been criticised by several authors in the organisational research area, claiming that the viewpoint is restrictive in advancing the field of research, as it lacks a critical perspective (Welford, 1998; Ählström, et al., 2007; Seidel, 2011).

At the opposite end of the ontological spectrum lies *interpretivism*, a complete divergence from the objective views of *positivism*. An *interpretivtist* view contends that there are no absolutes because individuals and circumstances differ, and that realities depend on the inter-subjectivity between people (Burgess, et al., 2006; Bryman, 2008). *Interpretivism* contends that a researcher cannot see outside their own reality and cannot be objective.

Realism lies somewhere in the middle of this spectrum of research paradigms, and shares some concepts with *positivism*. Both *positivism* and *realism* accept that the natural and social sciences can apply similar approaches to data collection and explanation, and both accept the existence of an external reality apart from the description of it (Bryman, 2008).

One specific form, c*ritical realism,* recognises the reality of the natural world and its events, and that "*we will only be able to understand – and so change – the social world if we identify the structures at work that generate those events and discourses*" (Bhaskar, 1989). Unlike *positivism*, the *critical realist* does not ignore the social aspect in the generation of knowledge. *Critical realism* lends itself to the study of complex issues (such as the subject in this investigation) and contributes towards the understanding of complex phenomena in the natural world. For example, it will allow the consideration of context, such as the SME owner-manager's background and experiences, when taking into account the environmental performance and management of their business.

An interdisciplinary approach is appropriate to examine the complex research problem in this investigation, which is not possible through traditional single-disciplinary viewpoints. Figure 3.2 illustrates that the *critical realism* epistemology lies slightly centre left on the ontological spectrum, lying closer to the objective focus than subjective. Both quantitative and qualitative methods can be employed, to allow the ideal and the feasible to converge, which will ultimately lead to new knowledge generation in the research area which is objective and context specific.

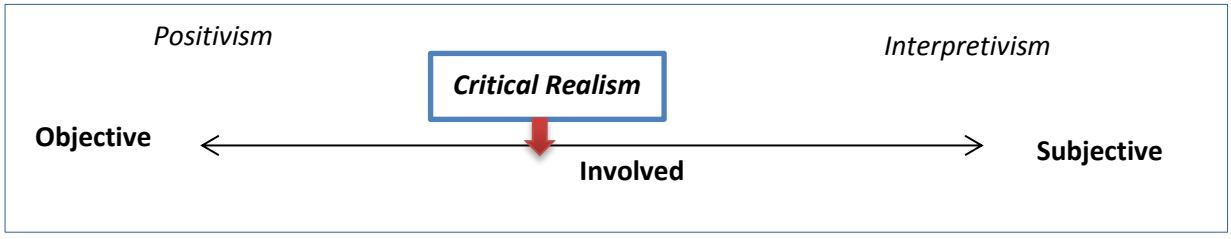


Figure 3.2: Epistemological paradigm choice for this research

3.3 The Research Approach

A number of elements contribute to the research approach in this study, as illustrated in Figure 3.3 below. Firstly, *systems' thinking* (which is discussed below) aligns with the holistic epistemological position of *critical realism*, and falls in the paradigm spectrum where a combination of mixed methods is used to collect data. Secondly, an *action research* approach allows the researcher to

collaborate with members of the research setting in the development of a solution. Finally, *triangulation* is applied from a number of data collection methods to increase validity of the process and the confidence in conclusions drawn. These three concepts are discussed in the following sections.

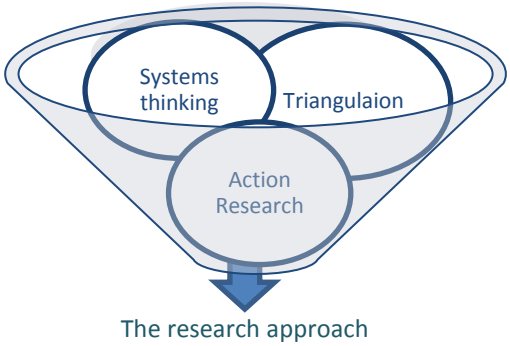


Figure 3.3: Elements combined to form the overall research approach in this study

3.3.1 Systems Thinking

SMEs are complex social systems. The study of a research problem is difficult when it includes a social system. *Systems thinking* has been applied effectively in complex organisational research, as it views problems in the context of their internal and external environment and can capture interactions and feedback through the use of feedback loops (Maani & Cavana, 2007; Seidel, 2011). *Systems thinking* is a holistic approach which allows a 'bigger picture' to be formed by looking at how a system's constituent parts influence one another as a whole, lending itself well to interdisciplinary research (Meadows, 2009; Sterman, 2002; Kelly, 1998; Arbnor & Bjerke, 1997).

Systems thinking has its origins in the 1950s, when a biologist, Ludvig von Bertanlanffy, sought to include a generalisation of theory beyond the limitations of the dominant, mechanistic world-view of the time. The term *General System Theory* was coined by von Bertanlanffy (1950) in an attempt to emphasise a necessity to allow the dynamic interaction of organisms to be investigated, instead of studying a collection of their individual parts (von Bertalanffy, 1950).

The term *systems dynamics* evolved from engineering traditions of control theory and servomechanisms design in MIT in the 1950s. It is argued by Sterman (2002), that engineering solutions to problems are set to fail in the absence of a systems view, and that:

> *"for many of the most important problems, there are no purely technical solutions…because there are no purely technical problems … engineering must consider the social, political, ecological and other impacts of proposed technical solutions"* (Sterman, 2002).

Sterman (2002) argues that the world-view of an engineer can contribute to the complexity of a social system. An intervention to solve a problem comes up against this complex system, therefore it is necessary to understand the system. However, well-intended efforts can have unforeseen circumstances when trying to solve a problem related to a complex system (Sterman, 2002). The example of the 'Beer Game' is used to teach college students about systems dynamics. It can demonstrate in 15 minutes how minor changes in the size of orders in a supply chain leads to

unexpected outcomes, resulting in massive fluctuations in the system (Sterman, 2002). An SME owner-manager operates in the much more complex dynamic system of the business environment.

A *system* can be viewed as a set of elements and functions that are interrelated and organised in a way to create a pattern or a particular behaviour over time (Meadows, 2009). Changing individual elements has the least effect on the system, even though some elements, such as resources in the case of the SME, can have more of an effect than others can. However, changing the interconnections can have a radical effect (Meadows, 2009). In an SME, these interconnections can be seen as relationships (with stakeholders, funders or support agencies) which can ultimately lead to behaviour change over time.

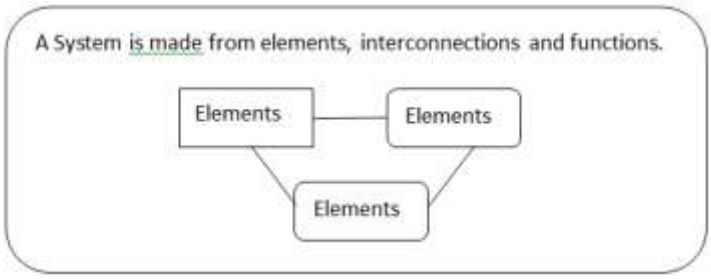


Figure 3.4: A simple system

Systems dynamics describes the *behaviour* of a *system* by stocks, flows and time delays. Stocks in systems change slower than flows. Sterman (2002) and Meadows (2009) use a metaphor of the flow of water in a bathtub to describe systems dynamics. The stock in this metaphor is the water, which can be changed by the inflow. However, it can also change at the outflow by blocking its exit (using a plug) or changing the rate of flow in that direction (Sterman, 2002; Meadows, 2009).

If the bathtub metaphor is applied to the SME system, the stock can be viewed as the SME environmental behaviour of the owner-manager[1]. The inflow is the knowledge tools and techniques, and the outflow, learning from experiences. Theoretically, the stock (the environmental behaviour) takes time to change, is subject to time delays and affected by the knowledge, tools and techniques that are applied.

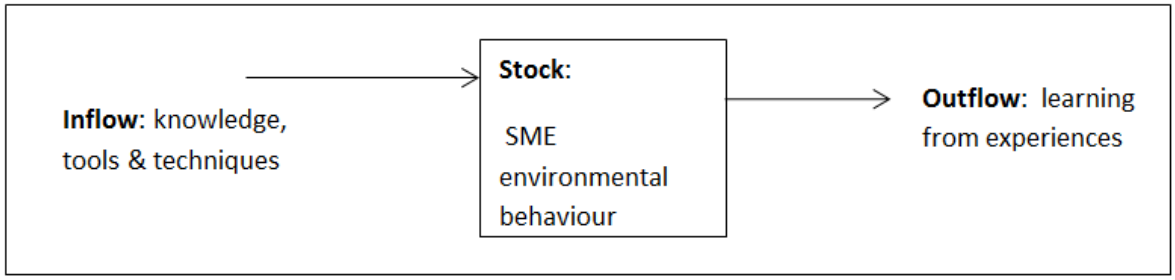


Figure 3.5: Stocks and Flows applied to the SME System and Environmental Behaviour

Feedback is also an important element of systems thinking. Solving a problem within a social system is not possible through single events. Feedback loops are the fundamental structure of systems. Feedback occurs through the flow of information back and forth (Kelly, 1998). Strategies for

[1] Measured by the *sustainability maturity*

sustainability solutions need a systems approach to enable the identification of key information about the structure and behaviour of systems (Kelly, 1998).

Systems thinking can make it possible to analyse and rationalise cause and effect on a system. It is applied to this study in the overall discussion, the development of the SEco Framework and the drawing of conclusions from the empirical data.

3.3.2 Action Research

Action Research is defined by McKay and Marshall (2001) as *"the active and deliberate self-involvement of the researcher in the context of his/her investigation."*

Action research allows for the importance of practical conclusions to be within the research process (Bryman, 2008), which is of particular importance to the SME context. The research environment (the FutureSME project described in Chapter 1, section 1.2) allowed unique access to involve 13 SME organisations and SME owner-managers throughout the four years of the research project to develop and test the practical applications.

Action research aligns with the epistemology adapted for this research, as the underlying principle of action research rejects the traditional positivist methods (Checkland, 1991). It also allows for qualitative and quantitative data collection, as is common in business and management research (Bryman, 2008). Action research is sometimes criticised for being limited, unscientific and having the potential for bias (McKay & Marshall, 2001; Bryman, 2008). However, the complexity of research in organisations (such as an SME) needs an approach beyond that of the purely scientific approach (as discussed in section 3.2 above).

Action research allows for a staged research approach to the planning and design of a project to address the research questions (McKay & Marshall, 2001). It can help to gain an understanding whether or not a methodology will work in practice, and to identify potential enhancements through these cycles (McKay & Marshall, 2001; Zuber-Skerrit & Perry, 2002).

Figure 3.6 illustrates how action research is applied to this research project over the two research stages. Firstly, the researcher engages with SME owner-managers in the planning and design of the SEco Pilot Framework to assist SMEs to improve their sustainability maturity (the SEco Pilot Framework). This happens through interviews and questionnaires with SME owner-managers (see Research Methods section 3.4). When the SEco Pilot Framework is developed, it is applied to the end-user group of SMEs, and testing activities take place. Observations and evaluations are recorded to identify gaps in the Pilot Framework. The Framework is then redesigned and improved by the researcher to create the enhanced SEco Framework, which incorporates changes to address the gaps. Several authors argue that action research should rely on the case study method (Cunningham, 1993; McKay & Marshall, 2001; Blitchfiedt & Andersen, 2006). The new enhanced SEco Framework is tested with the end-user group using testing case studies (see Research Methods section 3.4). The process ends when the research questions have been resolved, which leads to a contribution to knowledge.

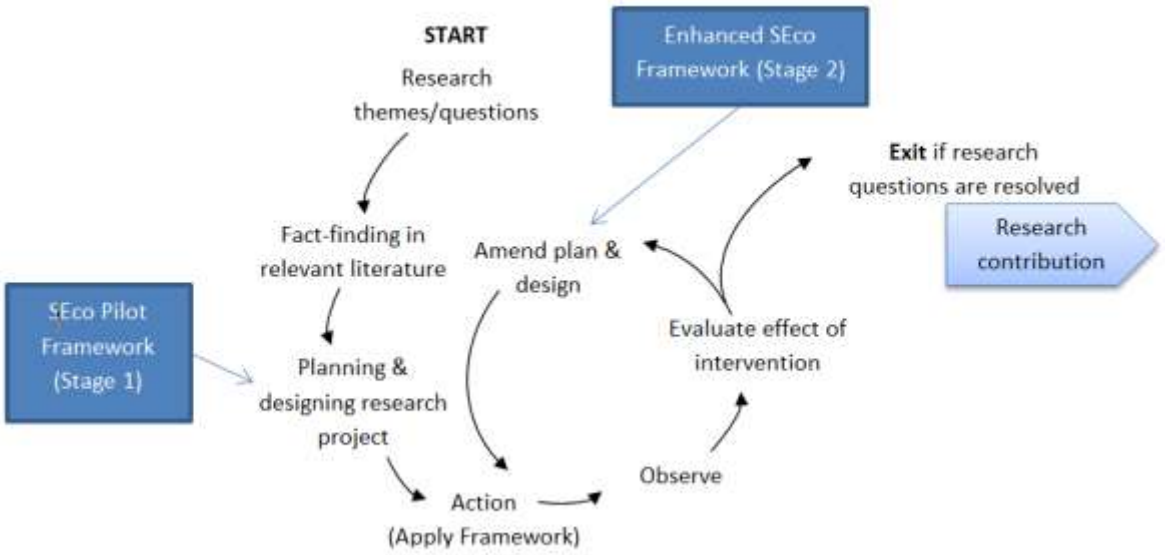


Figure 3.6: Action research applied to this research project

3.3.3 Triangulation

Webb, et al. (1996) developed triangulation as a research approach, which involves the use of mixed methods of data collection and tactics to investigate phenomena to increase the validity of the research. Jick (1979) argues that triangulation can capture a holistic interpretation that enriches understanding of the phenomena under investigation. Triangulation is employed in two main stages of this study.

Firstly, the specifications for the Pilot SEco Framework will draw from a number of sources and methods to gather the needs and requirements of SMEs (Chapter 4). Figure 3.7 summarises the triangulation approach planned at this stage which includes a literature review on best practice environmental management in SMEs, followed by online questionnaires. Follow-up interviews with SME owner-managers will also be conducted to make the quantitative questionnaire data more meaningful. This is to ensure that the set of tools and supports will meet the needs of SMEs, and be designed in a manner to suit their particular characteristics.

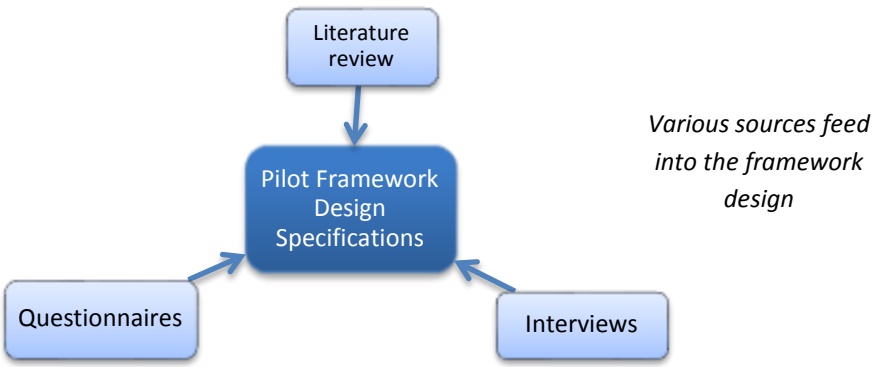


Figure 3.7: Triangulation in the SEco Pilot Framework development

Secondly, as a method of achieving greater confidence in the findings of this research study, conclusions will be drawn from various methods of testing and analysis of the Pilot and Enhanced SEco Framework (see Figure 3.8). Individual elements will be tested using checklists and participant observation. The entire SEco Framework will be tested through the analysis of the test companies, which will provide rich data from real-life applications. Other measures will also be incorporated, such as feedback received in project meetings, and unobtrusive measures via monitoring the use of the online tools on the website by the SME owner-managers.

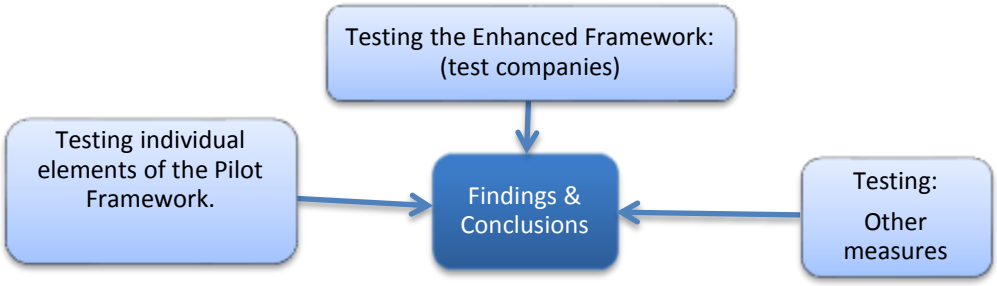


Figure 3.8: Triangulation to validate findings and conclusions of the research

There are advantages and limitations to all research methods. Jick (1979) highlights that limitations in *triangulation* as an approach, often relate to the replication of the research. This is particularly true when an organisation is the subject of the investigation. There is no prescribed method to conclude on mixed methods and triangulation. The analysis process, whether convergent or divergent, always leaves the researcher seeking out logical patterns and findings in the data (Jick, 1979). Unexpected results can emerge. However, mixed methods and triangulation aim to minimise any weaknesses in a research strategy. The integration of fieldwork, questionnaires, checklists, interviews and testing case studies generate a rich and comprehensive picture of sustainability within manufacturing SME organisations.

3.4 Research Design

The aim of the research design is to guide the researcher to collect, analyse and extract significant findings from the investigation. It is "*a logical model of proof that allows the researcher to draw inferences concerning causal relations among the variables under investigations*" (Nachmias & Nachmias, 1992) cited in (Yin, 2009, p. 26). This section deals with the research design as a whole, describing the process and the steps taken.

Progressive stages lead to the development and testing of a SEco Framework for SMEs (Figure 3.9):

1. Background – The Literature Review stage involves a synthesis of the extant literature on SMEs and the environment. This leads to the identification of the research problem and its contributing factors. It includes analysis of the best-in-class tools and methodologies for sustainability, to inform the development of a set of SME user needs.
2. Research Stage 1 – The SECo Pilot Framework specifications drew on best practice from the literature. Primary research with SMEs through surveys and interviews (see Section 3.5) led to the development of a set of SME user needs. The SEco Pilot Framework incorporated a comprehensive set of tools and methods to suit the needs and requirements of SME owner managers. This was then tested.

3. Research Stage 2 – The SECo Pilot Framework is enhanced to create the final SEco Framework. This was followed by data collection and analysis through two testing case studies (presented in section 3.5). Finally, the triangulation of the data led to the research conclusions.

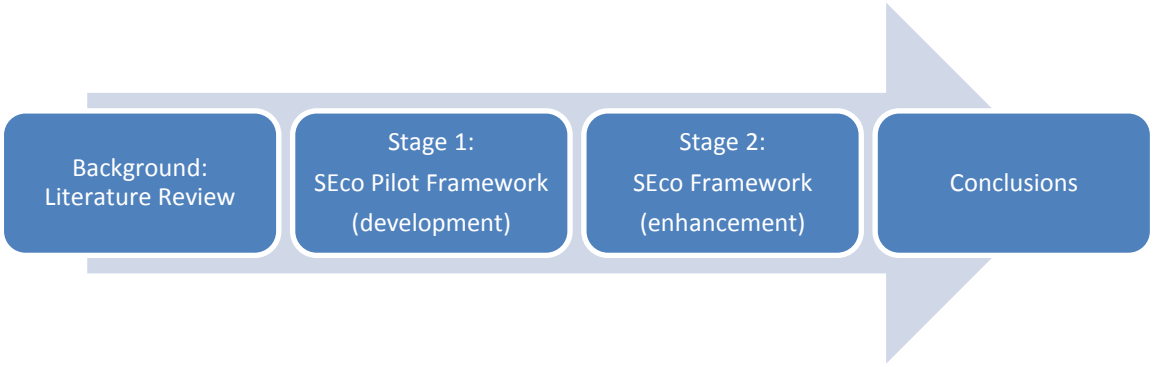


Figure 3.9: Research Design

3.4.1 Validity in the Research Design

The data collected in a research investigation is of little use unless its validity and reliability can be demonstrated (Flynn, et al., 1990; Yin, 2009). The most important criterion in research design is that of *validity*, described by Bryman (2008) as *"the integrity of the conclusions that are generated from a piece of research"*. *Validity* can be distinguished into different forms, namely *construct validity*[2], *internal validity*, *external validity* and *ecological validity* (Bryman, 2008).

Construct validity ensures that the measures used truly reflect the concept(s) they are supposed to be representing (Bryman, 2008). In this study, the overall measure used to measure the change in performance is the SME's 'Sustainability Maturity'. This is a holistic and systems approach adapted from Seidel's (2011) study of environmental management of manufacturing SMEs in New Zealand.

Internal validity concerns the causality between variables in question (Bryman, 2008). In this instance, the testing case study aims to show the improvement (or not) in one variable, the 'Sustainability Maturity' of an SME, as a result of the interventions by the researcher of the SEco Framework being applied. In order to validate this, the final stage of this framework asks the SME owner-manager if he/she believes this is the case, as well as collecting objective data (refer to Chapter 5 for full details of the SEco Framework).

External validity is about the generalisation of a study outside the research context. It concerns the selection criteria and whether or not the samples or cases used are representative of their population (Bryman, 2008). This will be assessed through the analysis of the testing case studies in Irish SMEs.

Ecological validity refers to the applicability of the findings to everyday natural settings (Bryman, 2008). This research study has been carried out in everyday manufacturing SME businesses, and feedback was gathered at every step from the owner-managers. The SEco Framework was developed with this in mind during the development and testing process. The SEco Pilot Framework is tested in an SME setting, and then enhanced to form the SEco Framework to ensure it is

[2] *Construct validity* is also called *measurement validity*

ecologically valid. A summary of how validity is incorporated into the research design is set out in Figure 3.10.

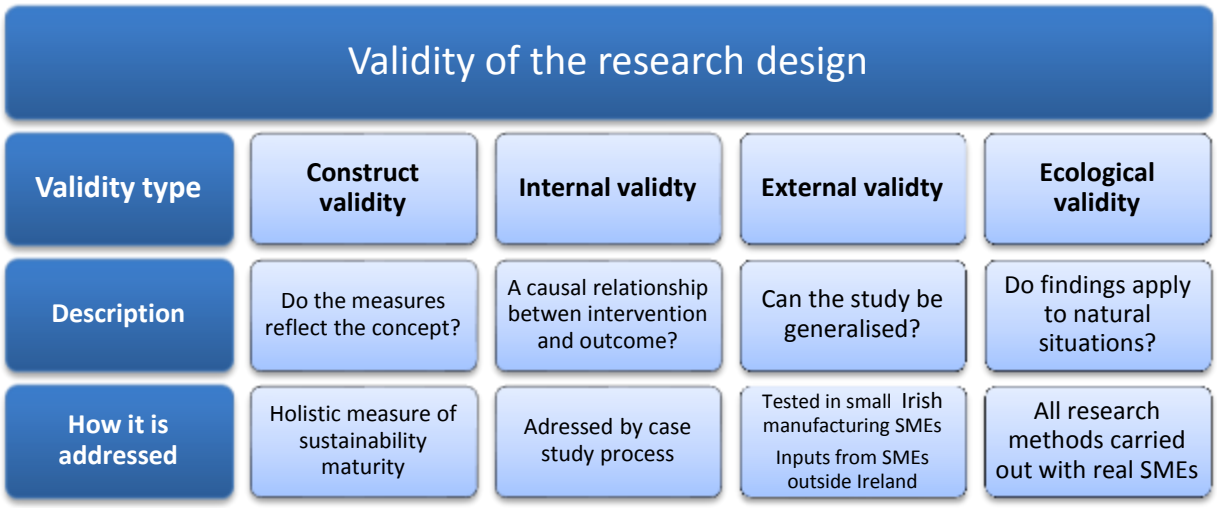


Figure 3.10: Validity of the research design

The *research design* can also be evaluated through *reliability* and *replication* as well as *validity* (Bryman, 2008). *Reliability* concerns the repeatability and stability of the data and the measures used (Bryman, 2008). This was addressed in the data collection and testing phase by repeated analysis of the data collected at each step of the process.

Replication calls for a detailed description of the procedures used to allow replication of a study by another researcher. The use of multiple cases maximises the potential for the replicability of the study.

A validation methodology developed by Cormican & Van Leeuwen (2006), will assess the validity of the data collected. This methodology is based on a synthesis of a wide range of literature on the validating frameworks and methodologies. Table 3.1 shows Cormican & Van Leeuwen's criteria categories and related questions, mapped to validity types, which will act to validate the SEco Framework as follows:

- *Construct validity* is assessed by questioning the chain of evidence throughout the entire framework for the concepts being studied
- *Internal validity* seeks to find if the results of the interventions have shown any positive improvements by questioning the effectiveness, manageability, reliability and accuracy.
- *External validity* is assessed through the replicated case studies, which can help to underpin the validity of the framework.
- *Ecological validity* is assessed through examining how comprehensive the methodology is to the participants and how acceptable it is to the SME owner managers, including the efficiency of the framework, considering the characteristics of SMEs lack the resources to engage in improvement practices and comprehensibility.
- The *reliability* of the SEco framework is addressed by assessing its stability, robustness and flexibility.

- The *replicability* calls for detailed procedures, which are set out in the SEco Framework itself through the testing case studies.

Cormican & Van Leeuwen's Criteria	How the criteria is assessed	Mapping to validity
• **Effective**	• Does the methodology work? • Does it solve the problems, or produce the products, for which it is intended? • Do projects that follow the methodology turn out successfully?	• Construct validity • Internal validity
• **Efficient**	• Are all the tasks and activities prescribed by the methodology strictly necessary? • Are all legitimate short cuts exploited? • Is there any redundant effort?	• Construct validity • Ecological validity
• **Universally applicable** • **Comprehensive**	• Does the methodology work across the whole of a domain? Is this a general-purpose methodology or a specialized methodology? • If there are any restrictions on the range of situations that the methodology can handle, are these restrictions well understood? • Does the methodology work in any organization size or culture, or does it assume a particular organization or management style. • Does the methodology have limits of the size or complexity of projects it can handle?	• Construct validity • External validity • Ecological validity
• **Reliable** • **Accurate**	• What risks are involved in using the methodology? • How are the risks minimized? • At what stage of a project can we be reasonably certain of success? • What quality control procedures are there, and how do they work?	• Construct validity • Internal validity
• **Stable** • **Robust** • **Flexible** • **Evolving**	• Is the methodology tolerant of minor errors and alterations? • Does the methodology allow for human imperfection? • Does the methodology contain a self-preservation mechanism, to maintain its relevance within the organization? • Is the methodology capable of incremental change, to cope with new ideas or technological opportunities? • Is the methodology capable of incorporating improvements learned from experience?	• Construct validity • Ecological validity • Reliability
• **Simple, easy to learn and use** • **Acceptable to participants**	• Is the methodology targeted at a well-defined population? • Is the methodology based on a coherent set of concepts and techniques? • Are all the concepts and techniques strictly necessary? • Does the methodology conform to the prevailing conceptual paradigms and values? • Is it easy to motivate people to adhere to the methodology? • Is the methodology scalable (in other words, does the complexity of the methodology grow in proportion to the complexity of the problem faced, or do you have to have complex solutions even to simple problems)?	• Construct validity • Ecological validity

Cormican & Van Leeuwen's Criteria	How the criteria is assessed	Mapping to validity
• **Manageable**	• Does the methodology provide guidelines for the management environment of the project (including project management, inter-project coordination, risk assessment and quality management)? • Does the methodology clearly state what it regards as success or failure for a project, and provide suitable measures (e.g. for productivity and quality)? • Is the methodology self-monitoring? In other words, does it provide the project manager with information about the effectiveness of the process?	• Construct validity • Internal validity
• **Visible** • **Comprehensible**	• Does the methodology make its reasoning clear and visible to the participants, so that they can intelligently judge the relevance and completeness of each piece of work? • Do participants attribute their successes (if any) to the methodology?	• Construct validity • Ecological validity
• **Well supported**	• To what extent are relevant tools, skills and services currently available to support this methodology? • What are the future prospects for the development and commercial dissemination of such tools, skills and services? In other words, is the methodology automatable?	• Construct validity • External validity

Table 3.1: Cormican & Van Leeuwen's (2006) criteria and questions used for validation of the SEco Framework

3.4.2 The Researcher's Preferences

The research design of any investigation is innately influenced by the researcher's background and preferences. According to Arbnor & Bjerke (1997), "*you can never empirically or logically determine the best approach. This can only be done reflectively by considering a situation to be studied and your own opinion of life*". The researcher brings with her a distinctive perspective to the debate because of her previous experiences.

The choices made, are to some extent, resulting from a certain worldview held before starting the investigation. The researcher had a prior interest in both environmental issues and supporting small business owners. The researcher had previously run a small business, developed a social enterprise and gained experience in an EU entrepreneurship development programme. There was already an awareness of the stark differences in the operation and success of smaller organisations compared to their larger counterparts. This clarity was due to the researcher's previous positions in large multinational manufacturing organisations (in an engineering role). These combined experiences helped to guide the researcher through the synthesis of the literature, highlighting how smaller businesses are constrained by their size and associated characteristics.

Another factor that guided the researcher was her educational background. The researcher's undergraduate degree was in Industrial Engineering. Defined by the Institute of Industrial Engineers (2013), this branch of engineering is concerned with the:

> *"design, improvement and installation of integrated systems of people, materials, information, equipment and energy. It draws upon specialized knowledge and skill in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design, to specify, predict, and evaluate the results to be obtained from such systems"*

Industrial engineering marries the diverse fields of mechanical engineering, business and management to optimise production and people with a systems perspective. This guided the choice of a systems-thinking perspective rather than a segmented perspective.

3.5 Data Collection Methods

Research methods form the inner layer of the research paradigm (Figure 3.1) and are the techniques for collecting data. These are chosen based on the epistemological position of the researcher. Due to the holistic systems thinking approach taken in this study, a variety of methods are used. Mixed research methods in quantitative and qualitative research can be complimentary by offsetting each other's strengths and weaknesses to enhance the credibility of the findings. Quantitative methods (such as surveys) provide numerical accounts of phenomena, whereas the qualitative ones (e.g. interviews) are associated with a holistic perspective (Institutes of Technology Ireland, 2010; Bryman, 2008). The methods for collecting this data are discussed in this section.

3.5.1 How the Data Collection Methods Map to the Research Paradigm

The FutureSME project facilitated a range of opportunities for data collection throughout the research project. The 13 partner SMEs representing end-user were particularly instrumental to the design and the development of the Pilot and the Enhanced SEco Framework. This allowed a prolonged involvement and persistent observation of the target research group – manufacturing SMEs. To improve the reliability of the research a number of recommendations for best practice data collection proposed by Long and Johnson were applied (Long & Johnson, 2000). Table 3.2 summarises these recommendations and maps them to their application in this research project.

Recommendation by Long and Johnson (2000)	How this is applied in this research	Why this was applied	Where it was applied
Respondent validation	After a survey was conducted	To confirm the reporting of responses in survey	Primary research to input to the design of the Framework
Prolonged involvement and persistent observation	The Future SME project facilitated this through face-to-face and online project meetings and stage gate reviews	For the researcher to spend time in the research environment to build trust and to avoid misinformation	Throughout the entire project
Peer debriefing	With research supervisors	To allow the research material to be reviewed	Approximately fortnightly throughout the entire project
Triangulation	Action research, surveys & case studies	The use of multiple data collection methods	Throughout the entire project
Audit of the decision trails	Researcher's journals and drafting of research documents	To collate all sources of data, techniques, experiences, meanings interpreted and influences on the researcher	Throughout the entire project

Table 3.2: Best practice recommendations for data collection (Long & Johnson, 2000)

The research methods were chosen based on the epistemological considerations of the research paradigm, which in turn influenced the research approach. A *critical realist* epistemology allows the

researcher to independently and objectively contribute to knowledge, taking into consideration the context specific situation of the SME. The research approach employed *systems thinking, action research* and *triangulation* due to the complexity of the research problem. Figure 3.11 maps the choices made for this research.

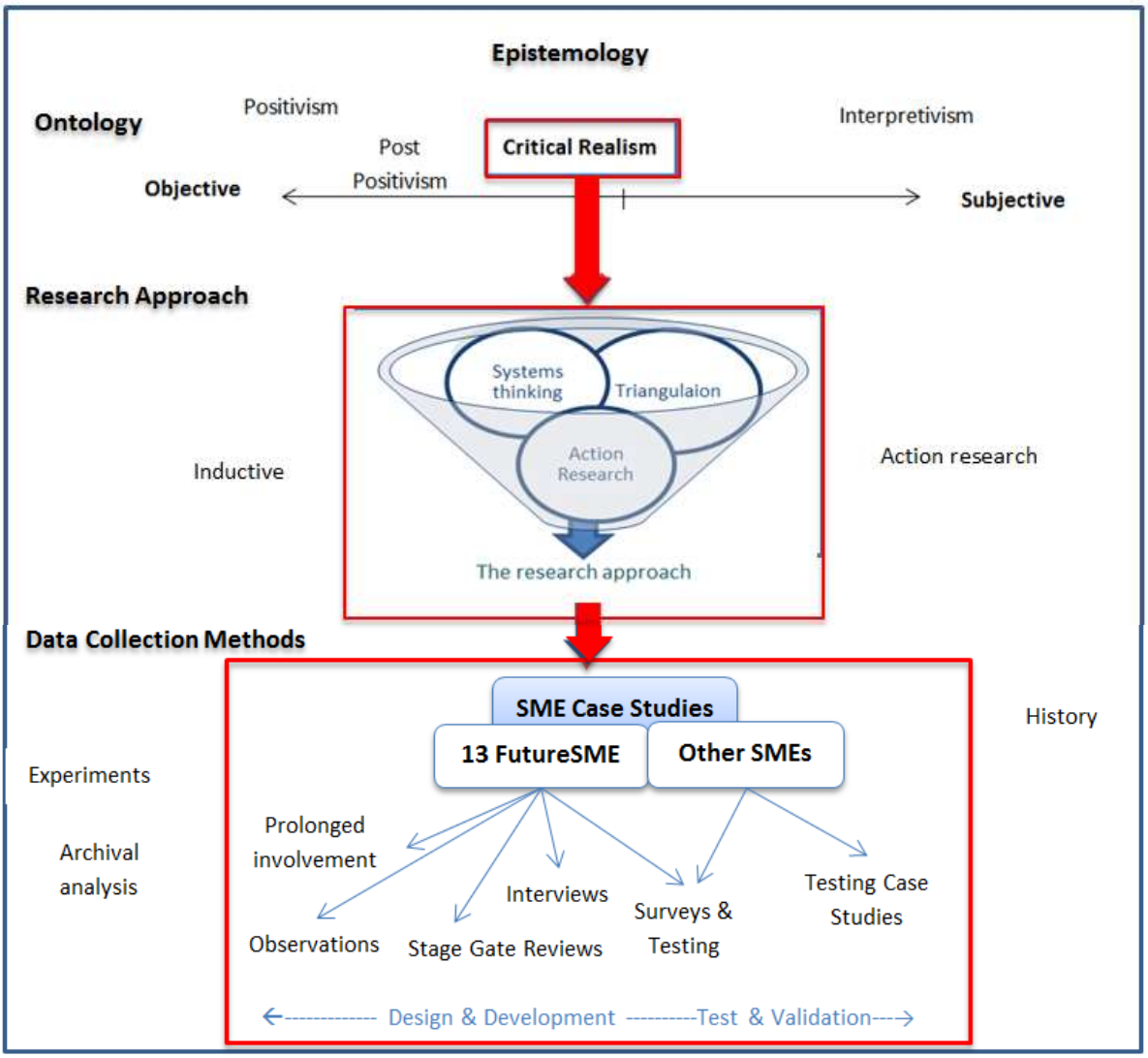


Figure 3.11: Research methods matched to the research paradigm (methods used highlighted in red)

The data collections methods were applied throughout the research project, from the design and development of the SEco Framework, through to the testing and validation. A number of primary research studies were completed at the design a development stage with SME owner-managers. Table 3.3 summarises these studies, why they were conducted, how the analysis was carried out and what it expected from the data. Chapter 4 (section 4.4) discusses these in more detail and provides the findings. Table 3.3

Study	Reason to carry it out	How the analysis is done	What the analysis is expected to tells us about the data
Environmental challenges and opportunities for SMEs.	To investigate environmental threats and opportunities currently facing SMEs.	Questionnaire & interviews	How current trends among SMEs compare with the extant literature in the area
An analysis of corporate social responsibility (CSR) in SMEs.	To investigate the views of SME owner managers on Corporate Social Responsibility (CSR)	Questionnaire and interview	To provide new information to this under researched area
The issues of waste in European SMEs.	To investigate the factors underpinning environmental behaviour in SMEs, using waste as an example.	Questionnaire	To allow for a deeper analysis of one of the most significant challenges for SME owner-managers in relation to sustainability

Table 3.3: Primary research studies for the design and development stages of the SEco Framework

3.5.2 Data collection protocols

The use of protocols to collect data increases the reliability of research, and in particular case study research (Yin, 2003). A case study protocol is followed to provide a structured approach to the collection and documentation of data to improve reliability and validity. The data collection protocol guides the researcher, which involves the following process:

- **Identification of company**: The unit of analysis is manufacturing SMEs, therefore, must be classified as an SME (see section 2.3) and a manufacturing enterprise (see section 1.2).
- **Interviewees**: This research is particularly interested in the views of the owner-managers, therefore this person must be available for face-to-face interview.
- **Preparation**: Prior to carrying out an interview, some research on the company is carried out. This is available for the FutureSME end-user SMEs, otherwise the company's website will be researched
- **Confidentiality**: this is maintained and communicated to the interviewees involved.
- **Organisation**: To gain an understanding of the company, information on various aspects are gathered, such as the history of the business, size, products and services and the general marketplace.
- **Interviews**: A semi-structured interview approach is taken (discussed in more detail in section 3.5.5).
- **Documentation**: Following interviews, notes and recordings are written up for analysis, and coding carried out where indicated, and a case study report is written.
- **Validation and reliability**: Testing case studies are carried out using the structure of the SEco Framework.

The data collected is used to answer the research questions. The testing *case study* is the main method chosen to answer the *how* and *why* type research questions to enable the testing and

validation of the SEco Framework. Other methods are employed in the initial stages, such as *interviews* to answer the *what* type research questions.

3.5.3 Mapping the Research Questions to the Research Methods

Table 3.4 lists the five main methods of data collection and subsequent analysis. Yin (2009) sets out three conditions that should be considered to guide a researcher's choice of methods to the relevant situations under investigations:

1. The form of the research question(s);
2. The control of behavioural events ;
3. The focus on contemporary events.

This process was completed for the current study, and the results are listed in Table 3.5. Of the five methods identified by Yin, three of these can be dismissed immediately as not appropriate for this study. In this investigation, *interventions*[3] are carried out with SMEs. However, the researcher does not have control of events within the SME, thus the *experiment* method is not relevant. This study is a focus on contemporary events, which leads to the rejection of *archival analysis* and *history* method also. A rationale for choosing between survey and case study methods will now be explained.

METHOD	(1) Form of research question	(2) Requires Control of Behavioural Events?	(3) Focuses on Contemporary Events?	To be used in this study? (=1 & 3)+ (≠2)
Survey	Who, what, where, how many, how much?	x	√	**Yes**
Case Study	How, why?	x	√	**Yes**
Experiment	How, why?	√	√	No
History	How, why?	x	x	No
Archival Analysis	Who, what, where, who many, how much?	x	x	No

Table 3.4: Methods of data collection and subsequent analysis (Yin, 2009)

The first condition concerns the form of research question(s) posed - whether they are *how*, *why* *what*, *where* and so on. The research questions posed in this study are a combination of *what*, *how* and *why* questions. Table 3.5 maps these question types to the two main methods used, the survey and the case study method.

The first two research questions are *what* questions. According to Yin (2009), a *what* question signifies that a *survey* is an appropriate method. The *what* questions in this study intended to discover:

- *What* factors influence positive environmental behaviour in SMEs and *why*? (research question 1)
- *What* engineering solutions are needed to create sustainability- and eco-innovation-supports that meet the needs of manufacturing SMEs? (research question 2)

[3] An intervention is defined in this report as activities aimed at introducing new ways of working through a series of focused activities in an organisation

In addition to a focused literature review, survey methods in the form of questionnaires and follow-up interviews were deemed relevant, and were used in the development phase of the SEco Pilot Framework to answer these two research questions.

The last research question is a *how* type question, and research question 1 has a *why* element.

- How w*ill the supports affect the environmental sustainability maturity in the firm? (research question 3)*
- *What* factors influence positive environmental behaviour in SMEs and *why*? (research question 1)

This process of allocating data collection methods was completed for the current study and the results are listed in Table 3.5. As the study relates to the investigation of current events, and the researcher does not control behaviours in the investigation, a testing *case study* method was considered relevant and chosen as the most appropriate method to answer *why* and *how* type questions.

Research Question		Method	Rationale
1	***What*** factors influence positive environmental behaviour in manufacturing SMEs and **why**?	Survey	A '*What*' and a '*why*' question with a focus on contemporary events
2	***What*** engineering solutions are needed to create sustainability- and eco-innovation-supports that meet the needs of manufacturing SMEs?	Survey	A '*What*' question with a focus on contemporary events
3	**How** w*ill the supports affect the environmental sustainability maturity in the firm?*	Case Study	A 'How' question with a focus on contemporary events

Table 3.5: Research questions mapped to the method chosen

3.5.4 Case Study

Yin (2009) defines the case study method as

> *"an empirical inquiry that investigates a contemporary phenomenon within its real life context, when the boundaries between the phenomenon and the context are not clearly evident, and in which multiple sources of evidence are used".*

As outlined above, the case study is the most suitable method to investigate and answer the *how* and *why* research questions. The case study approach assists in the development of the methodology so that it is focused on the end-user being more likely to adopt the necessary environmental behaviour changes being suggested to them. Carrillo-Hermosillaet *et al* (2010), agree that a case study is ideal for research in the area of environmental improvement, in order to gain insights through observations which may go unnoticed in quantitative analyses. Another reason for choosing the case study method is that it can assist in understanding complex phenomenon, such as that which is under scrutiny, an SME organisation (European Commission, 2005-a).

The case study is an appropriate method to observe the environmental management practices of manufacturing SMEs, including the development and testing of a sustainability framework intended to meet their needs. The case study method allows for a holistic approach to be applied when

observing complex phenomena, and for the recording of many types of empirical data, such as, interviews, meetings, surveys, documents and interactions within the real life manufacturing SME context (Yin, 2009).

The case study method is, to some degree, less accepted among the scientific community than, for example, the controlled environment of laboratory experiments (Yin, 2009). Concerns about the validity of the method claim that the case study has little basis for generalisation (Yin, 2009). However, Williams (2000), argues that a limited *moderatrum* generalisation can be made from case studies. This is a generalisation in which the characteristics of the focus of examination (in this case the sustainability characteristics of SME organisations) can be seen as instances of a broader set of distinguishable features.

Another preconception of the case study is the claim that this method is too *subjective*. However, Eisenhardt & Graebner (2007) argue that findings emerging from case studies are "*surprisingly objective*" due to the rich data that are collected, and the close adherence to the analytical procedures set out by the research design (Eisenhardt & Graebner, 2007). Case studies can also offer important elements where other research methods are limited, as they are better able to explain the *how* or *why* research questions than any other method (Yin, 2009).

More than one case study can allow for distinctive reflections about contrasting or comparative findings (Eisenhardt & Graebner, 2007; Yin, 2003). Multiple cases reveal a stronger case for the theory, and are a step towards better generalisability. The varied data of a multiple case study allows for broader explorations, offers stronger grounds and evidence for insights derived from the empirical evidence, and provides comparisons and possible replications that are not possible in a single case (Eisenhardt & Graebner, 2007).

The case study method is an iterative rather than a linear process and it aims to link the data collected in the study to the research questions (Yin, 2009). The case study design links the data to be collected in a coherent manner before preparing to collect the evidence. The preparation phase allows the researcher to develop a set of procedures to follow. The collection phase involves the collection of multiple sources of data. The researcher examines the evidence in the data analysis phase, including a cross case synthesis where applicable. Finally, the results of the study are shared to bring the results and findings to a conclusion (Yin, 2009). (The process is summarised in Figure 3.12 below). In this research study the case study method is used in the application of the SEco Framework. The evidence that will be collected will include only relevant data associated with the sustainability measures in the SME including the views of the owner-manager before and after the application of the Framework.

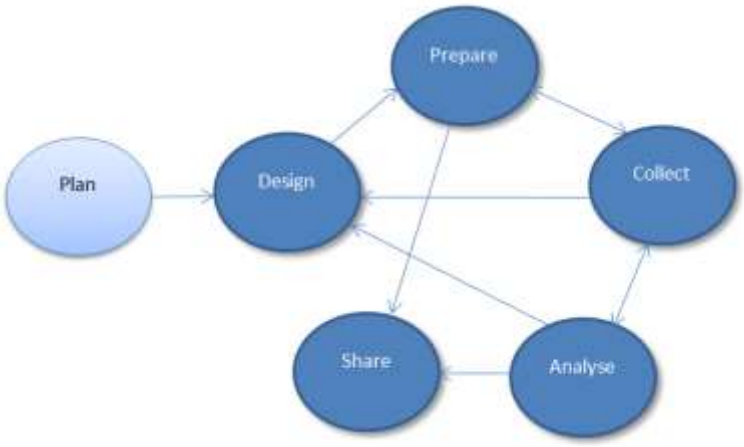


Figure 3.12: The case study research process (Yin, 2009)

Case studies do more than testing in a real-world context. They also add to existing knowledge and theory (Eisenhardt & Graebner, 2007). The main aim of the case study method in this study was to test the SEco Framework within a real-word context of an SME using an *action research* approach. All research, including the case study method, can be both *inductive* and *deductive*. Case studies can be carried out to test a theory, but theory-building also results. The evidence collected in the SEco pilot development in multiple SMEs produces new knowledge from data (*inductive*) and further testing can be carried out using subsequent case study data for additional testing.

The choice of case can affect the findings and conclusions and the possibility for generalisations, and should be suitable for "*illuminating and extending relationships and logic among theories*" (Eisenhart, 1989). Primarily, this research is limited to manufacturing SMEs. Although the research project *FutureSME* spanned nine countries, this particular study does not investigate cross-national cases in the final testing – mainly because of the practicality of carrying out such research. Focusing on the Irish SME context enables comparisons across cases to be like-for-like. The case in Ireland is also of particular interest as manufacturing companies face major competition from those based in low-cost countries, in particular since the global recession of 2008. Guided by Yin (2009), the test cases are not seen as a "sample" of the total SME population. However, the test cases were selected for the following reasons:

1. Suitability: SMEs cases should be comparable -all are Irish manufacturing SMEs
2. Insight: the likelihood that a theoretical insight can be offered
3. Revelatory: the chance that unfamiliar phenomena may emerge
4. Replication: to be able to be general enough to be replicated
5. Contrary replication: that elements of the SME organisation, or SME owner manager differ to investigate a broader range of cases
6. Pragmatic: access to the owner-manager within the organisation was a deciding factor.

3.5.5 Interview Data

A research interview is a way to extract meaning from the research topic through conversation. Interviews can be flexible methods of data collection suitable for complex issues, as new points that arise can be followed up on. They allow access to views and opinions and give more depth than that which can be gathered through other methods.

Interviewing in the project happened in two stages:

1. The initial investigations, in the early exploratory stage of the research, such as
    - Opportunities and threats of SMEs in relation to environmental issues included two in depth interviews with SME owner-managers.
    - Corporate Social Responsibility (CSR) in SMEs included one in-depth interview with an SME owner-manager.
2. The second group of interviews formed part of the case study testing of the SEco Framework, where each SME owner-manager was interviewed twice. Firstly, before the intervention of the SEco framework, and again at the review stage when the SEco Framework was applied – to measure the change in sustainability behaviour of the SME owner-manager.

These interviews had a semi-structured design resulting in a qualitative interview. A series of general questions were asked of the SME owner-managers. Unlike a structured interview, there was some latitude to ask further questions in response to what were seen as significant replies. The unstructured element allowed the style of questioning to be informal, and allowed for the phrasing and sequencing of the questions to vary from interview to interview. It allowed the interviewee's point of view to be the focus. All the interviews were held face-to-face at the SME owner-manager's manufacturing site, to allow the interviewee to be in their natural environment and to minimise disruption to the SME owner-manager.

The interview questions were phrased in a comprehensible jargon-free manner, without leading questions, and a recording device was used to minimise the need for note-taking. The interviews were then transcribed for detailed analysis and stored for future access. To eliminate possible bias further, the interview data was collected throughout the investigation, which mitigated retrospective thinking by the SME owner-manager.

3.5.6 Self-completion Questionnaires

Three online self-completion questionnaires were administered during the early/exploratory stages of the research. The advantage of this method of collecting data is that it is quick to administer, and compared to interviewing. It eliminates interviewer effect bias and variability. The research instruments related to three different subjects:

1. The perceived opportunities and threats of SMEs and the environment – Aim – to assess the current state of environmental management knowledge, perceptions, practices and future plans of manufacturing SMEs, consisting of mainly closed questions.
2. Corporate social responsibility and SMEs – Aim – a short questionnaire with open questions to gather qualitative information about what "corporate social responsibility" meant to SME owner-managers.
3. SME owner-managers perceived Environmental behaviour in SMEs – Aim – to explore waste management practices, and enquire about interventions that could lead to a positive behaviour change in behaviour.

The questionnaires were administered using an online survey tool on www.surveymonkey.com.

There are limitations to this questionnaire method. Despite the easy-to-follow design, it is not possible to prompt the respondent or probe further into the reason behind certain choices. Although it asks for the SME owner-manager to complete the questionnaire, there is no guarantee that this is the case. It is also difficult to measure the response rate. The online anonymity makes it difficult to measure the number of surveys received by SME owner-managers.

3.6 Limitations of the Research Design

Research is often constrained by the practicality of carrying out the required investigation (Bryman, 2008). Critics of a qualitative approach claim that the research can be subjective. It can rely on what the researcher's believes is significant, and may also be influenced by the relationships formed with the people being studied (Bryman, 2008). It is also claimed that it is impossible to create true replicated studies or generalise the findings of the research (Bryman, 2008).

It is not possible to eliminate bias from a research study completely. With this in mind, the following limitations and constraints have been identified:

1. **Bias –** Three possibilities of bias in this study were identified:
   - Researcher bias: The characteristics of the researcher as an interviewer may have an impact on the responses given (Bryman, 2008). An action research approach has a possibility for bias in general. However, bias is minimised by careful consideration of the research design documented here.
   - Selection bias: It is likely that companies with good environmental practices are more likely to respond to questionnaires and enquiries, which would generate selection bias.
   - Social desirability - The phenomenon of *social desirability* bias can occur in research. This means that the participant may respond in a way that is more socially desirable. This can happen in interviews and when filling out questionnaires. Surveys have been selected as a method to gather quantitative and qualitative data, but there are limitations to this method. Data collected in surveys among companies, related to environmental issues, and the results given, may often not reflect the reality. Companies tend to answer in a way that gives a positive view of their company (Fernández-Viñé, et al., 2010; Uhlaner, et al., 2010). It was not possible to monitor this phenomenon in the self-completion questionnaires. During the interviews, the researcher was prepared for this eventuality. When these questions arose, the response was invariably that their activities caused little or no damage. More probing questions followed to elicit a truer reflection of the facts.
2. **Practicalities** - The research strategy has been designed mainly around the organisations involved in the *FutureSME* project, but did extend beyond these organisations as the SEco Framework was developing. The initial exploratory stage was conducted with SMEs in the wider EU geographical area. Firms outside Ireland tested some of the individual tools. However, because of practical implications, testing the framework outside of Ireland was not viable.
3. **The topic and the population** -There were a number of considerations taken into account in relation to the SME organisations:
   - The SMEs who agreed to take part may have been open to the idea of sustainability improvements to some degree, even if they did not express this. This may have issues for replication in other SMEs who are not interested in sustainability

- SMEs are a difficult group to target, as they do not have the time to engage in the research process, and the fact that the definition of an SME is so broad it is difficult to generalise. For this study, the researcher focused on small manufacturing SMEs.

3.7 Conclusion of Chapter 3

The complex issues under investigation call for the researcher to think beyond traditional *positivist* boundaries. The philosophical stance of the researcher is that of *critical realism* with a *systems thinking* approach using an *action research* approach and *triangulation* to answer the research questions.

Quantitative and qualitative strategies are combined to give a full picture of the subject matter being investigated. The exploratory and development stages employ methods such as questionnaires, interviews, and testing checklists, whereas the testing and validation stage mainly employs an action research approach and the case study method.

This study employs mixed methods throughout the different stages of the research to suit the approaches taken. A testing case study was chosen to test the SEco Framework because:

- The research problem led to *how?* and *why?* questions being posed.
- A case study can contribute to the knowledge of organisations related to a particular phenomenon.
- The researcher is actively trying to influence and make changes within the SME, but has no direct control over the phenomenon under investigation.
- A present-day complex phenomenon (sustainability) is the focus of the study in a real-life context (in an SME manufacturing business).
- Multiple sources of evidence concerning triangulating data are collected and converge to form evidence and conclusions.

The research and development happens in a phased manner. The initial SEco Pilot Framework is tested, and then improved to form the enhanced SEco Framework. This is discussed in the next chapters, starting with the development and testing of the SEco Pilot Framework in Chapter 4.

4 Developing and Testing the SEco Pilot Framework

4.1 Introduction

This chapter summarises the development of the SEco Pilot Framework. The development process was informed by the literature review, which evaluated the state-of-the art tools, methodologies and frameworks for sustainability management in SMEs in Chapter 2. Figure 4.1 illustrates the elements feeding into the design and development of the Framework, such as the characteristics of SMEs, and factors contributing to the research problem (highlighted in chapter 2) with a systems perspective (refer to chapter 3). To ensure relevant barriers were being addressed, SME owner-managers were consulted with to gather up-to-date opinions, practices, behaviours and requirements (addressed in section 4.4). This primary research added another layer of requirements to the design specifications of the tools and methodologies in the SEco Pilot Framework. The result of the development process comprised a set of requirements and a framework for environmental training and associated tools, suitable for manufacturing SMEs.

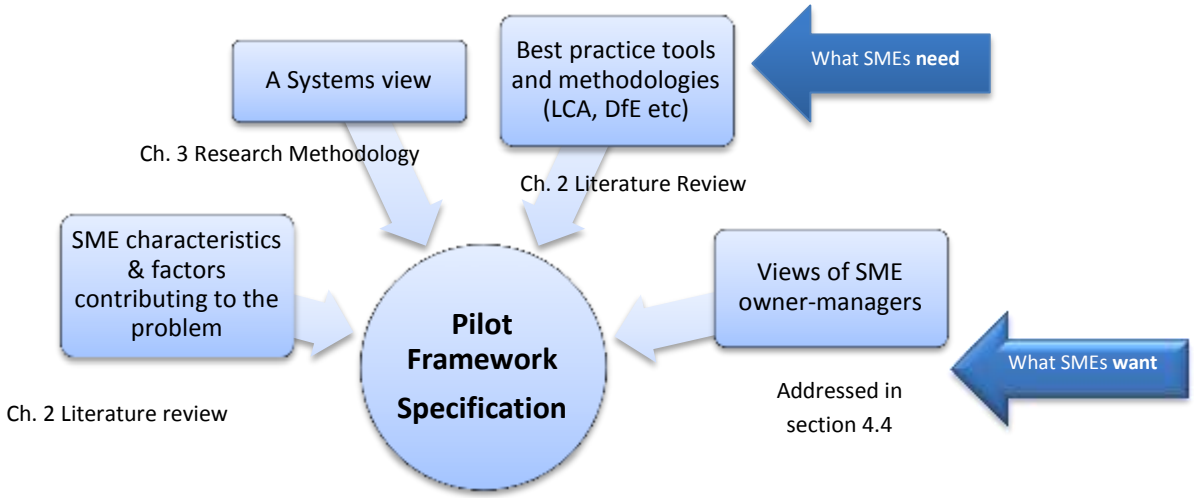


Figure 4.1: Elements feeding into the SEco Pilot Framework development process

This chapter then describes the testing of all the elements within the Pilot Framework, to establish that it is efficient and effective within the context for which it was designed. The chapter concludes with the outcomes of the testing and discusses what was successful and where gaps remain (see Figure 4.2).

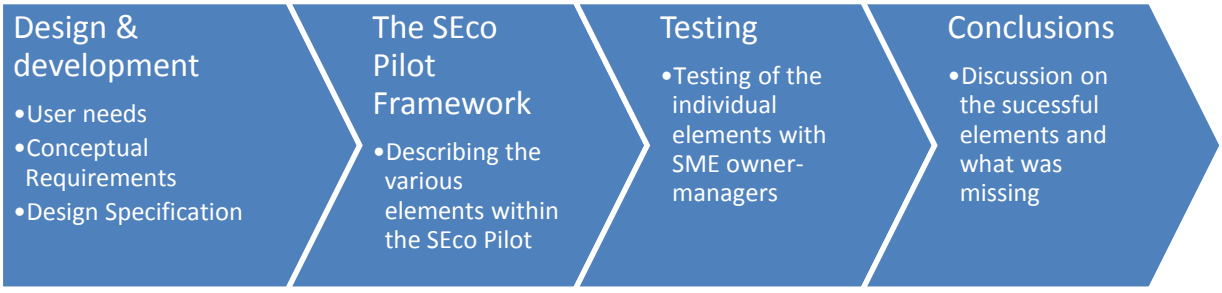


Figure 4.2: The process of development of the SEco Pilot Framework in this chapter

A pilot study is an important part of the research process. It allows researchers to test their methods are feasible and to modify them accordingly, prior to rolling out the full study (Institutes of Technology Ireland, 2010). The development of the SEco Pilot Framework will be described in four parts: the design and development, the description of the elements within the SEco Pilot Framework, the testing and conclusions drawn (see Figure 4.2). The overall aim of the development of the SEco Framework is to improve sustainability maturity in manufacturing SMEs. The purpose of the SEco Pilot is to ensure the Framework contains the correct methods and is easy and reliable to use.

The SEco Pilot Framework is a collection of tools and methodologies that have been designed to support SMEs to overcome the factors contributing to the research problem identified in Chapter 2 - a slow uptake of sustainability practices in SMEs. The tools included in the Framework are tools chosen based on the analysis completed in Chapter 2 (e.g. LCA, DfE tools etc.). All of these tools will be described individually, using screen-shots of each, to show how they work, and the simplified look and feel. Most of the tools are SME-friendly versions of already existing tools, while some are new tools created during the research project.

4.2 Conceptual Requirements

Previous sustainability research has failed to appropriately address the factors contributing to the research problem - *a slow uptake of green practices in SMEs* (identified in Chapter 2, section 2.5, The Research Problem). To create supports for SMEs, the factors affecting a broad range of SMEs including small and micro SMEs must be taken into consideration (Parker, et al., 2009; Association of Chartered Certified Accountants, 2013). Therefore, the SEco Pilot Framework needs to address the barriers identified in Chapter 2. Table 4.1 lists the conceptual requirements for SMEs to overcome these barriers to increase the uptake of better environmental practices.

Barriers for SMEs	The Pilot Framework conceptual requirements
A ***lack of awareness*** of the impact their actions have on the environment.	Communicate how and where the environmental impacts of manufacturing activities occur, and the ability to measure, thus acting to improve and reduce environmental impact.
A ***lack of knowledge*** of sustainability, including the legislation pertaining to environmental issues.	Connect SMEs with knowledge and information on environmental legislation.
A ***shortage of resources***, both financial and human resources, to address the issues.	Be of little or no cost, and take minimum time to implement.
The ***negative perception*** that there is no immediate benefit to their organisation	Lead to an improved perception that environmental issues can benefit the business rather than hinder it.
Insufficient supports and tools to affect change	Support voluntary SME improvements and any elements only suitable for larger organisations.
Limited research in the area of SMEs and the environment	Allow for feedback to contribute to knowledge in the area of SMEs and the environment.

Table 4.1: Conceptual requirements to overcome the barriers to the uptake of better environmental practices in SMEs (as identified in section 2.5, the Research Problem)

These conceptual requirements are revisited in the conclusions (chapter 7) to see how the proposed Framework addressed the barriers

4.3 Design Specifications

The literature review in Chapter 2 examined the most suitable tools and training to equip SME business owner-managers to improve environmental management practices. These should include:

- Life Cycle Management Tools (LCM) to measure environmental impact of products, services and activities
- Design for Environment methods (DfE) to guide the design process towards more sustainable products, services and equipment use
- Environmental Management Systems (EMS) to provide a framework to guide and implement best practice environmental management
- General sustainability assessment and reporting tools to create awareness of the benefits and gain a competitive advantage by articulating sustainable business practices
- Explore new business models through Product Service Systems (PSS) tools
- Audit and measure environmental indicators (waste, water and energy),
- Be compliant with environmental legislation
- Eco-Innovation and sustainability training to support all of the above.

The result of the literature synthesis and tool suitability analysis leads to the development of *a one-stop-shop* Pilot Framework to suit a broad range of manufacturing SMEs, through a *multi-method* approach.

The tables below illustrate a traceability matrix[1], listing the design specifications for the Pilot Framework. The matrix defines the:

- *User requirement specification (URS)* - the minimum specification description
- *Functional specification* (FS) - guides the *appropriate tool* selection.
- Appropriate *tools*
- *Eco-innovation and/or business benefit* mapped to the requirements
- Eco-innovation *dimension* is categorised into *design*, *user*, *governance* and *product service*.

Table 4.2 lists the design specifications and traceability matrix of the *Tools*.

Table 4.3 lists the design specifications and traceability matrix of the *Training*.

The following section will build on the design specifications and form an additional layer of requirements to be considered in the development and implementation of the tools, methodologies and training.

[1] A traceability matrix correlates requirements against proposed design specifications, and in this case the relationships to business benefits and eco-innovation dimensions.

Table 4.2: Traceability matrix of the Pilot Framework - design specifications arising from the literature review and suitability analysis of best practice (tools)

No.	User Requirement Specification (URS) (minimum requirement)	Functional Specification (FS) (What the tool should do)	Appropriate Tool(s)	Eco-innovation (What identifies it as an eco-innovation and/or business benefit)	Eco-innovation dimension
1	**Life Cycle Management Tools**				
1.1		Evaluate the environmental impact of a product/ process /activity	Life Cycle Analysis (LCA) tool(s)	• Identifies areas for environmental performance improvement • Provides data to communicate a greener product/service offering (through LCA methods including carbon footprinting)	• Design • User • Governance
1.2		Measure the overall cost and environmental impact of products and processes	Life Cycle Costing (LCC) tool(s)	• Identifies areas for environmental improvement • Identifies the environmental-related cost benefits • Provides data to communicate a greener product/service offering • Aids equipment purchasing decisions by evaluating cost over entire life-cycle	• Design • User
2	**Design for Environment (DfE) methods**				
2.1		Evaluate the compliance with legislation	Design for Environment (DfE) tool(s)	• Avoids environmental fines • Meets customer requirements	• Design • Governance
2.2		Evaluate the compliance with customer requirements		• Identifies areas for improvement • Meets customer requirements	
2.3		Measure and minimise the carbon footprint of products and processes		• Identifies areas for improvement • Provides data to communicate a greener product/service offering	• Design • Product service

No.	User Requirement Specification (URS) (minimum requirement)	Functional Specification (FS) (What the tool should do)	Appropriate Tool(s)	Eco-innovation (What identifies it as an eco-innovation and/or business benefit)	Eco-innovation dimension
3	**Environmental Management Systems**				
3.1		Conduct a gap analysis on environmental practices	Environmental Management System	• Improves environmental management, performance and compliance	• User • Governance
3.2		Implement a structured environmental management		• Provides evidence for tendering and guides sustainable procurement	
4	**Sustainability Reporting tools**				
4.1		Raise awareness of the benefits of sustainability	Sustainability Assessment	• Improves awareness of what sustainability practices are already in place and where the gaps are to guide improvements	• User • Governance
4.2		Provide a method for SMEs to report their sustainability practices publicly	Sustainability Reporting Manual	• Allows the SME to keep up with growing trend of transparency in business practices	
4.3		Provide a standard temple to create a the sustainability report	Sustainability Reporting Template	• Simplifies the sustainability reporting process	
5	**Auditing tools**				
		Measure and minimise waste streams	Waste audit tool	• Identifies opportunities for waste prevention by tracking usage patterns	• User • Governance
		Measure and minimise water usage	Water audit tool	• Identifies opportunities for water prevention by tracking usage	
		Measure and minimise energy usage	Energy audit tool	• Identifies opportunities for energy prevention by tracking usage	

No.	User Requirement Specification (URS) (minimum requirement)	Functional Specification (FS) (What the tool should do)	Appropriate Tool(s)	Eco-innovation (What identifies it as an eco-innovation and/or business benefit)	Eco-innovation dimension
6	**Legislation tool**				
6.1		Outline the purpose of environmental legislation	Environmental Legislation tool	• Reduces compliance costs • Reduces the possibility of fines • Provides guidance at the design phase	• User • Governance
6.2		Outline why a business should comply with legislation			
6.3		Signpost further information			
7	**Product Service Systems tool**				
7.1		Provide a framework for SMEs to investigate a more servitised business model	Product Service Systems tool	• Identifies the opportunities for developing sustainable servitised business models	• Design • Product Service
7.2		Provide a decision support methodology for those considering the shift to a servitised model		• Extends the life cycle of products by designing more durable products	

Table 4.3: Traceability matrix of the Pilot Framework - design specifications arising from the literature review and suitability analysis of best practice (training)

No.	User Requirement Specification (URS) (minimum requirement)	Functional Specification (FS) (What the tool should do)	Appropriate Training	Eco-innovation (What identifies it as an eco-innovation and/or business benefit)	Eco-innovation dimension
8	**Eco-Innovation and Sustainability Training – Lesson 1 Introduction**				
8.1		Create a general awareness of the importance of eco-innovation and sustainability in business	Sustainability eLearning Lesson	• Identifies the general opportunities for sustainable business practices	• User • Governance
8.2		Demonstrate the business benefits of adopting sustainable business practices using case studies		• Identifies the general business benefits of sustainable business practices	
8.3		Provide skills needed to implement simple sustainable practices within a business		• Implements the skills for sustainable business practices in general	
9	**Eco-Innovation and Sustainability Training – Lesson 2 LCA**				
9.1		Create awareness of the importance of LCA	LCA eLearning Lesson	• Identifies the opportunities for improving the design of products and services	• Design • User • Governance
9.2		Demonstrate the business benefits of an LCA through case studies in SMEs		• Identifies the business benefits of using an LCA	
9.3		Provide skills needed to implement an LCA		• Implements the skills to carry out an LCA	

No.	User Requirement Specification (URS) (minimum requirement)	Functional Specification (FS) (What the tool should do)	Appropriate Training	Eco-innovation (What identifies it as an eco-innovation and/or business benefit)	Eco-innovation dimension
10	**Eco-Innovation and Sustainability Training – Lesson 3 LCC**				
10.1		Create awareness of the importance of LCC in the design of products and services and the purchase of equipment	LCC eLearning Lesson	• Identifies the opportunities for improving the design of products and services and the purchase of equipment	• Design • User • Governance
10.2		Demonstrate the business benefits of implementing an LCC through case studies in SMEs		• Identifies the business benefits of using an LCC	
10.3		Provide skills needed to implement an LCC		• Implements the skills to carry out an LCC for design and the equipment procurement purposes	
10	**Eco-Innovation and Sustainability Training – Lesson 4 DfE**				
10.1		Create awareness of the importance of DfE in the design of products and services	DfE eLearning Lesson	• Identifies the opportunities for improving the design of products and services	• Design • User • Governance • Product Service
10.2		Demonstrate the business benefits of using DfE methods via case studies in SMEs		• Identifies the business benefits of using an DfE	
10.3		Provide skills needed to implement DfE methods		• Implements the skills to carry out DfE methods	

No.	User Requirement Specification (URS) (minimum requirement)	Functional Specification (FS) (What the tool should do)	Appropriate Training	Eco-innovation (What identifies it as an eco-innovation and/or business benefit)	Eco-innovation dimension
10	**Eco-Innovation and Sustainability Training – Lesson 5 PSS**				
10.1		Create awareness of the importance of PSS in the design of products and services	PSS eLearning Lesson	• Identifies the opportunities for improving the design of products through servitisation	• Design • Product Service • User • Governance
10.2		Demonstrate the business benefits of using PSS via case studies		• Identifies the business benefits servitisation	
10.3		Provide skills to transition towards a servitised system		• Provides a decision support methodology to assess a servitised business model	

4.4 Primary Research with SME Owner-managers

The design specifications arising from the literature review will form the main framework for the design of the Pilot Framework. However, it was crucial to involve the end-users at the design phase to ensure it met their needs, and fitted within the SME system (ECOTEC , 2000). This section aims to investigate the views of manufacturing SME owner-managers on sustainability and eco-innovation, and what they want from a Framework (Figure 4.3).

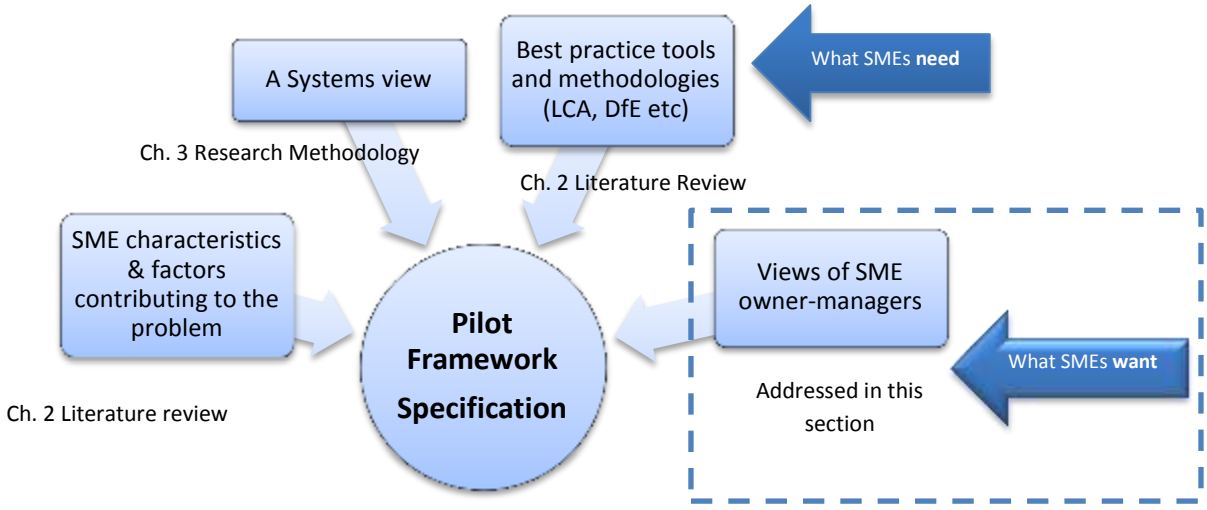


Figure 4.3: This section addresses the primary research with SME owner-managers

To gather views of SME owner-managers, primary research was carried out with them. Three surveys were conducted using questionnaires and interviews to gather data. FutureSME project meetings and stage gate reviews also feed into this process. These are summarised in Table 4.4 and discussed in the following sections.

Instrument	Method	Sample size	Title	Aims
Survey #1	Questionnaire	n=13	Environmental challenges and opportunities for SMEs.	To investigate environmental threats and opportunities currently facing SMEs.
	Interview	n=2		
Survey #2	Questionnaire	n=24	An analysis of corporate social responsibility (CSR) in SMEs.	To investigate the views of SME owner managers on Corporate Social Responsibility (CSR).
	Interview	n=1		
Survey #3	Questionnaire	n= 32	The issues of waste in European SMEs.	To investigate the factors underpinning environmental behaviour in SMEs, using waste as an example.

Table 4.4: Primary research carried out with SME owner-managers

4.4.1 Survey # 1: Environmental Challenges and Opportunities for SMEs

The aim of survey # 1 was to gain an overview of sustainability practices in a group of manufacturing SMEs, to determine what challenges they faced and whether they viewed change in this area as an opportunity or a threat.

This survey was carried out in two stages and targeted at a known sample group (FutureSME end-user participants) (see Figure 4.4). The first stage was a questionnaire, and the second stage was an in depth interview with two selected SME owner-managers. As a pre-cursor to the investigation, informal face-to-face meetings took place with all of the SMEs that participated. This allowed the researcher to build trust and to increase the chance of obtaining richer responses in the questionnaire, to overcome the difficulties of gathering data on SMEs, as reported by Côté, et al. (2006). See full questionnaire in Appendix C.

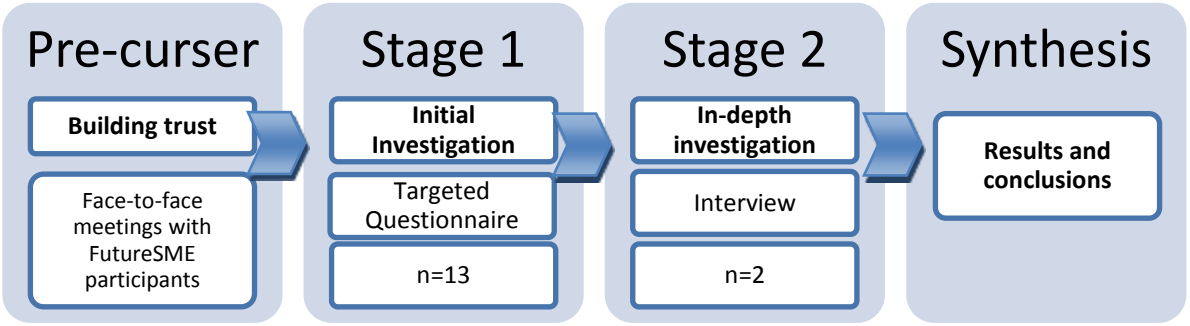


Figure 4.4: Survey #1 methods

Findings

The majority of respondents to the questionnaire (82%) considered environmental change as a business *opportunity,* for example through greener manufacturing processes and greener products. None of the SMEs considered environmental change exclusively to be a *threat*. One owner-manager saw an opportunity to increase revenue, but most (72%) saw environmental change as a potential cost increase in day-to-day business. All the SMEs reported having eco-efficient practices of some sort in place. They were all measuring the costs related environmental indicators, in an effort to reduce them.

Market demand and compliance were the main drivers cited for environmental change. Pressure was also felt from competitors. However, one SME indicated the supply chain as a driver of change.

Energy and waste were reported as the most important environmental areas. Both SME owner-managers interviewed made significant reductions in energy bills in recent years. One SME identified these cost savings after a Life Cycle Assessment[2], while the other had focused on efficient building design.

Environmental compliance was viewed as a cost and a barrier, in particular when competing with larger companies. Confusion was expressed over what regulations and standards applied to their companies, and which ones were mandatory. They were not sure where to get help on these issues and had not heard of the key support designed to address this issue, the European Compliance Assistance Programme[3]. One interviewee believed that better legislative enforcement was needed to allow companies with good environmental practices to trade on equal footing with those who have more lax practices. Another respondent was disparaging of the focus on paperwork rather than practice. The most important environmental legislation or standard mentioned was ISO14000. The Building Energy Rating (BER) directive was not considered important, even though buildings contribute approximately 40% of energy consumption and carbon emissions in Europe (European Commission, 2003-b). However, as energy was one of the most important issues reported, the SME owner-managers may not have considered this as a regulation, as many were already saving money by reducing their energy usage.

The majority of respondents (56%) stated that they were *fully* aware of their organisations' environmental impact. The majority (63%) measured cost-related environmental indicators (energy consumption, water, waste, gas and raw materials). However, most of the SMEs had never used the tools and methodologies necessary to measure their actual environmental impact, such as LCM and DfE tools. It may be concluded that none could report accurately without these tools.

The follow up interviews yielded some interesting results in relation to the timeliness of the research, as the global recession (since 2008) had a major negative effect on their business. Both companies interviewed saw the importance of environmental challenges, but admitted that the survival of the business was taking priority over all other issues.

Half of the respondents had plans to benefit from environmental issues in the future, but very few (18%) had an environmental policy which related to global issues such as climate change or global warming. Emerging technologies (73%) were considered to be the most significant environmental aspect in the following 10-15 years, closely followed by rising costs and resource shortages.

None of the SMEs stated that they measured non-monetary indicators such as carbon emissions, even though some of them stated in an earlier question that they used methodologies such as LCA.

In summary, all the SMEs could see a potential business benefit from addressing environmental issues, but still perceived it as a cost to the business. There was also an element of "*I don't know*

[2] The LCA was completed as part of a funded project. There is no expertise, or perceived need to do this on a regular basis, as their product lines do not change significantly.

[3] A support specifically designed for such issues for SMEs (refer to section 2.4.3)

where to start", in relation to compliance issues. Therefore the SEco Pilot Framework should have a focus on cost savings, environmental legislation and assistance on where to start.

4.4.2 Survey # 2: An Analysis of Corporate Social Responsibility (CSR) in SMEs

Sustainability reporting (also called CSR reporting) emerged in chapter 2 as an important area for SMEs. Survey #2 was an exploratory study to investigate this particularly under-researched area, CSR in SMEs, in particular the views of manufacturing SME owner-managers.

The survey was carried out in two stages (see Figure 4.5). The first stage was an online anonymous qualitative questionnaire (See Appendix D for the questionnaire), which was sent to a large email contact list (response rate of approximately 2%). The second stage involved in an-depth interview with one SME owner-manager, and finally a synthesis of the data was prepared using NVivo for analysis.

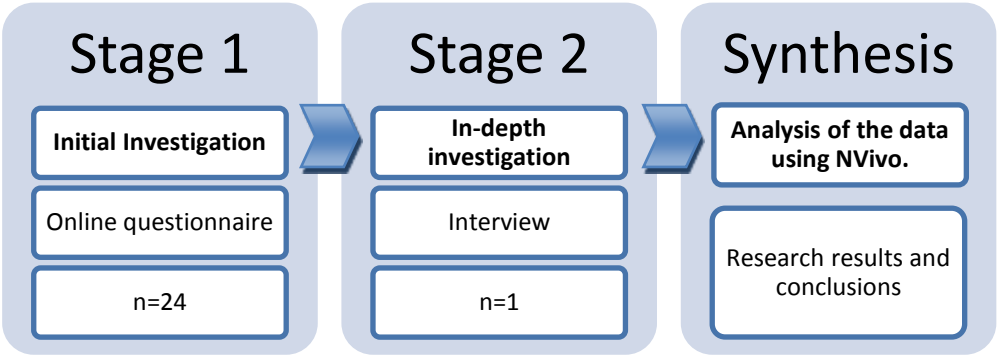


Figure 4.5: Survey #2 methods

Due to the exploratory nature of this survey, an unstructured, qualitative interview approach was taken (as mentioned in Chapter 3, section 3.4.3) to ensure that there was an emphasis on the voice of the SME owner-manager. The candidate selected was someone[4] interested in CSR, therefore, it was a *purposeful sample* (Bryman, 2008).

The data gathered was read several times and imported into NVivo for analysis. Attributes based on classification were given to the respondent and coding was completed on all responses. The questionnaire data and interview transcript were imported with the interview recordings.

Transcripts were coded into themes. Memos were created for most themes and linked accordingly to respective nodes.

The role of e*mployees* was the most prevalent theme that emerged, from both the survey and interview data. Most of the respondents had alluded to it, in particular in relation to employee welfare, and importance of creating employment opportunities. The current '*economic situation*' was referred to in many responses in relation to the SME sector being key to economic success and overcoming the recession. The area of '*integrity*' or '*ethics*' emerged as an important issue. CSR was seen as being equivalent to acting in an ethical manner, and respecting people in all business activities. The '*local community*' and '*society*' were referred to in different contexts. Some survey respondents noted that their specific products or services benefited society, for example, products designed to increase personal security were seen as socially responsible. Some respondents believed

[4] This was one of the FutureSME end-user participants.

that CSR was everyone's responsibility (not just businesses); while one respondent went further and believed that there should be a legal responsibility on businesses to support local community initiatives. There were references to specific work the SMEs were doing already. Some said that they are doing enough already, while others said CSR was too costly or time consuming for them to engage in. *CSR was seen as important*, and to a minority of respondents as a '*competitive advantage*' for their company, (in line with trends in larger organisations) as a way to differentiate them from others in the marketplace. '*Environmental issues*' cropped up frequently in the questionnaire, showing that the respondents see this as a key part of CSR. Wanting to actively measure and reduce their impact was clear in some cases. However, other respondents viewed this as a cost.

In summary, this survey and interview gave an insight into the views on CSR within SMEs. There is a clear link between CSR and the provision of employment in the community and society. The environment was also a recurring theme and the importance of realising the impact of business on the environment was indicated. A common view emerged - that SMEs have a part to play in bringing themselves, and their country out of recession - and that this was part of social responsibility.

For the purpose of the Framework development, cost is again seen a barrier. However, the topic of CSR generates a lot of interesting views. Leveraging the possible competitive advantages of CSR is an angle to address, which should be a key part of SEco Framework design.

4.4.3 Survey # 3: The Issue of Waste in Manufacturing SMEs

The purpose of this survey was to explore the issue of waste in SMEs (see Figure 4.6). This followed on from survey #1, which identified waste as one of the main environmental challenges that European SMEs face[5]. As the literature revealed, little has been done to improve waste management behaviour in smaller companies (Smyth & Lonsdale, 2010). Over the last 20 years many studies of waste management have been undertaken, but few studies specifically look at SMEs. This study sought to discover what motivates people to manage their waste, and what would encourage them to improve. Waste management practices in manufacturing SMEs were examined to investigate the factors underpinning behaviour in relation to waste prevention, reuse, recycling and recovery, activities that are commonplace in their larger counterparts. The questionnaire group consisted of a variety of manufacturing-related business sectors (see Appendix E for the questionnaire).

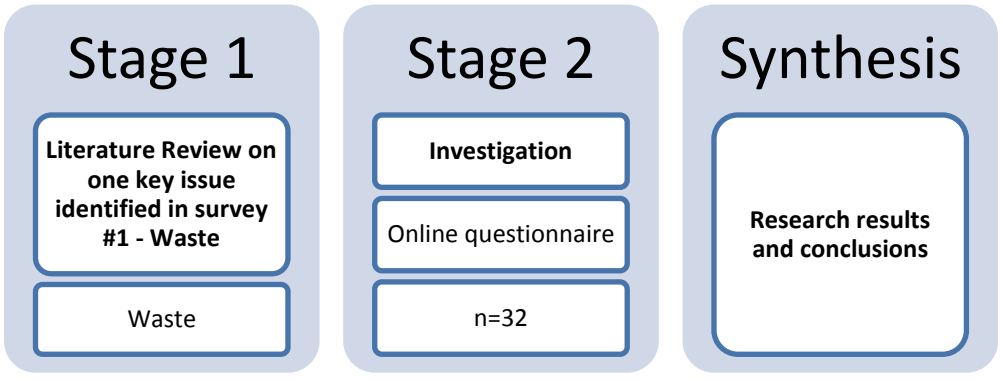


Figure 4.6: Survey #3 methods

[5] Waste and energy were equally important, but waste was chosen due to the particular difficulties reported in the literature to improve waste practices in SMEs compared to larger companies.

The survey was carried out in two stages (see Figure 4.6). The questionnaire was based on similar studies carried out on SMEs in the UK and Australia (Dye, Emma, 2008; Redmond, et al., 2008). The survey posed questions on general views on environmental issues, waste practices in their organisation, and what drives waste behaviour.

A sample of 32 SMEs from Ireland, the UK, Turkey, Italy, Sweden, and the Czech Republic were represented. Two thirds of the group were male owner-managers and the median age range was 41-50 years old.

Most of the responses (97%) indicated a general concern for environmental issues. However, having "*a safe place for their families to live'* was cited as the main reason by only 22% of the respondents. While their personal values may indicate concern for environmental issues, previous studies have shown that this concern is not always reflected in the actual behaviours (McCarty & Shrum, 1994). Furthermore, it was surprising that only 9% of the SME owner-managers claimed that the main reason for their interest in environmental issues was cost.

Although the majority of the SMEs (69%) realised that their business activities contributed to some environmental damage, only 18% actually measured it.

The owner-managers of the SMEs largely claimed to be personally responsible for waste management and environmental issues (75%). Only 22% of them did not believe waste was an important issue in their business, and 66% indicated that waste was, in fact, very important.

Almost half (47%) of the businesses were actively reducing their waste. Reuse of waste took place in 56% of the SMEs surveyed[6], and recycling took place in 59% of the businesses.

"*It was just the right thing to do"* was reported by most (63%), of the SMEs for their driver to manage their waste well. The fact that "*it costs less*" was only mentioned by 35% of the respondents. One owner-manager reported pressure from a supplier to do so. Interestingly, two of the respondents had identified new business opportunities from a waste stream.

Most of the respondents (82%) did not know what impact their waste had on the environment. Only 10% of the SMEs surveyed knew exactly what waste they generated and 70% were not sure. 20% did not believe that monitoring their waste was important. However, the majority of the SME owner-managers (60%) could not name any waste legislation with which they had to comply.

The total cost of waste from this sample of SMEs varied widely from €0 to €60,000 per annum, the average being €4,500. The view that good waste management could result in cost savings was reported by 64%. However, less than half (43%) were managing their waste to reduce cost, with a further 21% planning to do so.

This study has shown that SME owner-managers have good intentions, and wish to behave in an environmentally favourable fashion, but they may need to be "nudged" to act on these good

[6] 25% of this waste is reused for processes, 19% for products and a further 13% for composting. The materials that are being reused are mainly paper (61%), cardboard (52%) and plastic (26%), while others reuse wood, green waste, textiles and construction waste.

intentions. SME managers are keen to make a positive impact on their local communities. The SME managers surveyed claimed that they would recycle more if they knew the exact environmental benefits of doing so. Other studies have indicated that SMEs would also like reports on carbon savings or recycling quantities (Smyth & Lonsdale, 2010).

The additional key information indicates that influencing environmental behaviour could be most effective way to improve environmental behaviour. Some of specifications set out in section 4.3 were confirmed here, such as the need for environmental measurement tools and support with environmental legislation.

4.4.4 FutureSME Meetings & Stage Gate Reviews

The FutureSME project formed the basis for access to thirteen SME owner-mangers, who acted in the role of '*end-users*' for the tools and methodologies developed. This ensured continuous feedback throughout the process. Therefore, it was possible to present the SEco Pilot Framework (in various forms of progress) to SME '*end-user*' project partners as part of the development process. The FutureSME project activities included local fortnightly workgroups, monthly technology board meetings, and six monthly all-partner meetings, where the Framework was passed through a stage gate review process periodically.

Much of the other Future SME project interactions featured recurring themes, which can be summarised in a set of requirements as follows:

- Make SMEs aware of successful case studies
- Ensure all tools are simple
- Provide the tools at low or no cost
- Do not expose the SME to any significant risk
- Make the Framework easily accessible
- Ensure that the usability factor compensates for lack of resources and knowledge
- Focus on cost savings and competitiveness
- Ensure that confidentiality of business data is respected at all times
- There must be practical applications to the tools
- The design must be specific to meet SME needs
- It should take very little time to implement
- There should be a quick impact with visible results

4.4.5 Summary of Findings from Primary research - User requirement Specifications

In line with the literature review in chapter 2, the primary research indicated that the environmental area was not high on the SME agenda, and formal structures to deal with environmental issues were not commonplace.

This research indicated that the majority of SME owner-managers viewed environmental change as a cost. Compliance to requirements was seen as a threat. Findings showed that the SME owner managers did not use appropriate tools to measure the environmental impact of their products and service, even though they believed that they knew what the impact was.

SME-friendly versions of LCM and DfE tools need to be developed, to include awareness training and case studies of how this has benefitted other SMEs. See Table 4.5 below for a set of user requirements to feed into the development of the Pilot Framework.

#	Key Findings from the primary research	Applicability to the Pilot Framework development/ User Requirement
1.	Despite reports of eco-efficient practices, environmental management is considered costly by SME owner-managers.	• The cost factor needs to be addressed in a positive way to highlight cost saving opportunities. • The tools need to be free or low cost.
2.	Compliance to legislation is seen as a burden and a future threat.	• A tool to help with environmental legislation awareness, information and compliance is required.
3.	There are indications that there are no solid structure in place to monitor environmental costs.	• Tools are needed to help to manage feedback (e.g. in the form of environmental tracking of water, waste and energy).
4.	SMEs need to be "nudged" towards good practices, to capitalise on good intentions.	• The competitive advantage of responsible business practices should be centre place within the Framework design.
5.	There are good intentions, but they are not always acted upon.	• A comprehensive set of tools, formatted in an easy-to-follow way to give access at any entry level. • The design of the Framework must have practical applications, lead to visible results and be backed up by case studies.
6.	Many of the SME owner-managers did not know where to start.	
7.	Despite claiming to know what their environmental impact is, there was no evidence to back up this claim.	• Information on life-cycle tools and methodologies.

Table 4.5: Summary of key findings from primary research activities, and how it applies to the Pilot Framework

For the Framework solution to be successful, the major factors contributing to the problem identified in Chapter 2 need to be addressed because they are the *barriers* to the uptake of better environmental practices in smaller businesses. An SME-specific approach is required to encourage SME owner-managers to engage with sustainability issues (Dimache, et al., 2009; Parker, et al., 2009; Association of Chartered Certified Accountants, 2013). Small businesses require simple methodologies that are easily integrated into what they do already (Association of Chartered Certified Accountants, 2013).

The conceptual requirements listed in Table 4.1 are revisited in Table 4.6 below, to illustrate how the barriers are being addressed by the proposed requirements.

The next sections will describe the development and build of the Framework and its individual elements.

Barriers faced by SMEs	The Pilot Framework needs to…	Proposed requirements	How the barriers are being addressed
A *lack of awareness* of the impact their actions have on the environment.	• Communicate how and where the environmental impacts of manufacturing activities occur. • Measure, improve and reduce environmental impact.	• Training on the impact of products, processes and other business activities, including the importance of sustainable design.	LCA, LCC & DfE training modules.
		• Tools to measure and monitor impacts, to allow owner managers to make more informed decisions on activities from an operational, organisational and design viewpoint.	LCA, LCC, DfE & auditing tools.
A *lack of knowledge* of the legislation pertaining to environmental issues.	Connect SMEs with information on environmental legislation	• Training on environmental legislation, environmental management systems and signposting to appropriate resources.	Legislation awareness training module, EMS training.
A *shortage of resources*, both financial and human resources, to address the issues.	Be of little or no cost, and take minimum time to implement.	Framework needs to be: • Simple • Low cost • Low risk • Compensate for lack of resources and knowledge.	The entire Framework will be provided online, free of charge to registered users of FutureSME.
The *negative perception* that there is no immediate benefit to their organisation.	Lead to an improved perception that environmental issues can benefit the business rather than hinder it.	The Framework should highlight opportunities and tools to facilitate business benefits such as • Cost savings • Competitive advantage • Opportunities for sustainable business models. • Make SMEs aware of successful case studies	Auditing tools, PSS, and case studies are used in all training modules to show good examples.

Barriers faced by SMEs	The Pilot Framework needs to…	Proposed requirements	How the barriers are being addressed
***Insufficient supports and tools* to affect change.**	Support voluntary SME improvements and any elements only suitable for larger organisations.	Tools and training should be SME friendly: • Practical • Easily accessible • Respect confidentiality • Does not require expert knowledge.	• Tools vary from starter to more expert levels and focus on practical business benefits. • Can be easily accessed online. No data has to be uploaded online for the tools.
***Limited research* in the area of SMEs and the environment.**	Allow for feedback to contribute to knowledge in the area of SMEs and the environment.	• Attractive to SMEs in general to allow for information to be fed back to allow for modifications and improvements to ensure it meets the needs of SMEs.	• Testing and validation activities will take place on the Pilot Framework. • This review will inform the enhanced SEco Framework in the next stage.

Table 4.6: Conceptual requirements and where they are met in the Pilot Framework development process

4.5 The SEco Pilot Framework

Many SME owner-managers have good intentions to manage their business in a more environmentally responsible manner, as we have seen in Chapter 2. A well-designed Framework with a systems approach may be part of the solution to support SMEs, and contribute to solving the research problem, by helping them act on these good intentions. This next sections describe the SEco Pilot Framework.

The training modules and the individual tools are described. The Framework focuses on business benefits, and considers the characteristics of smaller organisations and the difficulties faced by SME owners and managers, which were defined in Chapter 2.

The development process identified tools that are simple and easy to use. The majority of the elements within the Framework were based on tools that were already in the public domain. They were packaged in a format that makes them SME-friendly, accessible and usable with a similar FutureSME *look-and-feel*.

Many of the tools were simple and downloadable for ease of access and privacy and they used software formats common to the majority of manufacturing SMEs, such as Microsoft Word, Microsoft Excel and Adobe PDF. All of these tools were developed alongside associated training material, which acts as a support to use the tools, and/or generate awareness. The eLearning lessons were built in a format that did not require the SME to have any prior knowledge of the platform.

The SEco Pilot Framework comprises seven tool and training categories, which will be further detailed in this chapter. Table 4.7 below summarises the tools and training (resulting from the literature review) and the user requirements (from the primary research). It identifies the platforms used and the source from which the SME-friendly version was adopted.

SEco Pilot Framework Specifications		
Sustainability training for SMEs		
Training Module	**Platform**	**Source or author**
Legislation	Articulate[7]	Aurora Dimache & Sinéad Mitchell
Life Cycle Analysis (LCA)	Articulate	Aurora Dimache
Life Cycle Costing (LCC)	Articulate	Aurora Dimache
Design for Environment (DfE)	Articulate	Aurora Dimache
Product Service Systems (PSS)	Articulate	Aurora Dimache
Environmental Management Systems (EMS)	Articulate	Aurora Dimache & Sinéad Mitchell
Corporate Social Responsibility (CSR)	Articulate	Sinéad Mitchell
Sustainability tools for SMEs		
Tool	**Platform**	**Source or author**
Legislation Paper	PDF	Aurora Dimache
Life Cycle Analysis (LCA) tools 1. Met Matrix 2. Eco-compass 3. Eco-indicator 99 4. Carbon Footprint	Excel	 1. Brezet & Van Hemel (1997) 2. Fussler & James (1997) 3. PréConsultants (2000) 4. GHG Protocol (2011)
Life Cycle Costing (LCC) 1. Product LCC 2. Equipment LCC	Excel	 1. Aurora Dimache 2. Aurora Dimache
Design for Environment (DfE) 1. EcoDesign Checklist 2. LiDS Wheel	Excel	 1. Tischner, et al. (2000) 2. Hemel & Brezet (1996)
Product Service Systems (PSS)	PDF Manual	Aurora Dimache
Environmental Management Systems (EMS) 1. Energy Tool 2. Water Tool 3. Waste Tool	Excel	1. Sinéad Mitchell 2. Sinéad Mitchell 3. Sinéad Mitchell
Corporate Social Responsibility (CSR) 1. CSR Assessment 2. Sustainability Reporting	Word	1. Sinéad Mitchell 2. Sinéad Mitchell
User Requirements		
• Simple • Low cost • Low risk • Easily accessible • Make SMEs aware of successful case studies • Compensates for lack of resources and knowledge		• Respects confidentiality • Focus on cost savings and competitiveness • Practical • Specific to SME needs • Little time to implement • Quick impact with visible results

Table 4.7: Summary of Pilot Framework Specifications

[7] Articulate' is an eLearning software package from www.Articulate.com

4.5.1 The Presentation of the Pilot Framework

Many tools already exist to help with sustainability. However, many were designed for larger organisations. Therefore, the tools had to be in a format that was SME-friendly, accessible and practical. The focus of the development had to find a suitable presentation method to SMEs.

For the Framework to be attractive to SMEs, it is presented to them in a manner which highlights the business benefits by focusing on eco-innovation. There are two types of business opportunities for SMEs: the internal cost cutting benefits (e.g. through eco-efficiencies and resource minimisation), and external opportunities in the *eco-market* for tools and services (ECAP, 2010), (e.g. by qualifying as a *preferred supplier* of larger companies (de Haes & van Rooijen, 2005) and public bodies[8]).

To conceptualise how it would be attractive to SMEs, the Framework is framed and presented to support SMEs in four key areas: cutting costs, being compliant with legislation, gaining a competitive advantage and finding new business opportunities, (see Figure 4.7).

Figure 4.7: Framing the tools and methodologies

Table 4.8 maps this structure to the features, recommended tools and training and eco-innovation type to address sustainability.

[8] The EU Green Public Procurement (GPP) scheme is creating a market for greener products by including environmental impact during the tendering process (European Commission, 2013-b).

Table 4.8: Framing the Pilot Framework to meet the needs of SMEs

Process	Features	Recommended Tools (downloadable)	Recommended training (via eLearning)	eco-innovation type			eco-innovation dimension			
				Product	Process	Organisational	Design	User	Product service	Governance
1.Reduce cost	A sub-system process to measure and monitor environmental-related company costs thereby helping to reduce them.	*Environmental cost tools:* • Energy Tracker • Waste Tracker • Water Tracker	• Responsible Business training course - to highlight benefits of being more sustainable in business • Environmental Management Systems (EMS) Training Course - to highlight benefits of a formal or informal EMS		●	●	●			
	A Life Cycle Costing (LCC) process to assess the life-cycle costs of: • *Equipment* before purchase to ensure the costs over the entire life-cycle are minimised • *Products* to make them more attractive to customers by minimising running costs.	*LCC tools:* • Equipment calculator • Product calculator	• LCC training course - to support the LCC process	●		●	●	●		
2. Get informed: environmental legislation	A process for scanning the business external environment in order to identify environmental trends and legislation issues related to the environment.	*Legislation tools:* • Environmental Legislation overview paper	• Environmental legislation training course - to support business compliance and performance			●		●		

Process	Features	Recommended Tools (downloadable)	Recommended training (via eLearning)	eco-innovation type			eco-innovation dimension			
				Product	Process	Organisational	Design	User	Product service	Governance
3.Gain a competitive advantage	Provide a process for evaluating and improving the environmental and social performance of the product/company and how to use these as a competitive advantage	*LCA tools:* • Eco-indicator 99 (Quantitative) • Eco-indicator 99 • Eco-compass (Qualitative) • *MET (Materials, Energy and Toxic Emissions) Matrix* • Carbon Footprint Calculator *DfE tools:* • LiDS (Life Cycle Design Strategy) Wheel • Eco-Design checklist *CSR tools*: • Social Responsibility Assessment • Sustainability Reporting Guide	LCA, DfE, carbon footprint calculator, social responsibility tool; training course for some of the tools/methodologies used to support this process (LCA, DfE, Environmental Management Systems); case studies							
4.Identify opportunities for new business	Provide a process for generating and evaluating new product/service/business starting from sustainability principles	*PSS tools:* • Transition along the Product Service System (TraPSS) Manual	PSS; training course for PSS; case studies							

The Framework was presented as part of the FutureSME support environment, which was created to allow SMEs to access tools, techniques and training materials in many different areas. What makes FutureSME different from other approaches to small businesses is:

- FutureSME takes a holistic approach to a business
- It is not just a website, or tools and techniques; it is about:
    - Developing the capability of a company
    - Creating a culture to allow a company to evolve, adapt and innovate
- It is also:
    - A one stop shop; avoids the need for endless searching for solutions
    - A multi-method approach:
        - SMEs can access online help and diagnostics
        - Recommendations are made to proven tools & methodologies
        - FutureSME consultants are available if required
    - Specifically focused on SMEs and their particular needs.

The Pilot Framework was contained within the Future SME website www.FutureSME.eu. The overall FutureSME online resource pack was divided into four capability areas, *Strategic*, *Managerial*, *Operational* and *Adaptive*. The SEco Framework is contained within the *Strategic* set of resources and called 'Business Sustainability' (see screenshot below in Figure 4.8).

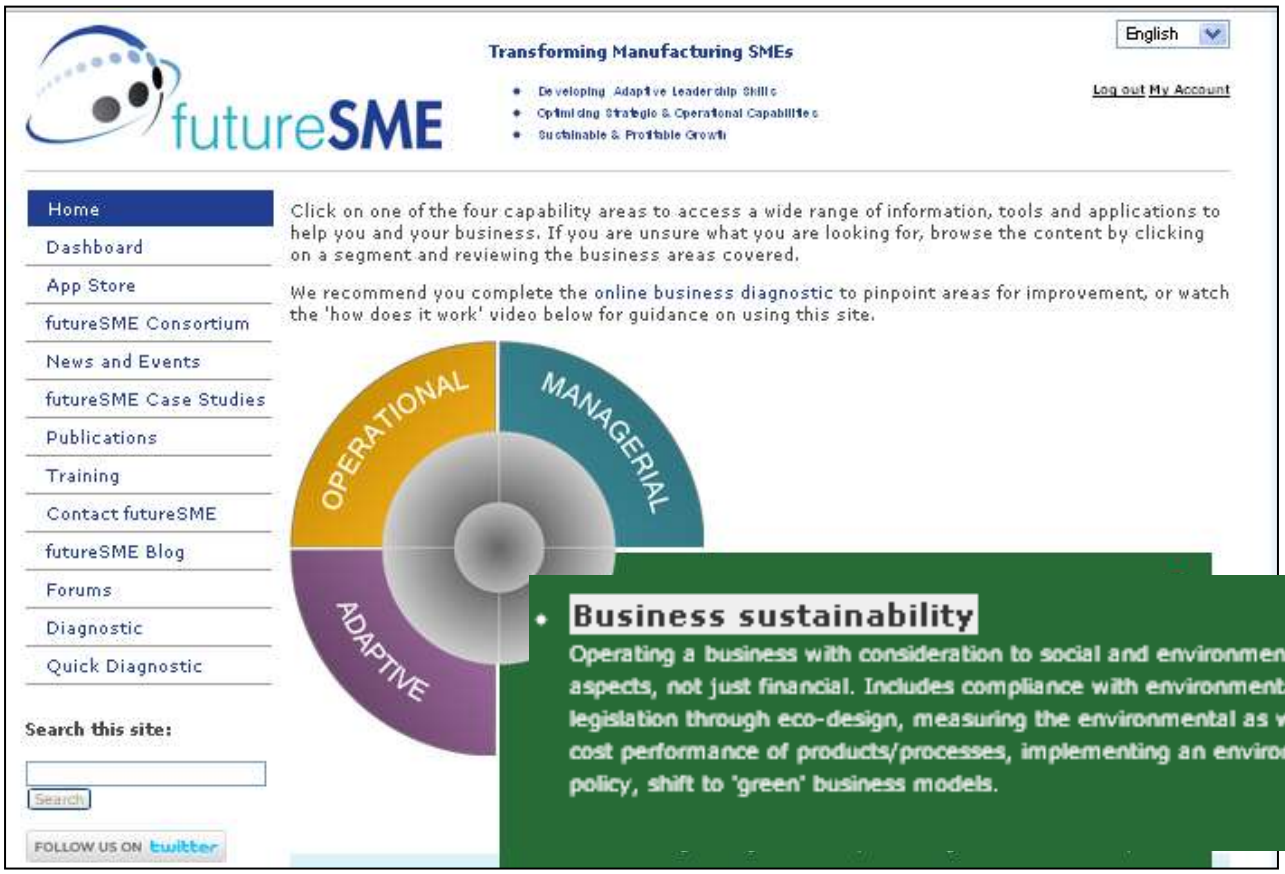


Figure 4.8: Screen shot of the Framework (called Business Sustainability) embedded within the FutureSME portal

Figure 4.9 is a screenshot of the FutureSME *Business Sustainability* webpage, which gives an overview of what *Business Sustainability* is, and why it is important. Video case studies (extracted from the training modules) are embedded within the webpage to inspire SME owner-managers.

Figure 4.9: Main Business Sustainability Webpage

The Framework is presented in the '*Strategic*' category within the main menu of FutureSME resources. A heading "*Why is it important?*" outlines the overall business benefits. A set of suggested steps to take is given under the title "*How do I use it in my business?"* These steps are a simplification of the approach described in Table 4.8, and designed to follow the template of all other areas of the FutureSME website.

Each of the individual tools has its own webpage, which gives details of how it can be of benefit in business, what format it is in (e.g. Microsoft Excel) and a link to download the tool, as seen in the example below in Figure 4.10.

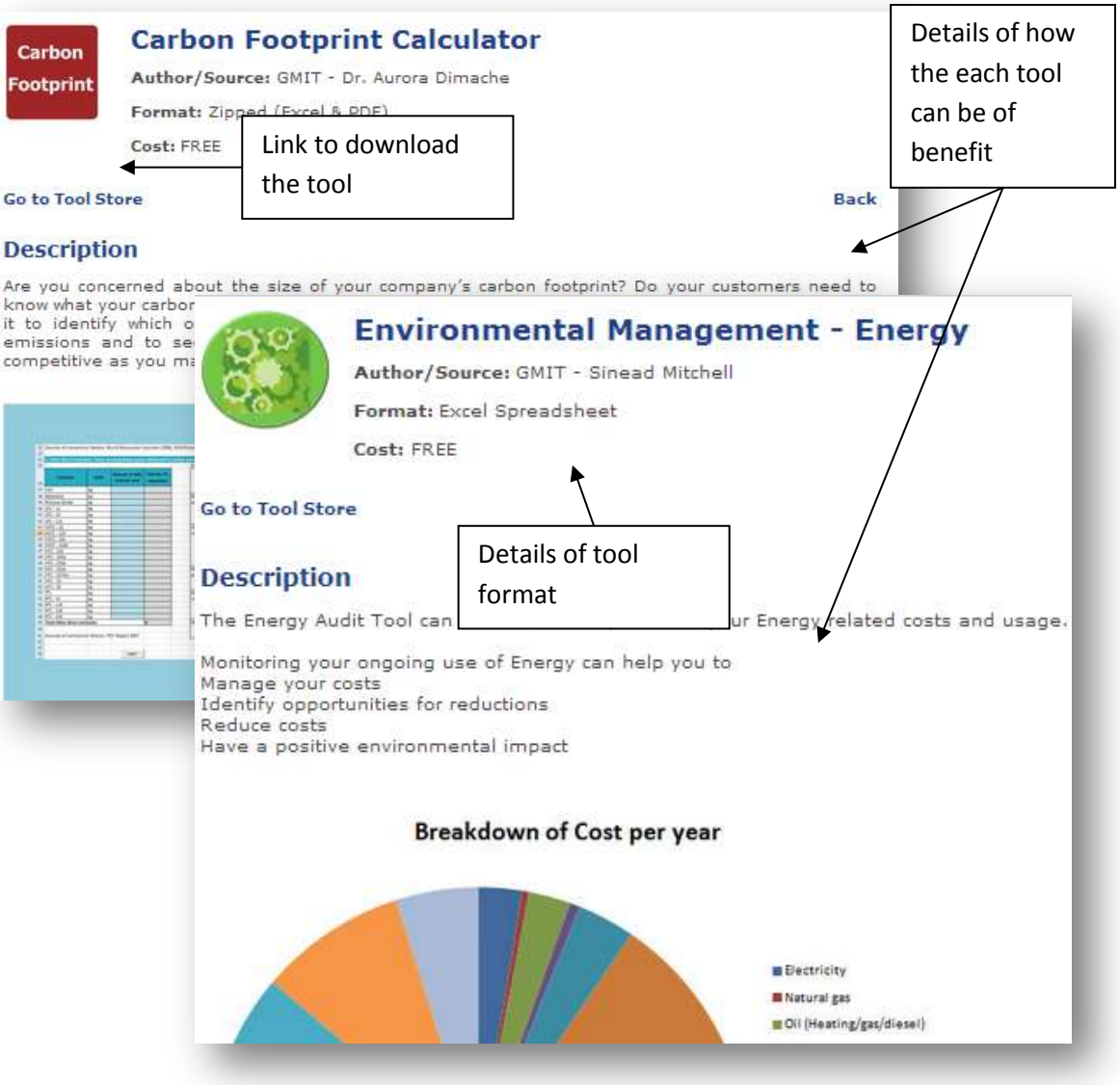


Figure 4.10: Description page on the individual tools

The next section will give the results of the testing activities.

4.6 Sustainability and Eco-Innovation training

The training was designed to meet the needs of SMEs. An eLearning instructional design expert was involved in the design process. Each lesson follows a similar structure.

4.6.1 eLearning Design

eLearning was chosen as the most appropriate delivery mode. Issues have been reported in SMEs in relation to eLearning (see Table 4.9), such as upfront costs and additional support required at the outset (Averlill & Hall, 2008; SIMPEL, 2008). To overcome these issues, the training modules were provided free for all registered users of the online platform (www.futureSME.eu) where the lessons were hosted. It did not require any pre-training before undertaking the lessons.

To be accessible to SMEs, the learning module development took an andragogic[9] approach. Employees within SMEs need to learn within the constraints of their own environments, therefore a heutagogic[10] approach was also taken. Because the intended audience was very broad, a combination of learning styles was accommodated; a blend of visual, logical, auditory and interpersonal learning. The lessons were focused on the need to solve problems or enable opportunities, as espoused in the business goals of the organisation.

It has been reported that eLearning providers do not develop or tailor content to the needs of SME, (Hamburg & Hall, 2008; ARIEL, 2005). SMEs require that the learning material be modified to their particular requirements. This issue was overcome by careful design and consideration of SMEs needs, and involving them throughout the development process.

In order to increase the penetration of eLearning deployment in the SME sector, SME owner-managers need to be able to see clear business benefits to investing in it (McPhearson, 2008; Engert, et al., 2008). With this in mind, each module has a section which lays out the business benefits at the outset.

Common issues reported with eLearning in SMEs	How these were addressed in the Pilot Framework
Cost	Provided for free
Upfront payment requirement	Provided for free
Content is not tailored to SMEs	SME owner-managers consulted at every stage of development
Pre-training required	The platform used does not require any training (Articulate[11]) and permits self-paced learning
Employee is too busy to undertake the learning	Clear business benefits highlighted at the outset.

Table 4.9: How issues with eLearning in SMEs was addressed in the Framework

[9] An adult learning approach
[10] A self-determined learning approach
[11] 'Articulate' is an eLearning software package www.Articulate.com

4.6.2 Lesson Structure

Following an introduction to the lesson, the user is given specific business benefits of the content. The main body of the lesson gives detailed instruction on the specific material, supported by assessments and case studies where applicable. The concluding part of the lesson summarises the content using assessments and gives further relevant information on the topic that the user may find useful (such as links to tools and/or further support) (see Figure 4.11). A voiceover guides the user through the lesson and this text is provided in the notes if required. If there are attachments (e.g. worked examples), these can be directly accessed at any time.

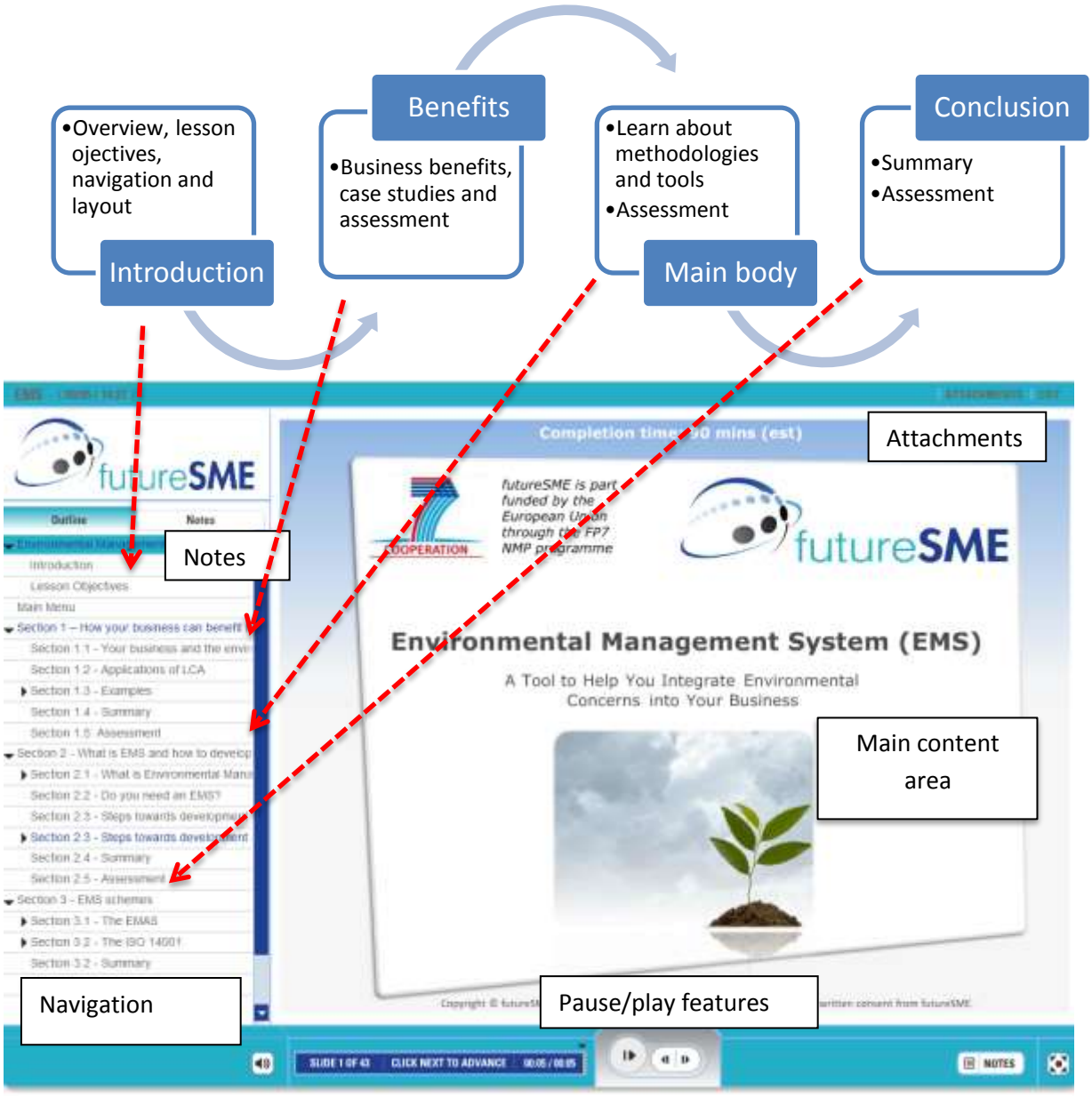


Figure 4.11: Common Structure of the environmental training lessons

An overview of each lesson will now be described. Please note, the outer framework including the navigation menu are all present in each lesson as shown in Figure 4.11. However, screenshots from main content areas only will be shown for display purposes.

4.6.3 Overview of Environmental Legislation for Managers

This topic is intended for the use of owners and managers of SMEs who need to understand environmental legislation applicable to their business and comply accordingly.

This lesson is a high-level view of legislation in the categories of Energy, Chemicals, Noise, Air Quality, Water and Waste, and sub categories within each area (see Figure 4.12).

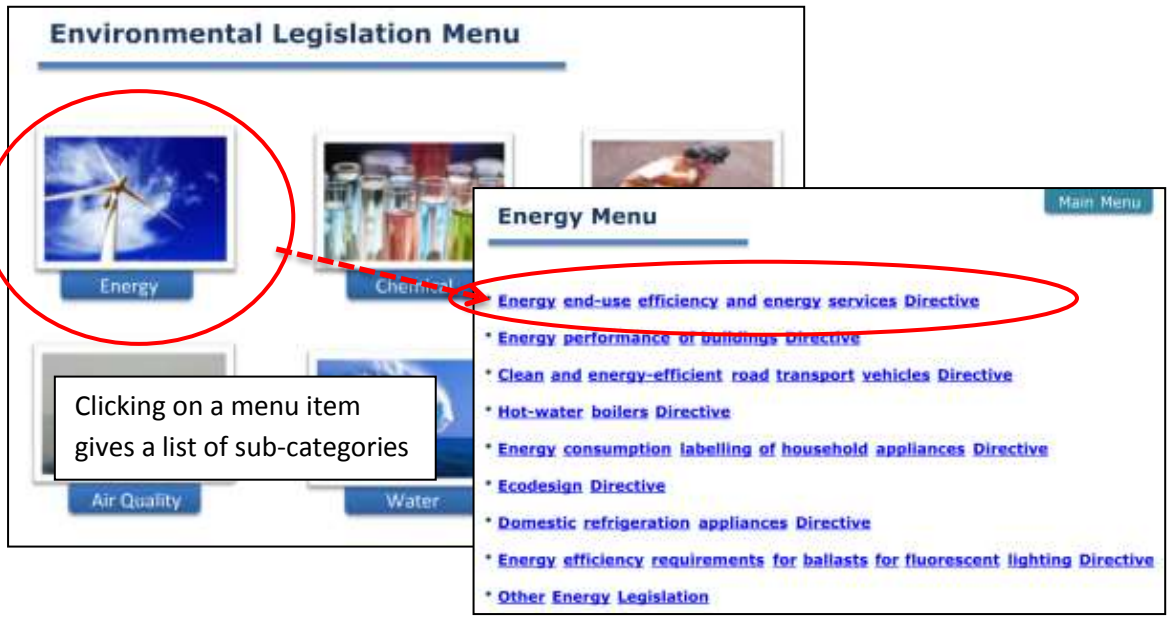


Figure 4.12: The legislation main menu (left) and sub-category example

Each sub-category presents a high-level overview of the requirements of the legislation and the consequences of non-compliance (see Figure 4.13). It links to the applicable legislation online and directs the user to further information and assistance.

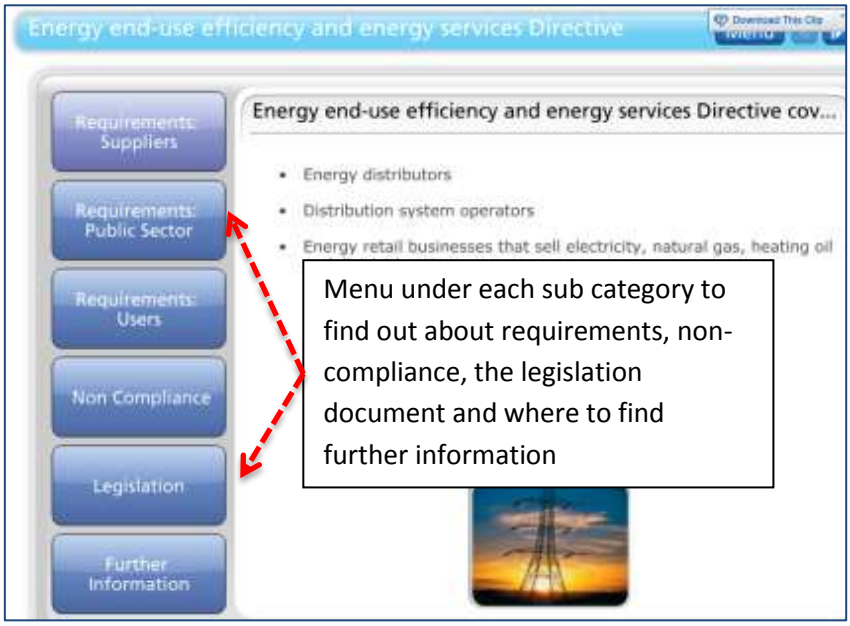


Figure 4.13: Each legislation area gives a brief overview of its requirements, links to the legislation text and where to find further information

4.6.4 Life Cycle Assessment (LCA) Training

This topic is intended for use by the person within the SME responsible for environmental compliance.

It gives the user the knowledge to assess how green their product or business is, and may require this analysis to meet regulations and/or customer requirements. It outlines how to calculate a carbon footprint and complete a Life Cycle Assessment (LCA). After the lesson, the user should be able to apply an LCA tool in order to enhance the environmental performance of the company's products or processes.

The lesson takes an estimated 90 minutes to complete and is structured as follows:

Introduction and lesson objectives	•Overview of what the LCA lesson will cover and what the user will learn
Secition 1. How your business can benefit from LCA	•Identify how LCA can help measure the environental impace and how this can benefit a business
Section 2: The LCA Methodology	•The steps involved in an LCA study •How an LCA can help improve environmental performance •The importance of interpreting the LCA results
Section 3: LCA Tools	•Apply LCA tools to calculate the environmental impact of a product/service/activity •Apply LCA toosl to compare product alternatives to make informed decisions
Section4 : Carbon Footprint	•Identify the benefits of measuring your carbon footprint •Apply LCA toosl to measure your carbon footprint
Assessment	•Assessment on the use of LCA
Next steps	•Links to further information, tools and support

Figure 4.14 below shows some screen shots from the LCA lesson.

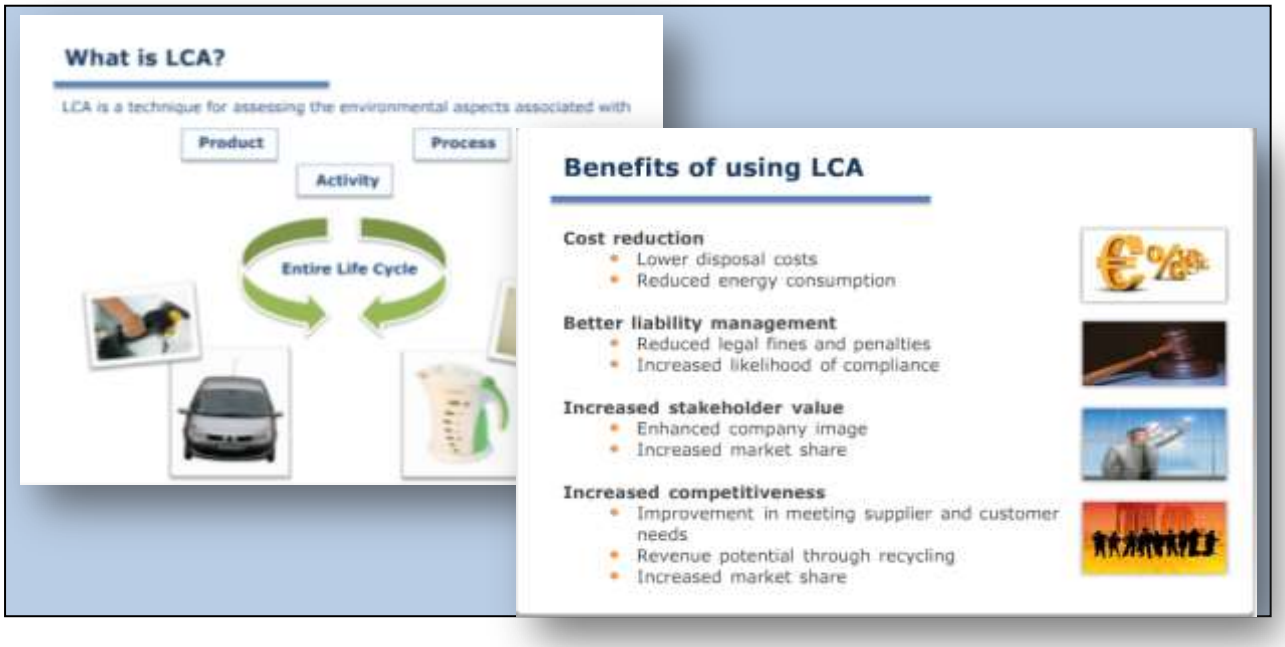


Figure 4.14: LCA lesson screen shots

4.6.5 Life Cycle Costing (LCC) Training

This topic is intended for the use by both the owners and managers of the SME and the staff member within the company responsible for environmental compliance. They should be able to apply an LCC to identify potential cost savings at various stages of the product life cycle.

It is relevant to businesses that want to offer products with lower operating costs to their customers. It is also used to support decisions when purchasing equipment, as it can evaluate the cost over its useful life.

The lesson takes an estimated 90 minutes to complete and is structured as follows:

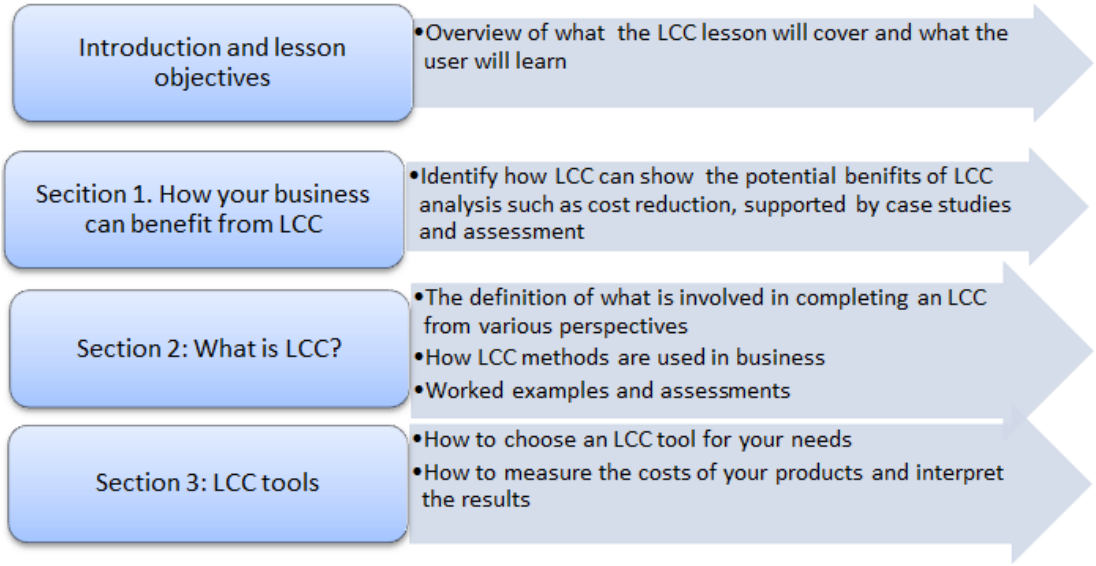


Figure 4.15 below shows some screen shots from the LCC lesson.

Figure 4.15: LCC lesson screenshots

4.6.6 Design for Environment (DfE) training

This topic provides a useful guide for anyone working in an SME who wishes to understand the process of Design for the Environment (DfE). This lesson provides the user with the skills and knowledge required to implement DfE and generate significant business benefits, such as cost savings, appealing to a wider customer base and complying with environmental legislation.

The lesson takes an estimated 90 minutes to complete and is structured as follows:

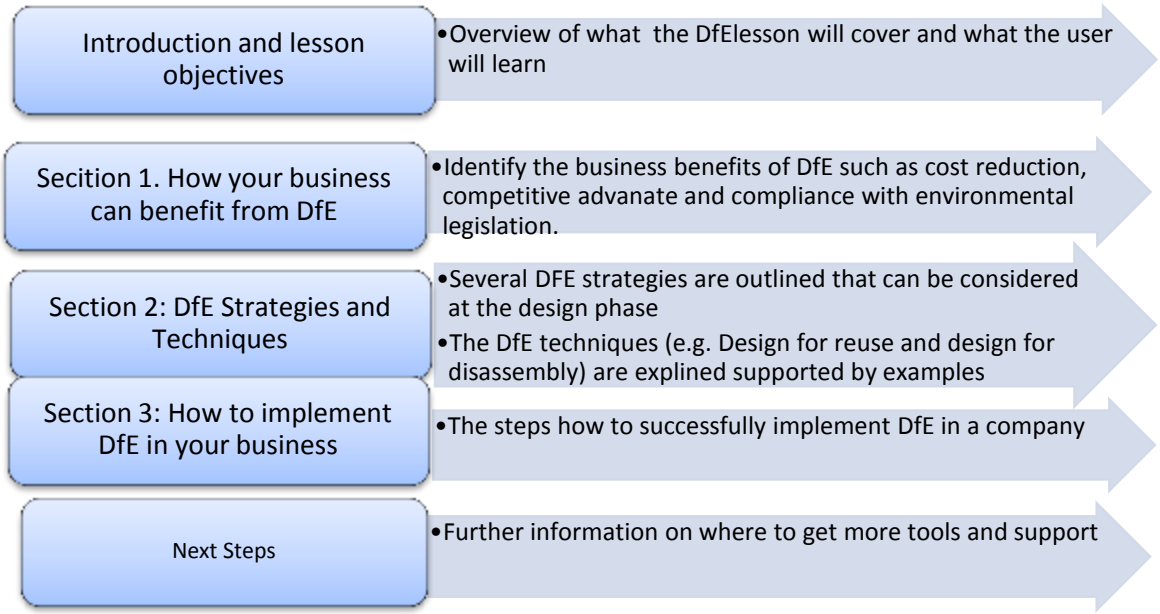


Figure 4.16 below shows some screen shots from the DfE lesson.

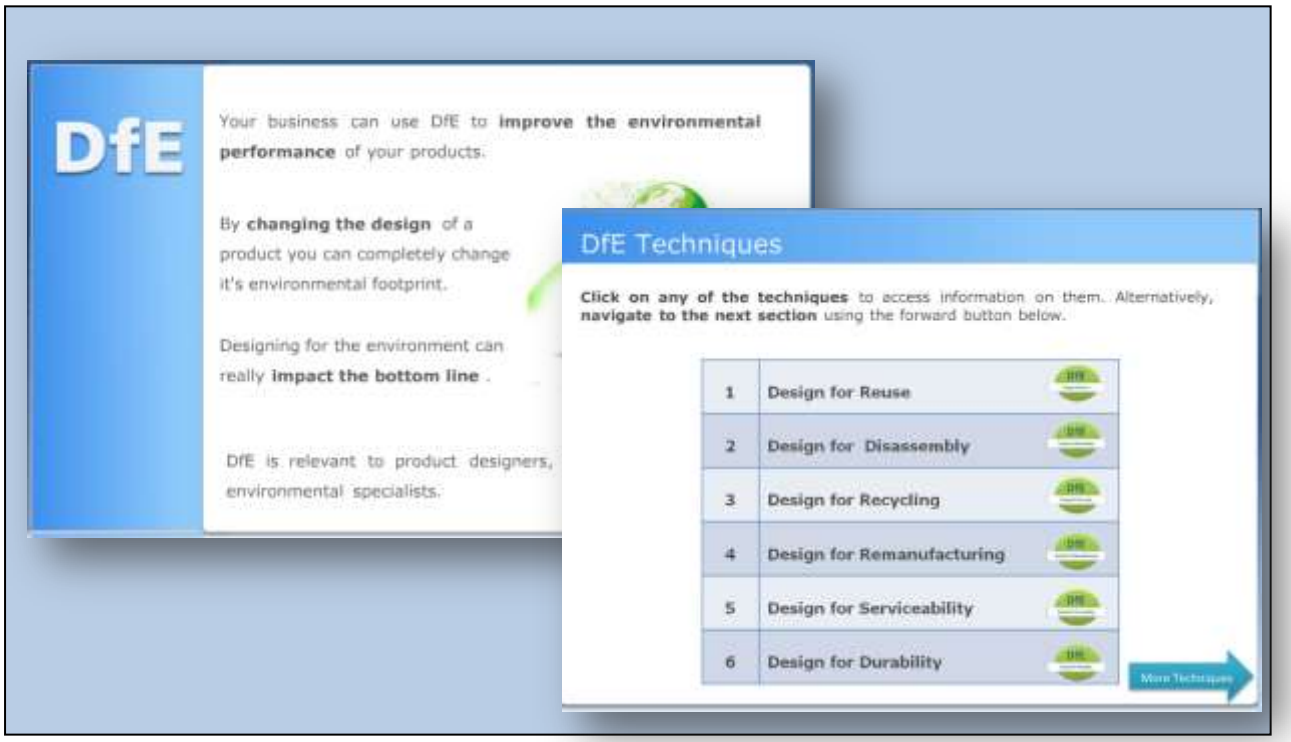


Figure 4.16: DfE lesson screenshots

4.6.7 Product-Service System (PSS) Training

This topic provides a guide for anyone working in an SME who wishes to understand the Product-Service Systems concept. It highlights the business-related benefits of this model based on a new value proposition, the product plus service system. It also introduces a decision support methodology for SMEs when they are considering a transition along the PSS route.

The lesson takes an estimated 90 minutes to complete and is structured as follows:

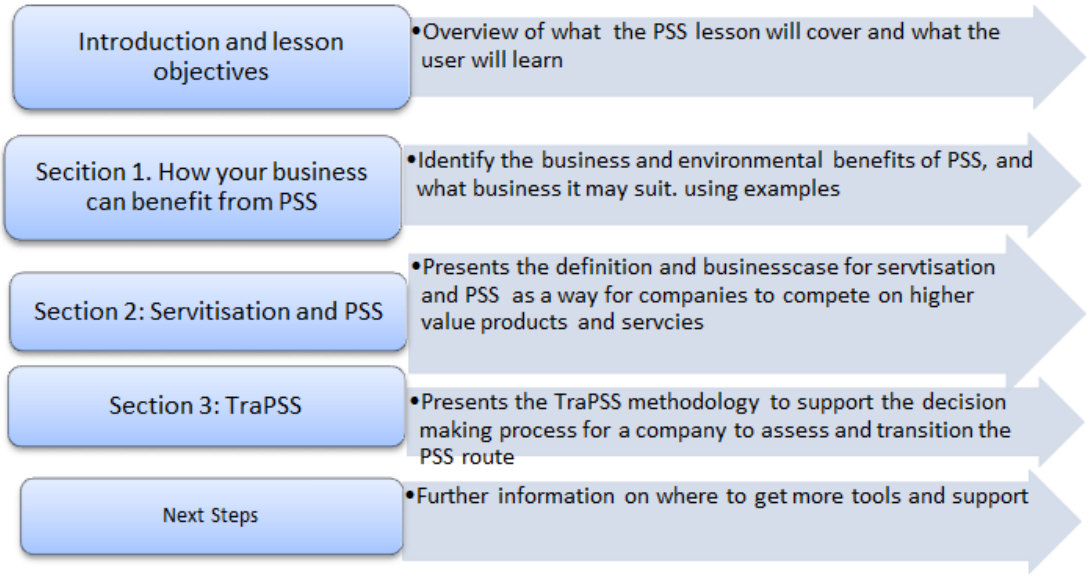


Figure 4.17 below shows some screen shots from the PSS lesson.

Figure 4.17: PSS lesson screenshots

4.6.8 Corporate Social Responsibility (CSR) for SMEs Training

This lesson provides a guide for anyone working in an SME on how to integrate social and environmental concerns into business activities. On completion of the lesson, the user will have learned how to use CSR to the company's advantage, such as by achieving cost savings, gaining a competitive advantage and brand enhancement. It gives a systematic process for implementation of CSR into their business activities.

The lesson takes an estimated 90 minutes to complete and is structured as follows:

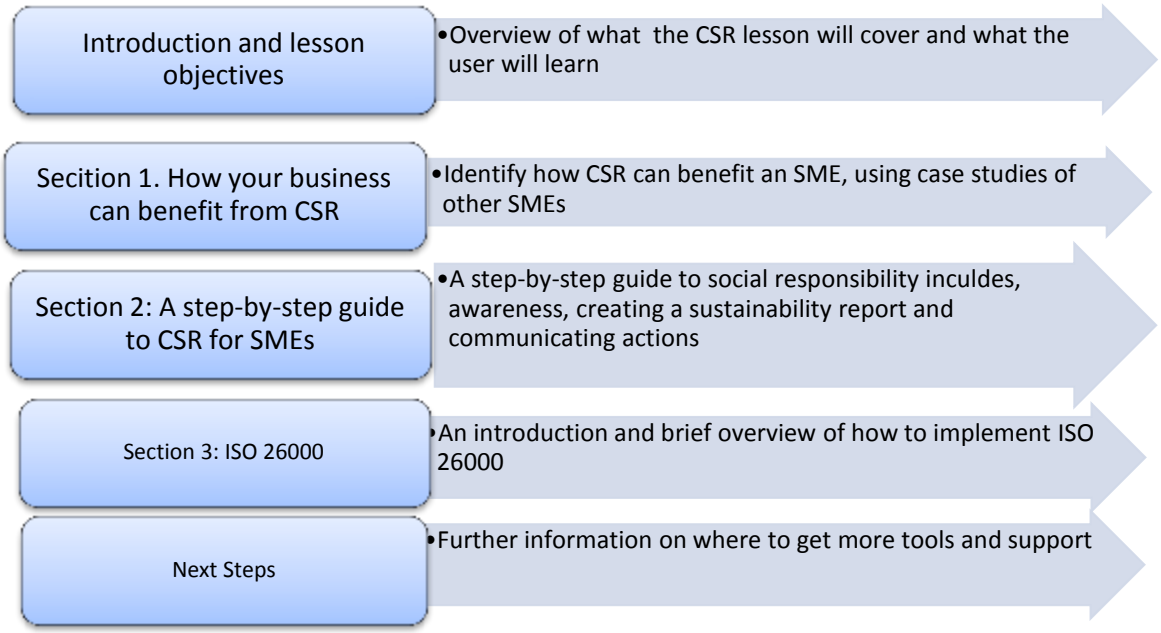


Figure 4.18 below shows some screen shots from the CSR lesson.

Figure 4.18: Screen shots from CSR lesson

4.6.9 Environmental Management Systems (EMS) Training

This lesson aims to help an SME work towards the adoption of an EMS (such as ISO14001, EMAS and EMAS easy) and integrate environmental concerns into its business.

The lesson takes an estimated 90 minutes to complete and is structured as follows:

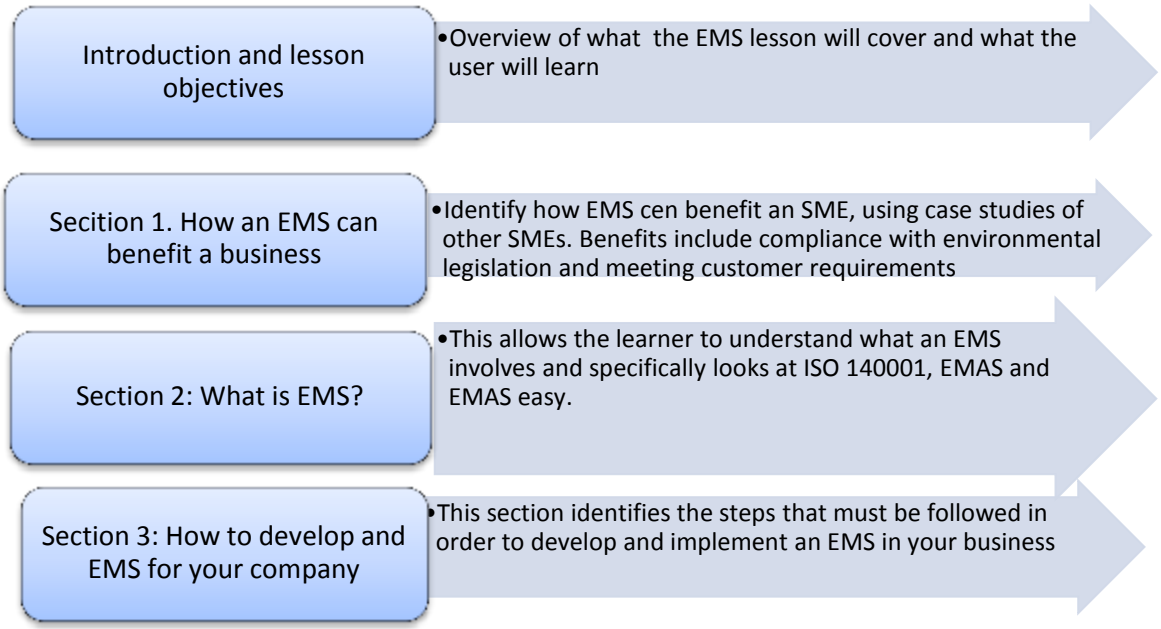


Figure 4.19 below shows some screen shots from the EMS lesson.

Figure 4.19: Screen shots from the EMS lesson

4.7 Sustainability and Eco-Innovation Tools

The toolset adopts a *multi-method* and *one-stop-shop* approach, so that it is suitable for as many manufacturing SMEs as possible. The tools were prepared so that the SME owner-manager does not necessarily need to do the associated training course, although that is recommended, as it highlights the business benefits, using case studies.

4.7.1 Tools Structure

Each of the tools was formatted in a similar manner, starting with an introduction page (see Figure 4.20). It describes the purpose of the tool, outlines the business benefits and how the tool works. Each tool has a link to a worked example. The majority of the tools were built in Microsoft Excel, and the tabs at the bottom can be used to navigate between worksheets.

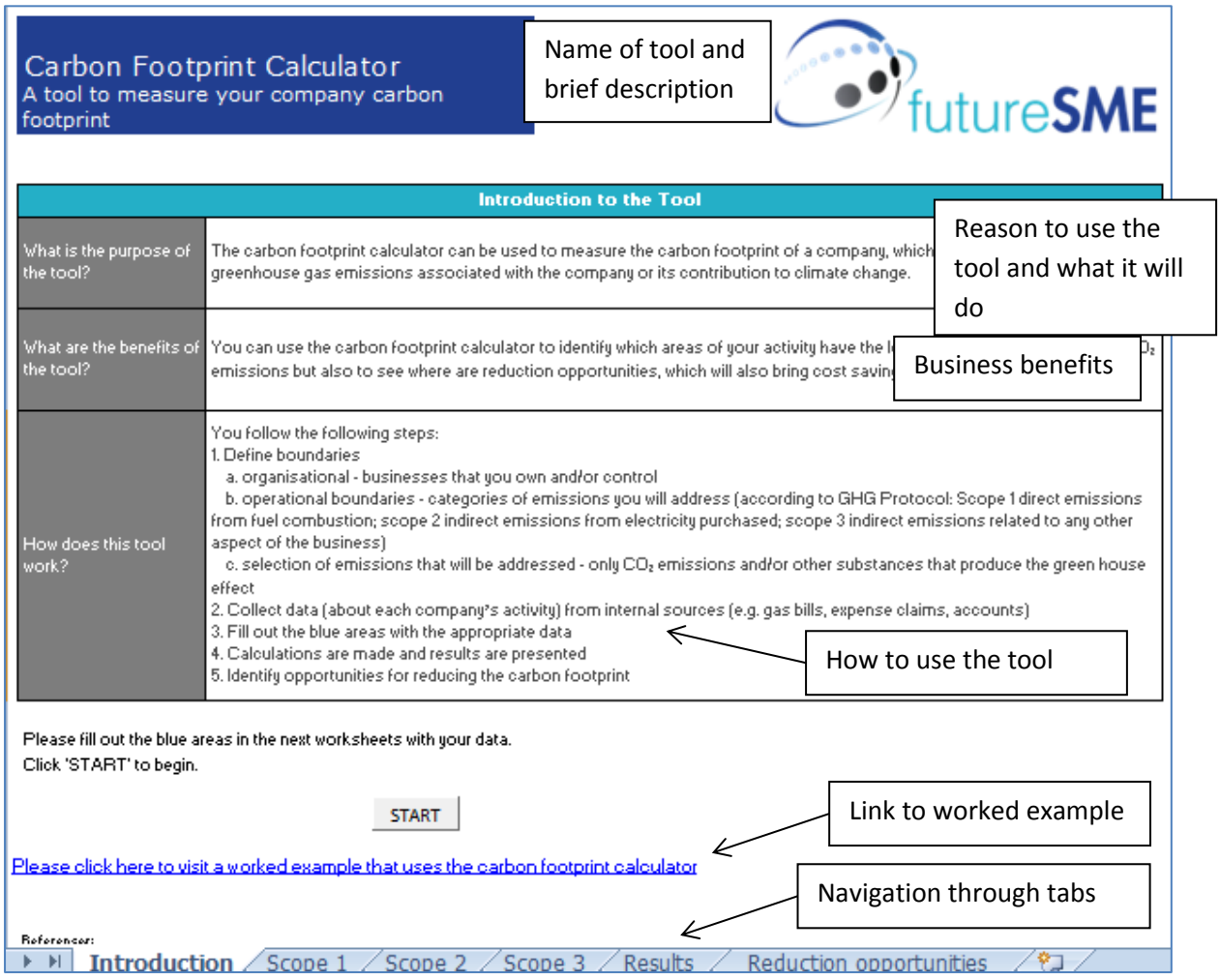


Figure 4.20: Tools structure, introduction page

Where referenced, tools have been adopted from published work. Otherwise the tools are newly formed versions of common methodologies.

4.7.2 Environmental Legislation Tool

This tool is an *Environmental Legislation Paper* and can be used in conjunction with the related e-learning lesson on Environmental Legislation.

This tool is very simple and is in the form of a downloadable Adobe PDF document (5 pages). It outlines:

- The purpose of environmental legislation,
- Why a company must comply with environmental legislation
- EU environmental resources
- Where to find further information on relevant environmental legislation

Figure 4.21 shows screen shots from the Environmental Legislation tool.

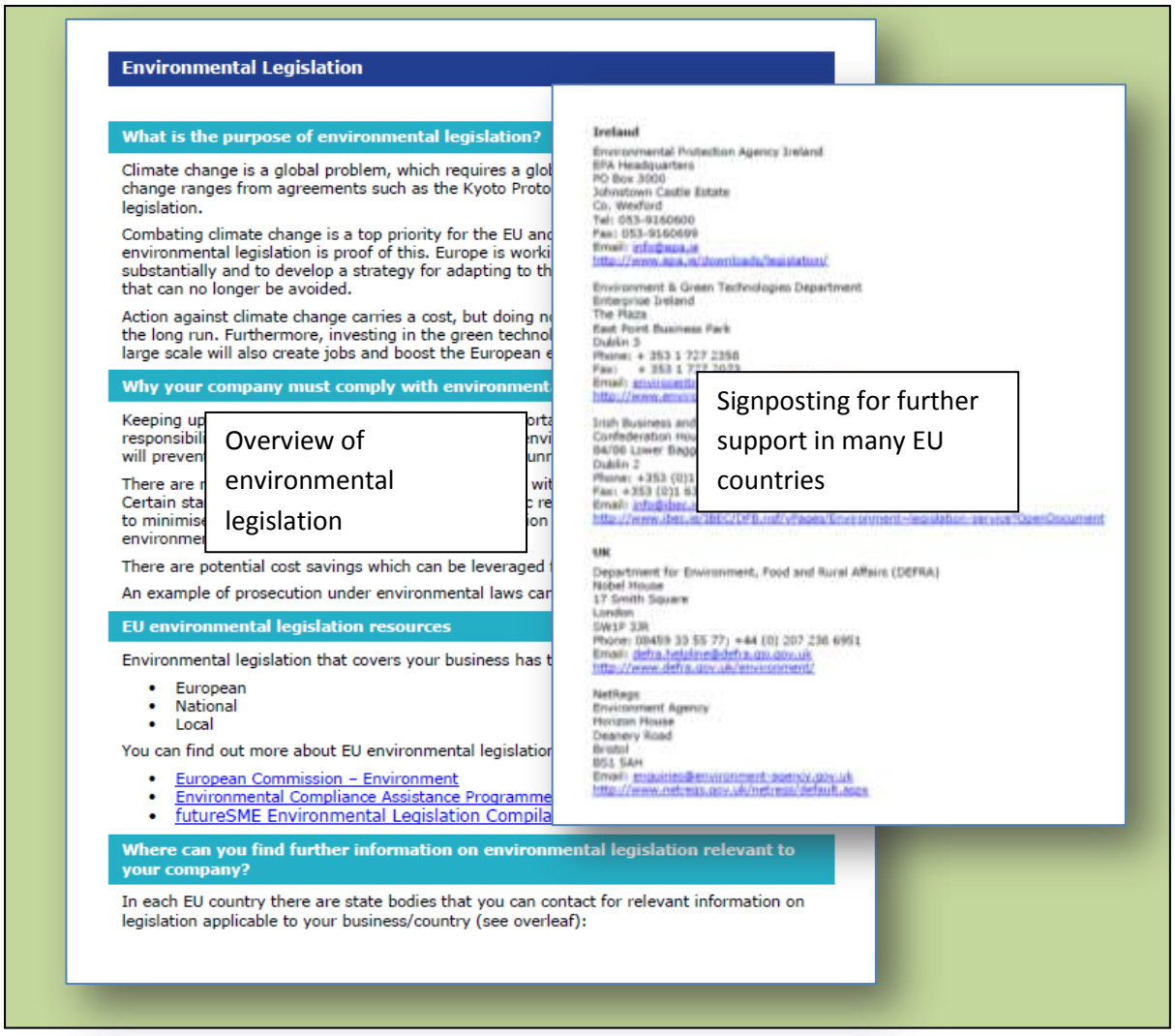


Figure 4.21: Screen shots from the Legislation Paper

4.7.3 Life Cycle Assessment (LCA) Tools

The LCA tools can be used in conjunction with the related e-learning lesson on LCA. The lesson describes how to calculate the environmental impact of a product/process/activity using an LCA as well as identifying possibilities for improvement.

An abridged LCA methodology is most appropriate for use in a smaller organisation. Roche (1999) classifies a number of LCA methodologies into qualitative or quantitative types, which would be more suitable for use within an SME. Three of these LCA tools were chosen to develop and package into an SME-friendly way, and discussed in the next sections, MET Matrix, Eco-Compass and Eco-Indicator 99.

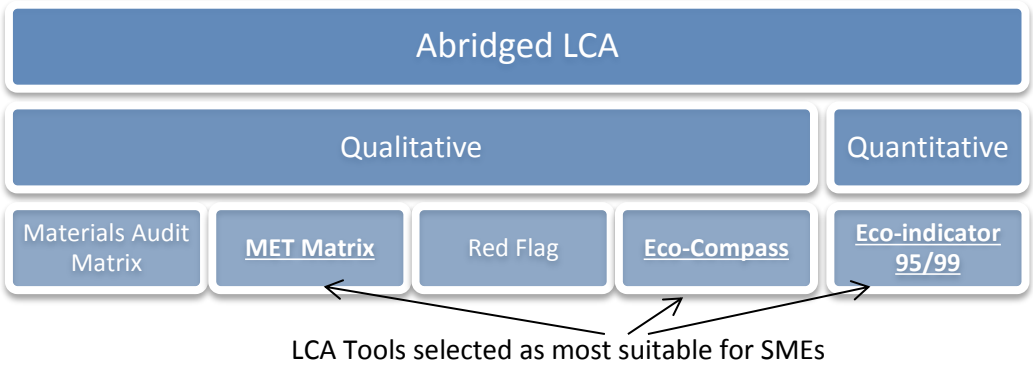


Figure 4.22: Classification of LCA methodologies (Roche, 1999)

4.7.3.1 MET matrix (LCA) Tool

The MET matrix tool is based on a very simple LCA developed by Brezet & Van Hemel (1997). It is an abridged qualitative method. It is useful at the idea generation or the concept development stage, as a tool to analyse the product's impact on the environment.

It allows designers to identify where material use, energy use or toxic emissions are a priority at different stages in the product's life cycle. It can be used as an analysis tool in the first stage of a design process, analysing existing products to obtain a competitive advantage. It was built in Microsoft Excel and gives quick estimations of the environmental performance.

See Figure 4.23 for some screen shots of the tool.

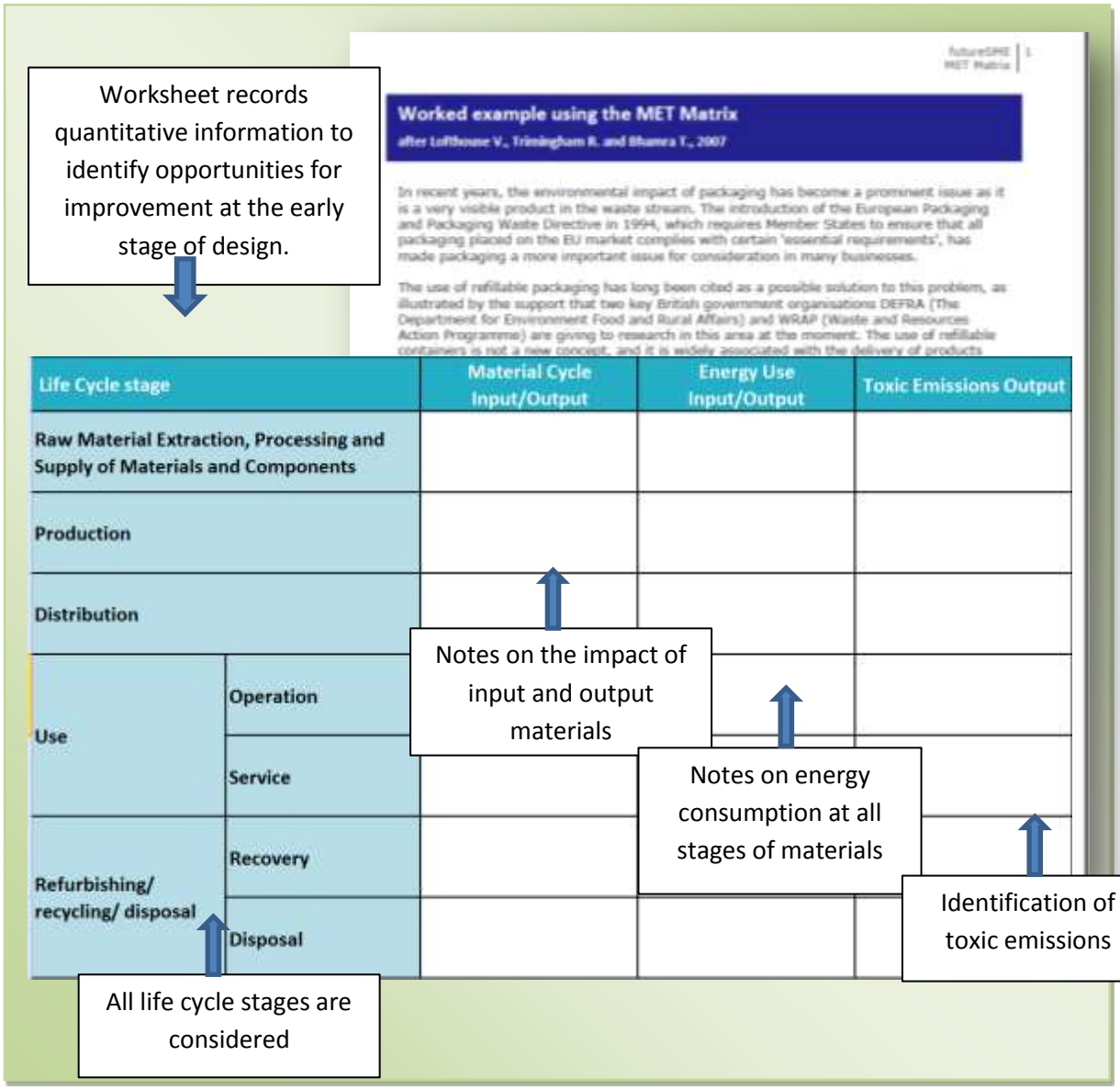


Figure 4.23: Screen shots from the MET Matrix (LCA) tool

4.7.3.2 *Eco-compass (LCA) Tool*

The *eco-compass* is a slightly more detailed abridged qualitative LCA, based on Fussler & James's (1997) tool. It has been built in Microsoft Excel. It allows the user to evaluate a new product design against an older version to reveal more sustainable or environmentally friendly options.

It is a visual representation of six significant environmental impact categories[12] to ensure that all aspects of ecological and resource security are taken into account. The trade-offs between designs are highlighted graphically, where the original design serves as a benchmark and the new design is expected to do better in more sections.

See Figure 4.24 for screen shots of the tool.

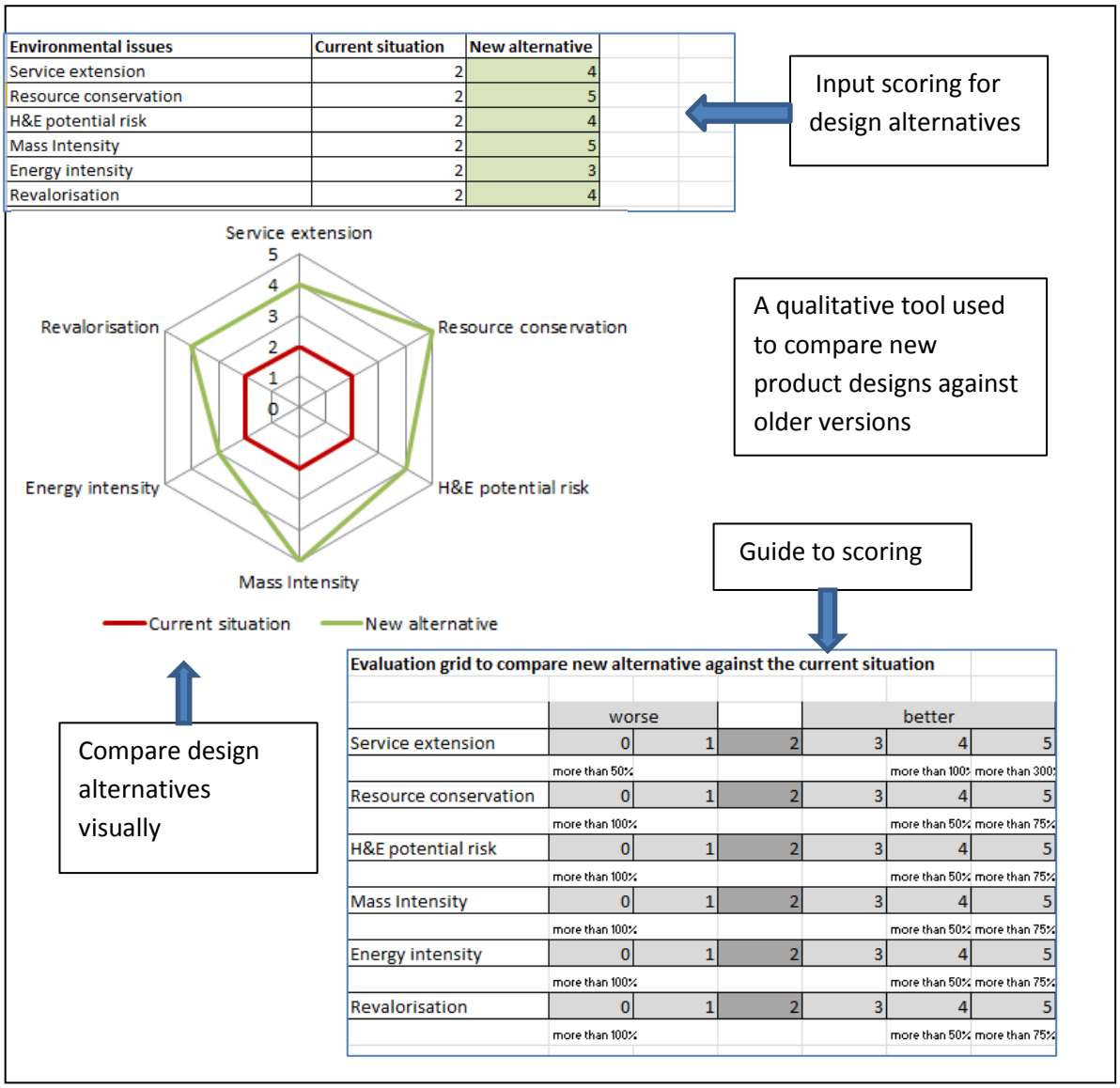


Figure 4.24: Screen shots from the Eco-compass (LCA) tool

[12] The six dimensions are Resource Conservation, Health & Environment Risk, Revalorization, Service Extension, Energy Intensity and Mass Intensity

4.7.3.3 *Eco-indicator' 99 (LCA) Tool*

The Eco-indicator '99 tool is an abridged quantitative LCA. It is a Microsoft Excel version of the methodology developed by PréConsultants (2000). This method is more comprehensive and accurate than the Met-Matrix and Eco-Compass, but takes more time.

It is used to analyse products or design ideas to find the largest causes of environmental pollution and opportunities for improvement. It can also be used to compare products, semi-finished products or design concepts, after which the least environmentally polluting components/design alternative can be chosen. The tool employs a weighting method to convert the environmental impact into a score measured in mPt, called the eco-indicator. This allows the user to identify the most significant environmental impacts of a product and compare designs.

See Figure 4.25 for some screen shots of the tool.

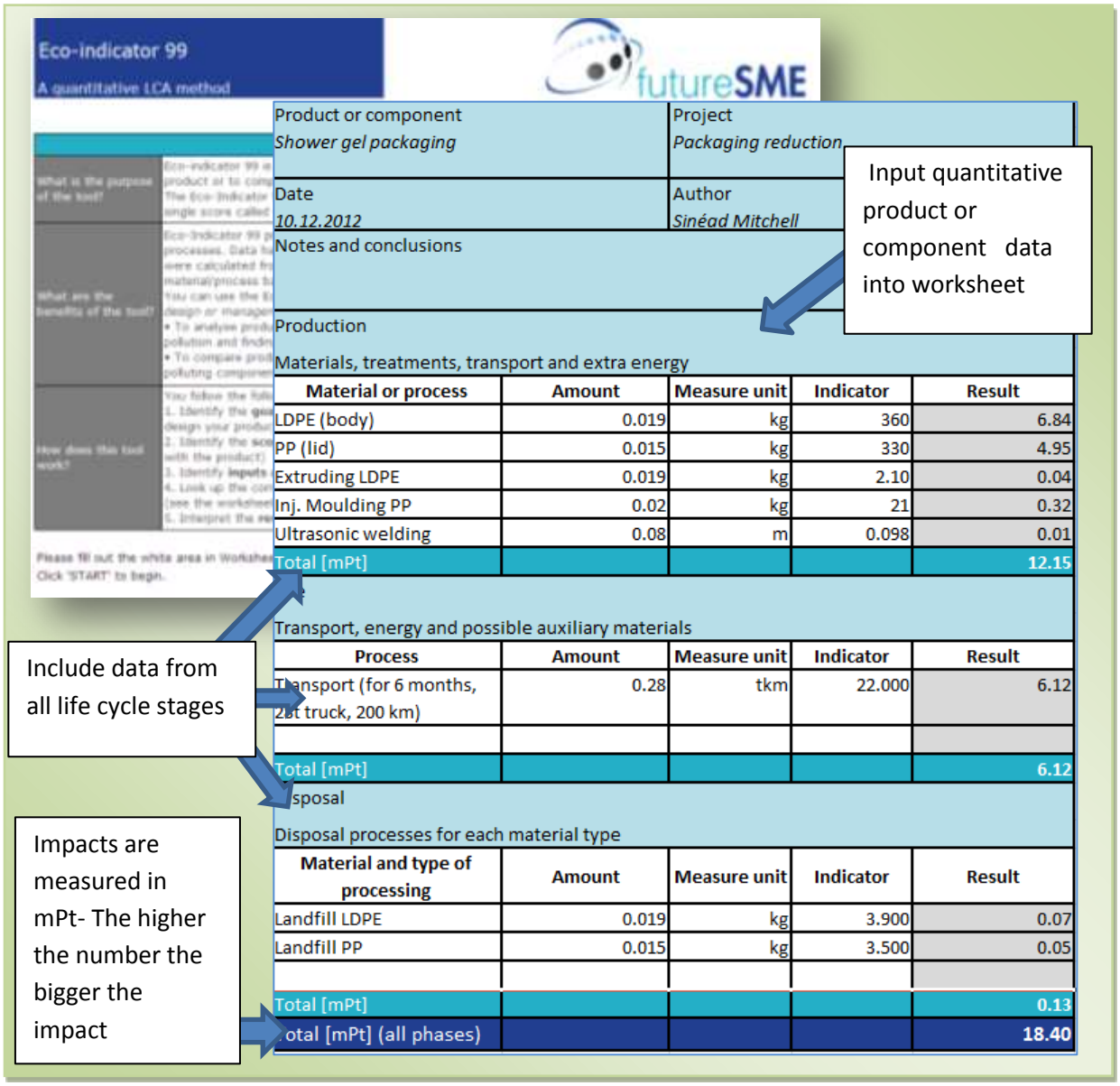


Figure 4.25: Screen shots from the Eco-Indicator 99 (LCA) tool

4.7.3.4 *Carbon Footprint (LCA) Tool*

There are many carbon footprinting tools available but they are not standardised (Cucek, et al., 2012). This carbon footprint tool uses the Greenhouse Gas Protocol methodology (GHG Protocol, 2011) and is built in Microsoft Excel for ease of use. This tool is beneficial if the SME is only interested in the carbon footprint of its activity.

It can be used to identify which of a company's activities have the lowest performance in terms of CO_2 emissions which are analysed in a pie chart. This can identify opportunities for reductions in carbon emissions which are also potential cost savings.

See Figure 4.26 for screen shots of the tool.

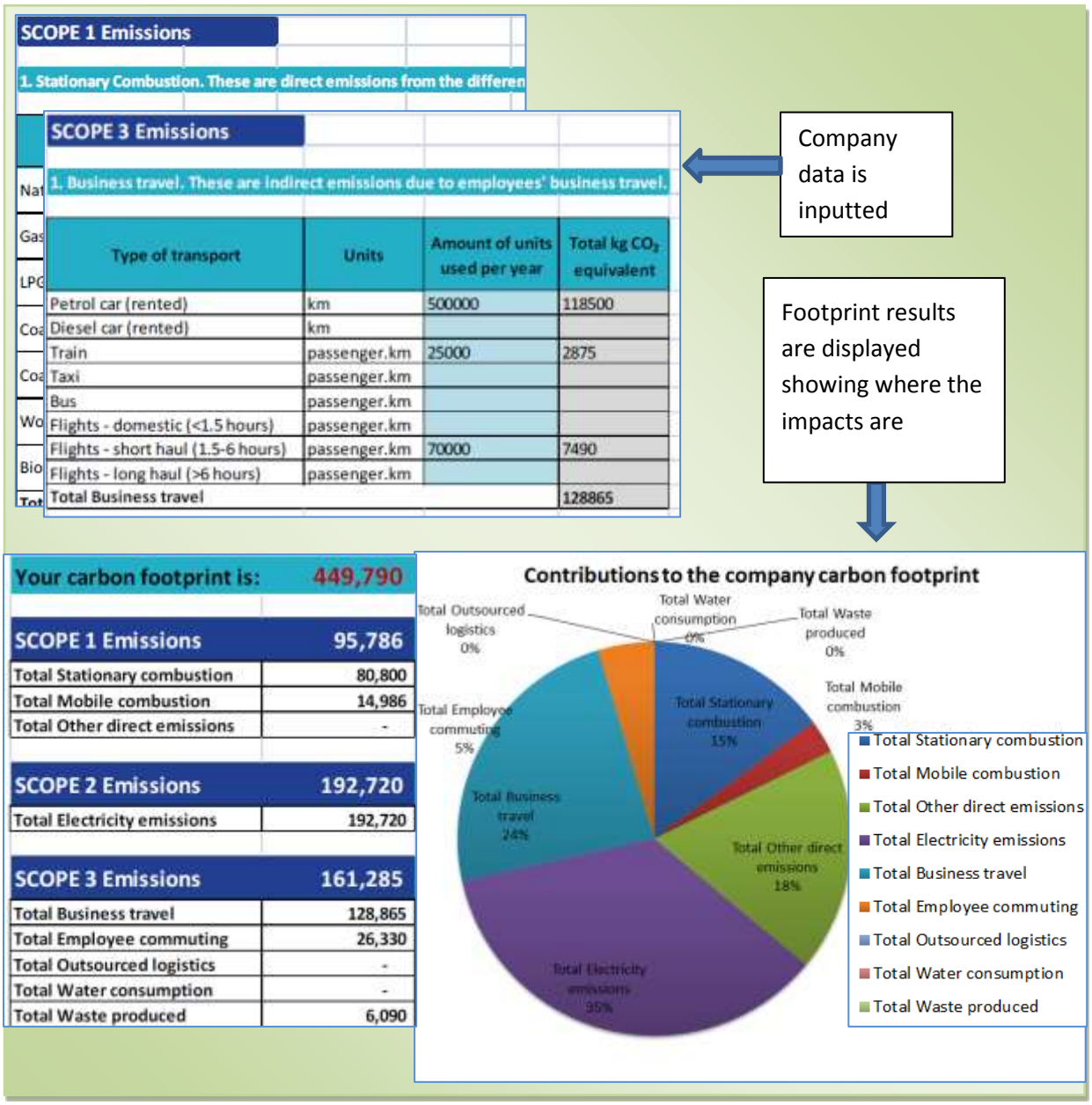


Figure 4.26: Screen shots of the carbon footprint (LCA) tool

4.7.3.5 *Life Cycle Costing (LCC) Tools*

The LCC tools can be used in conjunction with the related LCC e-learning lesson. LCC is described in the lesson. It is a methodology that can be used by manufacturing SMEs to calculate the entire life-cycle cost of a product and to determine the contribution of each life cycle phase or component to the total cost. Opportunities for cost reductions can therefore be identified.

Two types of LCC tools are included for different types of analysis.

4.7.3.6 *Product LCC Tool*

The product LCC tool is used to analyse the product that the SME is manufacturing. It is built in Microsoft Excel.

This tool can allow SMEs to analyse the costs involved in product ownership. Preventable costs can be identified when the analysis is done at the beginning of a project. At the product design phase, unnecessary costs can be identified and eliminated. This tool can help the SME to communicate the cost of performance of their product, and gain a competitive advantage by doing so.

See Figure 4.27 for some screen shots of the tool.

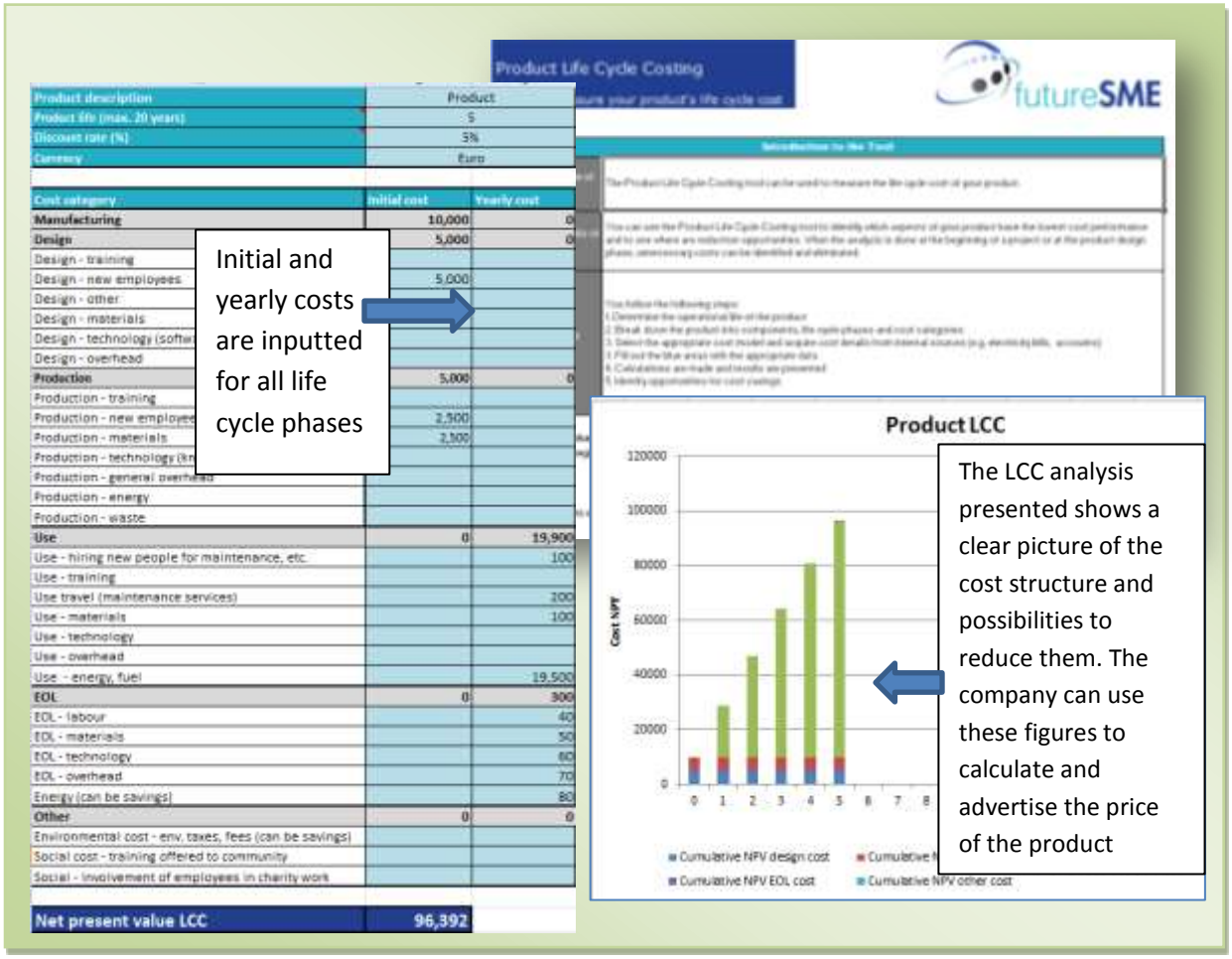


Figure 4.27: Screen shots from the Product LCC tool

4.7.3.7 *Equipment LCC Tool*

The equipment LCC tool is used to analyse equipment that an SME may be purchasing. It allows the SME to make a buying decision by comparing alternatives. It is built in Microsoft Excel. This tool can allow SMEs to analyse the costs involved in equipment ownership (e.g. company car). It looks at maintenance cost, disposal cost and any other costs incurred during the equipment's life, identifying opportunities for choosing the most cost efficient equipment.

See Figure 4.28 for some screen shots of the tools.

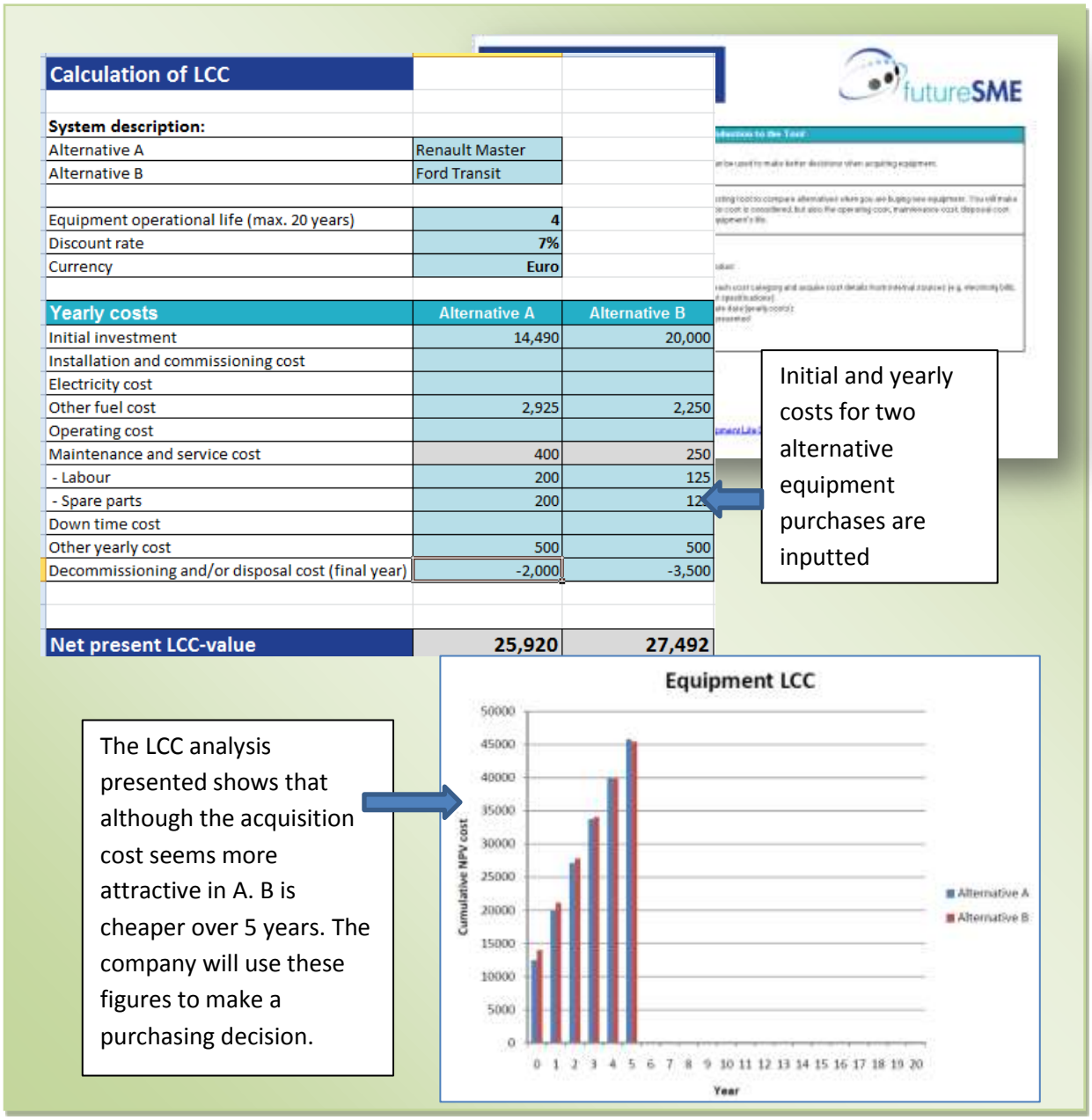


Figure 4.28: Screen shots from the Equipment LCC tool

4.7.4 Design for Environment (DfE) Tools

The DfE tools should be used in conjunction with the related e-learning lesson. DfE provides an organised structure into which SMEs can integrate most features of sustainable development (eco-efficiency, pollution prevention and clean production etc.). Because it offers new perspectives with a product and business focus, DfE can be a powerful tool to make a company more competitive and more innovative, as well as more environmentally responsible.

Two DfE tools were developed and are described below.

4.7.4.1 EcoDesign Checklist (DfE) Tool

The *EcoDesign Checklist* is a Microsoft Excel version of a simple methodology originally developed by Tischner, et al. (2000). It was created for product designers to allow them to quickly assess a product and to identify problems that can be fixed in order to achieve an environmentally superior product. The tool is beneficial when there is very little time available or information available.

The tool contains a broad list of environmental issues related to a product over its entire life cycle. It is a first step basic tool that can be used to make a quick assessment of the current product design, to identify where the problem is before the application of more comprehensive DfE tools.

See Figure 4.29 for some screen shots of the tool.

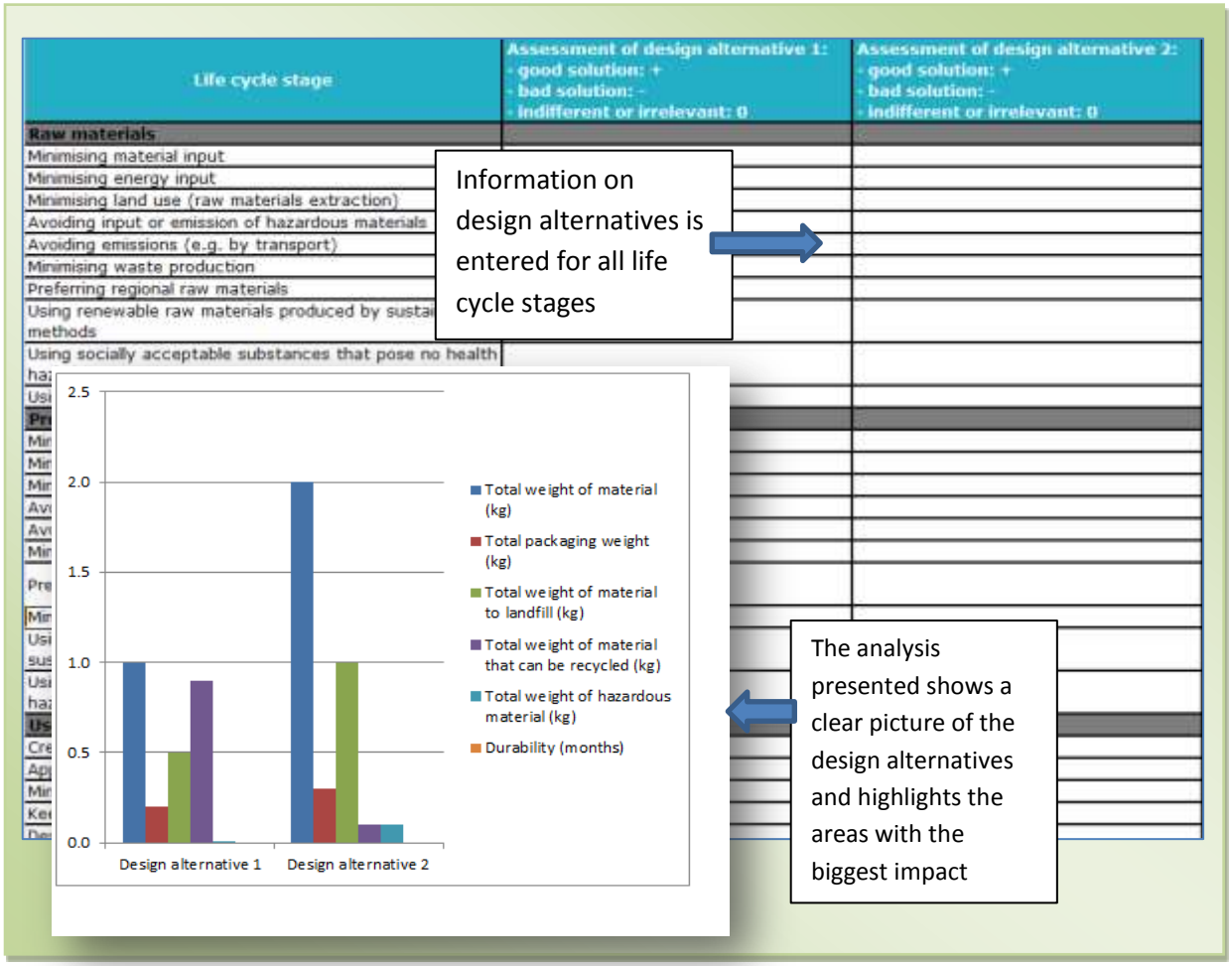


Figure 4.29: Screen shots of the EcoDesign Checklist (DfE) tool

4.7.4.2 LiDS Wheel (DfE) Tool

The *LiDS Wheel* is a more advanced than the *EcoDesign Checklist*. It is based on a methodology developed by van Hemel & Brezet (1996). It is built in Microsoft Excel. This tool can help SMEs to redesign products to be greener.

It allows the SME to quickly assess a product and to apply DfE strategies or techniques to achieve an environmentally superior product. It is a visual tool that graphically represents eight possible DfE strategies that can be applied, which translates the qualities of environmentally superior products into basic design recommendations. It allows design comparisons to identify the best/greenest option, thereby supporting decision-making in the design team.

See Figure 4.30 for some screen shots of the tool.

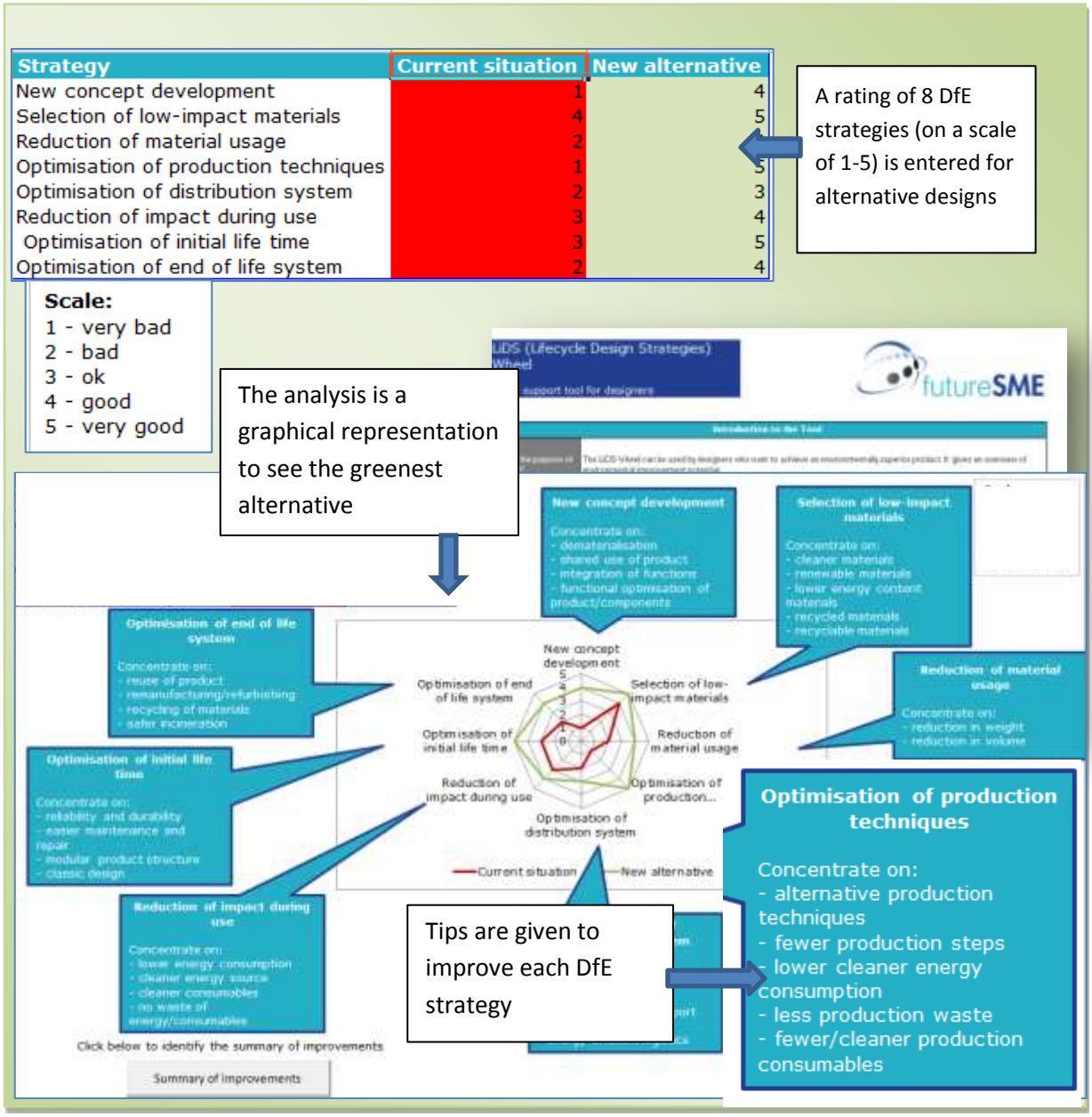


Figure 4.30: Screen shots of the LiDS Wheel (DfE) tool

4.7.5 Product-Service System (PSS) Tool

The PSS tools should be used in conjunction with the related e-learning lesson. The PSS tool is titled "*Servitisation of your business/Product-Service Systems*". It is based on a decision support methodology developed by Dimache (2009) and is in a manual format. It can be downloaded as a zipped folder containing Word, Excel and PDF files. This tool is the most advanced in the entire suite of tools in the Pilot Framework. The PSS tool can be used if an SME is considering the shift to servitisation and is facing difficult decisions such as:

- What is servitisation in the context of my business?
- How appropriate is my offering for a move to a PSS?
- What are the changes necessary in my company to develop a new PSS model?
- Where is my business on the PSS route?
- What is my end goal in the PSS route?
- What is the next step on the PSS route for me?
- How can I find that great idea?

These questions are difficult to answer; therefore, the transition to a PSS business model is not a trivial decision for a manufacturing company. The methodology can help answer these questions and support an SME in the decision-making process.

See Figure 4.31 for screen shots of the tool.

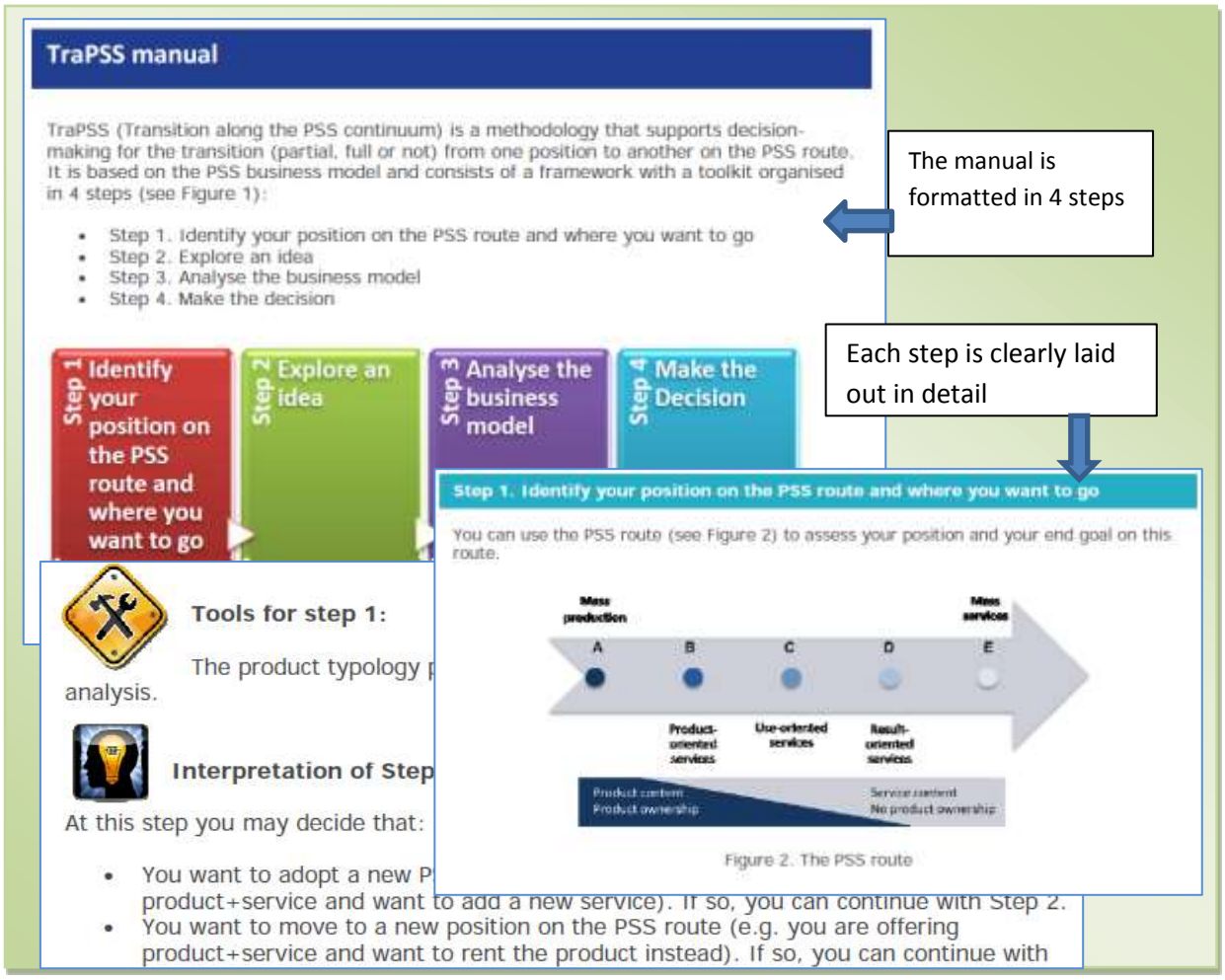


Figure 4.31: Screen shots of the PSS tool

4.7.6 Corporate Social Responsibility (CSR) Tools

The Corporate Social Responsibility (CSR) tools should be used in conjunction with the related e-learning lesson on CSR.

These are original tools designed by the researcher to the user requirements and design specifications. The three tools are presented as two manuals and a template document in Word format.

The CSR tools are based on a three-step methodology (see Figure 4.32).

- Step 1 involves the completion of a questionnaire, to raise awareness about what CSR is, and to assess what CSR activities the company is involved.
- Step 2 collects the data from the first step, which feeds into the generation of a sustainability report.
- Step 3 is a guide for SME owners and managers them to communicate their good practices to leverage this for competitive advantage.

Figure 4.32: CSR Methodology for SMEs

To complete this methodology, the tools involved are:

1. A guide to Sustainability Reporting for SMEs
2. A Corporate Social Responsibility (CSR) Assessment for SMEs

4.7.6.1 *A guide to Sustainability Reporting for SMEs*

This tool is an overall guide showing SMEs owner-managers how to create a sustainability report. It is created in Microsoft Word format and outlines the core methodology and the benefits of sustainability reporting.

See Figure 4.33 for some screen shots of the sustainability report tool.

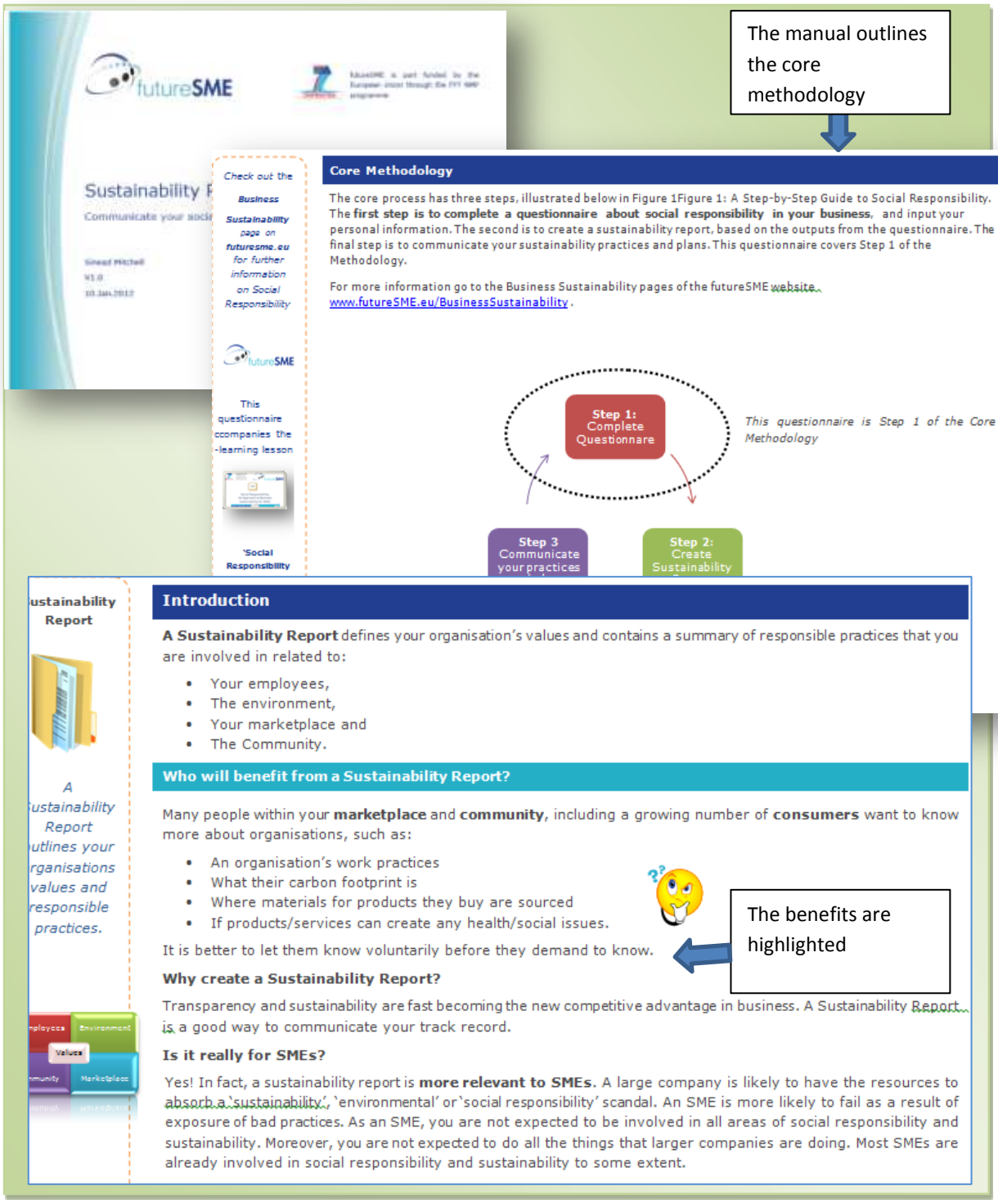


Figure 4.33: Screen shots of the Sustainability Reporting tool

A sustainability report template is also included to make the process as simple as possible for the SME, which can be easily customised as required.

See Figure 4.34 for some screen shots of the sustainability report template.

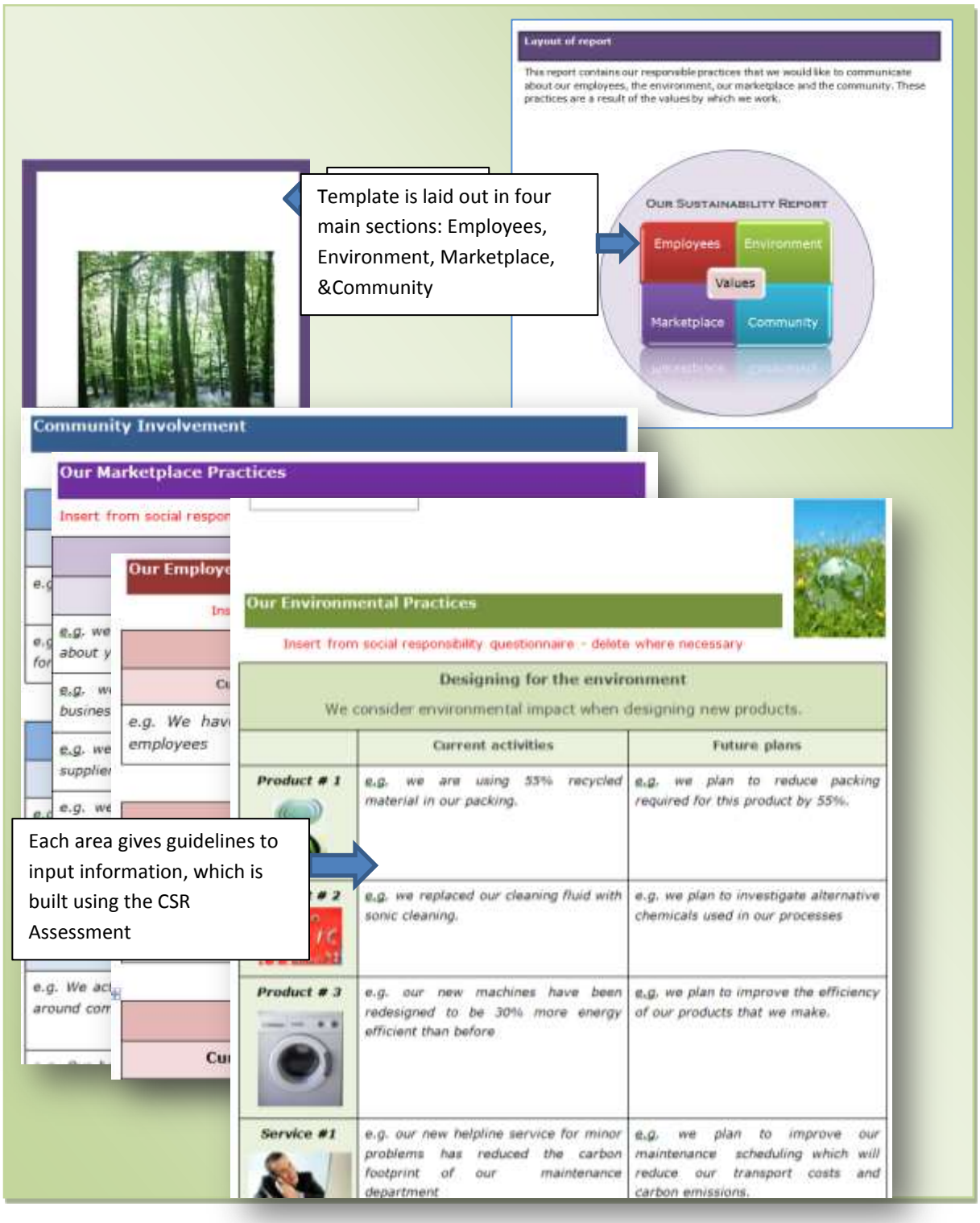


Figure 4.34: Screen shots of the sustainability reporting template

4.7.6.2 A Corporate Social Responsibility (CSR) Assessment for SMEs

This tool is a guide to assess Social Responsibility in an SME. It is designed as a simple manual, and created in Microsoft Word. It can be used in conjunction with the CSR eLearning lesson. It is intended to be used to implement step 1 of the methodology described in section 4.7.6. It gives direction to an SME owner or manager on how to approach CSR, using the three simple steps described above.

This tool raises awareness of what elements make up a responsible and sustainable business for SME owner-managers in all the pillars of CSR: environment, employees, marketplace and community. It explains the importance of each of these areas and why they are relevant to the business objectives. The guide is very simple and practical and can be used in any type of business. The output of the assessment is intended to form the basis for the sustainability report.

See Figure 4.35 for some screen shots of the tool.

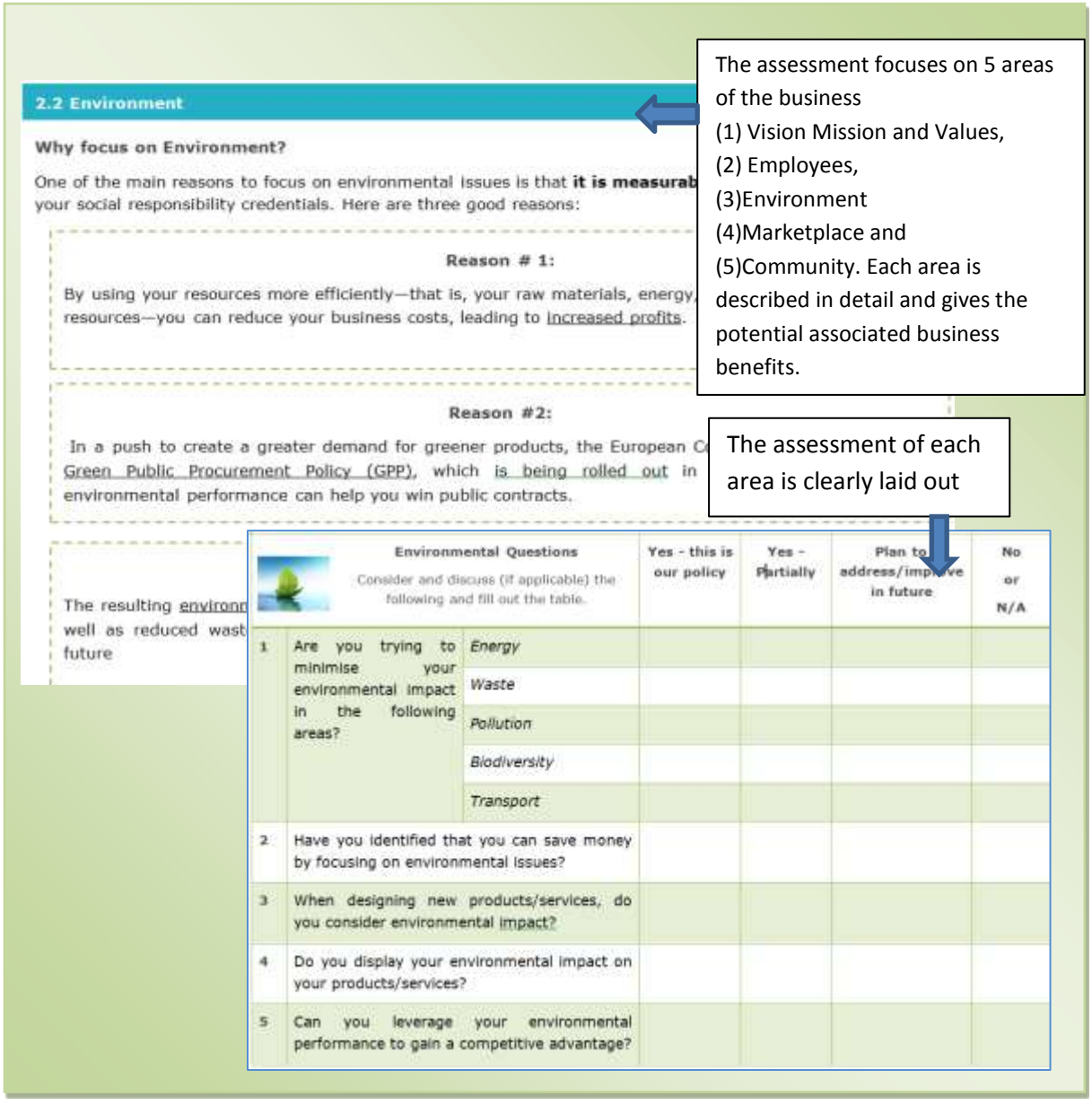


Figure 4.35: Screen shots of the CSR assessment tool

4.7.7 Environmental Management System (EMS) Tools

The EMS tools can be used in conjunction with the related e-learning lesson on EMS. They are auditing tools. They allow SMEs to monitor and improve their performance, and track and trend their environmental costs in three areas: energy, waste and water.

4.7.7.1 Environmental & Cost Management – Energy

The Energy Audit Tool was created by the researcher and can be used to keep track of Energy related costs and usage. Monitoring ongoing use of Energy can help an SME to manage costs, identify opportunities for reductions, reduce costs and have a positive environmental impact.

The tool is created in Microsoft Excel and is simple to use. There are clear instructions, showing how to input data into a sheet. Information is tracked and the trends are displayed graphically over a year, to highlight peaks in energy usage.

See Figure 4.36 for some screen shots of the tool.

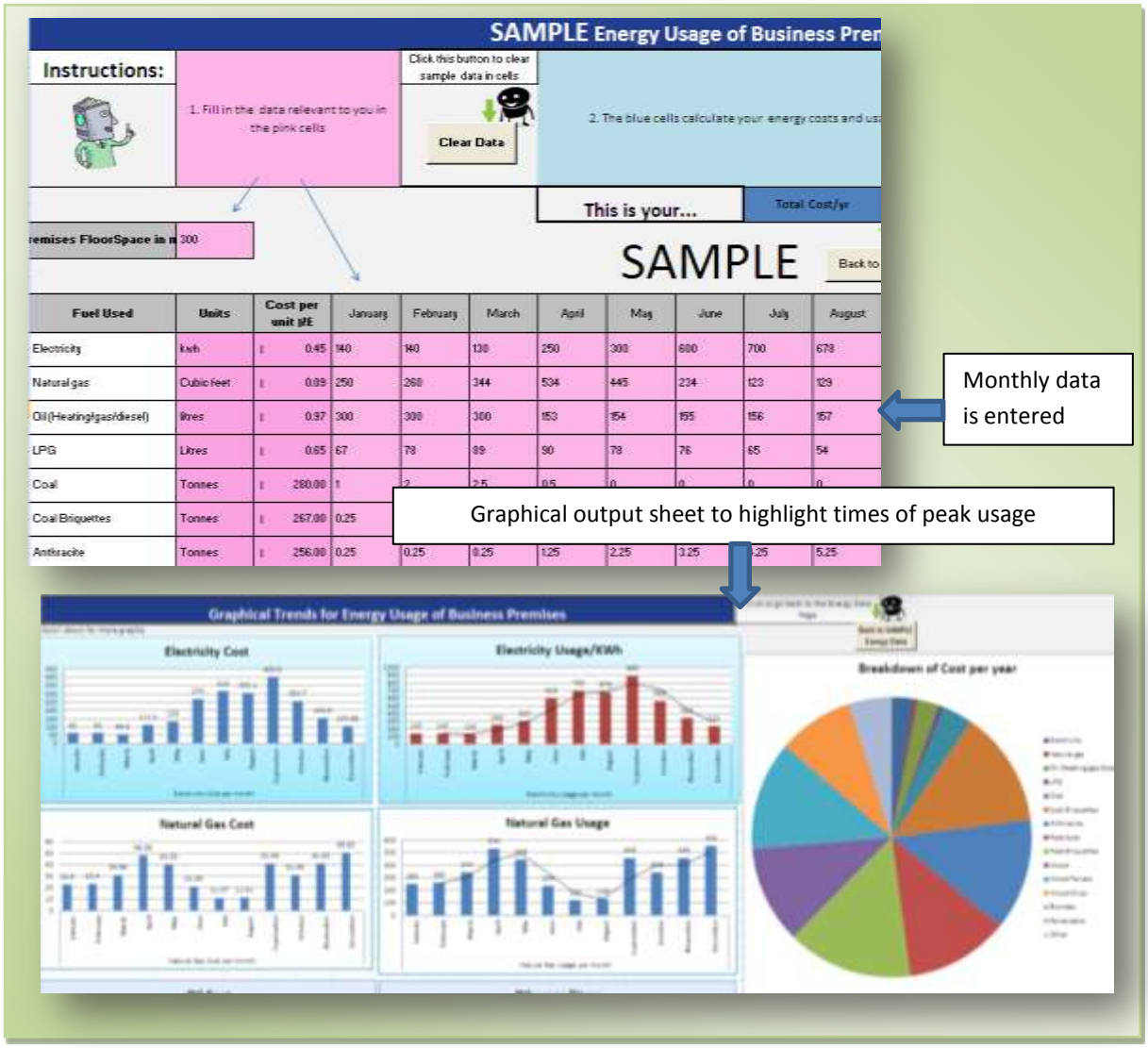


Figure 4.36: Screen shot of the energy management tool

4.7.7.2 *Environmental & Cost Management – Water*

The Water Audit Tool can be used to keep track of water-related costs and usage in the business. It is a simple tool, created in Microsoft Excel. The water balance part is based on one create by WRAP (Envirowise, 2011). It allows the SME to monitor its ongoing use of water, to help it to manage costs, identify overuse of water and leaks/losses, reduce associated costs and have a positive environmental impact. It may also allow the SME to comply with future legislation.

The tool comprises a trending and tracking function, similar to the energy tool above. It also gives some water saving tips.

See Figure 4.37 for some screen shots of the tool.

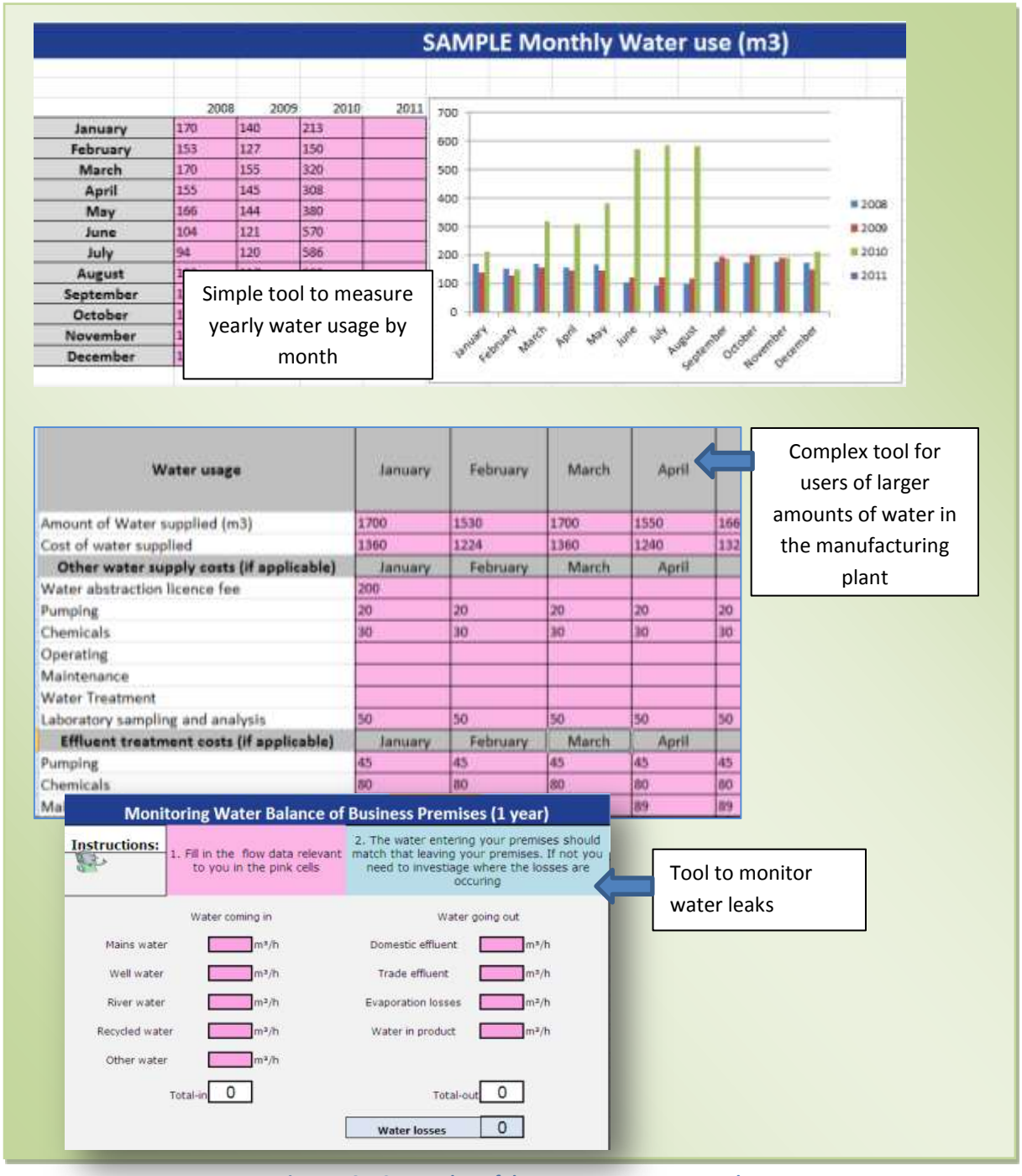


Figure 4.37: Screen shot of the water management tool

4.7.7.3 *Environmental & Cost Management – Waste*

The Waste Audit Tool was created by the researcher. It can be used to keep track of waste-related costs and usage in an SME. It is a simple tool, built in Microsoft Excel, and similar to the energy tool. It allows monitoring of waste, which can help an SME to manage and reduce costs, identify opportunities for reductions and have a positive impact on the environment. The user inputs the data for different streams of waste, and the trends can be tracked and compared over different years. There is a simple version and a detailed version to allow for different types of businesses.

See Figure 4.38 for some screen shots of the tool.

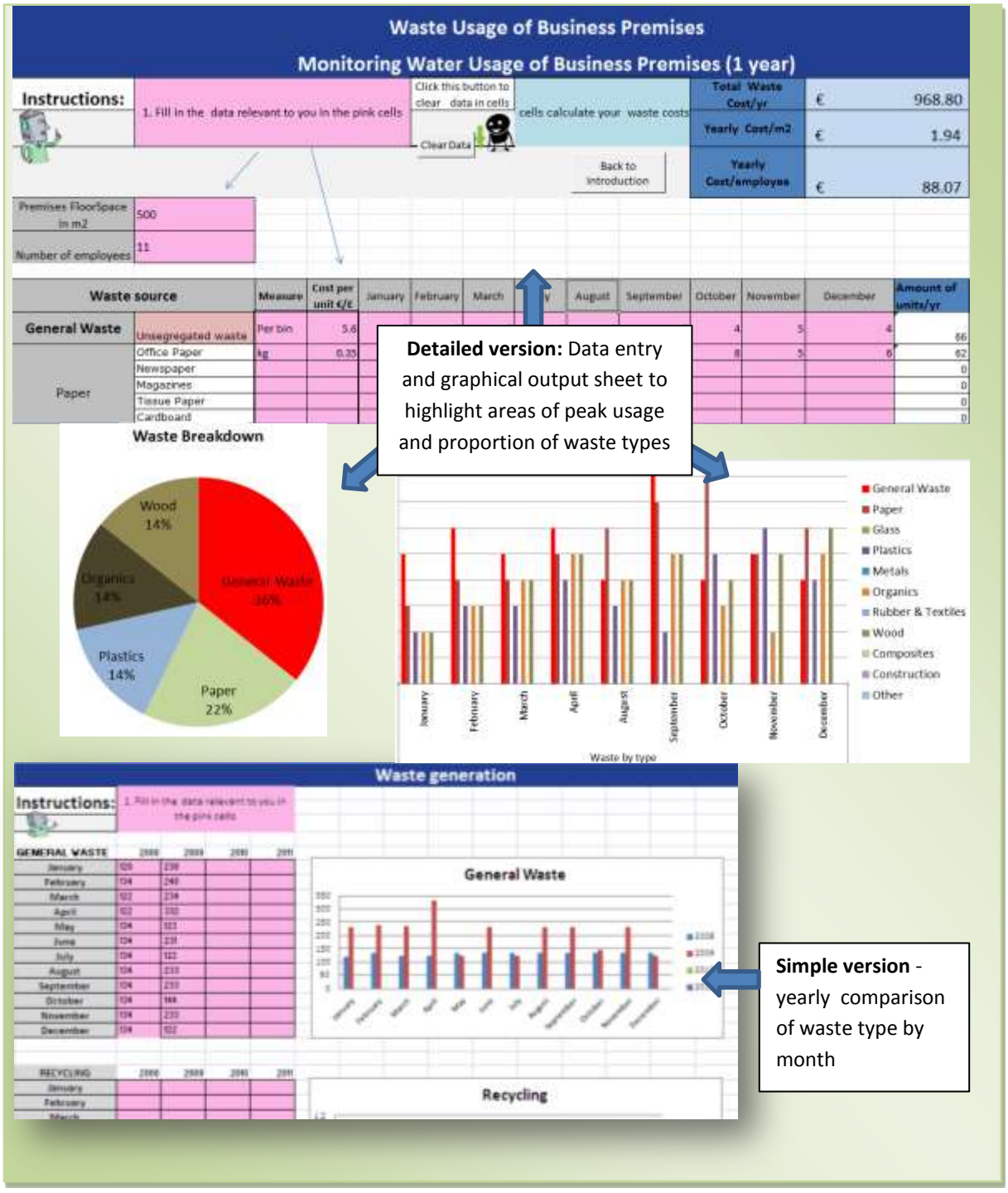


Figure 4.38: Screen shots of the waste management tool

4.8 Testing the SEco Pilot Framework – Testing design

To test the Pilot Framework, a testing framework was designed, which set out a comprehensive strategy to ensure that all of the tools within the Pilot Framework were tested thoroughly. Figure 4.39 outlines the three steps involved:

- **Preparation**: This involved the development of the testing guidelines
- **Testing**: Each of the tools within the Framework was tested by SMEs. This was followed by a stage gate review with the end-user group
- **Observation:** SME engagement with the Framework was observed

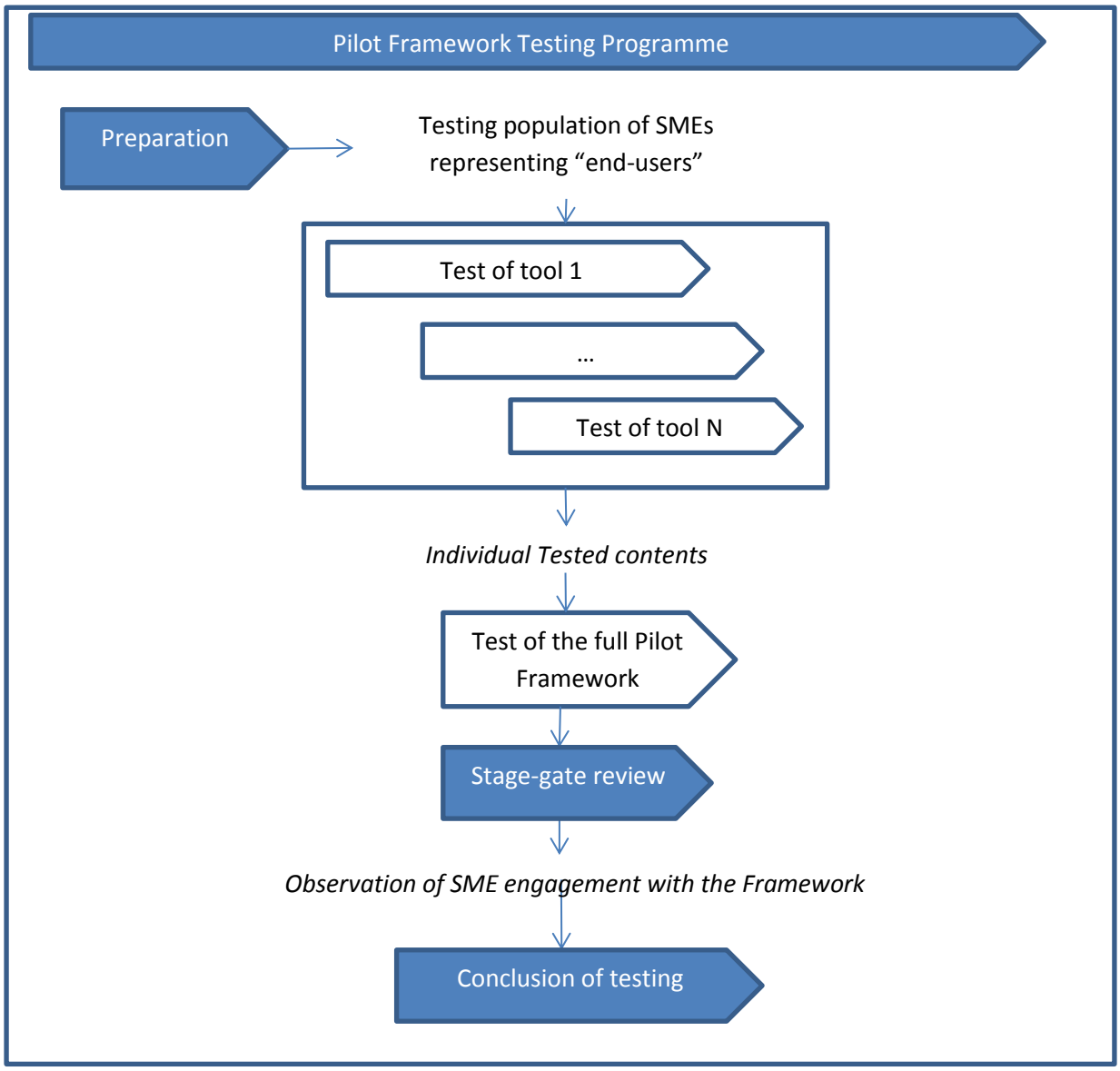


Figure 4.39: Pilot Framework Testing Framework

4.8.1 Preparation: The Testing Process

Test plans were designed to ensure that each of the Framework elements was tested rigorously. A test-plan is a systematic approach to testing a system such as software or a methodology. Figure 4.40 summarises the testing process. Firstly, the tests were designed, and then the "*testers*" were enrolled from the FutureSME end-user group and from outside of the consortium. Figure 4.40

describes the testing process. The testing was organised with the testers, carried out, and then an analysis of the testing results was completed.

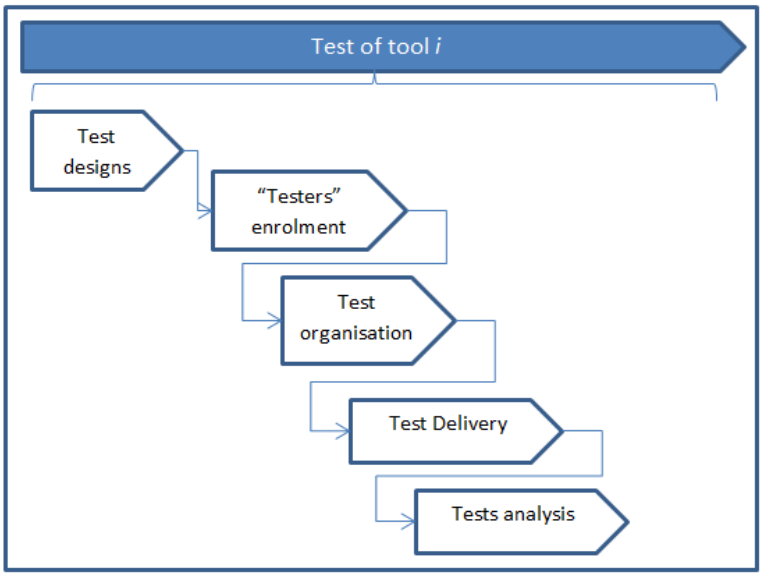


Figure 4.40: The testing process

ISO9241 "*Ergonomics of Human System Interaction*" provides a framework for applying a set of usability heuristics in relation to the interaction of people with information systems. All of the tools were designed in Microsoft Excel and Word, and the eLearning was viewed on a browser. The ISO9241 standard was considered in the testing process, specifically for:

- **Suitability** of a user's individual skill level for the task and for individualisation of learning
- **Self-descriptiveness** to ensure the user is clear about what to do
- **Controllability** to ensure there is a suitable pace
- **Conformity** to ensure it meets user expectations
- **Error tolerance** to ensure the interaction is forgiving for the user.

Part 11 of ISO9241 defines usability as "*the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*". The testing design considered part 11, and the testing is based on:

- **Functionality** – to ensure accuracy as well as suitability for the task and the individual
- **Operability** – that the effort needed by the user group is suitable for learning, being clear, comprehensive, conforming with expectations and being self-descriptive
- **Reliability** –that there is an error tolerance considered under the expected conditions
- **Efficiency** – to ensure consideration of time and resources
- **Maintainability** – so that it is stable, changeable and testable
- **Portability** – to ensure the use can adapt to suit.

The most important aspect of the testing was that it considered the needs of SMEs.

The testing was carried out by SME owner-managers across Europe. The test plans and tools were sent to the testers via email.

The testing activities had a general approach for each Framework element and aimed to:

- Ensure that it was working properly
- Verify its ease of use
- Check if it the objectives set out by the tools/eLearning were achieved
- Ensure that it was suitable in an SME context.

The test plans took the form of feedback questionnaires. The testing involved field use followed immediately by the questionnaire. This allowed each Framework element to be assessed for its operational characteristics and effectiveness, its usability and applicability in practice.

Figure 4.41 details the format of each questionnaire, which includes a brief instruction guide and six (for the tools) or ten (for the eLearning) questions, which allowed for both quantitative and qualitative answers. The questions were scored from one to five, where 1 is "not at all" 3, is "average", and 5 is "very likely". A comment box under each question allowed for further information and feedback from the testers.

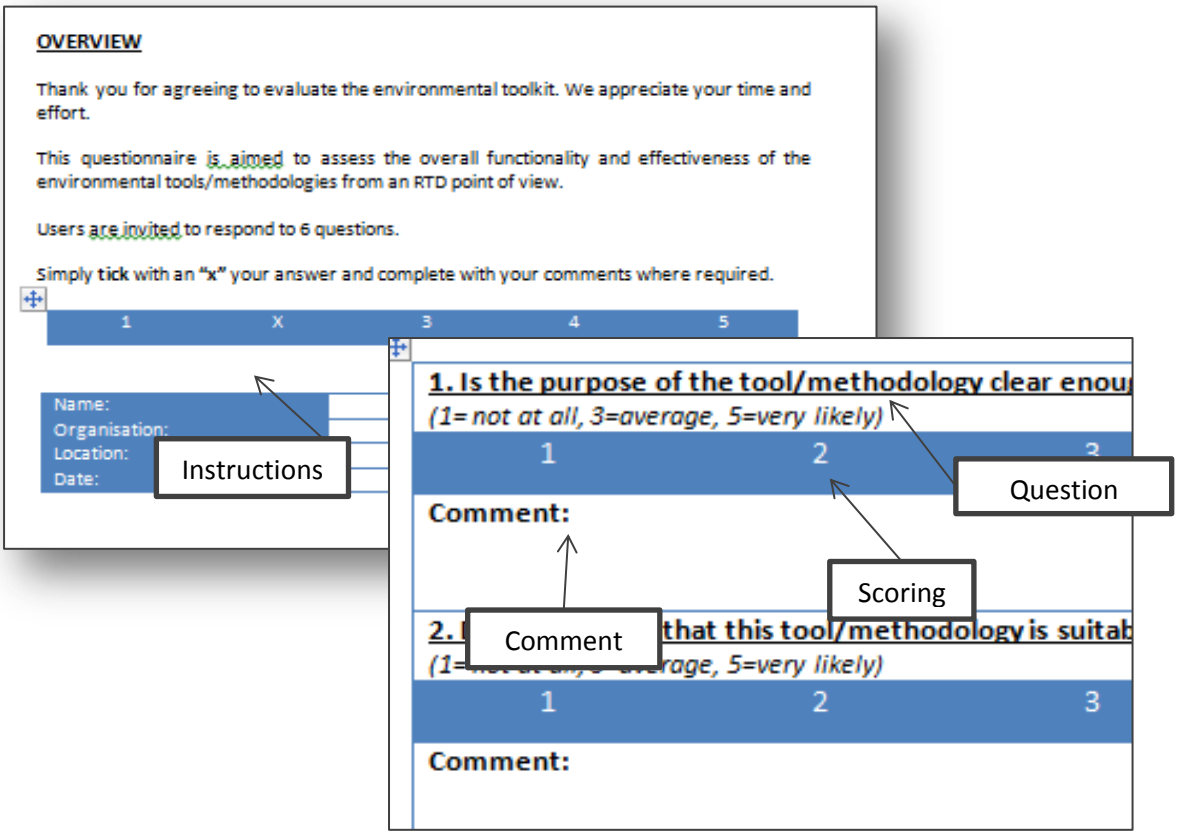
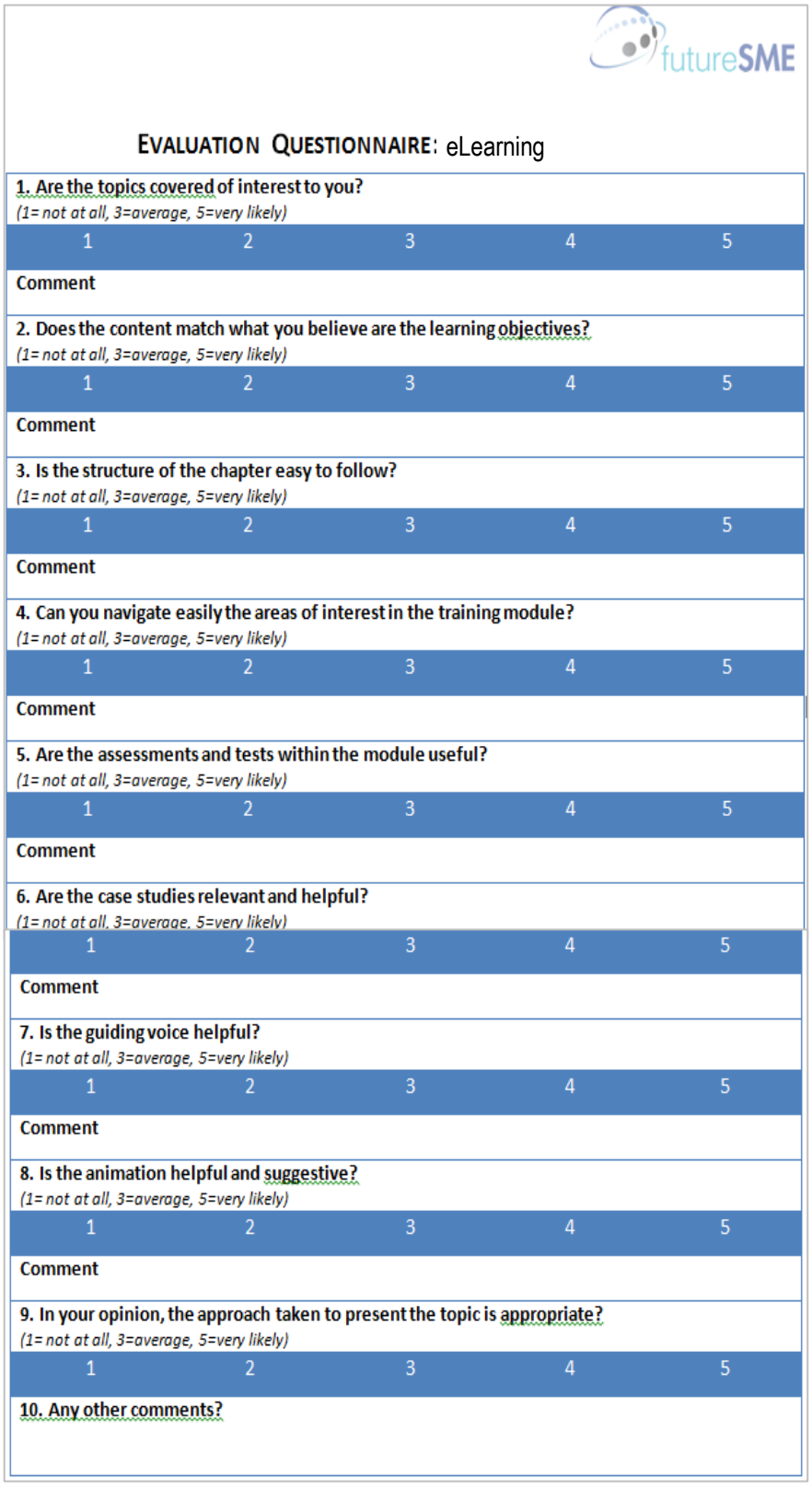


Figure 4.41: Testing questionnaire format

One questionnaire tested each of the individual tools and another tested each of the eLearning lessons. A sample of three SME owner-managers tested each of the tools and eLearning lessons.

The questions posed for the eLearning modules were aimed at assessing how interested the SMEs were in the subject and whether the lessons were pitched correctly to the SME audience. The questions asked can be seen in Figure 4.42

The questionnaire for the tools aimed to assess the overall functionality and effectiveness of the environmental tools/methodologies. The questions were selected to find out how easy the tool was to use, that the language used was suitably pitched at SMEs, and what the benefits of the tool were. The questionnaire can be seen in Figure 4.43.



futureSME

EVALUATION QUESTIONNAIRE: eLearning

1. Are the topics covered of interest to you? *(1= not at all, 3=average, 5=very likely)*				
1	2	3	4	5
Comment				
2. Does the content match what you believe are the learning objectives? *(1= not at all, 3=average, 5=very likely)*				
1	2	3	4	5
Comment				
3. Is the structure of the chapter easy to follow? *(1= not at all, 3=average, 5=very likely)*				
1	2	3	4	5
Comment				
4. Can you navigate easily the areas of interest in the training module? *(1= not at all, 3=average, 5=very likely)*				
1	2	3	4	5
Comment				
5. Are the assessments and tests within the module useful? *(1= not at all, 3=average, 5=very likely)*				
1	2	3	4	5
Comment				
6. Are the case studies relevant and helpful? *(1= not at all, 3=average, 5=very likely)*				
1	2	3	4	5
Comment				
7. Is the guiding voice helpful? *(1= not at all, 3=average, 5=very likely)*				
1	2	3	4	5
Comment				
8. Is the animation helpful and suggestive? *(1= not at all, 3=average, 5=very likely)*				
1	2	3	4	5
Comment				
9. In your opinion, the approach taken to present the topic is appropriate? *(1= not at all, 3=average, 5=very likely)*				
1	2	3	4	5
10. Any other comments?				

Figure 4.42: eLearning Questionnaire

futureSME

Evaluation Questionnaire: Tools

1. Is the purpose of the tool/methodology clear enough to you? Is it properly explained? *(1= not at all, 3=average, 5=very likely)*
1 2 3 4 5
Comment:
2. Do you believe that this tool/methodology is suitable for an SME? *(1= not at all, 3=average, 5=very likely)*
1 2 3 4 5
Comment:
3. Is the English clear (no grammar mistakes, etc.)? Is the tool working properly (calculations etc.)?
4. Which parts of the tool/methodology are most useful for SMEs?
5. Would SMEs use this tool/methodology by themselves (without help from a consultant/expert)? *(1= not at all, 3=average, 5=very likely)*
1 2 3 4 5
Comment:
6. Which of the following do you think are the benefits generated by the tool/methodology?
1 2 3 4 5
Communication tool internally and/or externally *(1=disagree, 3=average, 5=agree)*
1 2 3 4 5
Providing a structured manner of presenting information *(1=disagree, 3=average, 5=agree)*
1 2 3 4 5
Use as benchmark – compare various alternatives according to the impact on the environment/cost/etc. *(1=disagree, 3=average, 5=agree)*
1 2 3 4 5
Use as support for decision-making *(1=disagree, 3=average, 5=agree)*
1 2 3 4 5
Other benefits:
Add other comments about the tool/methodology

Figure 4.43: Questionnaire for the Tools

4.9 Testing the SEco Training

Every eLearning module within the Pilot Framework was tested by a minimum of three testers, representing the SME end-user group.

4.9.1 Life Cycle Assessment (LCA) eLearning

Three SME representatives tested the LCA eLearning modules. Table 4.10 summarises the scores. This lesson was of interest to the testers and the case studies were useful.

However, this lesson did not score as highly as the DfE one (see 4.9.3) and the content did not fully match the objectives. Some of the comments indicated that the topic was too comprehensive to cover in one lesson. One tester suggested that the theory of LCA be an optional part of the lesson, which related to the segmentation of the module, rather than the content and suitability.

LCA ELearning Module Testing	Average score (out of 5)	Satisfaction levels/ percentages (%)
Are the topics covered of interest to you?	4.3	86
Does the content match what you believe are the learning objectives**.**	2.6	52
Is the structure of the chapter easy to follow?	3.3	66
Can you navigate easily the areas of interest in the training module?	3.3	66
Are the assessments and tests within the module useful?	3.0	60
Are the case studies relevant and helpful?	3.6	72
Is the guiding voice helpful?	3.3	66
Is the animation helpful and suggestive?	3.0	60
In your opinion, the approach taken to present the topic is appropriate?	3.0	60
Comments "*Presentation was prepared very well and I can say that it is useful. When I think about my job, I can use some advantage of LCA against our competitors"* *"There is way too much there, and it should be split up into different lessons*"		

Table 4.10: LCA eLearning testing results

4.9.2 Life Cycle Costing (LCC) eLearning

Three SME representatives tested the DfE eLearning modules. Table 4.11 summarises the results of the testing. The topics were of interest to the testers and mostly met the objectives. The case studies seemed to be pitched well to the testing audience. The lowest score related to the assessments within the module. Some comments were made about small parts of the lesson that were easy to fix (such as using text instead of mathematical formulae). The lesson was considered a bit too long, which could be addressed by splitting the lessons into constituent parts for presentation to the SME.

LCC ELearning Module Testing	Average score (out of 5)	Satisfaction levels/ percentages (%)
Are the topics covered of interest to you?	4.0	80
Does the content match what you believe are the learning objectives.	3.7	73
Is the structure of the chapter easy to follow?	4.7	93
Can you navigate easily the areas of interest in the training module?	4.0	80
Are the assessments and tests within the module useful?	3.3	67
Are the case studies relevant and helpful?	4.0	80
Is the guiding voice helpful?	4.0	80
Is the animation helpful and suggestive?	3.7	73
In your opinion, the approach taken to present the topic is appropriate?	3.7	73
Comments *"It should be made more interesting to make you want to do an LCC"* *"The formulas are very unreadable – convert to all text instead"* *"Break up into different chapters – it is too long"*		

Table 4.11: LCC Learning testing results

4.9.3 Design for the Environment (DfE) eLearning

Five SME representatives tested the DfE eLearning modules. Table 4.12 summarises the results of the testing. The topics within the lesson were of interest to testers, and the approach was deemed appropriate. The highest scoring aspect was the animation. Usability scored well, which was reflected in the ease of navigation. The lowest score related to the usefulness of the assessment testing within the module.

Many positive comments were received. The testers found the lesson interesting and it prompted some ideas that would not otherwise have occurred to them. It was described as a "good tool for SMEs that can't afford to employ product designers for them to learn about DfE", which demonstrates that the tools was pitched suitably to the audience. There were some negative comments about the use of "jargon".

DfE ELearning Module Testing	Average score (out of 5)	Satisfaction levels/ percentages (%)
Are the topics covered of interest to you?	3.8	76
Does the content match what you believe are the learning objectives.	4.2	84
Is the structure of the chapter easy to follow?	4.0	80
Can you navigate easily the areas of interest in the training module?	4.2	84
Are the assessments and tests within the module useful?	3.2	64
Are the case studies relevant and helpful?	4.0	80
Is the guiding voice helpful?	4.0	80
Is the animation helpful and suggestive?	4.4	88
In your opinion, the approach taken to present the topic is appropriate?	3.8	76
Comments "*The cases presented can stimulate us to meet EU requirements"* *"It is a good tool for SMEs that can't afford to employ product designers for them to learn about DfE"*		

Table 4.12: DfE ELearning testing results

4.9.4 Product Service Systems (PSS) eLearning

Three SME representatives tested the DfE eLearning modules. Table 4.13 summarises the results of the testing. Considering the complexity of the PSS idea, the satisfaction scores were relatively high.

The topics were of interest to the testers and matched the objectives. The case studies rated a little low at 60%, but the approach taken in general was appropriate. Two of the testers found the lesson very useful, but one seemed frustrated with terms such as "*dematerialisation*" and thought they were "*made up*".

PSS ELearning Module Testing	Average score (out of 5)	Satisfaction levels/ percentages (%)
Are the topics covered of interest to you?	3.7	73
Does the content match what you believe are the learning objectives.	3.7	73
Is the structure of the chapter easy to follow?	4.3	87
Can you navigate easily the areas of interest in the training module?	4.3	87
Are the assessments and tests within the module useful?	2.7	53
Are the case studies relevant and helpful?	3.0	60
Is the guiding voice helpful?	3.3	67
Is the animation helpful and suggestive?	3.7	73
In your opinion, the approach taken to present the topic is appropriate?	3.5	70
Comments *"Topics were well covered"* *"What is dematerialization? These are made up words that help to cloak a simple concept in mystery"*		

Table 4.13: PSS ELearning testing results

4.9.5 CSR for SMEs eLearning

Three SME representatives tested the CSR eLearning module. Table 4.14 summarises the results of the testing. The testers found that the topics covered were of interest matching the objectives set out.

The case studies were helpful and the approach taken was regarded as appropriate. Again, the assessments did not rate highly, rating at just over 50% - one tester said that "*It would turn you off completing the lesson*". The comments were polarised from saying that it made them interested in doing a sustainability report to saying that some of the lesson was "*too generic and basically nonsense*" and expected names of specific companies to be highlighted throughout the lesson (despite the fact that real companies were named and profiled in the case studies).

CSR ELearning Module Testing	Average score (out of 5)	Satisfaction levels/ percentages
Are the topics covered of interest to you?	4.3	87
Does the content match what you believe are the learning objectives.	4.0	80
Is the structure of the chapter easy to follow?	4.7	93
Can you navigate easily the areas of interest in the training module?	5.0	100
Are the assessments and tests within the module useful?	2.7	53
Are the case studies relevant and helpful?	4.0	80
Is the guiding voice helpful?	3.3	67
Is the animation helpful and suggestive?	3.7	73
In your opinion, the approach taken to present the topic is appropriate?	4.0	80
Comments "*Makes you interested in doing a Sustainability Report when you read the example"* *"Make it possible to skip the assessments, and stop treating us like students. The topic does not lend itself to this, and an SME only wants to take out the relevant points to them, not have to do these. It would turn you off completing the lesson"*		

Table 4.14: CSR eLearning testing results

4.10 Testing the SEco Tools

Each tool within the Pilot Framework was tested with a minimum of three testers representing the SME end-user group.

4.10.1 DFE Tools

Table 4.15 summarises the testing of the suite of DfE tools, (DfE Checklist and the LIDs Wheel), which was carried out with four SME representatives. Both of the tools got the same score.

The results indicated that both tools were explained well and were suitable for an SME. The testers also agreed that the tools would be beneficial as a tool for their business. However, the result of 50% reflected a lack of confidence that SMEs would use the tools without some help from an expert.

DfE Tools Testing	DFE Checklist		LIDs Wheel	
	Average score	%	Average score	%
Is the purpose of the tool/methodology clear enough to you? Is it properly explained	4.5	90	4.5	90
Do you believe that this tool/methodology is suitable for an SME?	4.3	85	4.3	85
Is the English language clear (no grammar mistakes, etc.)?	4.3	86	4.3	86
Is the tool working properly (calculations, processes, etc.)?	3.6	72	3.6	72
Would SMEs use this tool/methodology by themselves (without help from a consultant/expert)?	2.5	50	2.5	50
Benefits generated of the tool/methodology?				
Communication tool internally and/or externally	4.0	80	4.0	80
Providing a structured manner of presenting information	4.5	90	4.5	90
Use as benchmark – compare various alternatives according to the impact on the environment/cost/etc.	3.5	70	3.5	70
Use as support for decision-making	3.5	70	3.5	70
Comments: *"Not suitable for all SMEs"* *"The SMEs who is working with EU countries must consider this tool in their business"*				

Table 4.15: Results of testing the DfE tools

4.10.2 LCA Tools

Table 4.16 summarises testing of the LCA tools, (MET Matrix, Eco Indicator 99, Eco Compass and Carbon Footprint tool), which was carried out with three SME representatives. None of these tools was rated as highly as the DfE tools.

Even though the purpose of the tools seemed to be fairly well defined, the conclusion was that the majority of SMEs would not use these tools without the help of an expert. Positive comments about the carbon foot-printing tool related to the visual output as a good communication method. One SME said that they would prefer to outsource the function to an expert, if needed.

LCA Tools Testing	MET Matrix		Eco-Indicator99		Eco-Compass		Carbon Footprint	
	Av. score	%	Av. score	%	Av. score	%	Av. score	%
Is the purpose of the tool/methodology clear enough to you? Is it properly explained	3.7	73	3.7	73	3.7	73	3.7	73
Do you believe that this tool/methodology is suitable for an SME?	3.0	60	3.0	60	2.3	47	3.7	73
Is the English language clear (no grammar mistakes, etc.)?	4.3	87	4.3	87	4.3	87	4.7	93
Is the tool working properly (calculations, processes, etc.)?	4.0	80	4.0	80	3.7	73	3.3	67
Would SMEs use this tool/methodology by themselves (without help from a consultant/expert)?	2.7	53	2.7	53	2.3	47	3.0	60
Benefits generated of the tool/methodology?								
Communication tool internally and/or externally			3.7	73	3.0	60	3.3	67
Providing a structured manner of presenting information	3.3	67	4.3	87	4.0	80	3.7	73
Use as benchmark – compare various alternatives according to the impact on the environment/cost/etc.	3.0	60	4.0	80	3.5	70	3.7	73
Use as support for decision-making	3.3	67	3.7	73	3.5	70	3.3	67

Comments

"Good to see where the differences are and identify where to improve visually (Footprint)"

"I prefer to get help from outsource to use this tool (Eco Compass)"

"It is good for comparing on environmental basis, but depends on the SME (Eco-indicator99)"

"It is more like doing a brainstorm. Good for comparing at design stage (Met Matrix)"

Table 4.16: Results of testing the LCA tools

4.10.3 LCC Tools

Table 4.17 summarises the testing of the LCC tools, (Product LCC and Equipment LCC), which was carried out with three SME representatives. These tools were rated very highly as an effective communication tool.

They were both deemed to be appropriately designed for use by an SME without the help of an expert. The product tool rated more highly than the equipment one in almost all aspects and one SME tester recognised the tool's ability "*to demonstrate that the products will be more efficient than a competitor*".

LCC Tools Testing	Product LCC		Equipment LCC	
	Average score	%	Average score	%
Is the purpose of the tool/methodology clear enough to you? Is it properly explained	3.7	73	3.0	60
Do you believe that this tool/methodology is suitable for an SME?	3.7	73	3.0	60
Is the English language clear (no grammar mistakes, etc.)?	4.3	87	4.3	87
Is the tool working properly (calculations, processes, etc.)?	4.7	93	3.7	73
Would SMEs use this tool/methodology by themselves (without help from a consultant/expert)?	4.7	93	4.0	80
Benefits generated of the tool/methodology?				
Communication tool internally and/or externally	4.7	93	4.0	80
Providing a structured manner of presenting information	4.3	87	3.0	60
Use as benchmark – compare various alternatives according to the impact on the environment/cost/etc.	3.0	60	3.0	60
Use as support for decision-making	3.0	60	2.7	53
Comments *"The cost saving part and comparison is the most useful"* *"Does not highlight environmental impact or savings"* *"Most useful to demonstrate that the products will be more efficient than a competitor (product tool)"*				

Table 4.17: Results of testing the LCC tools

4.10.4 PSS Tool

The PSS tool posed the most difficulty in carrying out the testing activities. The tool was presented to all of the SMEs on the FutureSME project, as well as some externally. The researcher was not successful in achieving more than one tester for this tool. The tool was tested by a very experienced business person, who was the owner-manager of a manufacturing SME, and the result is summarised in Table 4.18.

Although the purpose of the tool was clear to the tester, the application and complex method were deemed inappropriate for an SME (besides the calculations and the English language which is simply a minimum requirement). The tester stated that the tool was "*not suitable for an SME as it was too complex"*.

PSS Tool Testing	PSS Manual	
	score	%
Is the purpose of the tool/methodology clear enough to you? Is it properly explained	4	80
Do you believe that this tool/methodology is suitable for an SME?	1	20
Is the English language clear (no grammar mistakes, etc.)?	3	60
Is the tool working properly (calculations, processes, etc.)?	4	80
Would SMEs use this tool/methodology by themselves (without help from a consultant/expert)?	1	20
Benefits generated of the tool/methodology?		
Communication tool internally and/or externally	1	20
Providing a structured manner of presenting information	1	20
Use as benchmark – compare various alternatives according to the impact on the environment/cost/etc.	1	20
Use as support for decision-making	1	20
Comment "*The concepts are quite complex and not suitable for an SME*"		

Table 4.18: Results of testing of the PSS Tool

4.10.5 CSR Tools

The CSR tools were very successful in the testing stage, and five SME owner-managers participated in the testing process, which is summarised in Table 4.19.

The testing of this tool was carried out slightly differently – the researcher asked the questions to the owner-manager and wrote the sustainability report. All aspects of the tools were rated highly with the exception of the ability of an SME to do the test by themselves. The suitability of the tool for an SME rated over 90% for both tools, and it was rated highly as a communication tool. One SME owner-manager summed up this combination of tools as "*a thing that you would probably never think of doing yourself, and it could surprise you with the competitive advantage that it gives you*".

CSR Tools Testing	CSR Assessment		Sustainability Report	
	Average score	%	Average score	%
Is the purpose of the tool/methodology clear enough to you? Is it properly explained	5.0	**100**	5.0	**100**
Do you believe that this tool/methodology is suitable for an SME?	4.8	**96**	4.6	92
Is the English language clear (no grammar mistakes, etc.)?	4.8	96	4.8	**96**
Would SMEs use this tool/methodology by themselves (without help from a consultant/expert)?	2.0	40	2.4	48
Benefits generated of the tool/methodology?				
Communication tool internally and/or externally	4.6	92	4.6	92
Providing a structured manner of presenting information	4.4	88	4.6	92
Comments "*It is a good way to take a look at yourself that you would not have the opportunity to do , in a holistic way rather than simply looking at your economic value"* *"It is a novel interesting idea for SMEs to do this. It's a thing that you would probably never think of doing yourself, and it could surprise you with the competitive advantage that it gives you"* *"Good communication tool (report)"*				

Table 4.19: Results of testing of the CSR tools

4.10.6 Audit Tools

Table 4.20 summarises the results of testing of the audit tools by three SME representative testers. One SME summed these tools up as being "simple and useful for SMEs". The tools were formatted almost identically, and hence were scored as such by all testers. 100% of the testers believed these set of tools to be appropriate to SMEs, and they would be able to use them without any external assistance.

Audit Tools Testing	Energy Tool		Water Tool		Waste Tool	
	Average score	%	Average score	%	Average score	%
Is the purpose of the tool/methodology clear enough to you? Is it properly explained	4.7	93	4.7	93	4.7	93
Do you believe that this tool/methodology is suitable for an SME?	5.0	**100**	5.0	**100**	5.0	**100**
Is the English language clear (no grammar mistakes, etc.)?	4.7	93	4.7	93	4.7	93
Is the tool working properly (calculations, processes, etc.)?	5.0	**100**	5.0	**100**	5.0	**100**
Would SMEs use this tool/methodology by themselves (without help from a consultant/expert)?	5.0	**100**	5.0	**100**	5.0	**100**
Benefits generated of the tool/methodology?						
Communication tool internally and/or externally	4.3	87	4.3	87	4.3	87
Providing a structured manner of presenting information	4.3	87	4.7	93	4.3	87
Use as benchmark – compare various alternatives according to the impact on the environment/cost/etc.	4.3	87	4.7	93	4.3	87
Use as support for decision-making	4.3	87	4.3	87	4.3	87
<u>Comments</u> *"Simple and useful for SMEs"* *"A good monitor for Profit and Loss"*						

Table 4.20: Results of testing of the audit tools

4.11 Further Assessment of the SEco Pilot Framework

As mentioned in Chapter One, this Framework was developed within the wider context of the FutureSME project. A stage gate review processes was embedded within the FutureSME project plan, which facilitated feedback from the end user group. Moreover, the researcher had access to the analytics output of the FutureSME web portal to assess the activity of SMEs with the environmental tools and eLearning within the Business Sustainability section of the website.

4.11.1 Stage Gate Review

Stage gate reviews occurred periodically throughout the FutureSME project – namely at the conceptual stage, the Framework specification stage and at the testing stage of the tools. A sign-off from the end-user group was required at each stage before proceeding further.

For the testing stage, the end-user group convened a meeting during a two-day all-partner meeting in 2012 in Gothenburg. One of the SME owner-managers chaired the session to stimulate the discussion. A final "approved" verdict was given at the end of this session. The researcher sat in on the meeting to observe the feedback from the SME user-group.

One of the main wider issues within the broader set of tools in FutureSME that emerged during this process was the suitability of the language and terms used (being too academic at times), but the Framework was deemed to be appropriate. The SMEs welcomed tools related to particular areas such as financial (e.g. auditing tools and LCC tools), sales and marketing (e.g. CSR tools). All of the SMEs welcomed the case studies and worked examples with the eLearning lessons and tools. The CSR tool met the needs of the SMEs in relation to the preferred method of face-to-face facilitation and the requirement for a holistic approach.

A representative from the European Commission (who was responsible for tracking the progress of the FP7 FutureSME project) also attended the all-partner meetings and the stage-gate reviews. The representative commented that the results within the project were good and demonstrated the proof of concept.

All end-users agreed that FutureSME project tools (including the SEco Pilot Framework) should be signed off and that the progress of the project (which included the Pilot Framework) was acceptable at the time of testing.

4.11.2 Observation for Voluntary Uptake of the Pilot Framework

The researcher accessed the FutureSME website facility to extract reports to assess the user activity on the website i.e. what tools were being downloaded and by whom.

The summary data indicated that the environmental tools represented 23% of the tools that were being downloaded on the FutureSME web portal[13]. Figure 4.44 shows that the carbon footprinting tool was the most popular and the EMS eLearning module was the least popular for download.

[13] 225 downloads from the Business Sustainability Section, out of a total of 963 tools in the entire suite of tools

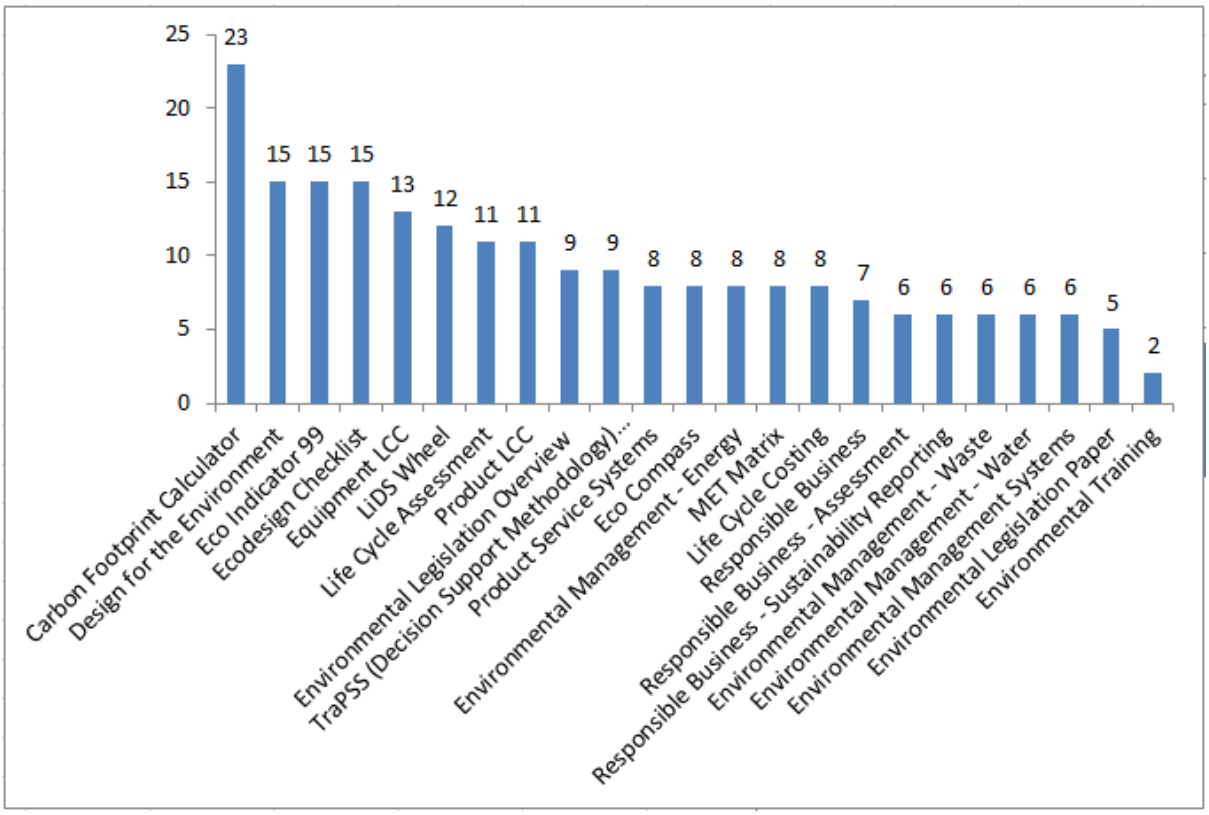


Figure 4.44: Environmental tools downloaded from the FutureSME website

From further evaluation of each of these downloads, it was possible to view which "*company*" downloaded each particular tool. This led to the realisation that the tools were not being downloaded by the target audience - SMEs. The downloads were mainly from universities, large organisations and environmental consultancy organisations.

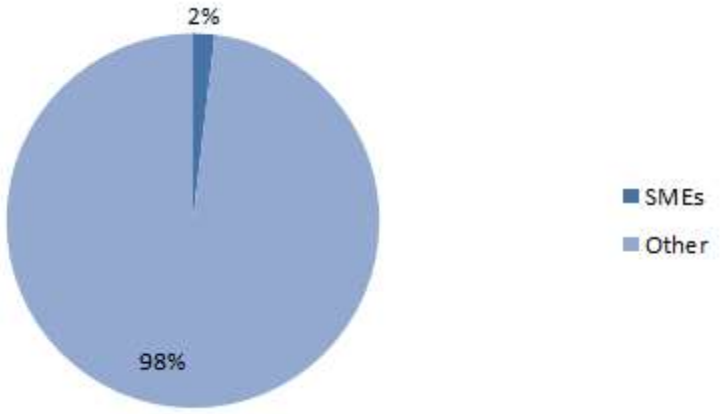


Figure 4.45: Percentage downloads by SMEs and other organisation types

The researcher investigated further to see why the SME owner-managers within the FutureSME consortium were not using the tools. None (0%) of the 13 SME owner-managers in the Future SME consortium had engaged any further with the SEco Pilot Framework. This was despite the positive feedback and their input during the development stage, the individual testing of the tools and the approval of the SEco Pilot Framework in the FutureSME stage gate reviewing process.

The feedback gathered from the SME owner-managers was that they still did not think that the Framework would be of any benefit to their organisation. The owner-managers who had engaged in the testing of the Sustainability Report valued the supported process and resulting outputs, yet were still unwilling to use the Framework on their own.

4.12 Discussion

Overall the tools were rated highly by the testers in relation to usability and appropriateness for SMEs, and the SEco Pilot Framework was subsequently approved by the end-user group.

The eLearning modules scored well overall. The DfE lesson received positive scores and comments. The LCA lesson did not score as well. However, the concepts in this lesson were more complex. The appropriate format of the lessons was reflected in the scores on to ease of navigation, and in general were pitched appropriately for a wide audience of SMEs. Some of the testers commented that the eLearning helped to generate ideas for the company, and provided the knowledge to apply sustainable design principles where that resources to do so were not present. Although some of the lessons may have been too comprehensive to be covered in one sitting, dissecting into constituent parts would be an easy solution to overcome this issue. The consistent low scoring related to the assessments. Getting this right is a difficult balance between appropriateness for an SME and the alignment with good instructional design principles. The option to skip these assessments is an easy way to overcome this.

The environmental management/audit tools scored the highest by the tester group. These were very simple and visual tools, easily understood by a wide audience. The CSR-related tools scored second-best; the SME representatives considered these tools to be an innovative approach for a smaller organisation, and they could see how the communication of sustainability credentials would be beneficial. The DfE tools scored the highest in the design-related tools, probably because the concepts such as [design for] *reuse*, *recyclability* are familiar in everyday language. The LCC tools were seen as an effective communications tool; the inclusion of cost-saving factors was rated highly as well as having a method to differentiate a product in the marketplace. The LCA tools scored the lowest in relation to the design-related tools. This may reflect the fact that this is the first time that SMEs were presented with the terms and ideas, and also that many SMEs did not see a direct application of these tools within their business due to their lack of influence over the design of the products that they manufacture.

The PSS tool scored extremely low in comparison to all other tools. This tool is the most complex within the suite. Its inclusion in the Pilot Framework is mainly to allow for a very broad range of offerings for the large population of SMEs, and at the current time, the concept is unfamiliar in everyday business. The need for such a tool may change in the near future, so this tool and the related eLearning lesson will remain in the SEco Framework as an offering (despite the low scoring and lack of SMEs who would even participate in the testing process).

The stage gate reviews further confirmed the approval of the SME group. However, through observing the FutureSME web portal, it was noted that SMEs were not voluntarily downloading the tools. The owner-managers were not voluntarily seeking to use the Pilot Framework because they could not see the business benefit of doing so.

4.12.1 Observed Gaps in the SEco Pilot Framework

The lack of voluntary uptake compelled the researcher to identify gaps in the SEco Pilot Framework. The ongoing engagement with the end-users gave some insight, particularly in the testing phase. For example, during the testing process, some SME owner-managers requested that elements of the Framework be demonstrated to them. They were interested in something that could relate directly to their business. The process had been simplified to suit any user with no prior knowledge of the area. However, some owner-managers did not want to spend the required short few minutes reading the instructions - time was precious to them and they wanted to get to the solution immediately. They wanted guidance from someone who knew about their business and was an expert in the area. Furthermore, the researcher identified elements within the FutureSME project that had been successful in capturing the attention of SME owner-managers. The tools that were successful in doing so included a 'measurement' of business capability following a diagnostic process, and visual management tools to develop and support the company's strategy.

This led the researcher to identify two major gap categories:

	Gap Identified
1	**An implementation process that is better tailored to the SME owner-manager's needs**
1.1	The 5-step 'suggested path' on the FutureSME website was too generic for owner-mangers
1.2	The owner-managers did not have the time in their busy schedule to start the engagement without any assistance
1.3	There was no initial motivator to convince the owner-manager to engage
1.4	The owner-manager was not convinced about "what is in it for me and my business?"
1.5	There was no general overview of the potential "opportunities"
1.6	The owner-managers needed to know how the tools would benefit their particular business
1.7	Being embedded within the FutureSME website did not contribute to the uptake, but took away from the importance of sustainability issues
2.	**A way to measure, track and communicate performance**
2.1	There was no measurement of how well a company was doing, either before or after using the Framework
2.2	There was no way to keep track of progress after the first engagement
2.3	There was no way to engage other staff within the organisation

Table 4.21: Gaps identified with the SEco Pilot Framework

4.13 Summary of Chapter 4

This chapter summarised the SEco Pilot Framework design, development and testing.

The main objective of this chapter was to develop sustainability approaches designed for manufacturing SMEs through eco-innovation tools and learning. Chapter 2 (Literature Review) had described the most suitable tools for SMEs for sustainability and eco-innovation. A detailed design specification was developed from this analysis (see Table 4.2 and Table 4.3 in Section 4.3). It included Life Cycle Management Tools (LCM), Design for Environment methods (DfE), Environmental Management Systems for auditing (EMS), Sustainability assessment and reporting tools (CSR), compliance (Legislation) and new business models (PSS). It also included eco-Innovation and sustainability training to support all of the above.

To ensure that the SEco Pilot Framework design met the needs and the most recent realities of the end-user, primary research was conducted with owner-managers as they are the most important influencers and decision makers in an SME. A central issue that emerged during the research and development was the lack of the SMEs' interest in the subject matter. The surveys completed with SME owner-managers indicated that environmental sustainability is at the bottom of their priorities, especially in a poor economic situation. This issue was addressed by:

1. The unique design of individual tools and training:
    - Each training module explicitly stated the business related benefits of the environmental tools and methodologies being presented.
    - It was backed up by case studies showing how other businesses had gained advantages using environmental strategies.
    - The tools were built in formats that were already familiar to most SMEs (using Word, Excel etc.)
    - It was focused on the need to solve problems or enable opportunities
2. The availability of the SEco Framework on the 'Business Sustainability' webpage on www.futuresme.eu
    - This webpage was designed to inform SMEs about sustainability in their business. It gives brief information about the benefit to their business and how to apply it. The objective is to attract SMEs to consider environmental issues. This is supported by short videos of SME case studies.
3. The SEco Framework was embedded within a website intended to support SMEs in many other ways
    - The Framework forms part of the FutureSME online resource pack. It is hosted on the FutureSME web portal and is available for European SMEs to access (www.futuresme.eu).

The final Pilot Framework was comprised of training and a set of tools, presented to SMEs as being able to help to:

- Be compliant with environmental legislation and customer requirements;
- Identify areas for improvement of their environmental performance at low cost;
- Identify cost saving possibilities;
- Identify new business opportunities coming from the environmental area.

The SEco Pilot Framework was designed to overcome the barriers faced by manufacturing SMEs when dealing with environmental issues. It provided SME owner-managers with a *one-stop-shop* approach that was *multi-method* and comprised an environmental training programme and a set of environmental tools with online access available at all times.

The end-user group approved the individual elements within the SEco Pilot Framework following the testing activities. However, when the SEco Framework went live online, and was disseminated across all the countries represented in the FutureSME project, there was little observed activity. There was very little recorded evidence that the SMEs on the project (or otherwise) were using any of the tools. This issue will be addressed in the next chapter by re-visiting the gaps identified in the SEco Pilot and through the development introduction of the enhanced SEco Framework.

5 The Enhanced SEco Framework

5.1 Introduction

5.2 Enhancement of the SEco Pilot Framework

5.3 The enhanced SEco Framework

5.4 Conclusions of Chapter 5

5.1 Introduction

Chapter 4 proposed a way of addressing the research problem (the large environmental impact contributed by SMEs, coupled with a slow uptake in environmental practices in SMEs) in the form of the SEco Pilot Framework. The testing activities deemed the individual tools to be suitable for use within SMEs. However, there was little or no uptake of the Framework by SMEs after the testing period.

The Pilot Framework comprised best-in-class tools and methodologies, designed with the needs and characteristics of SMEs in mind. It was simple, free, accessible, modular, and suitable for a broad range of SME sizes, activity and level of sustainability management. It addressed many of the factors contributing to the research problem, and the tools were tested and approved the by end-user groups. However, the online format was not successful in promoting its voluntary uptake.

A question remained, "if a set of tools and methodologies designed for SMEs to overcome the barriers, tested and approved by SMEs, provided for no cost, has not addressed the research problem; what *else* do SMEs need?"

	Gap Identified	Potential solution to address the gap
1	**An implementation process that is better tailored to the SME owner-manager's needs**	
1.1	The 5-step 'suggested path' on the FutureSME website was too generic for owner-mangers	A better process to guide owner-managers to use the Framework
1.2	The owner-managers did not have the time to start the engagement without any assistance	An expert mentor to support and guide the process
1.3	There was no initial motivator to convince the owner-manager to engage	A quick successful output to motivate the owner-manager
1.4	The owner-manager was not convinced about "what is in it for me and my business?"	A tailored systems view of how eco-innovation can be applied
1.5	There was no general overview of the potential "opportunities"	The guided process should identify potential opportunities
1.6	The owner-managers needed to know how the tools would benefit their particular business	The owner-manager needs to be guided through the Framework in a personalised manner
1.7	Being embedded within the FutureSME website did not contribute to the uptake, but took away from the importance of sustainability issues	Further development and testing to take place out of the FutureSME project context
2.	**A way to measure, track and communicate performance**	
2.1	There was no measurement of how well a company was doing, either before or after using the Framework	A method to assess the SME at the beginning of the process and after implementation of the tool(s)
2.2	There was no way to keep track of progress after the first engagement	A process to manage the implementation of the tool(s) within the business
2.3	There was no way to engage other staff within the organisation	A method to engage staff to support owner-manager

Table 5.1: Gaps identified in Chapter 4 mapped to new requirements for the enhanced SEco Framework

The main objective of this chapter is to address the gaps identified in Chapter 4 and find a way for SMEs to implement the SEco Pilot Framework. Table 5.1 maps the gaps to new requirements needed to enhance the SEco Pilot Framework.

This chapter reports on the development of an enhanced Framework, an overarching methodology to promote sustainability and eco-innovation, which builds on the Pilot Framework to form the enhanced SEco Framework.

5.2 Enhancement of the SEco Pilot Framework

A number of factors were considered in the enhancement the Pilot Framework. This included the re-examination of systems thinking, the interventions with SMEs on the futureSME project, exploration of sustainability maturity frameworks, and reviewing methods to measure the maturity (see Figure 5.1). Each of these elements will now be discussed.

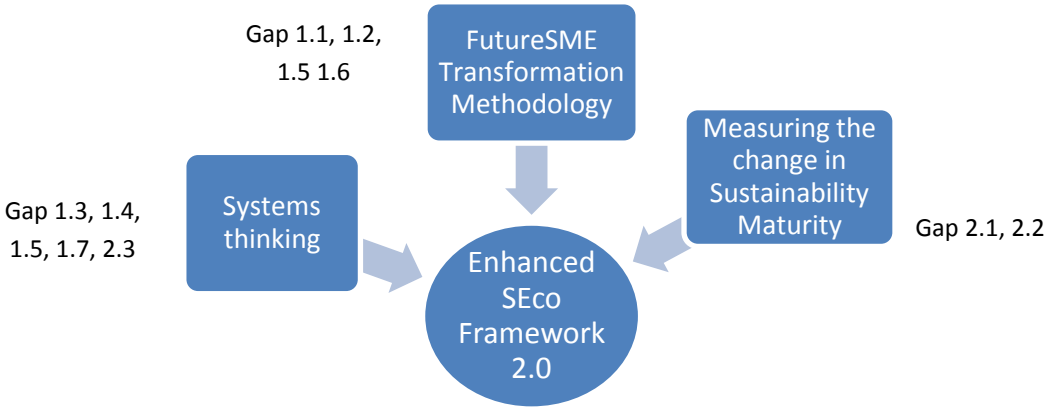


Figure 5.1: Inputs to chapter 5- creating the overarching framework to support the Pilot Framework implementation

5.2.1 Systems Thinking applied to the Pilot Framework

The principle of systems theory is that everything is made of systems and sub systems. Systems thinking solves problems by considering everything in its entirety (von Bertalanffy, 1950). Chapter 3 defined a *system* as comprising *elements*, *interconnections* and *functions*. A small manufacturing company may initially appear simple, but the internal *elements* of the SME are *systems* themselves.

The SME is interacting with the systems in the external business and wider environment. Changing elements has the least effect on the *system*, even though some *elements* (e.g. resources) have more of an effect than others do (Meadows, 2009). Figure 5.2 illustrates the researcher's basic conceptualisation of the potentially complex dynamics of the nested *system* within which an SME owner-manager lies. It was derived by inserting important considerations that an SME may have to consider on a regular basis, which were driven by the researcher's experience during this research project. SMEs, led by owner-mangers, embedded within their own system, are interacting with system elements such as their personal and/or family life. They manage enterprises, which are systems in themselves, and they operate within a much bigger structure – the business environment, itself nested within the economy, society and the natural environment.

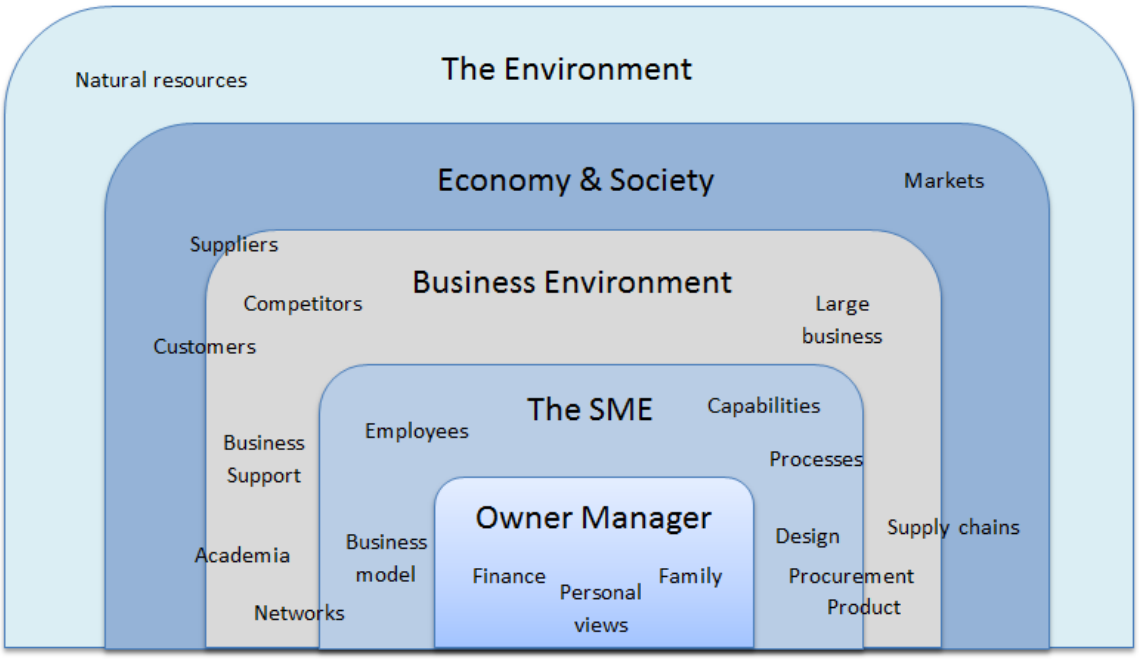


Figure 5.2: A basic conceptual model of an SME system

Furthermore, the purpose of an entire system (e.g. the business environment) does not necessarily match the purpose of the organisational system (the SME). SME owner-managers may have the desire to be more sustainable, but lack support, resources, knowledge and expertise.

External influencers trigger behaviour. Therefore, it is important to understand what the inter-connections are within the particular SME. The inter-connections within systems cannot be as easily identified (Meadows, 2009). They may be different for all SMEs, but can have a radical effect on a system. In an SME, these can be its relationships (with stakeholders, funders or support agencies) which can ultimately lead to behaviour change over time.

This can be assessed through established management tools. A SWOT Analysis and a Stakeholder Analysis can help personalise the SME supports to the particular culture and infrastructure, and help to communicate and integrate environmental management into the core business objectives.

5.2.2 The FutureSME Transformation methodology

The FutureSME project presented a unique opportunity to engage with 13 manufacturing SMEs over a four-year period. It is well documented that SMEs cannot easily implement management improvement approaches (such as quality management practices), which were designed for larger organisations (Yusof & Aspinwall, 2000). External intervention is a common approach to overcome this issue. However, long-term improvement is difficult to achieve in an SME (Shaha & Ward, 2003). Eco-innovation interventions in SMEs need to break the pattern of thought that sustainability is external to the company. Owner-managers need to learn instead that it is an opportunity for the business and can deliver cost savings and competitive advantage.

Where there are no established mechanisms in place to undertake particular interventions, each part of the process should be supported by appropriate tools (Cormican, 2001) [cited in (Mulligan,

2006)]. Many tools have already been included in the wider FutureSME support structure, including the SEco Pilot Framework.

The broader business process improvement interventions in the FutureSME project (as a whole) were successful in formulating business strategies and goals, leading to activities based on the content of the tools. On further analysis, Assarlind et al. (2013) defined that successful interventions relied on content that supports the business strategy, encourages dialogue and uses the company data. Such content can achieve short-term as well as long-term success (Assarlind, et al., 2013).

FutureSME developed many tools and methodologies to support capability development in manufacturing SMEs. The resulting final framework comprised an intervention support process - the *futureSME Transformation process* (Kearney, et al., 2013) (see Figure 5.3), which was supported by more than 100 tools. Two main tools supported the *transformation process*. The first was the *capability diagnostic,* which facilitated a *thinking together* phase. It helped owner-mangers view their business with a new perspective. It highlighted areas of best practice, identified gaps in capabilities, and recommended opportunities to improve. The second and third phases used a *visual strategy* methodology. This helped SMEs to assess and manage their capabilities through a one-page visual strategy document. Once the strategy was articulated, the *acting together* phase guided management meetings, aligned activities and goals to the business strategy and guiding vision. The final stage, *reflecting together* started the cycle again.

Figure 5.3: The futureSME Transformation process (Kearney, et al., 2013)

The FutureSME project revealed that SME owner-managers were mostly concerned about running their business, not about its environmental performance. Initially, it took time for the SME end-user group to engage with environmental matters. They were sceptical of the benefits. Building trust and developing a relationship was a key part of the process. Once the SMEs began to perceive benefits from the overall project, they were more willing to participate in the sustainability area. The SME end-user group needed a business incentive to improve, coupled with personalised supports (Horbal & Eisler, 2010). The Pilot Framework provided many possibilities for an SME to access eco-innovations; a simple guide was available to SMEs. However, it became clear that the process for the SMEs to start their sustainability journey needed a bigger *nudge,* and it needed to be directly connected to their core business.

McDonough & Braungart (2013) argue that environmental solutions in business will come from innovation. The imagination of manufacturing SME owner-managers needs to be ignited in the area of sustainability, and they need to be fully supported to manage it (Allen, et al., 2001).

The guided facilitation of the futureSME *transformation process* helped to trigger discussions with the major decision makers within the SMEs, and led to many business improvements. Therefore, a related methodology was proposed for the enhanced SEco Framework. To address the gaps in Table 5.1, the enhanced SEco Framework needs to be mediated by an expert.

5.2.3 Measuring the Change

Sustainability Maturity was defined in Chapter 2 (Section 2.15). A model for measuring the sustainability of manufacturing SMEs should effectively communicate the sustainability maturity of the SME and be able to measure and track improvement.

Seidel (2011) designed a practical framework to measure the sustainability maturity of manufacturing SMEs; the *ecoWheel*. This method has an academic foundation, and is a proven commercial success[1] (Seidel, 2011; Seidel, et al., 2009; Seidel, et al., 2006; EcoPortal, 2014). The *ecoWheel* visually communicates the status of business sustainability (see Figure 5.4) and measures the current state of sustainability against a future target or ideal state set according to the organisation. The "segments" or "slices" of the *ecoWheel* represent a particular project or theme for example. The individual elements represent the progressive objectives within the programme or theme. See Figure 5.4, depicting an SME that has achieved full EMS certification, and is performing particularly well in manufacturing efficiency and waste management.

Figure 5.4: Screen print of Seidel's (2011) *ecoWheel* used to measure progress in manufacturing SMEs

[1] The *ecoWheel* was developed as part of Seidel's PhD thesis, and is known commercially as the EcoPortal™ been applied commercially with SMEs in New Zealand.

It can take time to effect change (e.g. via an intervention) within a system (Meadows, 2009). Time lags may cause issues for the SMEs, involving elements within the system beyond their control (e.g. fluctuating material costs). However, time lags can also give stability after a successful intervention. Feedback information is key to understanding the systems dynamics (von Bertalanffy, 1950). An iterative intervention process with an integrated reinforcing feedback loop would be better than a one-off intervention with SMEs. Small steps through the different levels can cause ripple effects toward the growth in sustainability maturity (McDonough & Braungart, 2013). Time lags also allow for adjustments; progress cannot proceed faster than the SME can cope with. It may be difficult to predict the time that it will take any individual SME will take to effect positive change within the organisation.

The enhanced SEco Framework will involve taking a baseline measure of Sustainability Maturity, and comparing it with a measurement taken at a later stage in the process.

The next section describes the enhanced SEco Framework.

5.3 The Enhanced SEco Framework

A key element of the enhanced Sustainability and Eco-Innovation (SEco) Framework is that it is facilitated by an expert, who guides an SME owner-manager towards improving the sustainability of the organisation through eco-innovation. The Framework aims to fill the gaps identified in Chapter 4. The process is personalised to the context of the particular business.

The framework has four distinct stages (see Figure 5.5). Tools from the SEco Pilot Framework, and some new tools (which are described below) support the enhanced SEco Framework.

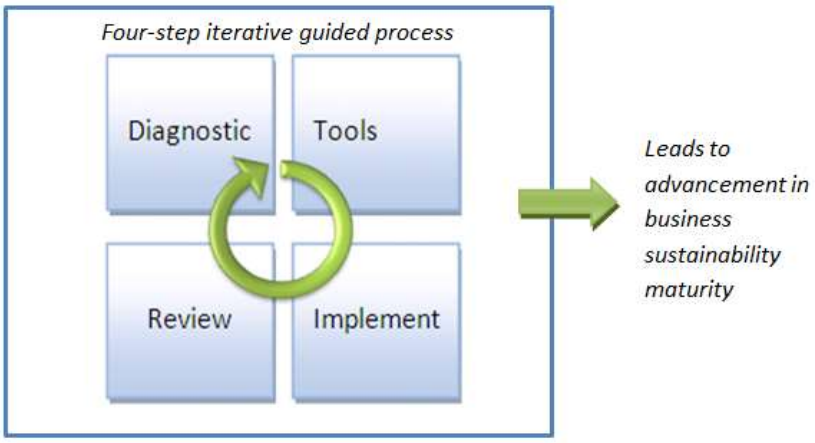


Figure 5.5: The SME Eco-Innovation Framework

1. An Eco-Innovation Diagnostic, which helps the facilitator to
   - Ensure there is appropriate alignment to the business objectives, by understanding the business model and the owner-manager's motivations
   - Perform a baseline sustainability maturity measurement of the business
   - Uncover eco-innovation opportunities suitable to the company
2. The Tools stage, which involves
   - Mapping the answers in stage 1 to the tools in Pilot Framework to fit the business context
   - The application of supporting tools for the business owner to manage the process through all stages of the framework
3. The tools Implementation stage, where
   - The eco-innovation opportunities are scoped
   - Projects are agreed and prioritised
   - The tools are applied in the agreed projects
   - The facilitator provides support as required
4. A Review of company measures the progress through
   - Performing a new measurement of sustainability maturity to compare to stage 1
   - Assessing if there is a change in the owner-manager's understanding of sustainability and eco-innovation

Each of these stages includes associated tools and/or methodologies (Figure 5.6). Stage 1 has five new tools, which form the diagnostic stage. The Pilot Framework is contained in stage 2, Tool Selection. Two new tools are in stage 3 to support the management of the implementation of the

selected tools within the SME. The final stage uses three tools to capture the results of the process so far and to measure the change.

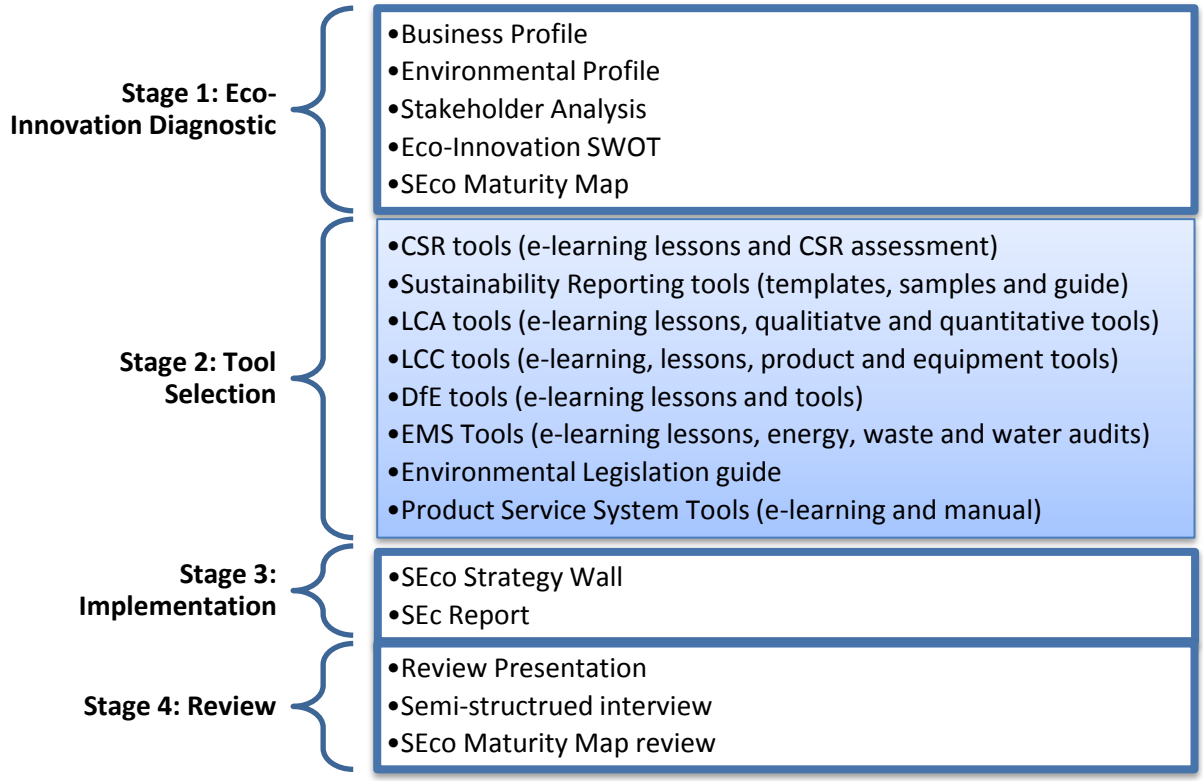


Figure 5.6: Tools associated with each stage of the enhanced SEco Framework

Each of these stages will now be discussed in more detail.

5.3.1 SEco Framework Stage 1: Eco-Innovation Diagnostic

The SECO Framework begins with the *Eco-Innovation Diagnostic*. The facilitator gathers key information on the business and its sustainability practices to personalise the delivery of the framework. Figure 5.7 illustrates the facilitated Eco-Innovation Diagnostic process. This investigative dialogue could potentially help spark eco-innovation ideas. This diagnostic process will also guide what tools and supports are suitable to the particular SME to implement the potential eco-innovation opportunities/ideas to suit the business context.

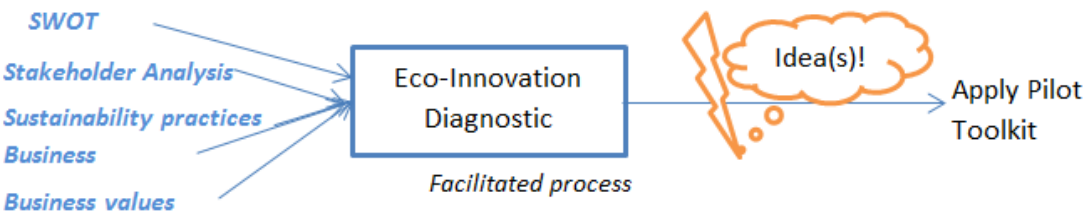


Figure 5.7: An Eco-Innovation Diagnostic could potentially help generate ideas within an SME

The diagnostic contains five elements; a business profile, an environmental diagnostic, a stakeholder analysis and an eco-innovation SWOT and the SEco Maturity Map (see Figure 5.8).

Figure 5.8: Eco-Innovation Diagnostic contains 4 elements

5.3.1.1 Diagnostic: The Business Profile

The *Business Profile* element of the Diagnostic gathers information for the facilitator to understand the business context. Articulation of the company's values should happen at the beginning of the decision-making process (McDonough & Braungart, 2013). This also includes the value proposition, the size and the sector it operates in, and its position in the value chain. This element of the diagnostic helps to build up the trust of the SME owner-manager by starting the process with a subject that they are most comfortable with and passionate about – their business. These questions and prompts are detailed below in Table 5.2.

Questions	Guide to Responses
What is your product/service? Describe what your business does.	A description of the main business activity and value stream(s)
What size is the business (no. of employees)?	Micro (1-9) -- Small (10-49) -- Medium (50-250)
Who are your customers?	Are they B2B or B2C? -- Large or small ?
Why do your customers come to you instead of your competitors? **(Indicate the primary and secondary Reason)**	• Quality of products/services • Low price • Close customer relations and excellent customer support • Leading brand • Innovative products and services • Products that are technological leaders • Unique/better design features of our products • Solutions/services that make our customers life easier • There is no competition or other alternatives • Because we are green (e.g. green products or green practices) Because we are a responsible and ethical business
What is the business' position in the value chain?	Design – Manufacturing – Distribution – Service – Retail -- End of life disposal/remanufacture
At what stage is the business in its lifecycle?	Start-up – Growth --Mature -- Decline/negative profit
Where is the business located?	Locally (town/city/region)—Nationally –Europe -- Rest of world
Where are the business's customers located?	Locally (town/city/region)—Nationally –Europe -- Rest of world
Where are the business' suppliers located?	Locally (town/city/region)—Nationally –Europe -- Rest of world

Table 5.2: Eco-Innovation Part 1, the Business Profile questions

5.3.1.2 *Diagnostic: The Environmental Profile*

The *Environmental Profile* is the longest part of the Diagnostic. It examines the company's environmental management practices. The questions aim to gather information to:

- Assess the company's environmental management practices
- Raise awareness with the owner-manager of company about environmental legislation

The questions are mapped to the Pilot Framework to help guide the Tool Selection. They are direct questions about how important environmental management is to the company, its customers, if they know what impact the company has, and what practices are in place (see Figure 5.9).

Figure 5.9: The environmental profile is mapped to the Pilot Framework

Environmental Profile Questions		Guide to responses	Pilot Framework mapping
Does the business try to operate in a 'green' way? (E.g. reducing energy use, using sustainable materials etc.)		Yes = implementing a broad range of measures To some extent = implementing at least one measure. No = not currently implementing any environment measures	Social Responsibility, eLearning, Assessment & Sustainability Report
Is 'being sustainable' important to your business?		Yes To some extent No	Social Responsibility
Is 'being sustainable' important to your customers?		Yes To some extent No	Social Responsibility
Do you measure and monitor the following: • **Waste (recycling, reuse, disposal)** • **Water** • **Waste water** • **Energy (non-renewable)** • **Energy – Renewable** • **Emissions (e.g. Emissions to air, land and water)** • **Transport** • **Other ... Please specify**		Yes, we have made many improvements Yes, we have just started to do this No, but we plan to do this No, we do not do this or plan to do this	DfE, LCA and LCC eLearning & tools
Is the management team aware of the impact that the business has on the environment?		Yes To some extent No	LCA, Carbon Footprint, DfE, EMS
Conditional question	**If 'yes' how do you know?**	Life Cycle Assessment Carbon Footprint Eco-label Environmental Management System Other (specify)	LCA, Carbon Footprint, DfE, EMS

Environmental Profile Questions		Guide to responses	Pilot Framework mapping
Conditional question	**How is this carried out?**	In-house Private consultancy Public support agency Other (specify)	LCA, Carbon Footprint, DfE, EMS
Conditional question	**If 'no' would you like to find out about this?**	Yes To some extent No	LCA, Carbon Footprint, DfE, EMS Carbon Footprint eLearning and tool
When designing products/services, is environmental impact considered?		Yes To some extent No	DfE, LCA, EMS
Conditional question	**If 'yes' how do you do this?**	Design for environment software... please specify LCA software... please specify Other design specific software... please specify Other (specify)	DfE, LCA, EMS
Conditional question	**If 'no', why do you not consider this?**	We have never considered it It is not important to us We don't have any interest in finding out	DfE, LCA, EMS
Do you consider environmental management and/or social responsibility as a process/group of connected activities?		Yes To some extent No	Social Responsibility, EMS
Is the business aware of the current environmental legislation that affects it?		Yes To some extent No	Legislation
Are you aware of forthcoming legislation that will affect your business?		Yes To some extent No	Legislation
How do you find out about legislation?		The internet Private consultant Public support agency Someone else... e.g. friend, business network	Legislation
Does the business contribute to any local/community events, groups or initiatives?		Yes To some extent No	Social Responsibility
Do you outsource any process or functions in this area? **e.g. Environmental management, carbon footprinting?**		Yes - it is part of our overall vision and/or strategy, No -the (functional name e.g. owner-manager) is personally responsible for this	

Table 5.3: Eco-Innovation Diagnostic Part 2 - the environmental diagnostic

5.3.1.3 Diagnostic: The Sustainability and Eco-Innovation SWOT

A Sustainability and Eco-Innovation SWOT can assist the SME to adopt more environmentally friendly behaviours. It can help to deconstruct and explain the *system* and SME behaviour, which can help to rationalise cause and effect. A SWOT can help define:

- *Strengths*: the attributes of the system that might be helpful in moving the organisation towards sustainability and eco-innovation
- *Weaknesses*: attributes of the company that hinder sustainability and eco-innovation opportunities within the organisation
- *Opportunities*: conditions external to the company that could help sustainability and eco-innovation
- *Threats*: external conditions that could impair sustainability and eco-innovations.

The sustainability and eco-innovation SWOT allows the facilitator to gain a strategic understanding of potential eco-innovation opportunities for the company. It also helps the facilitator to consider the larger context or *system* view. The process can highlight potential business opportunities to the owner-manager. Figure 5.10 shows what questions are asked to guide the process. The strengths and weaknesses represent an internal analysis of the business, while the opportunities and threats examine the external business environment.

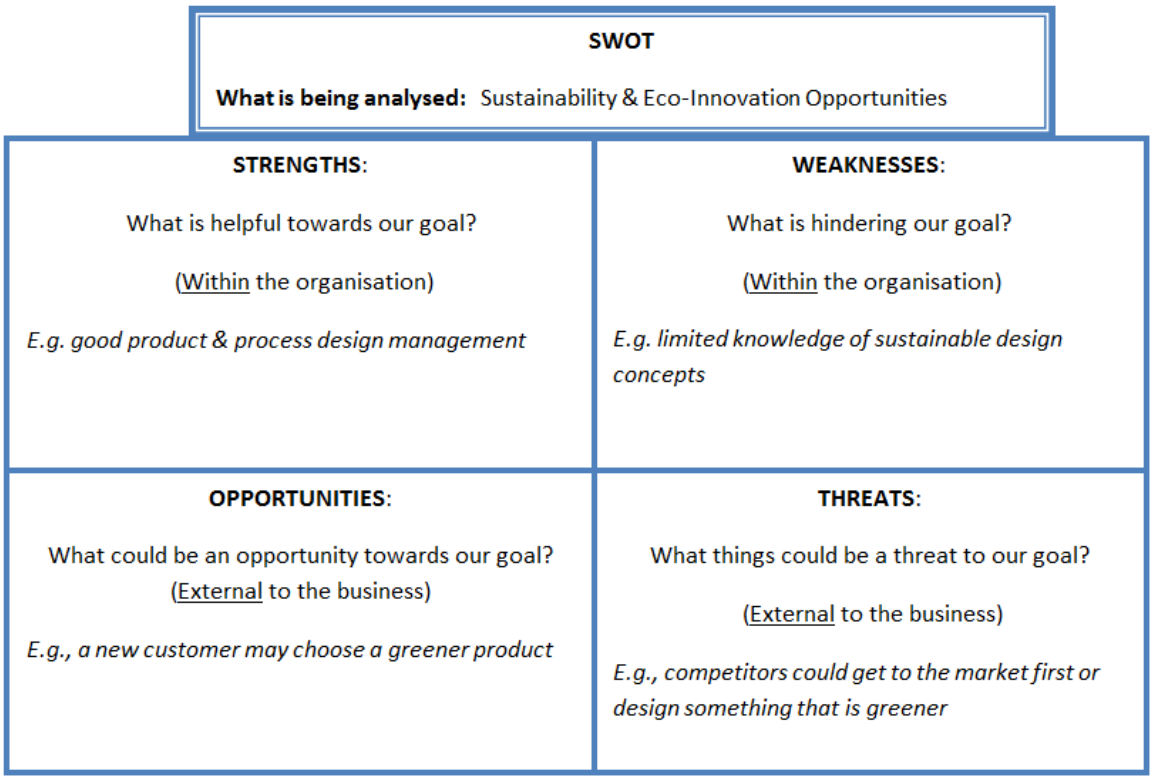


Figure 5.10: Eco-Innovation and Sustainability SWOT

5.3.1.4 Diagnostic: The Stakeholder Analysis

Meaningful solutions to sustainability should consider its stakeholders, as they are deeply connected to the value proposition, and the community within which the organisation is situated (Keitsch,

2012; Manzini , 2006; Sterman, 2002). A Stakeholder Analysis tool can help to integrate a *systems* view into the framework by highlighting the connections and relationships the SME has, and the motivations of its stakeholders. This process could identify ways to leverage strengths identified in the SWOT, by exposing synergies with its stakeholders from a sustainability perspective and assess possible conflicts that may occur in the future.

The stakeholder analysis is potentially a key to successful change for the SME, because it can highlight where the company can leverage opportunities identified in the SWOT through collaboration, partnerships and/or new business. Some suggested stakeholders are listed in Table 5.4 to guide the analysis and prompt the owner-manager.

Internal Stakeholders	Stakeholders along the value chain	Stakeholders in the local community	Societal stakeholders	Other Stakeholders
Owner-manager	*OEM Customers*	*Local authority*	*NGOs*	…
Sales & Marketing	*Other Customers*	*Neighbouring companies*	*Dept of Environment*	…
Designers	*Consumers*	*Companies in Networks*	*EPA*	…
Employees – production	*Retailers*	*Natural environment*	*The competition – local, national, international*	…
Employees- non production – management & admin	*Suppliers*	…	*Local college*	…
…	*Recyclers*	…	*Green business network*	…
…	*Waste company*	…	*Eco-labelling*	…
…	…	…	*Banks/funders*	…
…	…	…	..	…

Table 5.4: Eco Innovation Diagnostic Part 3 Stakeholder Analysis guide showing examples

5.3.1.5 Diagnostic: The SEco Maturity Map

A tool based on Seidel's (2011) design forms a useful measure of the sustainability performance. It can be used to measure current state against an ideal or target future state. The tool is capable of personalisation to fit the context of each individual SME. It can allow for multiple levels of maturity and be visually simple for ease of communication and comparison.

At the diagnostic stage, the *SEco Maturity Map* is used to take a baseline assessment of the company. Figure 5.11 illustrates the elements used to measure the *sustainability maturity*:

- Six project areas are used to measure the *sustainability maturity*, which applies to a broad spectrum of manufacturing SMEs[2]
- These projects can be customised to suit a particular company circumstance, e.g. by adding on more project areas that are relevant

[2] Based on the design of Siedel's EcoWheel (2011)

- Each of these project areas has 6 levels[3], where level 1 is *basic* and level 6 is *best in class*. For example, *Environmental Management System* in Level 1 involves basic awareness, where Level 6 is given for full certification awarded.

Figure 5.11: The SEco Maturity Map which measures sustainability maturity

The "Owner-manager view" is a description of the overall sustainability maturity of the SME where the levels are interpreted as follows:

1. Unassessed – before the SEco Framework,
2. Defensive –acts only when it is compulsory (e.g. enforcement by an authority),
3. Compliant – meets the minimum legal requirements,
4. Managerial – monitoring and measuring some key KPIs,
5. Strategic – leveraging sustainability for competitive advantage,
6. Best-in-Class – sustainability is embedded and is an inspiration to others.

[3] The measures are based on the information collected in the previous phases. This uses measures similar to Siedel's EcoWheel (2011)

5.3.2 SEco Framework Stage 2: Tools

The Diagnostic process guides the selection of appropriate tools for stage 2. Figure 5.12 summarises all the tools. A number of ideas will emerge in Stage 1. The potential ideas are selected process during a consultation. The facilitator will advise on how best to align the eco-innovation ideas to the business objectives in the particular context.

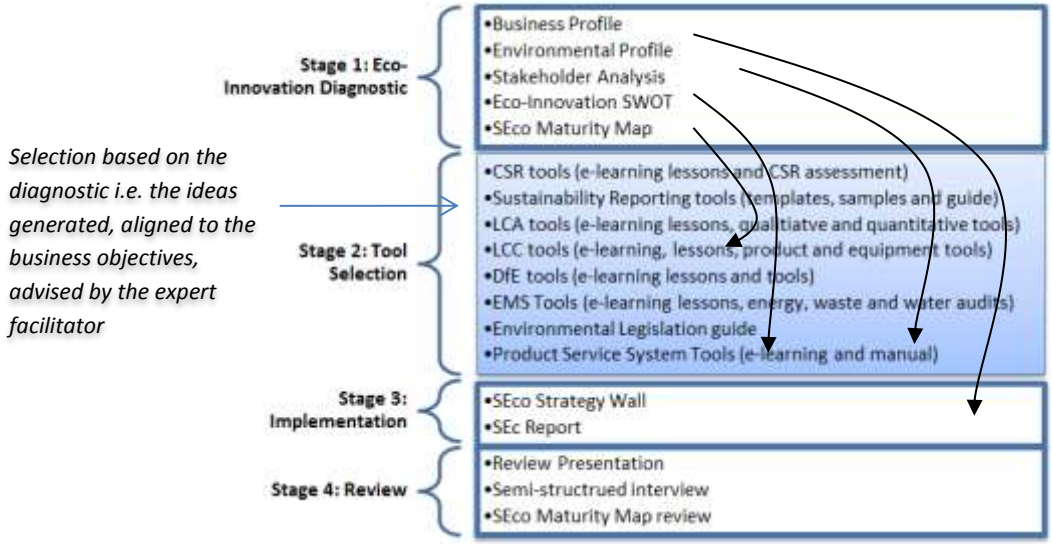


Figure 5.12: Tools mapped to the enhanced SEco Framework

Possible Scenario #1: If an SME owner-manager with a low sustainability maturity level (indicated by the SEco Maturity Map) is not measuring or monitoring the organisation's energy, waste or water, the environmental management set of tools and eLearning is selected as appropriate. The eLearning will help to illustrate the benefits of managing these indicators for the business. SME case studies are used to back up the business benefits in the eLearning lesson. The simple tools will allow the SME owner-manager to easily implement a system to measure and monitor the costs, which can help to identify reduction opportunities.

Possible Scenario #2: An SME with a moderate sustainability maturity level is tendering for a contract. The customer is requesting information on the company's environmental sustainability, which may be subject to an audit. The most appropriate selection would be the social responsibility eLearning, assessment and Sustainability Reporting process. This will help the SME owner-manager to understand how to self-assess the company's practices, and to produce a sustainability report as evidence.

5.3.3 SEco Framework Stage 3: Implementation

Two new tools support the Implementation stage (see Figure 5.13), the SEco Report and the SEco Strategy Wall.

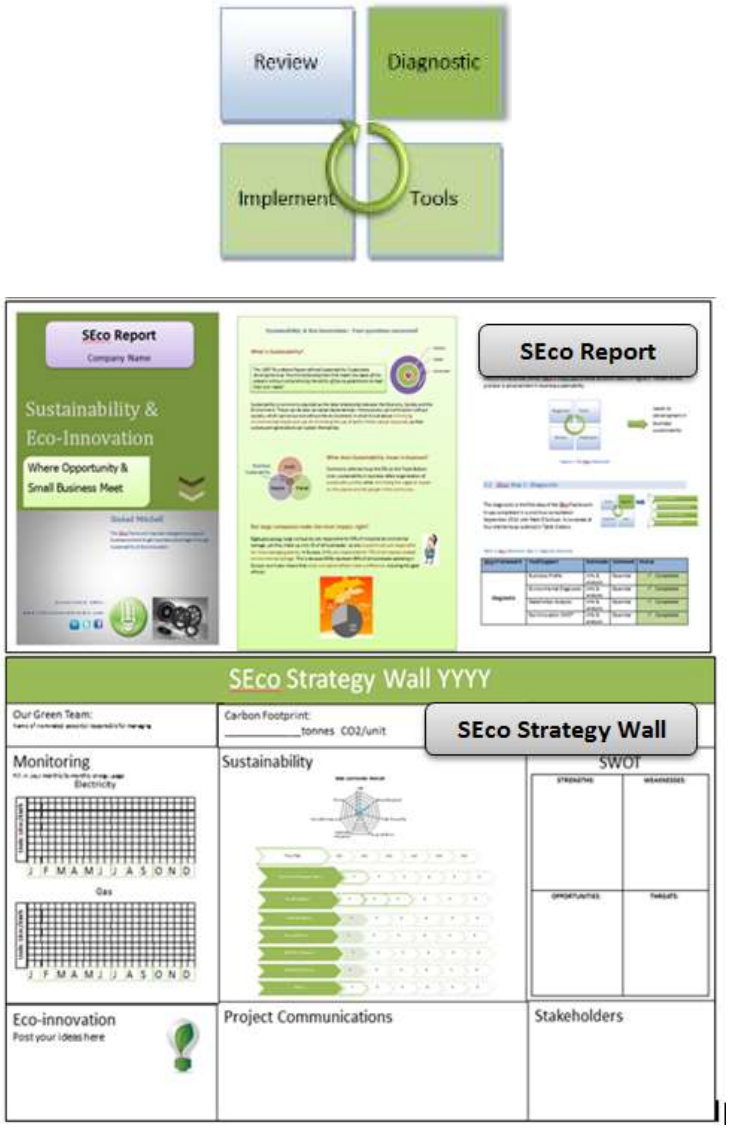


Figure 5.13: SEco Framework stage 3, Tools for Implementation phase

5.3.3.1 Implementation: The SEco Project Report

The SEco project report is a document produced after the diagnostic phase. The aim of this report is to act as a reference for the owner-manager after the face-to-face support.

(a) The first part of the report is common to all SMEs (see sample in Figure 5.14) and it:

- Explains the key concepts (such as sustainability and eco-innovation) and
- Reminds the owner-manager why SMEs need to improve environmental practices
- Summarises the business benefits of sustainability

Outlines the business benefits

Why should a small business be bothered about it?

There are many advantages to integrating sustainability in business ...

What is Eco-Innovation?

Eco-innovations include ANY improvements that have a beneficial effect on the environment REGARDLESS of whether this effect was the main objective of the innovation. An eco-innovation in one organisation may be the implementation of commonplace practice(s) of other organisations, but new/innovative to another company Eco-innovation can be categorised in three main types:

Explains what eco-innovation is

Product/Service Innovation

Results in the product/service having a lower impact during the lifetime of the product (produt lifecycle)

Example... a car with a more efficient engine, or with cleaner fuel

Process Inovation

Results in the processes having a lower impact

Example...less waste, leaner processes and energy efficient machinces lower the impact

Organisational Innovation

Indirect impact - facilitates the impementation of innovations that do have an impact, through changes in strategies and behaviours

Example...when the business owner/manager sees the opportunities instead of the threats, this can pave the way for product and process improvements

Introduces the SEco Framework

What is the "SEco Framework"?

The "SEco Framework" is the **S**ustainability & **Eco**-Innovation **Framework** for SMEs. It has been developed as part of FutureSME, an EU FP7 Project. It has been designed specifically with the needs of SMEs in mind, and overcomes the difficulties they may experience in adapting sustainable practices. The SEco Framework must be completed with the business owner/manager, namely the major decision maker in the organisation for it to be effective.

Figure 5.14: The SEco Project Report - common to all SMEs (sample)

(b) The second part of the SEco project report (Figure 5.15, Figure 5.16 and Figure 5.17) is *customised* to each SME, and it:

- Describes the SEco Framework and what stage the company is currently implementing;
- Records the outcome of the diagnostic and colour codes the recommended actions;
- Lists the data required from the company to carry out the eco-innovations (e.g. carbon footprint data);
- Is a reminder to the owner-manager;
- Used to communicate to staff.

1.1 SEco Step 1 –Diagnostic

The diagnostic is the first step of the SEco Framework. It was completed in a one-hour consultation DD/MM/YY 2012 with NAME. It consisted of four elements as outlined in Table 2 below.

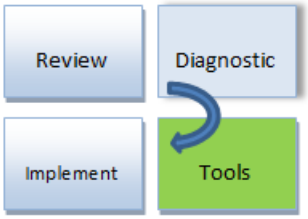
Table 2: SEco Framework Step 1, Diagnostic Elements

SEco Framework	Tool/Support	Rationale	Comment	Status
Diagnostic	Business Profile	Info & analysis	Essential	✓ Completed
	Environmental Diagnostic	Info & analysis	Essential	✓ Completed
	Stakeholder Analysis	Info & analysis	Essential	✓ Completed
	Eco-Innovation SWOT	Info & analysis	Essential	✓ Completed
	SEco Map	Info & analysis	Essential	✓ Completed

Records what has been completed to date

Figure 5.15: The SEco Project Report – customised for SMEs (part 1 diagnostic)

1.2 SEco Framework Step 2 – Tool Selection



The Tools/supports listed in Table 3 have been selected as appropriate for COMPANY NAME as a result of the diagnostic phase. It can be seen from this table that there are many "Strongly Recommended Tools" which should be completed. It is not essential at this stage that the "suggested" tools are implemented. There are other tools available that could be considered at a later stage.

Table 3: SEco Framework Step 2, Tool Selection

Documents outcome of the Diagnostic

SEco Framework	Tool/Support	Rationale	Comment
Tool Selection	Social Responsibility (SR) Assessment	Allows your company to reflect on what SR is and what good things you are already doing	**Strongly Recommended**
	Sustainability Reporting	To show a valuable output early in the process and to be used to communicate to relevant stakeholders	**Strongly Recommended**
	Carbon Footprinting	This will help with current sustainability communications and for future benchmarking and possible legislation.	**Strongly Recommended**
	Energy Tracking	To record & monitor usage for reporting purposes	**Strongly Recommended**
	Waste Tracking	To record & monitor usage if you want to communicate the little or no waste generated	**Strongly Recommended**
	Funding Tool	COMPANY X is interested in getting involved in sustainability & eco-innovation research. They are looking for possible collaboration and funding support to do this	**Strongly Recommended**
	e-learning Social Responsibility (CSR)	To learn more about CSR for SMEs, what the benefits are and to who it should be communicated	Recommended
	Water Tracking	To record & monitor usage and report on water footprint	Suggested
	e-Learning EMS	The manager indicated an interest in continuous learning, and will have a look at this	Suggested
	Legislation Tools	As a start-up company a quick guide to legislation may be handy	Suggested
	All other Tools	Only the tools and actions most relevant to COMPANY (at this time) have been recommended. Others may be explored later	Not recommended (at this time)

Figure 5.16: The SEco Project Report – customised for SMEs (part 2 Tool Selection)

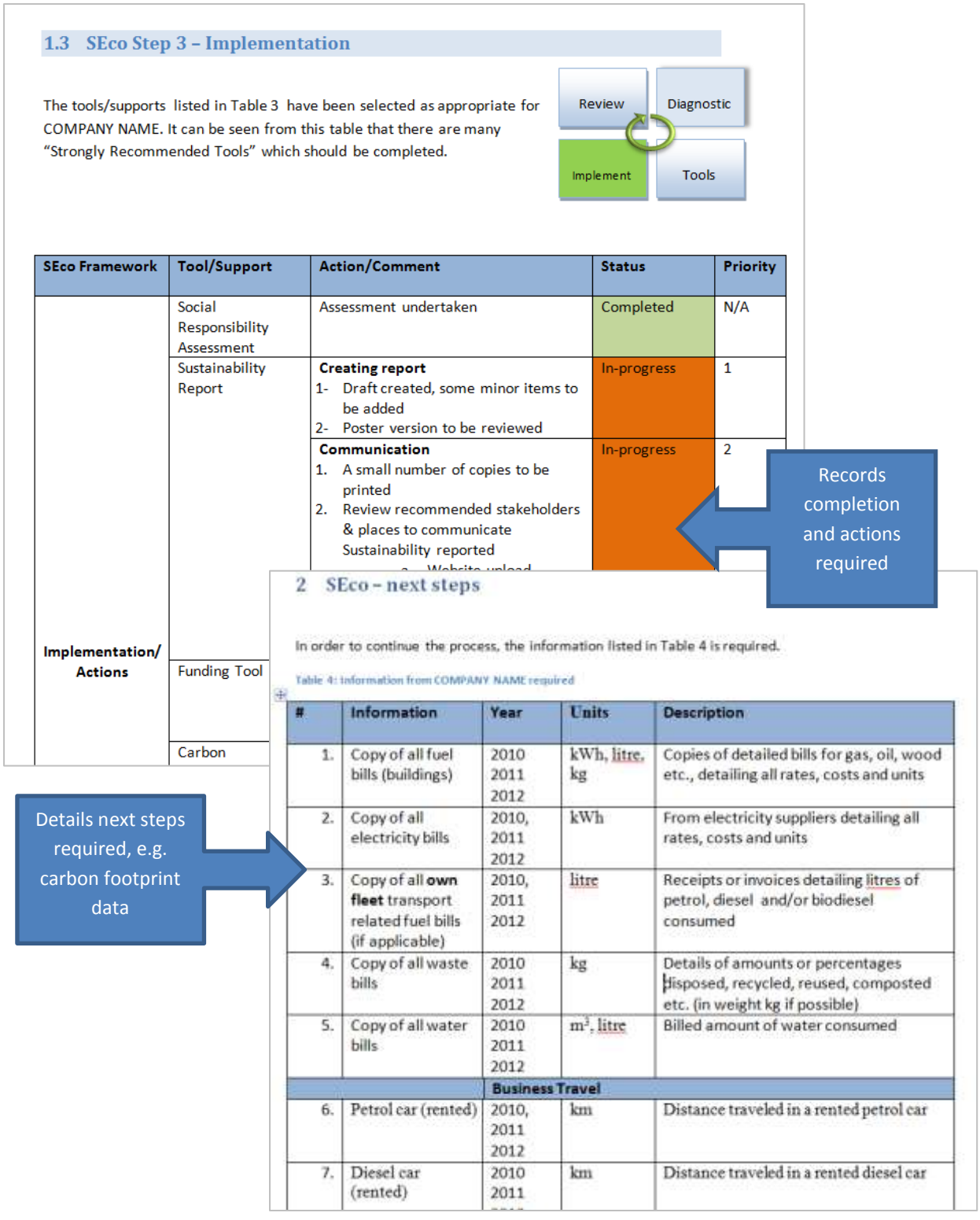


Figure 5.17: The SEco Project Report – customised for SMEs (part 3 implementation)

5.3.3.2 Implementation: The SEco Strategy Wall

The SEco Strategy Wall aids the management of the SEco Implementation stage. The Strategy Wall can be displayed on the shop floor, common areas and/or in the owner-mangers office. It can be printed out up to A0 size to ensure visibility of sustainability activities and to encourage staff interactions.

SME managers are typically reactive (Ates, 2008). However, this visual aid can promote proactive and reactive strategies and can be updated when necessary. The SEco Strategy Wall (Figure 5.18) can be used within the company to:

1. Manage and monitor the progress of the eco-innovation strategy
2. Display the company's commitment to improving environmental management
3. Use as a communication tool to raise awareness and promote engagement among all employees
4. Track key data for continuous feedback
5. Provide a place to record ideas, funding opportunities and partners for collaboration

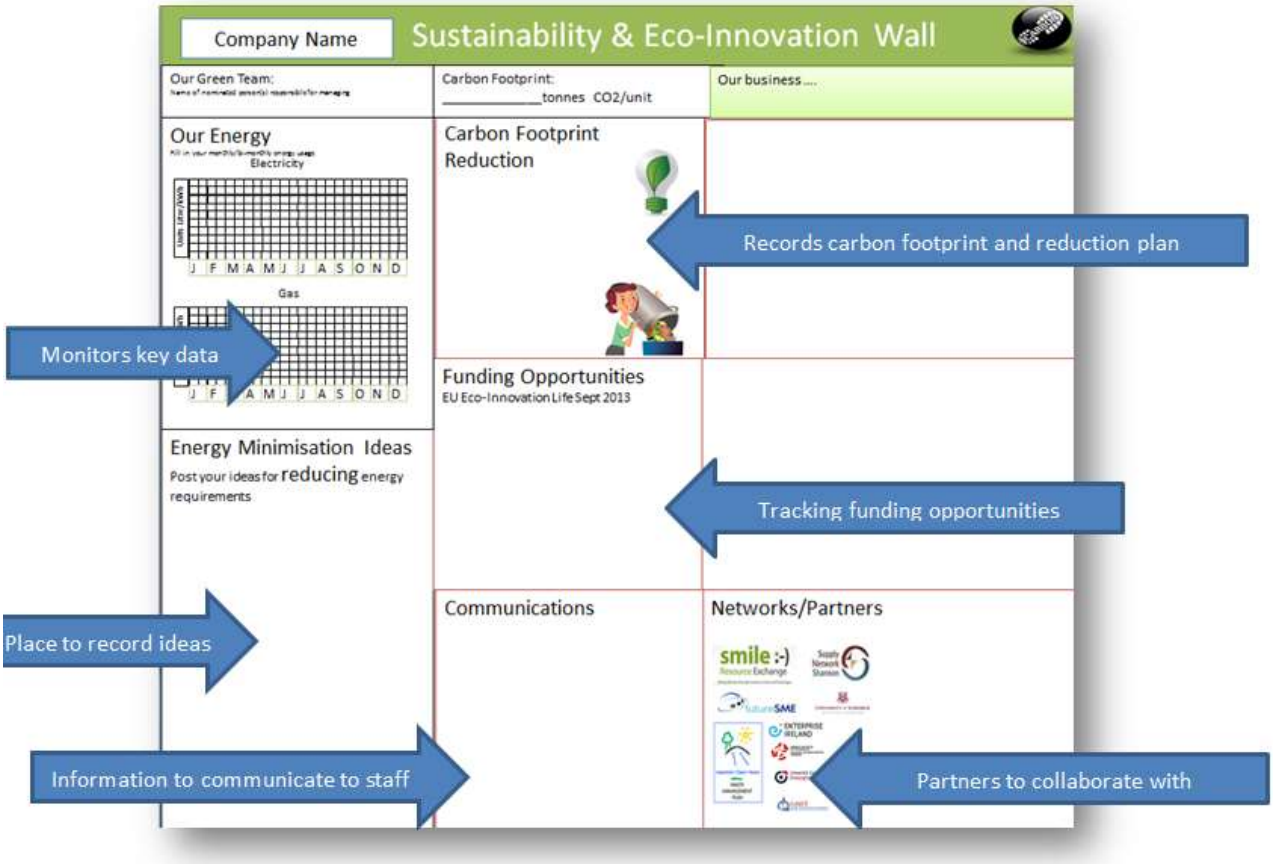


Figure 5.18: SEco Strategy Wall

5.3.4 SEco Framework Stage 4: Review

The final Review phase of the *SEco Framework* aims to produce feedback from the owner-manager. This stage is crucial to the promotion of continuous improvement within the company. This Review happens after the owner-manager has made some change. Figure 5.19 outlines the structure of the Review stage.

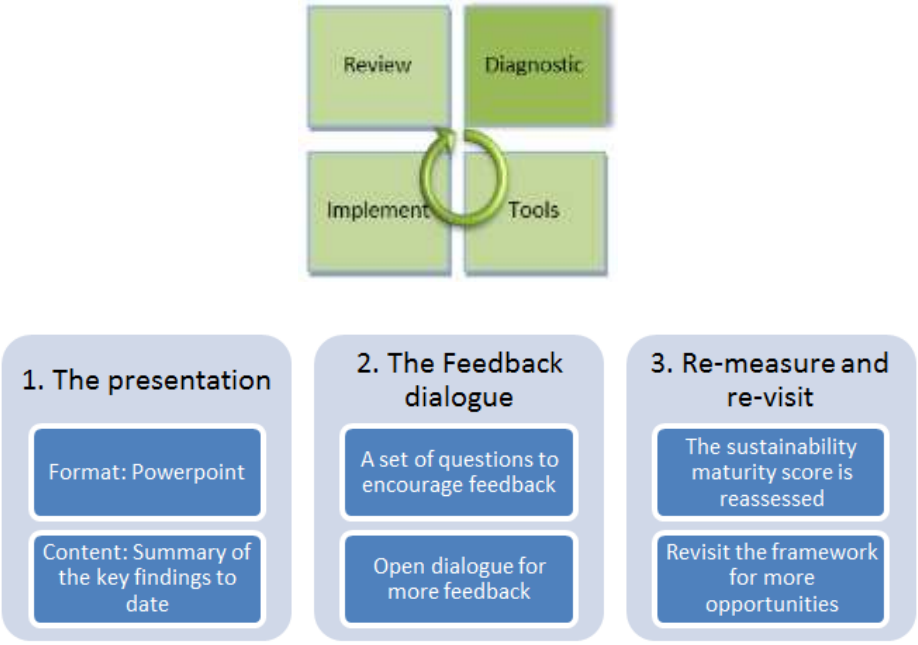


Figure 5.19: The structure of the Review phase

Firstly, a short presentation by the facilitator to the owner-manager summarises what was completed with the company.

Secondly, a set of questions prompt a dialogue with the owner-manager to gather feedback:

1. Has your view of environmental issues changed?
2. If so, how did the SEco Framework change your point of view?
3. Has the business benefited from the process?
4. Do you see the value of the SEco Framework?
5. Will you continue to use the SEco Framework
6. Do you have any other feedback?

Finally, the *sustainability maturity* is reassessed and the change is communicated to the owner-manager. The SEco Maturity Map tool took a baseline measure of the company at the start of the SECO Framework process. It is expected that sustainability maturity will have improved throughout the process. Another measurement is taken at this stage to measure maturity after implementation.

Figure 5.20 below illustrates visually how the initial baseline assessment is compared with the final assessment of the company after the implementation. This is communicated visually, showing the increased level of sustainability maturity.

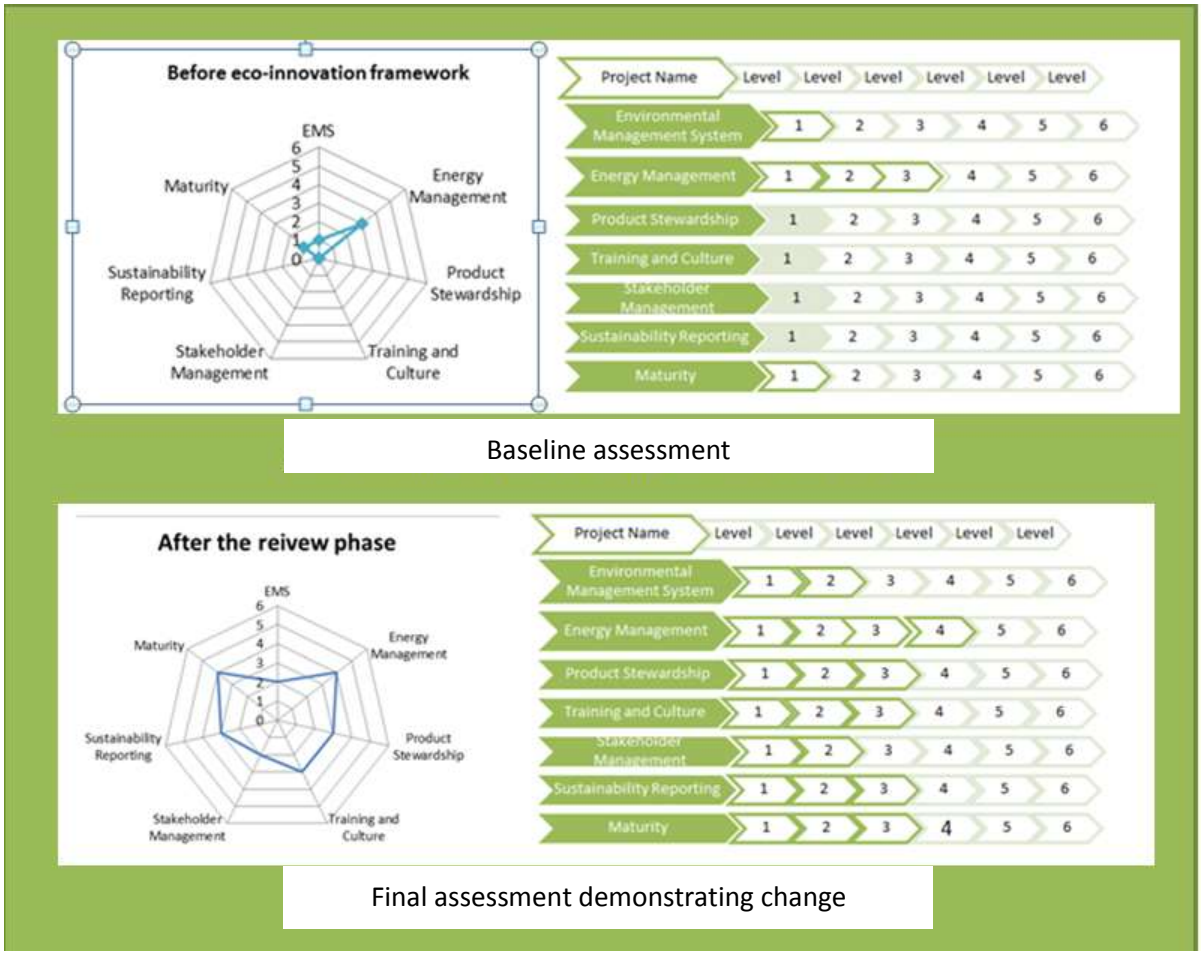


Figure 5.20: The SEco Maturity Map used to measure sustainability maturity (highlighting improvements in 6 months)

5.3.5 Systems Analysis of the enhanced SEco Framework

This research focuses on two of the most important characteristics of SMEs; the significance of the owner-manager in the decision-making process, and the lack of time and resources available (see Chapter 2). The development process involved an on-going consultation with owner-managers of SMEs and the supports were designed to need as little resources as possible.

As introduced in Chapter 3, *Systems dynamics* describes the *behaviour* of a *system* by stocks, flows and feedback from time delays. See Figure 5.21 below as a reminder.

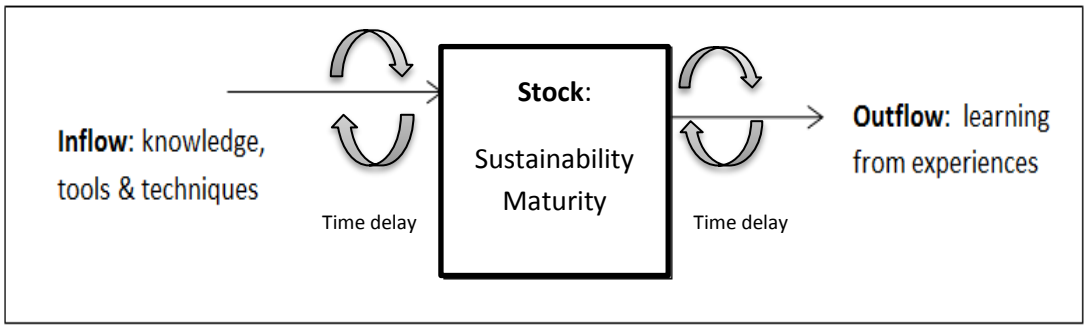


Figure 5.21: Systems dynamics describing how a system behaves

The *stock* in the testing case study is the *Sustainability Maturity* of the SME. The *inflows* are knowledge, tools and techniques delivered via the enhanced SEco Framework. The *outflow* is learning from the experience of the intervention process, and the feedback occurs in the *time delays* between each step and loop of the Framework.

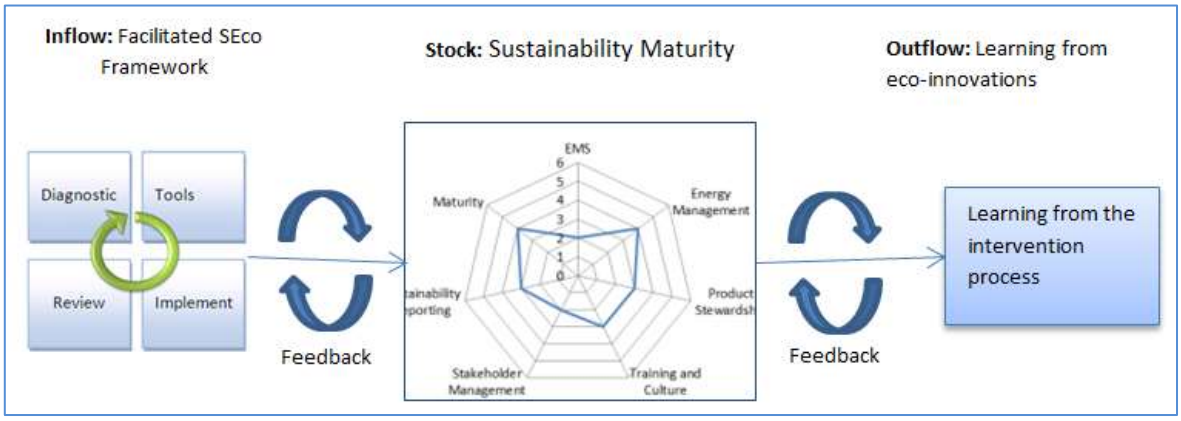


Figure 5.22: Systems dynamics describing how the enhanced SEco Framework behaves

Two testing case studies will be carried out and described in the next chapter. A systems analysis of the framework will also look at the individual steps and elements of the enhanced SEco Framework resulting from the intervention with SMEs, as demonstrated in the testing case studies.

Each part of the enhanced SEco Framework will be examined through a series of *causal loop diagrams*. A causal loop diagram assists in visualising how different variables are interrelated in a system. The variables in this case are the individual elements/actions, the sustainability maturity and where the enhanced SEco Framework has addressed the barriers identified in Chapter 2 (section 2.5). The barriers are:

- A *lack of awareness* of the impact their actions have on the environment
- A *lack of knowledge* of the legislation pertaining to environmental issues
- A *shortage of resources*, both financial and human resources, to address the issues
- The *negative perception* that there is no immediate benefit to their organisation
- *Insufficient supports and tools* to affect change
- *Limited research* in the area of SMEs and the environment

Figure 5.23 demonstrates the elements within the systems analysis causal loop diagrams. These include:

1. The causal loop diagrams representing each of the enhanced SEco Framework Steps 1-4 (and individual actions within these steps);
2. What barriers are addressed at each stage or step;
3. Where the sustainability maturity increases.

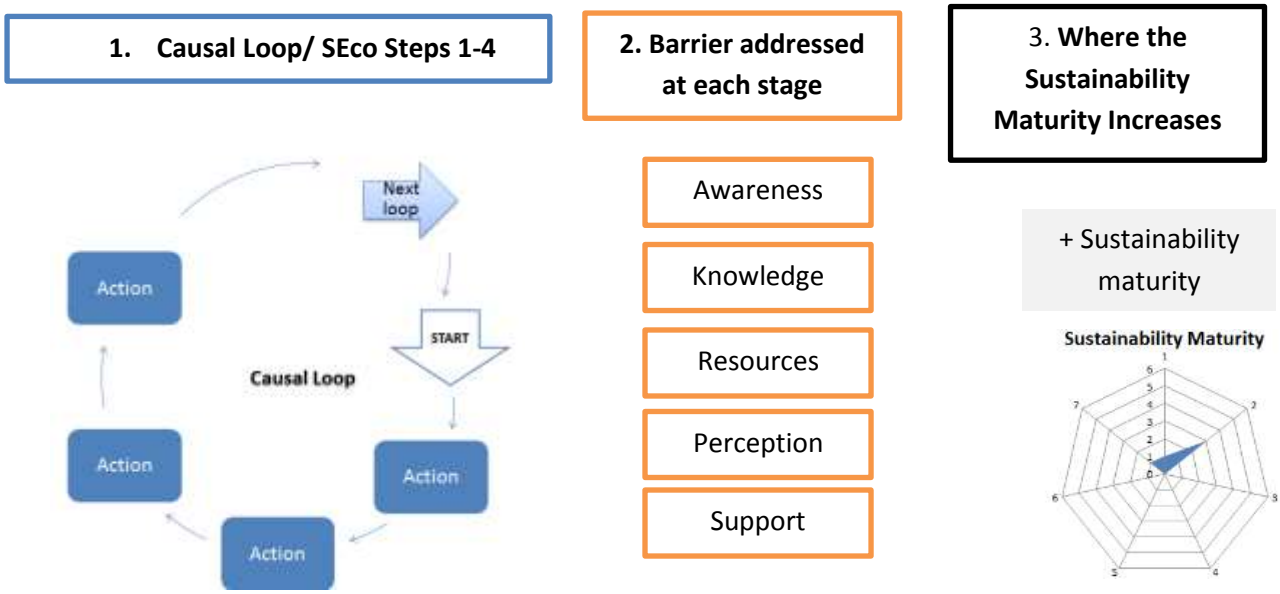


Figure 5.23: Causal Loop Diagrams Legend

5.4 Conclusions of Chapter 5

This chapter dealt with the issue of the SEco Pilot Framework not being readily adopted by SMEs. A number of factors were incorporated in this second phase of the framework development such as systems thinking, sustainability levels of maturity and the FutureSME transformation process.

The development process resulted in an overarching framework to guide and support manufacturing SMEs in four stages.

1. A **Diagnostic** guides the intervention to ensure the process is contextualised to the particular SMEs. Problems and opportunities are mapped to a set of tools that are selected and implemented. The *SEco Maturity Map* measures the sustainability maturity, and is a simple way to manage and communicate the eco-innovation process.
2. The **Tool** Selection Phase involves presenting the opportunities to the owner-manager and selecting appropriate actions.
3. The majority of activity happens in the Tool **Implementation** Phase.
4. A final **Review** Phase allows the business sustainability maturity to be measured and compared to the baseline.

To assess the behaviour during the different parts of the intervention process, a systems analysis will be carried out to see where the barriers are being addressed.

Table 5.5 below summarises how the gaps identified in Chapter 4 were addressed by the enhanced SEco Framework.

	Gap Identified	Potential solution to address the gap	SEco Framework Element added
1	**An Implementation process that is better tailored to the SME owner-manager's needs**		
1.1	The 'suggested path' on the FutureSME website was too generic for owner-mangers	A better process to guide owner-managers to use the Framework	**4 Step enhanced SEco Framework**
1.2	The owner-managers did not have the time to start the engagement without any assistance	An expert mentor to support and guide the process	**A one-to-one mentored process**
1.3	There was no initial motivator to convince the owner-manager to engage	A quick successful output to motivate the owner-manager	**CSR/Sustainability Reporting (Implementation)**
1.4	The owner-manager was not convinced about "what is in it for me and my business?"	A tailored view of how eco-innovation can be applied (a systems view)	**SEco Diagnostic**
1.5	There was no general overview of the potential "opportunities"	The guided process should identify potential opportunities	**SEco SWOT (Diagnostic)**
1.6	The owner-managers needed to know how the tools would benefit their particular business	The owner-manager needs to be guided through the Framework in a personalised manner	**A one-to-one mentored process and SEco Diagnostic**
1.7	Being embedded within the FutureSME website did not contribute to the uptake, but took away from the importance of sustainability issues	Further development and testing to take place out of the FutureSME project context	**Testing to take place away from the FutureSME project to minimise distraction**
2.	**A way to measure, track and communicate performance**		
2.1	There was no measurement of how well a company was doing, either before or after using the Framework	A method to assess the SME at the beginning of the process and after Implementation of the tool(s)	**SEco Maturity Map Systems Analysis**
2.2	There was no way to keep track of progress after the first engagement	A process to manage the implementation of the tool(s) within the business	**SEco Report SEco Strategy Wall**
2.3	There was no way to engage other staff within the organisation	A method to engage staff to support owner-manager	**SEco Strategy Wall**

Table 5.5: Summary of how gaps identified were addressed by the enhanced SEco Framework

The next chapter details the testing case studies to validate the application of the enhanced SEco Framework.

6 Data Collection: Testing and Validation of the SEco Framework

6.1 Introduction

6.2 Design of Case Study Testing

6.3 Testing Case Study 1

6.4 Testing Case Study 2

6.5 Validating the SEco Framework

6.6 Discussion

6.6 Conclusion of Chapter 6

6.1 Introduction

It is difficult to get SMEs to engage with sustainability issues. Chapter 4 showed that the self-led Pilot Framework designed specifically for SMEs was not enough to nudge them to improve their environmental management voluntarily. A well-designed sustainability intervention process with an SME owner-manager, focused on eco-innovations has more potential to improve environmental management practices. This chapter documents the application of the enhanced SEco Framework, an intervention-based methodology, which was developed and described in Chapter 5.

The aim of this chapter is to test the enhanced SEco Framework with SMEs away from the FutureSME project. The SEco Maturity Map is used to measure the change in sustainability maturity resulting from the application of the methodology. A case study analysis tests the framework against the research problem: *a slow uptake of environmental management practices in SMEs.* The analysis and results of the interventions detailed in two case studies are presented.

The insights derived from the cases contribute to a systems model that captures the dynamics of the situation, which validates the increase in sustainability maturity at each step of the SEco Framework. Another validation methodology is applied to test the SEco Framework for various criteria including effectiveness, efficiency, applicability, reliability, accuracy, robustness, comprehensiveness and manageability. The cases are discussed and analysed before conclusions are drawn. Figure 6.1 summaries Chapter 6.

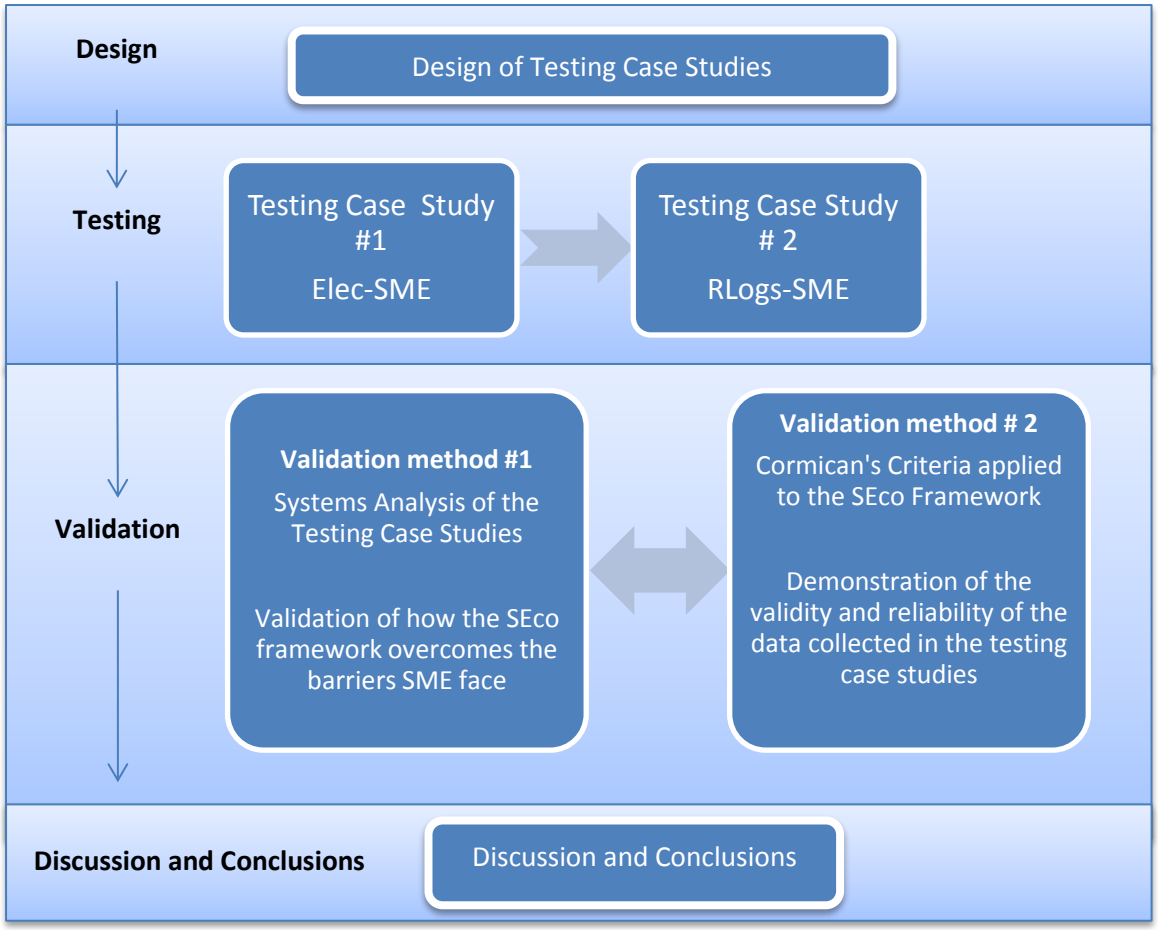


Figure 6.1: Summary of Chapter 6

6.2 Design of Case Study Testing

A case study approach was chosen as the most appropriate method for the complex issue of changing sustainability practices in SMEs (discussed in Chapter 3). Two cases are examined. The case study approach was guided by Eisenhart (1989) and Yin (2009), and took place in the following stages (see Figure 6.2).

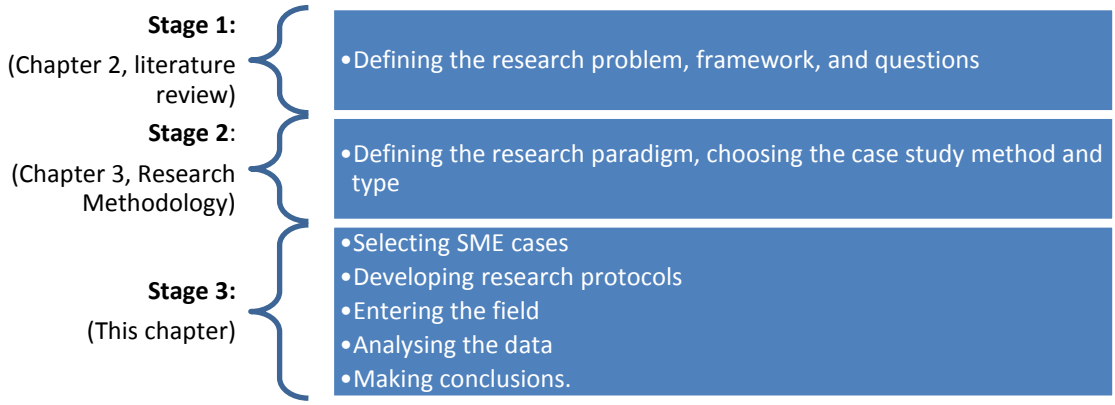


Figure 6.2: Stages of case study research

The boundaries for the testing case study are the SME owner-manager and the SME business. The scope of analysis is limited to the sustainability maturity and sustainability practices within the SME context. The focus of the case studies is to enhance and validate the usefulness of the enhanced SEco Framework.

The test case studies propose that the SEco Framework successfully facilitates improvements in the sustainability maturity of a manufacturing SME. It does so by raising awareness and creating eco-innovation opportunities that the SME owner-manager can understand and implement.

This proposition requires that:

- The enhanced SEco Framework is sufficiently detailed to engage with an SME manager to reveal eco-innovation opportunities
- The enhanced SEco Framework provides the tools to capitalise on the eco-innovations identified, that suit the needs and characteristics of an SME.

A simple multiple-case design is used, involving two testing case studies that are literal replications, i.e. cases where the framework is anticipated to be applied successfully (Yin, 2009). Additional case studies would be beneficial to increase the validity of the framework. However, the time available limits the number of case studies that can be carried out in this study.

6.2.1 Testing Case Study Selection

The criteria for selection of case studies were

1. SMEs in the manufacturing sector.
2. This study investigates *independent* SMEs (non-subsidiary) because they are more autonomous in decision making.

3. To compare like-with-like, SMEs in Ireland were chosen to carry out the case studies. The Irish context was interesting because the SMEs participating had survived the economic crisis since 2008, despite having a high cost base (within a European context).
4. SME owner-managers who are not convinced that sustainability is relevant to their business, and/or have little experience of the issues, as this may reflect a more "typical" SME.
5. Size: Small SMEs (i.e. fewer than 50 employees).

The case studies were carried out by implementing the SEco Framework step-by-step (described in detail in the previous chapter). To summarise, it is a four part iterative process; the first part involves an eco-innovation diagnostic to uncover opportunities for the company. Tools to support the process are selected from the toolset, and implemented. Finally, a review is carried out to measure progress in the company.

For the purposes of the research process, the interviews that took place at the diagnostic process and review process were recorded with the owner-manager's consent to be analysed afterwards. The researcher plays the role of the facilitator. To preserve the anonymity of the companies, they are given fictitious names. The case studies will be discussed in the next sections.

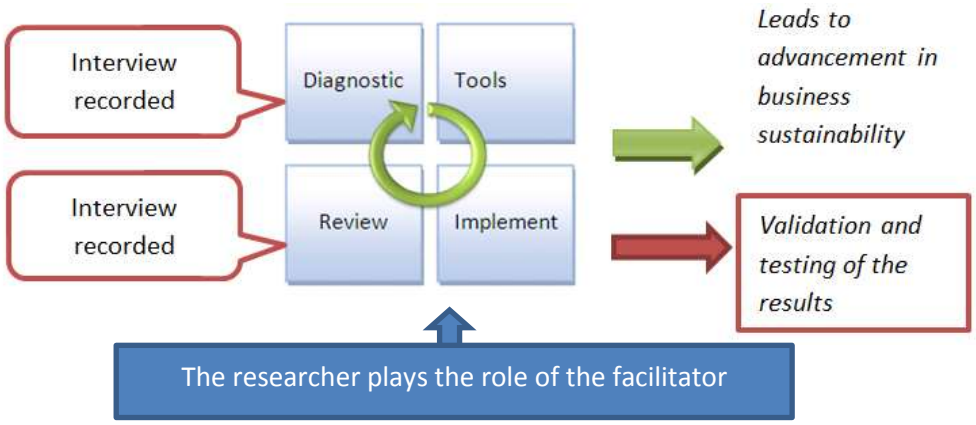


Figure 6.3: The SME Eco-Innovation Framework applied in the research setting.

6.3 Testing Case Study 1

Case Study 1 was carried out with a small electronics company. For the sake of anonymity, the company is referred to in this report as *Elec-SME*. The company is a small, specialised electronics business, based in the mid-western region of Ireland, manufacturing low-to-medium volume electronic systems and services, mainly to global OEMs. The intervention took place from Sept 2011 to May 2012 through five site visits, phone calls and emails, and is representative as a "manufacturing SME" due to its size, independence and activities. The owner-manager was contacted through the FutureSME project (but was not one of the 13 end-user partners).

6.3.1 Step 1: The Diagnostic

The diagnostic process took place on site with the owner-manager over two visits. This was preceded by a factory walk around to familiarise the researcher with the activities of the business.

6.3.1.1 The Diagnostic – The Business Profile

The owner-manager is male and in his forties. His wife works as an administrator within the business, doing the accounts. He has over 20 years' experience in the electronics manufacturing industry, having started the company in 2004. The business has suffered losses in recent years as result of the global economic crisis and through the loss of a major multinational customer (Dell) moving to a lower cost base in Eastern Europe. This resulted in a net loss of 60% of staff, which in 2008 exceeded 30 people. Nonetheless, the owner-manager has managed to sustain the profitability of the business. He is proud of his highly-skilled workforce and the company's dedication to quality and service. The strength of the company lies in its knowledge base.

The business profile is summarised in Table 6.1. There are 14 employees and the skilled workforce includes technicians and IPC Certified Operators. The Company is positioned in many parts of the value chain, and supplier locations are mainly in Ireland or China. There are two distinct value streams. Value Stream 1 (electronics manufacturing) is mature and its customers are mainly multinationals based in Ireland. These include GE, McHales, Apple, Dell, Analogue Devices, Quanta, Intepro Systems, Enterasys, Aisling Microsystems. Value Stream 2 (educational products) is in start-up phase, and its customers are Educational institutions, businesses and NGOs.

Elec-SME Business Profile	Value Stream 1	Value Stream 2
Activities	Electronics manufacturing	Educational products
Vision	"To provide the Electronics Industry with a Best-in-Class Manufacturing, Rework and Repairs Services, which is of high quality, flexible and cost effective"	"To bring images and sounds to life and change the way students see education"
Business maturity	Mature	Start-up
No. of employees	8 employees	6 employees
Customers	Business-to-Business Global OEMs, local small businesses, start-up innovative businesses, pilot projects for new business	Business-to-customer Educational institutions, businesses, non-profit sector
Position along the value chain	Design, manufacturing, distribution, service, end of life disposal/remanufacture	Retail
Supplier locations:	Ireland and China	Ireland and China

Table 6.1: Elec-SME's business profile

6.3.1.2 *The Diagnostic – The Environmental Profile*

Following the business profile diagnostic, it was decided to focus only on Value Stream 1 because the other value stream was not manufacturing-based.

The owner-manager was not personally interested in protecting the environment through business activities. He did not believe that sustainability or CSR were advantageous to the business and did not believe that sustainability would become a requirement of customers in the near future.

He did not measure the environmental impacts of products or business activities. No environmental management tools were used. The owner-manager initially believed that he knew what the environmental impacts of his business activities were, but this was not possible without any measures in place. However, there were excellent waste prevention processes in place. For example, component suppliers provided returnable packaging that could be re-used multiple times. Sustainable design was not a consideration because specifications were dictated by customer requirements. Monitoring current and future environmental legislation requirements happened through informal horizon scanning through business networks and the internet. The owner-manager was not comfortable approaching any business support agencies in relation to new legislation.

The environmental profile revealed that some eco-innovation opportunities had already been availed of, such as waste prevention and reuse. The outputs of the environmental profile are summarised in Table 6.2.

Profile question area	Analysis of Elec-SME's response	Is it a typical SME response?	Associated Tools from the Framework	Rationale for tool selection in this case
Awareness, interest & practices in environmental management	There is no awareness of the environmental impact of the company's activities	Yes	• CSR eLearning • CSR Assessment	• To increase awareness of the importance of sustainability and to build the personalised business case
	The business does not purposefully act in a sustainable manner	Yes		
	The owner-manager is responsible for all environmental management and staff are not consulted with	Yes		
	There are no resources to address the issues even if there was a desire to do so	Yes		
	Not aware that there are possible opportunities to be gained	Yes		
	Not aware that customers may be looking for green credentials	Yes		
Design	They are not involved in design	Yes	• LCA eLearning • LCC tool • LCA tool	Raises awareness of how they can impact the sustainable design of products

Profile question area	Analysis of Elec-SME's response	Is it a typical SME response?	Associated Tools from the Framework	Rationale for tool selection in this case
Are environmental impacts considered?	No, there are not considered	Yes	• Carbon Foot-printing tool	
Legal Requirements	Claimed to be aware of all legislation that affects it	**No**	• Legislation	To raise further awareness about the amount of environmental legislation it may need to comply to
	There is no confidence in contacting local business support agencies related to finding out environmental legislation.	**No**		
Importance of environmental issues	Being sustainable is not important to the business	Yes	• CSR eLearning • CSR Assessment	To increase awareness and build the business case for sustainability
CSR	There is little awareness of what this is, and how it would benefit the organisations	Yes	• CSR eLearning • CSR Assessment • Sustainability Report	To increase awareness of the importance of overall responsible business practices, and how assessing and communicating these can be a competitive advantage.
Waste	There is no waste generated from operations. Everything is recovered from the motherboards	**No**	• EMS eLearning, Waste audit tool	*No need in this case*
Energy	Energy is not monitored	Yes	• EMS, Energy audit tool	*No need in this case*
	Have not explored use of other suppliers that might offer better value or more sustainable	Yes		
Water	There is very little water used in the manufacturing process.	N/A	• EMS, Water audit tool	*No need in this case*

Table 6.2: Elec-SME's environmental management profile

6.3.1.3 The Diagnostic – The eco-innovation SWOT

The eco-innovation SWOT highlighted the strength of the company's technical expertise, the flexibility of the production systems, and highly experienced staff, which had led to many eco-innovations related to reductions in power consumption. The owner-manager did not see these measures as environmental, but merely cost saving. The recent economic downturn, and the loss of a major customer had driven energy saving projects and better resource management.

The weaknesses were few, and mainly around the lack of awareness and resources to engage in sustainability with any confidence.

Many opportunities were revealed, such as preparing for future compliance with legislation, and customer requirements. However, there were also threats that they may not be able to compete with their large competitors, and entering the arena of sustainability was daunting to the owner-manager. The SWOT is summarised below in Table 6.3.

SWOT Area	Details
Strengths What might be helpful within the organisation towards eco-innovation	• High standards of electronic production technology • Good experience of working with OEMs and other customers • Many years of experience in the industry with many good relationships built throughout the supply chain • Flexibility of the production and manufacturing processes • A highly skilled workforce • Identified past opportunities with respect to power consumption within the factory and for products that have been manufactured
Weaknesses What might hinder eco-innovation opportunities within the organisation	• No specialised experience with environmental sustainability • No strong drivers for sustainability from customers or other stakeholders • No obvious benefits can been seen at present
Opportunities: What things external to the company could help eco-innovation	• The FutureSME project can assist with the help of a researcher • Cost reductions from the minimisation of energy, waste , water and raw materials • Increased market share when/if OEMs look for sustainability credentials • Possible new market opportunities for sustainable products • To be prepared for future legislation • Practices may be good for brand image and marketing purposes • OEMs may be turning a corner currently in relation to social responsibility (e.g. drive for world leader in innovative electronics, Apple to improve worker conditions following recent press releases) • Social media engagement could be used to rapidly connect, communicate and gain knowledge of the area
Threats What the external business environment could be a threat to eco-innovations	• Local competition could also do the same, which may reduce profit margins • It is difficult to quantify the long-term benefits, as the future is uncertain • The loss, or potential loss of market share if eco-innovations fail, or sustainability goals are not met • Larger competitor companies internationally could be faster reaching sustainability as they have access to more resources to do so • Current economic worldwide recession has somewhat stifled demand for greener products • New legislation could be introduced which could hinder eco-innovation projects • The threat of new trade barriers based on new legislation • New legislation that is expected related to improved sustainability performance may not arrive fast enough to benefit from it

Table 6.3: Electronic SME's SWOT analysis

6.3.1.4 The Diagnostic – The Stakeholder Analysis

Despite the fact that the environmental profile did not reveal much interest in environmental or social responsibility issues, the company has established networks with the local community, including research projects and green business networks. Components, PCBs[1] and solders are mainly sourced locally from Irish suppliers and distributers. A neighbouring company is a source of shared resources, such as waste management, energy use, and equipment use. The SME is involved in educational projects with the local college and research project FutureSME.

Although there were many OEM and multinational customers, there was no push from them towards eco-innovation or sustainability. The most important stakeholders are listed in Table 6.4.

Internal Stakeholders	Stakeholders along the supply chain	Stakeholders in the local community	Societal Stakeholders
Owner-manger	OEM Customers *(Analogue Devices, Dell, Shaftner, Interpro, Aisling Microsystems, GE)*	Limerick Co. Council	Department of the environment and EPA
Sales & Marketing staff *(partly outsourced)*	New customers *(FlueMaster, Wincab)*	Neighbouring company *(MidWest Bread distributers)*	Competitors, local national and international *(Bright solutions, Aaran & Smart electronics)*
Design staff *(subcontracted)*	Consumers of end products	Networks *(Supply-Network-Shannon, Chamber of Commerce, Atlantic Way)*	Third level institutes (*GMIT, UL, LIT*)
Production employees	Suppliers of components *(Embassy, Farrell, Radionics* *Suppliers of PCBs* *Beta, Shipco* *Suppliers of solders* *HPelec, SVS)*	The natural environment	Green business network *(SMILE Resource Exchange & SNS representative from regional waste management office)*
Non-production employees – (*Management, Administrative & other subcontracted employees*)	Other suppliers: *(Airtricity)*		Banks/funders/investors
	Pallets Exchange Network for distribution		Social media networks: LinkedIn *(recently joined)* Own website *(good traffic)*
	Waste Management Company		
	Product installers		

Table 6.4: Elec-SME's Stakeholders

[1] Printed Circuit Boards

6.3.1.5 *The Diagnostic – The SEco Maturity Map*

Before the implementation, the SEco Maturity Map provided a baseline assessment measure of the company's sustainability maturity. Elec-SME's SEco Maturity Map was personalised to them. It has seven sections with six levels in each: *Environmental Management System*, *Energy Management*, *Product Stewardship*, *Training and Culture*, *Stakeholder Management*, *Sustainability Reporting* and *Overall Maturity*.

At this stage, Elec-SME had a low sustainability maturity, with *Energy Management* the most advanced. *Overall Maturity* is very low as the SME owner-manager did not see the business benefit of sustainability. They advanced to level 1 for *Environmental Management System*, as there were informal measures in place such as legislation compliance, energy management and waste management. The details of Electronic SME's SEco Maturity Map can be seen in Figure 6.4.

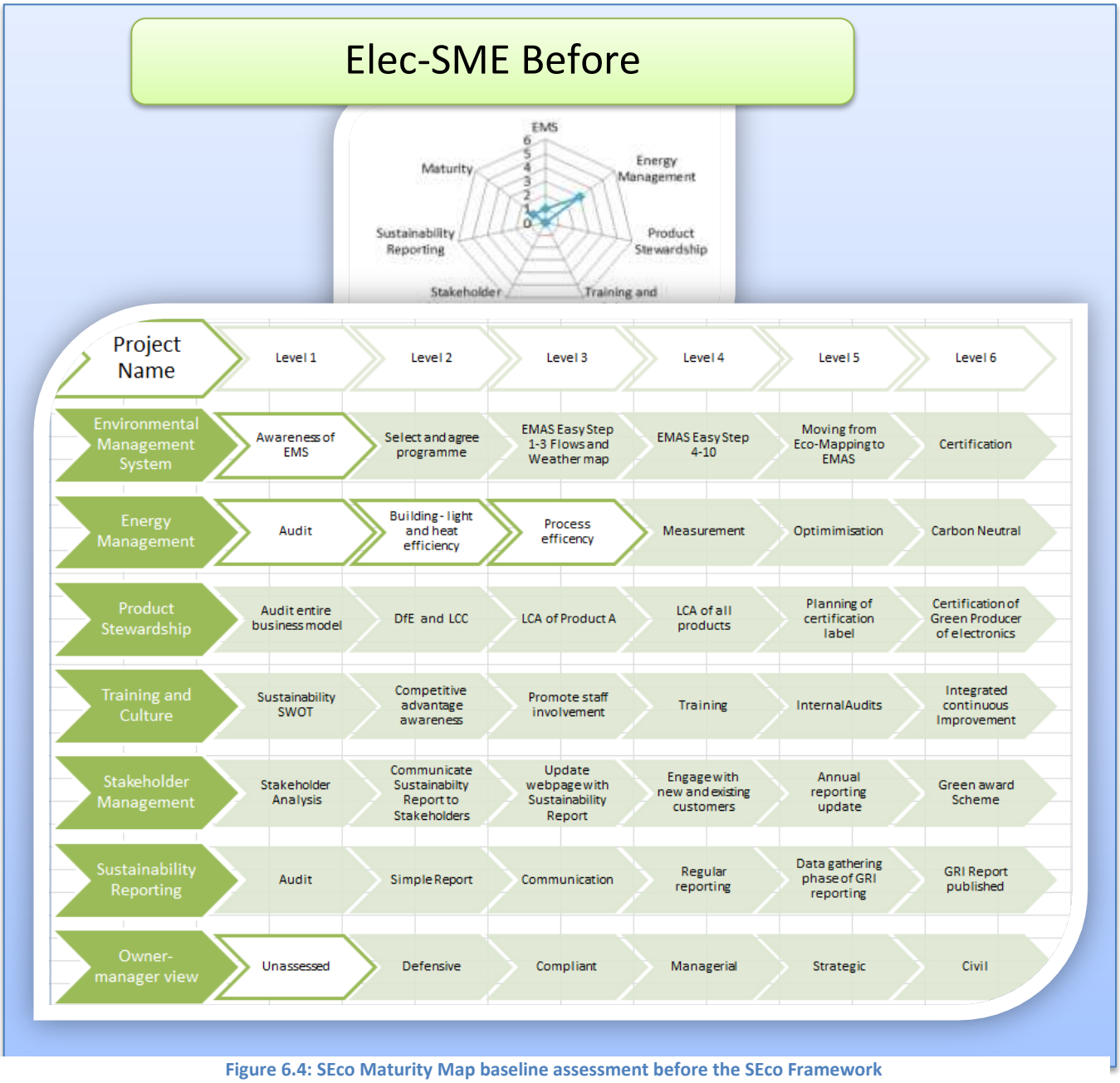


Figure 6.4: SEco Maturity Map baseline assessment before the SEco Framework

6.3.2 Step 2: The Tools Selection

The Environmental Profile was designed to identify tools that were suited to the particular SME. Table 6.2 above mentions a number of tools have already been pre-selected. The SWOT and the Stakeholder Analysis gave further insight into the company, gathering knowledge and looking for eco-innovation opportunities.

Each of the pre-selected tools was presented to the owner-manager, to explain why it would be of business benefit, and to register the owner-manager's interest (see Table 6.5).

The eLearning lesson "*CSR for SMEs*" was suggested first. It was explained that articulation of responsible and sustainable practices can help to build the business case for sustainability, through case studies and awareness-raising of how this can be applied in an SME.

The Stakeholder Analysis identified many stakeholders in the local community, which indicated a deeper engagement than the owner-manager had realised. Even though the SME owner-manager claimed not to be active in design-related decisions, the LCA eLearning and tools (LCA, LCC and Carbon Foot-printing) were recommended, to offer simple analyses on behalf of the customer, which could deliver added value. The LCC tools were suggested, to help when purchasing equipment. The SME owner-manager expressed a keen interest in carbon footprinting.

Sustainability Reporting was presented to Elec-SME as a way to communicate its responsible business practices to its stakeholder, in particular its customers. At the time of the case study, no customers were asking for any such data. However, there was an opportunity for Elec-SME to stand out from its competitors, particularly during the tendering phase.

During this conversation, the SME owner-manager expressed an interest in exploring the implementation of an EMS, provided that it did not take many resources to implement.

When the LCC tool was presented, the owner-manager realised he had already carried out a similar process when purchasing a new vehicle for the business, and for large equipment purchases. He used simple calculations, based on the knowledge available to assess the most economically suitable, based on combining running costs and purchase cost over its expected useful life. The owner-manager was not interested in another methodology that he was not familiar with, and preferred to stick to something that he already knew worked for him.

The legislation tool was presented in brief, including the various categories, to show the sheer amount of environmental legislation it must comply to. However, there was no interest from the SME to engage in this tool, as he already believed that he was in compliance.

Suggested Tools for Elec-SME based on diagnostic	Potential business benefit to Elec-SME	Interest of owner-manager (Not at all, slightly, somewhat, quite, very)
CSR for SMEs eLearning	To learn about other SME case studies to further highlight the business benefits of an overall approach to CSR	Somewhat interested
CSR Assessment	To dig deeper into what broader activities the company is active in its local community, and to form the basis of a sustainability report	**Quite interested**
LCA E-Learning	To learn about other SME case studies to further highlight the business benefits	Somewhat interested
LCC Tool	To apply to equipment purchases, to assess the most economically	Not interested
LCA Tool	To apply a simple LCA one or more of the products manufactured, for the benefit of the customer, and to look for opportunities to make it more environmentally friendly	**Quite interested**
Carbon Footprinting tool	The owner-manager is familiar with this term, and expressed an interest in using this tool	**Very interested**
Legislation Tool	To raise awareness about the scope of legislation it must comply to as a business in the EU	Not interested
Sustainability Reporting	This would allow the SME to future proof his business by learning how to communicate its responsible business practices to its customers	**Very interested**
EMS eLearning	To further assess and validate the business against a European standard	Somewhat interesed

Table 6.5: Tools selection matrix for Elec-SME

There are other tools that are prescribed in all cases described in Chapter 5. These are the SEco Strategy Wall and SEco Project Report. These were also presented in brief to the owner-manager, who seemed interested in these. In summary, it was planned to implement the following tools:

1. Tool – Carbon Foot-printing
2. Tool – Sustainability Reporting
3. Tool – CSR Assessment
4. ELearning – CSR for SMEs
5. Tool – LCA tool
6. ELearning – LCA for SMEs
7. eLearning – EMS for SMEs
8. Tool– SEco Strategy
9. Tool - SEco Project Report

6.3.3 Step 3: The Implementation

The recommended tools were implemented and tested over three more meetings with the SME owner-manager, with email communication in between. Each of these will now be discussed.

6.3.3.1 ELearning – CSR for SMEs

The CSR ELearning lesson was targeting the lack of awareness and lack of knowledge within the organisation, and aimed to dispel the negative image that the SME owner-manager had. This lesson was recommended to be implemented first, as it would highlight the business benefits to the SME owner-manager at the outset.

The owner-manager asked for the lesson to be demonstrated to him, as he did not want to spend the time going through instructional slides. He did not want to hear all the voice-overs, and quickly scanned and skipped to content that was interesting to him.

The case studies were of particular interest. Seeing the real business benefits that implementing an overall approach in other SMEs, by managing the business more responsibly and reporting on it, was of great interest. The owner-manager could see the business benefits clearer after doing this lesson. It led naturally to the next tool.

6.3.3.2 Tool – CSR Assessment for SMEs

The social responsibility assessment was carried out with the SME owner-manager on the third site visit. At this stage, the owner-manager was much more relaxed, was less defensive in his communication, and was starting to engage with sustainability issues. The owner-manager requested to be facilitated through the process rather than using a self-guided approach.

The tool is in the form of a manual and assessment. It gives examples and the business significance of each area, to align sustainability thinking with business objectives. There are five parts to the assessment. A summary of Elec-SME's responsible policies and practices is provided below in Table 6.6.

Elec-SME's vision was "*To provide the electronics industry with Best-in-Class manufacturing solutions*". The company was strong in the area of workplace and its employees, allowing flexible working time to allow employees work around their family lives. There was ad-hoc community engagement happening through local community groups, and there were various policies in practices identified in the 'marketplace' section of the assessment, such as good engagement with customer and a payment policy. One of the most revealing parts of the assessment for the owner-manager himself was the realisation that "*the most important success factor for our business over the years is honesty in our business practices*".

At the end of the process, the SME owner-manager commented on the value of carrying this out with external guidance, and said that he would have not been able to do so himself, due to the time it would take, but also due to his lack of expertise in the area and inability to identify responsible and sustainable practices.

Elec-SME's responsible business practices	
Part 1: Vision Mission Values	
Company's Vision	• "To provide the electronics industry with Best-in-Class manufacturing solutions"
Company's Mission	• "We aim to achieve our vision through our professionalism, enthusiasm, highly skilled workforce and dedication to quality and service."
Values	• Honesty, Dedication, Professionalism, Enthusiasm, Quality, Integrity
Part 2 Employees and Workplace	
Training and development	• Funded employee electronics manufacturing skills training
Communications	• Communications with employees on a regular (weekly) basis
Health & Safety	• Health and Safety Statement published
Work life balance	• Flexible working hours available to fit around family
Part 3: Environment	
Environmental Efficiencies	• Waste prevention, Managed energy, Shipment consolidations, Lead free components
Designing for the environment	• Working in an advisory role for customers to design greener products and processes • Local sourcing of components • Repair, rework and recovery service for electronics to minimise resources
Part 4: Marketplace	
Policies	• Customer warranties and agreements are transparent, and easy to understand. • Stakeholder engagement with customers on a monthly basis • Payments policy to clear invoices each month. • Capabilities are honestly outlined in business advertising
Networks	• Research project involvement through, futureSME to learn and promote successful business practices in manufacturing SMEs
	• Member of Shannon Network Supply, an industry-led business network, to promote, develop and connect companies in the Shannon region of Ireland
	• Regularly engage with the local authority's environmental support to help improve our business practices
Part 5: Community	
Employment	• Student placements provided with work experiences from local secondary schools
	• Ongoing responsible business practices have ensured the survival and continuation of our business during the economic downturn
Local Suppliers	• Supporting local suppliers where possible
Community Engagement	• Sponsoring of local community projects, on an ad-hoc basis, such as the drama club, camogie club and soccer clubs • Open to any dialogue with community groups about our manufacturing facility if the need arose.

Table 6.6: Elec-SME's responsible business practices

6.3.3.3 Tool – Sustainability Reporting

The Sustainability Report was recommended for Elec-SME, to help it to articulate its sustainable and responsible business practices to customers. The previous tool, CSR assessment, formed the basis for the sustainability report. Again, the SME owner-manager did not want to do this himself, so this report was written for Elec-SME by the researcher.

The owner-manager was very happy with the Sustainability Report. He was pleasantly surprised by the amount of sustainable and responsible business practices that he was involved in. Even though he already knew that he did all these things, the process of the assessment and production of the report allowed him to see his business in a new light. He was already very proud of his business expertise, and now he was proud of the manner in which he carried out his business and was happy

to share this if it would give him a competitive advantage. It was recommended that this report be used when tendering for work with new and existing customers. The report could also be edited by the SME owner-manager as he saw fit. The sustainability report is in Appendix F, and some selected screen shots can be seen in Figure 6.5.

Figure 6.5: Screenshots from Elec-SME's Sustainability Report

6.3.3.4 *ELearning – LCA for SMEs*

The LCA eLearning lessen was recommended to help the owner-manager to learn how to assess the environmental impact of products and services that Elec-SME makes for its customers. Again, the owner-manager asked to be guided through the lesson, and wanted to skip to the parts that were of

interest -he did not want to spend the recommended 90 minutes given as a guide. He was only interested in the parts that applied to his business. The description of the LCA methodology was clear to the owner-manager, as were the business benefits, in particular those identified through the case studies. The owner-manager was ready and willing to try out the LCA tool after the lesson was demonstrated.

6.3.3.5 Tool – LCA tool

The tool selected was the Eco-indicator '99. This is a quantitative method to find the largest causes of environmental pollution, and identify opportunities for improvement. The LCA was carried out with the owner-manager on-site. All the separate components of the product were weighed and the data inputted into the tool, as seen below in Figure 6.6. The simple analysis revealed that the biggest impact was during the production phase from a steel high alloy nozzle component.

Date		Author		
01/05/2012		*Sinead Mitchell*		
Goal - To analyse the environmental impact of the product to see where the largest impacts are and assess if improvements would be useful.				
Material or process	**Amount**	**Measure unit**	**Indicator**	**Result**
ABS Plastic housing	0.17	kg	400.000	66.00
ABS Mixer Valve	0.02	kg	400.000	9.60
ABS Solenoid	0.11	kg	400.000	42.00
PP Circuit Board Plastic	0.06	kg	330.000	19.14
Copper	0.04	kg	1400.000	56.00
Steel high alloy - Nozzle	0.36	kg	910.000	**327.60**
Steel high alloy - Temp sensor	0.02	kg	910.000	13.65
Packaging Cardboard box	0.27	kg	69.000	18.63
Total [mPt]				**552.62**
Use				
Transport, energy and possible auxiliary materials				
Process	**Amount**	**Measure unit**	**Indicator**	**Result**
Transport of raw materials product Truck 16ft 770g	0.77	kg	34.000	26.18
Chemical	1.00	litre	99.000	99.00
Total [mPt]				**125.18**
Disposal				
Disposal processes for each material type				
Material and type of processing	**Amount**	**Measure unit**	**Indicator**	**Result (negative score)**
ABS Plastic recycling	0.29	kg	240.000	70.56
PP Circuit Board Plastic recycling	0.06	kg	210.000	12.18
Steel high alloy recycling	0.38	kg	70.000	26.25
Cardboard recycling	0.27	kg	8.300	2.24
Total [mPt]				**111.23**
Total [mPt] (all phases)				**566.57**

Largest environmental impact identified

Figure 6.6: Eco-indicator LCA for Elec-SME

The SME owner-manager found the process and results very interesting. He admitted to not being aware previously what the impact of any of his products had, or how to go about assessing this. Despite highlighting the biggest environmental impact in the LCA, the SME owner-manager decided that the high spec required for this particular component could not allow for a change in material or dimensions to reduce the weight at this particular time. However, he said that he would look into it in future if it became more relevant, and nevertheless found the tool very useful and easy to apply.

6.3.3.6 Tool – Carbon Foot-printing

The owner-manager was particularly interested in measuring the carbon footprint of his company. The LCA eLearning lesson had covered the business benefits of this tool.

The organisational boundary of the carbon footprint only included the electronics manufacturing value stream (see Figure 6.7). The greenhouse gas emissions boundary covers some elements in Scope 1, Scope 2 and Scope 3. Although there is a company van, this is not used extensively and there was no accurate measure of the mileage, so this was not included. Direct emissions from fuels Scope 1 Stationary Combustion emissions were inputted for Natural Gas (26801kWh), which was the only fuel used on site. Electricity use of 20775kWh was entered as a Scope 2 emission. Waste use was included in Scope 3.

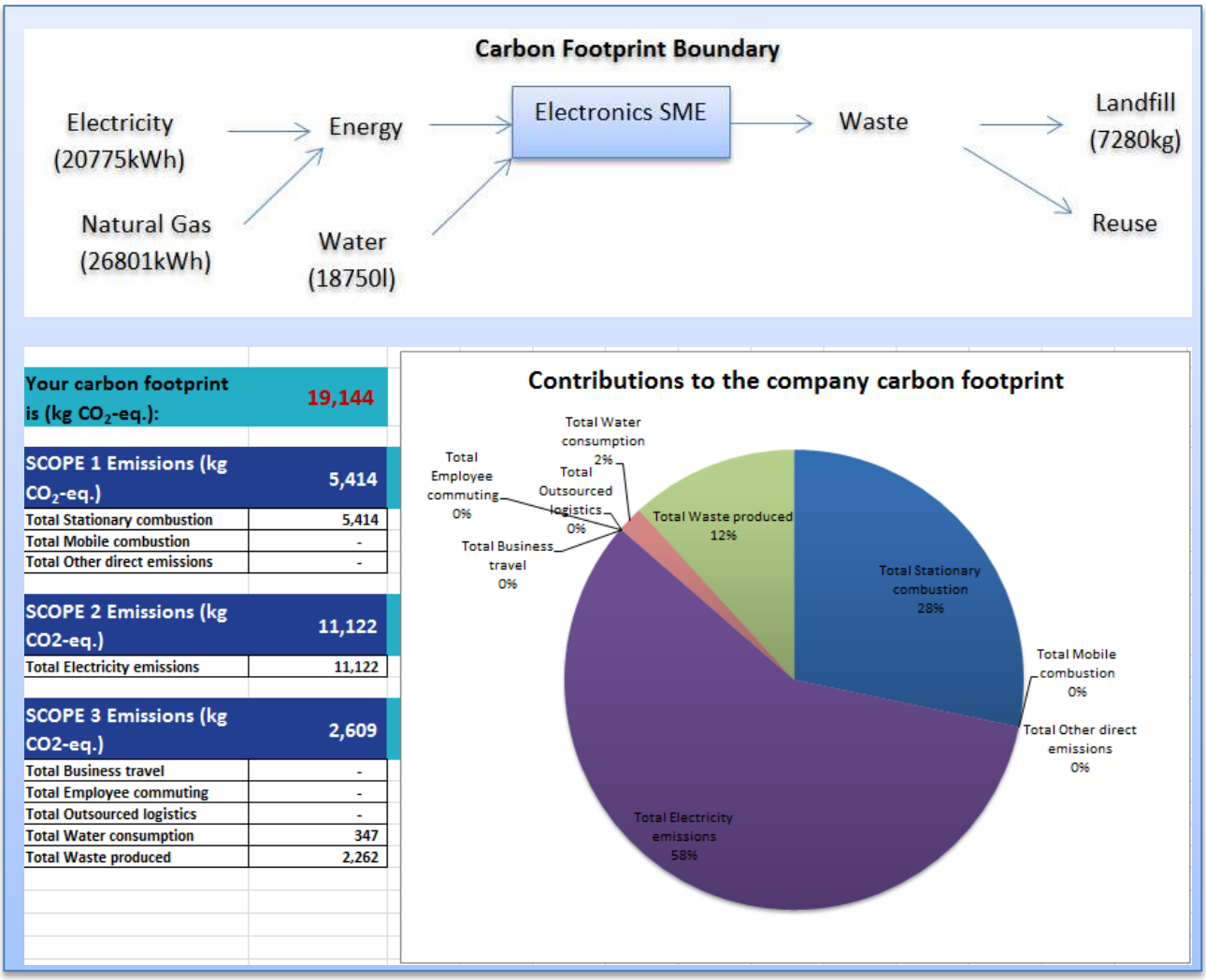


Figure 6.7: Elec-SME Carbon Footprint Results

From the analysis of the carbon footprint, the majority of carbon contribution stemmed from electricity emissions at 58%. The tool outputs recommendations, which could include:

- Upgrading lighting to lower electricity consumption bulbs
- Delivery of staff training and awareness programmes to reduce electricity consumption
- Installation of electricity efficient technologies

Total stationary combustion (from natural gas) is the next highest contributor at28%. Measures that can be taken to improve include:

- Improving the thermal insulation of the building
- Changing the source of heating to a lower carbon one (e.g. biomass)

Waste contributes 12% of the carbon emissions, which was a surprise to the owner-manager, that what they considered almost zero, still contributes a significant amount to the overall carbon footprint. The tool recommends removing dustbins and creating a centralised bin system.

The owner-manager found the tool to be advantageous from a learning point of view. Although he had already reduced the energy by a significant amount, carrying out the carbon footprint focused him more on making further reductions. He said that he would include the carbon footprint into the sustainability report in future. However, the process to collect the data for the carbon footprint took a lot longer than the other tools. It involved various emails to the finance administrator to gather fuel and electricity bills.

6.3.3.7 eLearning – EMS for SMEs and EMAS -easy

The EMS for SMEs eLearning lesson was chosen by the SME owner-manager, as he had expressed an interest in finding out how easily an environmental standard could be applied in his business. At this stage, the owner-manager was growing in awareness about sustainability and eco-innovation.

The owner-manager asked for the lesson to be demonstrated, as he did on the previous eLearning lesson. The researcher went to areas that she thought would be most relevant to the company. These included the case studies, highlighting the benefits of EMSs in SMEs as well as an overview of the EMAS Easy methodology. Afterwards the owner-manager decided that he would like to explore the possibility of implementing EMAS easy.

The first two parts of the methodology were applied over 2 site visits.

- **Part 1 of EMAS Easy**
    - Step 1: A map of the manufacturing site and surrounding area was made including car parks, access areas, roads and the surrounding environment. The aim of the step is to see the big picture including transport, subcontractors, procurement policy and the impact of products and services.
    - Step 2: A quick assessment of material flows is mapped to visualise health risk and resource use and associated costs.
    - Step 3: A short survey was conducted with the staff to get their opinions, experience and ideas. This step helps to get staff involved in the process and assists in the analysis of the shop floor.

- **Part 2 of EMAS Easy**
    - Steps 4, 5, 6, 7, 8, 9**.** A series of Ecomaps were created within the manufacturing facility to evaluate environmental behaviour and equipment. The Ecomaps are simple visualisations of the real situation within the manufacturing site. This included inputs and outputs in relation to materials, waste, water, wastewater and energy usage (e.g. highlighting equipment with high consumption.

6.3.3.8 Other Tools for Elec-SME

To help manage the recommendations from the process, a personal SEco Strategy Wall and SEco Project Report were created for the company (see Figure 6.8).

The SEco Strategy Wall brings everything together in a visually easy to communicate manner. This includes a poster version of the sustainability report as a reminder to all employees and visiting customers, what the responsible business practices are. The SEco Strategy Wall helps manage current projects and collect ideas from staff. These were printed in A1 poster format, and the owner-manager hung these in the manufacturing facility. The project report was used as a reference for the SME owner-manager.

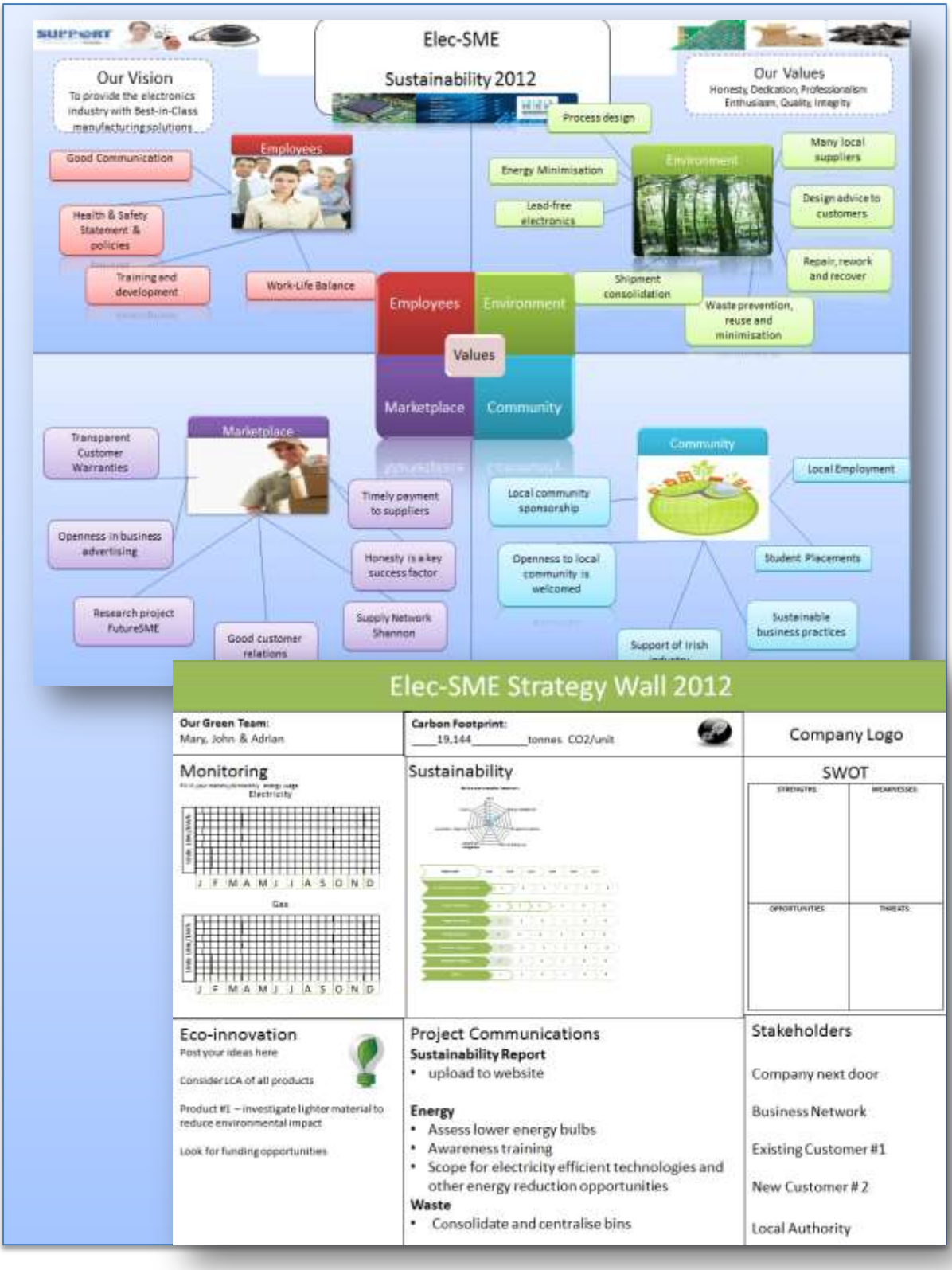


Figure 6.8: Elec-SME Strategy Wall

6.3.4 Step 4: The Review

After a period of 6 months from starting the intervention, Step 4 was carried out with Elec-SME.

A face-to face review was completed in May 2012 in the form of a semi-structured interview, allowing the owner-manager to give his overall impression of the framework. The review began with a short presentation summarising what had happened throughout the intervention process. The SEco Maturity Map was used to illustrate how the company's sustainability maturity had increased.

The owner-manager was involved in some of the testing of the SEco Pilot Framework and he welcomed the enhanced SEco Framework overall as a great improvement. The time scheduled for the one-to-one meetings were set aside to do work in this area. If left to his own devices, it would have fallen off the list of important activities on a daily basis. He said that the key to the successes was being facilitated and led by an external expert through a clear process, which was personalised to his business case. The intervention allowed him to view his own company through a different lens. It succeeded in convincing the owner-manager that sustainability issues were important to his business. It also increased the company's capability in relation to the issues. He had positive experiences with the Sustainability Report in particular, which had impressed future customers. His future plans were to continue his involvement in sustainability issues through staff engagement and collaboration with his stakeholders.

The questions asked in the review interviews were answered as summarised below in Table 6.7.

Question posed to the owner-manager	Response summary
Did your view of environmental issues change?	Yes, a change from a very negative association of environmental issues being of little importance to the business, to being more positive about it.
How did the SEco Framework change your point of view?	The process made him realise that "i*t is not something that is annoying as I had thought before*". There was an increased awareness of what it means. They were doing eco-innovations without actually connecting their activities to sustainability.
Has the business benefited from the process?	The process highlighted areas where there are more opportunities to save money, and it *"will allow us to have a competitive edge"* "*I can really see it as an opportunity, and have used the sustainability report to communicate what we have done with one of our customers so far*". Potential new customers were very impressed with the sustainability report.
Would you like to do more to embed the framework	The next cycle will involve creating an environmental management structure in the organisation, and engaging more with all the employees to get new ideas
Do you see the value of the SEco Framework?	Yes, would definitely pay for the service – the sustainability report alone would be worth €200-300 to small business owners.
Any other feedback?	"*The process has changed my whole perception. Most important is the face-to-face delivery, which is needed to push actions. Emailing and relying on the SME alone is not going to work, as it falls off the agenda of daily activities fairly fast*"

Table 6.7: Elec-SME review summary

Elec-SME was reassessed using the SEco Maturity Map tool. In a short six months' the company advanced from *Defensive* to a *Managerial* level of sustainability maturity, as illustrated below in Figure 6.9.

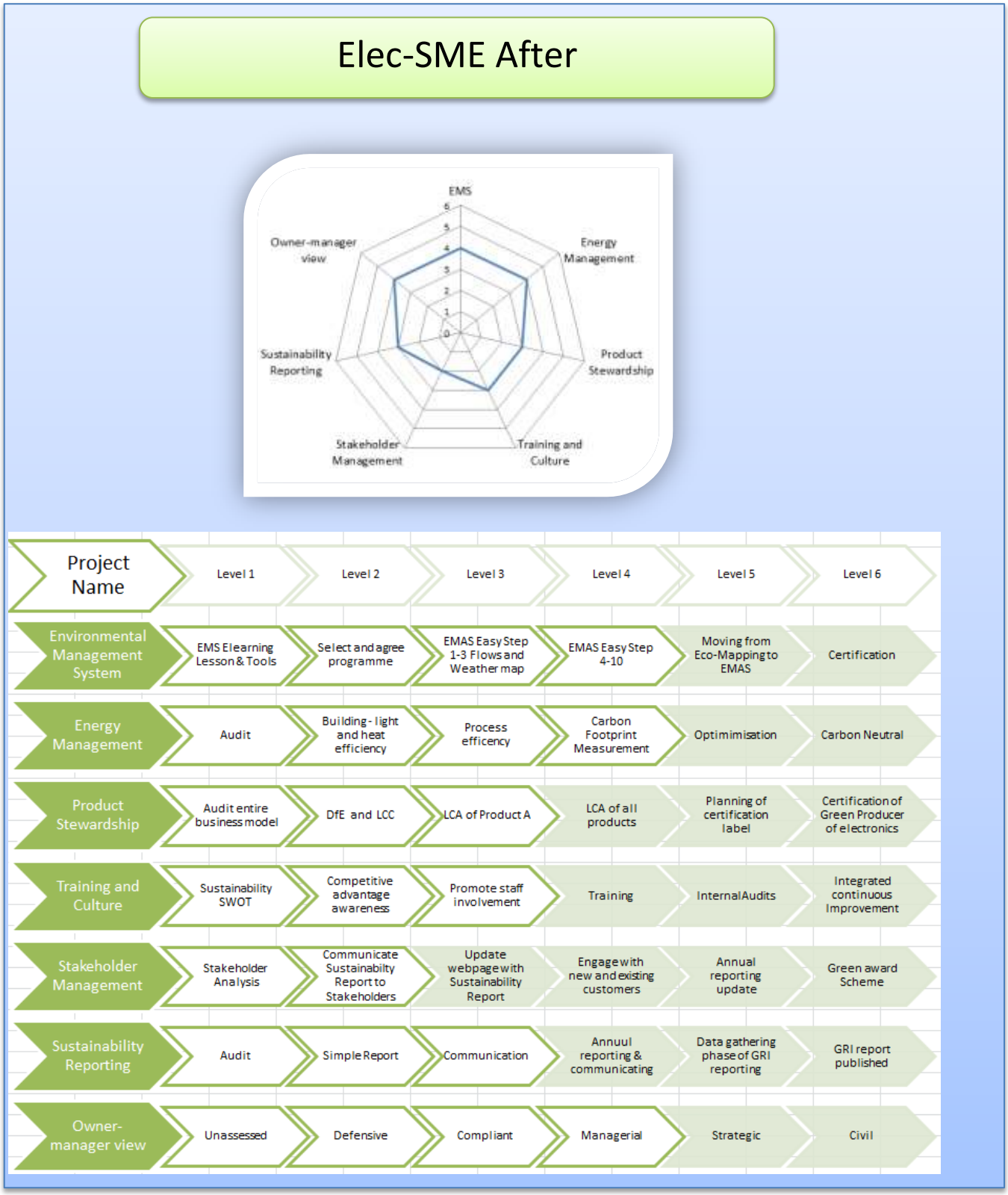


Figure 6.9: Elec-SME's SEco Maturity Map reassessment after implementation stage

Elec-SME had increased its sustainability maturity in various ways.

- The owner-manager had agreed upon starting an E*nvironmental Management System* and had chosen to apply EMAS-Easy.
- *Energy Management* had improved by monitoring and measuring usage, assessing the building for light and heat efficiency, and had measured their carbon footprint.
- An advance in *Product Stewardship* was a result of completing an LCA of a product they manufactured on behalf of another company.
- *Training and culture* had increased to level 3 because the owner-manager now recognised the competitive advantage of sustainability, and were using the SEco Strategy Wall to engage staff in continuous improvement.
- Its *Stakeholder Management* increased after undergoing the Stakeholder Analysis which gave the owner-manager a more holistic view of further eco-innovation opportunities.
- *Sustainability Reporting* had increased because it had undergone an assessment of the company to create its own Sustainability Report. The owner-manager began including the sustainability report in tender documents with customers, with positive responses.
- The *owner-manager view* had increased to a *Managerial* level, because the owner-manager's view had completely changed, and was using its good practices as a competitive advantage to differentiate himself within the marketplace.

6.3.5 Summary of Case Study 1

Elec-SME was initially very sceptical of the business case for sustainability. The intervention revealed that the company was already engaging in eco-innovation activities, but they did not identify them as such. It became clear that many cost reduction 'quick wins' in the production and manufacturing process had already been accessed. However, the owner-manager had not considered these as eco-innovations, rather, simply as cost saving exercises.

Typically, it is expected that an external expert will easily identify a lot of "low-hanging fruit" in SMEs - particularly regarding energy and waste management. However, this SME had already implemented many energy saving projects including capital investment in new soldering equipment, and processes to minimise the use of energy intensive machines. All of these changes had been made after the global recession of 2008, to cut costs when the business suffered a severe slowdown in business.

Nonetheless, the SEco Framework implementation with Elec-SME identified many opportunities to increase sustainability maturity. At the start of the process, the owner-manager knew little about sustainability and at best maintained compliance to legislation. By the end of the SEco Framework cycle, the owner-manager exhibited increased understanding of what sustainability activities were within his organisation, and had a more strategic view of how sustainability fits with the organisation, and aligns with the business objectives. Elec-SME moved from "*defensive/compliance*" to a "*managerial*" level of sustainability, because the owner-manager recognised the importance of sustainability to the business.

The most significant improvements, captured at the review included:

- **Attitude turnaround**: An overall change in attitude of the SME owner-manager, who initially considered environmental issues to be '*annoying*'.

> *"the environment wouldn't have really interested me in the beginning. I would have been kind of steering clear of it, but now definitely it's going to be useful, so I would like to keep going on it"*

Although the company had already implemented eco-efficient practices into its production facility, the owner-manager did not think of it as such, but does now.

> *"When we're doing stuff that I didn't realise would also be environmentally friendly. We'd probably have just been looking at it as a cost saving to the company"*

- **Increase in sustainability maturity:** The company increased its sustainability maturity from an initial overall *Defensive* to a *Managerial* level (see Figure 6.10).

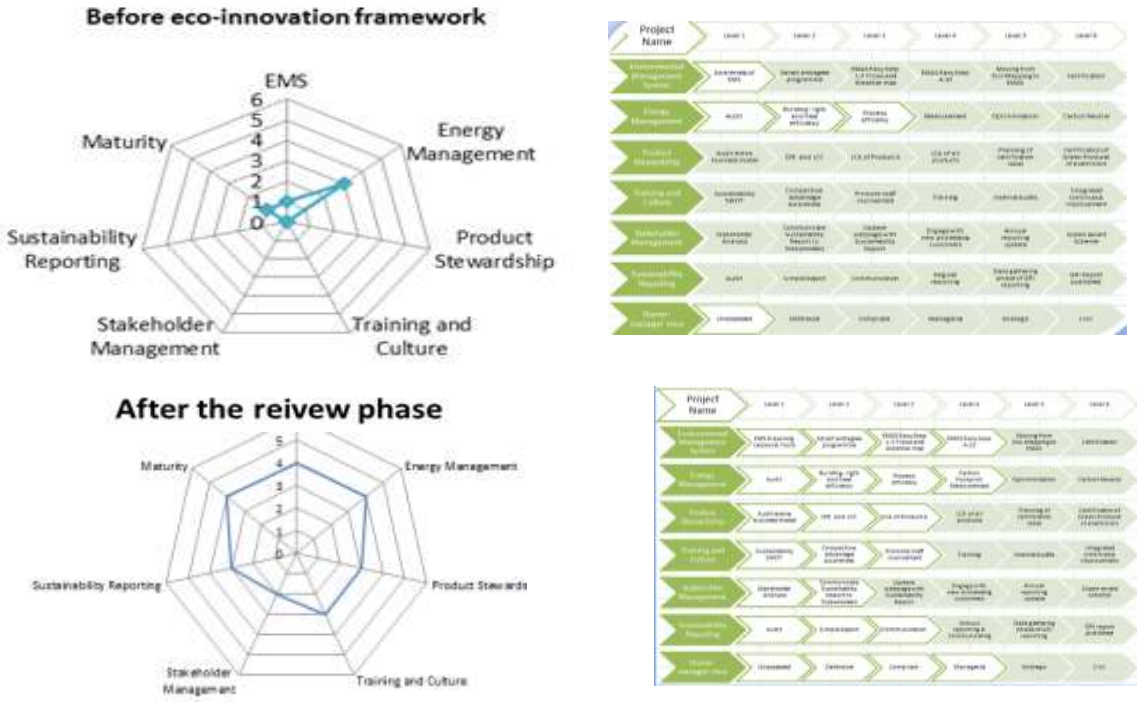


Figure 6.10: SEco Maturity Map review of the eco-innovation framework for Elec-SME

- **Future outlook**: During the review phase the SME owner-manager stated that using the company's sustainability report on environmental practices would help him to stand out from the crowd when competing for business.

"I think it [the environment] would actually, definitely I think it would be [a competitive advantage to the company]".

- **New orders:** The SME began sending the sustainability report to potential new customers. The reaction so far has been very positive.

"I actually sent that report [Sustainability Report] to a company … they were impressed with it. They didn't ask for it, but I just added it in with the other stuff."

- **Update since 2012**: Since completion of the test study, Elec-SME continues to be involved in sustainability issues
    - The owner-manager continues to include the Sustainability Report when tendering for new business. He is not able to say for sure that this has won new orders that he has received since, as his reputation and quality of manufacturing and service also play a major part in winning business. However, he does believe that it helps him to stand out from his competitors.
    - The owner-manager has collaborated with stakeholders on two more research projects through its local business network (Supply Network Shannon) and local authority (Limerick County Council). One of these projects "*Resource Efficiency in Supply Chains"* included the company's involvement in an exhibition as part of seminar.
    - Without guidance, the tools and supports provided online were not used.

6.4 Testing Case Study 2

Rlog-SME is a small company based in the Mid-West Region of Ireland. They mainly provide outsourced services to large multi-national electronics manufacturers. The company was formed in 2009, with the merging of two specialist companies. The intervention took place from Sep 2012 to Feb 2013. This company is representative of a "manufacturing SME" due to its size, independence and manufacturing activities. The owner-manager was contacted through the business network partner on the FutureSME project.

6.4.1 Step 1: The Diagnostic

The diagnostic process took place mainly with one of the owner-managers of the company (there was one other owner-manager). Due to the location of the main business activities being in Poland, Holland and the Czech Republic, there was no visit to the operational sites in this case. Instead, the owner-manager was consulted within Ireland at the headquarters.

6.4.1.1 The Diagnostic – The Business Profile

The owner-manager is male in his forties. He has over 20 years' experience working in a manufacturing environment, and may be termed a "serial entrepreneur". The company's expertise was developed before its formation. The directors gained a wealth of experience working with electronics multi-national organisations in Ireland. Due to the "Celtic Tiger" economic boom in Ireland (late 1990s to 2008), many multi-national electronic manufacturing companies moved their manufacturing facilities to lower-cost countries, such as Eastern Europe.

The company specialises in the provision of reverse logistics services, mostly to Asian multinational contract manufacturers and OEMs. They provide post-consumer services, and manage the after-sales and the end-of-life of the electronics manufacturing value chain. They also provide a Failure Analysis Engineering (FAE) and account management services (representing the Asian customers in Europe). They have close customer relationships and their quality of service is known within the field, as much of the business comes from referrals. They have their own bespoke Returns Materials Authorisation (RMA) management system, which is their unique selling point. It allows any product to be returned easily through China and the service tracked in the field.

All of the sites are situated in close proximity to their customer's manufacturing site. A simplified example of what happens on site is described below:

- The customer places a work order with Rlog-SME e.g. a batch of 5000 laptops have been recalled due to a potentially hazardous defect and need a new motherboard to fix the problem.
- Rlog-SME accepts the order and schedules the work e.g. handling the logistics of the returns, how many contract staff are required to complete the work, and what materials are required.
- The returns are handled and delivered to the site.
- The contract staff complete the work order e.g. unpacking, carrying out the work, and repacking.
- The repaired laptops are returned to the customers.
- Other work order examples include the management of electronics at the end of life e.g. enterprise servers, and personal computers sent for recycling. All the components are

recovered to their highest value possible. Rlog-SME reuses all viable components and packaging.

- All sites are similar, but work order types vary with demand.

The business profile is summarised in Table 6.8. The number of employees varies considerably, depending on demand. There are six full time permanent employees based at the headquarters in Ireland. Depending on customer demand, temporary employees are contracted to fulfil orders, usually around 65 employees, which may rise to 200 for particular jobs.

The customers are all large electronics manufacturers, and Rlog-SME's facilities are situated in close proximity, to carry out the work as it is ordered. The business is in a growth phase. Increasing legislation and regulation in the area of electronics is fuelling this growth. The large MNCs have not yet developed the capability or capacity to carry out this work, and are outsourcing to other companies who do. Suppliers are mainly from Ireland, or Europe. China is used when supplies cannot be sourced locally. The company is positioned towards the end of the value chain, in the after-sales, end-of-life, while also feeding into the start of new value chains in a 'cradle-to-cradle' way. The customers are all MNCs.

Rlog-SME Business Profile	
Activities	Reverse Logistics/aftersales management and engineering and account management in the electronics-manufacturing industry
Vision	"*To enhance the user experience of consumer electronics industry through the provision of best-in-class after-sales management and engineering services*"
Business maturity	Growth
No. of employees	Full Time permanent: 6 Contract Staff: 65 - 200
Customers	Business-to-Business Multinational electronics manufacturers based in Holland, Czech Republic, UK, Poland and China
Position along the value chain	After sales, returns, repairs, refurbishment, customisation to local markets and managing product recalls
Supplier locations:	Ireland mainly (including Rehab Enterprises) Europe and China

Table 6.8: Rlog-SME's business profile

6.4.1.2 The Diagnostic – The Environmental Profile

The owner-manager is personally not interested in protecting the environment, and often refers to sustainability as "tree-hugging". On meeting the second business owner, he said to the researcher, "I expected you to look like a hippy". The owner-manager did not think that sustainability or CSR was of any particular advantage to him. He was interested in participating on the research as part curiosity and part assessing possible future risk of legislative requirements to be more structured around their environmental management in Europe.

There was no environmental monitoring or measurement happening in the organisation. However, there are some excellent practices in place, particularly on the prevention of waste. Recovered components and reclaimed materials from circuit boards are reused, remanufactured or sold on as

component parts. Most of their operations happen adjacent to the customer site. The company does not actively manage environmental aspects, but are aware of the cost-related issues. Energy is monitored closely on one site, as this is charged directly. In one instance the owner-manager claimed to have no emissions, but then later admitted that environmental impacts are not measured. The company is not active in designing the products, but they do design their own services and only *"if there is a cost associated with the environmental aspect of it, it will be captured*".

The owner-manager thought ahead when planning overseas trips. For example in the UK, they would travel at the same time to consolidate travel costs.

Their customers have never asked about their sustainability credentials.

The owner-manager is not aware of any environmental legislation that the company must comply to, but they do work under any policies and procedures set out by the customer that are reviewed annually. When probed, he said that he would ask someone that he knows in his local authority if he wanted to find out about it. Being sustainable is important to the business, mostly because there is a cost element and it is related to marketing, so look at environmental sustainability only as a consequence of this. The owner-manager is aware of some supports that are available to him through information circulated through his business network, but has not availed of any of these supports. See summary of the environmental profile in Table 6.9.

Profile question area	Analysis of Rlog-SME's response	A typical SME response	Related Tools	Rationale for tool selection in this case
Awareness, interest & practices in environmental management	There is no awareness of what the environmental impact of the company's activities	Yes	• CSR eLearning • CSR Assessment	• To increase awareness of the importance of sustainability and to build the personalised business case
	The business does not purposefully act in a sustainable manner, but sees a revenue stream, cost cutting and marketing	No		
	The owner-managers are responsible for environmental management.	Yes		
	Financial resources may be available if the business needed to address new issues	No		
	Customers were not looking for any green credentials from the company	Yes		
Design	The SME is not involved in the product design stage, but designs its services which indirectly impact the use and end-of-life stage of products	N/A	• LCA eLearning • LCC tool • LCA tool • Carbon Foot-	To raise awareness of how they influence the environmental impact and the design of a product life-cycle

Profile question area	Analysis of Rlog-SME's response	A typical SME response	Related Tools	Rationale for tool selection in this case
Are environmental impacts considered?	The impact to the environment is not considered as an individual process, but linked to cost and marketing		printing tool	
Legal Requirements	Not aware of any legislation related to the environment	No	• Legislation	To raise further awareness about the amount of environmental legislation it may need to comply to
	There are some trusted local support agencies and networks, such as the local authority and through membership of business networks that he would trust to seek assistance on this	No		
Importance of environmental issues	Being 'green' or environmentally sustainable is only important in relation to costs, generating revenue and marketing	Yes	• CSR eLearning • CSR Assessment	To increase awareness and build the business case for sustainability
Waste	The owner-manager has a desire to be zero-waste, but for cost rather than altruistic reasons. There is widespread reuse, remanufacturing and recovery of components	**No**	• EMS eLearning, Waste audit tool	Due to the main customer being large MNCs, they could bring in new requirements such as EMSs for its suppliers
Energy	Energy is not monitored in most of the location, the premises are leased to include the energy requirements	No	• EMS, Energy audit tool	No need at this time, as the SME would not be able to gather the data
Water	There is very little water used in the manufacturing process	N/A	• EMS, Water audit tool	No need in this case
CSR	There is little awareness of what this is, and how it would benefit the organisation	Yes	• CSR eLearning • CSR Assessment • Sustainability Report	To increase awareness of the importance of overall responsible business practices, and how assessing and communicating these can be a competitive advantage.

Table 6.9: Rlog-SME's environmental profile

6.4.1.3 The Diagnostic – The eco-innovation SWOT

The SWOT has revealed many strengths in the area of eco-innovation and various opportunities in the business environment. The company has been identified by Enterprise Ireland as being uniquely set to be a major player in their specialised field and have been chosen to participate in the High Potential Start-up Programme. The electronic sector is the second fastest growing industry worldwide (second only to the food industry), and has the most promising potential for reduction opportunities related to environmental damage, and the highest for eco-innovation opportunity. Rlog-SME has already created a name for themselves for excellence in service delivery.

SWOT Area	Details
Strengths What might be helpful within the organisation towards eco-innovation	• Well known for excellence in service delivery within the industry • A unique expertise in reverse logistics • Close customer relationships • Many years of experience in the industry with many good relationships built throughout the supply chain • Flexibility of the production and manufacturing processes • The core business and much of the operational activities can be defined as eco-innovations in themselves • Recognition that sustainability does have some business advantages, such as cost reduction, revenue generation and marketing
Weaknesses What might hinder eco-innovation opportunities within the organisation	• No drive by management to pursue any environmental projects • No specialised experience with environmental sustainability • No drivers for sustainability from customers or other stakeholders • No awareness of environmental legislation
Opportunities: What things external to the company could help eco-innovation	• The electronics sector is the most important goods-producing sector worldwide, • Reverse logistics is becoming an increasingly important part of the electronic products eco-system • The increasing modularisation of the electronics industry and, reverse logistics becoming part of “closing the loop” of the circular economy will increase the importance of their operations • The FutureSME project can assist with the help of a researcher • To prepare for future legislation and regulation within the industry • Communicating sustainable practices is good for brand image and • Electronics industry is under a lot of scrutiny, driving traceability in the reverse logistics industry
Threats What the external business environment could be a threat to eco-innovations	• It is difficult to quantify the long-term benefits • The loss, or potential loss of market share if eco-innovations fail, or sustainability goals are not met • Larger competitor companies internationally could be faster reaching sustainability as they have access to more resources to do so • Current economic worldwide recession has somewhat stifled demand for greener products and services • New legislation could be introduced which could hinder eco-innovation projects • The threat of new trade barriers based on new legislation • New legislation that is expected related to improved sustainability performance may not arrive fast enough to benefit from it

Table 6.10: Rlog-SME's eco-innovation SWOT

The main weakness includes the lack of motivation within management to be pro-active in measuring their environmental impacts, and lack of awareness of legislation pertaining to their business activities. The threats are mainly future unknowns such as legislation, regulation and competitors within the marketplace. The SWOT is summarised in Table 6.10.

6.4.1.4 The Diagnostic – The Stakeholder Analysis

The stakeholder analysis reveals the range of links the company has across the world with its customers, down to local industries. The main internal stakeholders are the directors, direct employees and contract staff. They also contract a software company to design their RMA system, and other services are outsourced such as accountancy.

The company's services extend to the consumer because of the nature of after-sales, but as they are working on behalf of their customer (the well known brand), their own brand is not known by the consumer. It is more important for Rlog-SME to build its relationships with the OEM and contract-manufacturing customer, but part of their excellence and reputation is linked to how they deal with the consumer. The company is part of the SMILE Network, but are not currently involved in any industrial symbiotic relationships with other companies. See Table 6.11 for all relevant stakeholders.

Internal Stakeholders	Stakeholders along the supply chain	Stakeholders in the local community	Societal Stakeholders
2 x directors (owner-managers)	OEM Customers based in Ireland and Europe *(Dell , Pumps Ltd)*	Networks *(Supply-Network-Shannon, Chamber of Commerce)*	Department of the environment and EPA
Software development company *(outsourced)*	Contract manufacturing and OEM customers from China, Taiwan and Korea *(Quanta, Foxconn, Inventec)*	Suppliers	Competitors, local national and international *(Bright solutions, Arran & Smart electronics)*
Account managers (permanent staff)	New and potential customers (e.*g. Amazon*)	The natural environment	Third level institutes (*GMIT, UL, LIT*)
Production employees (contracted)	Consumers	Rehab Enterprises	Green business network *SMILE Resource Exchange regional waste mgmt. officer*
Non-production employees – (*accounting & other subcontracted employees*)	Suppliers of components and services *(various, mainly on behalf of the customer)*		Banks/funders/investors
	Recyclers and certified destructors		

Table 6.11: Rlog-SME's Stakeholders

6.4.1.5 *The Diagnostic – The SEco Maturity Map*

Before the implementation, the SEco Maturity Map provides a baseline assessment measure of the company's sustainability maturity (see Figure 6.11). Rlog-SME's SEco Maturity Map is personalised to them, but is very similar to that of Elec-SME. It has seven sections with six levels: *Environmental Management System*, *Energy Management*, *Product Stewardship*, *Training and Culture*, *Stakeholder Management*, *Sustainability Reporting* and *Maturity*. At this stage, Rlog-SME has a low capability. The owner-manager was not aware of any environmental legislation that he must comply to, and did not reach level 1 *Awareness of EMS*. Energy management was at level 3, as the diagnostic revealed an ongoing involvement in this area. Overall owner-manager view of maturity was very low, as the owner-manager did not see the business value of sustainability.

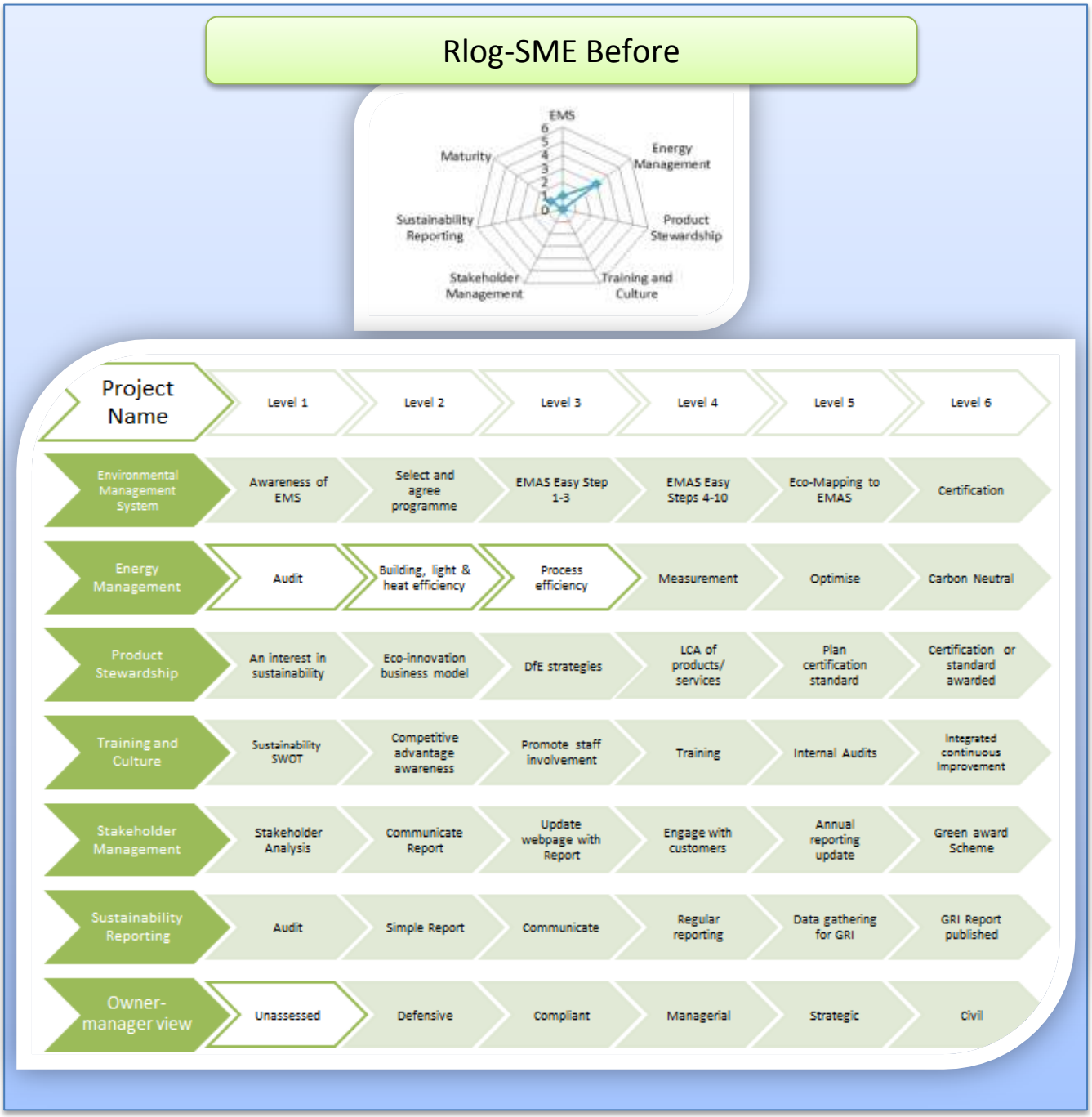


Figure 6.11: Rlog-SME SEco Maturity Map assessment before the eco-innovation framework

6.4.2 Step 2: The Tools Selection

The first stage has revealed that the company is interested in sustainability if it is of direct business benefit to this growing business. However, the owner-manager has very little capability when it comes to knowledge of legislation and regulation, which would be of benefit considering the company's growth into new markets.

The environmental diagnostic was designed to personalise the tools to the particular SME, and Table 6.9 above lists a number of preselected tools. The SWOT and the Stakeholder Analysis has given more insight into the company and possibilities for eco-innovations. This led the researcher to include Design for Environment eLearning, for the SME to learn about what impact they have related to their processes.

Each of the pre-selected tools was presented to the owner-manager, with a brief explanation of why it might benefit his business case, to see if the owner-manager was interested (see Table 6.12). He was only slightly interested in the eLearning module from an overall viewpoint, and did not want to take this on immediately. There was also a slight interest in the LCA eLearning and associated tools, but more so in the carbon footprinting. He had no interest in the LCC tool, as he does not make large equipment purchases at the moment. Despite the fact that he was unaware of environmental legislation, he was not interested at all in any related tools, but did register that it was there if he needed to refer to it in future. He was mostly interested in producing a sustainability report, to be used as a communication tool with his customers and potential new customers.

Suggested Tools for Rlog-SME based on diagnostic	Potential Business benefit to Rlog-SME	Interest of owner-manager
CSR for SMEs eLearning	To learn about other SME case studies to further highlight the business benefits of an overall approach to CSR	Slightly interested
CSR Assessment	To dig deeper into what broader activities the company is active in its local community, and to form the basis of a sustainability report	**Quite interested**
LCA E-Learning	To learn about other SME case studies to further highlight the business benefits	Slightly interested
LCC Tool	To apply to equipment purchases, to assess the most economically	Not at all interested
LCA Tool	To apply a simple LCA on the service, for the benefit of the customer, and to look for opportunities to improve	Slightly interested
Carbon Footprinting tool	The owner-manager is familiar with this term, and expressed an interest in using this tool	**Quite interested**
Legislation Tool	To raise awareness about the scope of legislation it must comply to as a business in the EU, and his customers selling into the EU	Not interested
Sustainability Reporting	This would allow the SME to future proof his business by learning how to communicate its responsible business practices to its current and future potential customers	**Very interested**

Table 6.12: Tools selection matrix for Rlog-SME

An overview of the CSR assessment and what was required to carry it out was demonstrated. A sample of a Sustainability Report and poster were shown to him also, and he was keen to get started on these straight away. A summary of the data needed to measure the carbon footprint was described, and he said that his accountant should be able to provide him with this data.

In summary, the following tools were planned to be implemented:

1. Tool – CSR Assessment
2. Tool – Carbon Foot-printing
3. Tool – Sustainability Reporting
4. Tool– SEco Strategy Wall
5. Tool - SEco Project Report

6.4.3 Step 3: The Implementation

The recommended tools were implemented and tested over three more meetings with the SME owner-manager.

6.4.3.1 Tool – CSR Assessment

The social responsibility assessment was carried out with the SME owner-manager at a second meeting. It was suggested that he could carry this out without guidance, but he wanted it to be facilitated, preferring not to have to spend any more time than necessary to read the background information or instructions.

The tool is a manual with forms, guidance and questions related to the overall business, and the responsible and sustainable business practices. There are five parts to the assessment, and a summary of Rlog-SME's responses can be seen in Table 6.13.

The vision of Rlog-SME is "*to be best-in-class in aftersales management and engineering services*" company. They do this by making it easy for customers to manage their product logistics. They extend the product life-cycle of electronics through remanufacturing and refurbishment. They believe in getting it right 100% of the time for customers. This is communicated to all employees, by encouraging them to focus on accuracy rather than speed. The operations are designed to ensure only the energy needed is used. Waste prevention is paramount.

Rlog-SME's responsible business practices	
Part 1: Vision Mission Values	
Company's Vision	• "*We want to be best-in-class in aftersales management and engineering services* "
Company's Mission	• To enhance the user experience of consumer electronics industry through the provision of best-in-class after-sales management and engineering services. Providing our in-house RMA (Returns Material Authorisation) software system to make it easier for our customers to manage their product logistics • Extending the product life-cycle of electronics through remanufacturing and refurbishments • Building and sustaining very strong personal relationships with customers
Values	Nothing less than 100% is good enough Being honest and good to our word, to deliver the highest quality possible
Part 2 Employees and Workplace	
Training and development	• Encourage and fund relevant training and development for staff
Communication	• Ongoing within the small core team • The message of "100% right always to customers" encourages employees to focus on quality and accuracy over speed so mistakes do not happen • Pledge to publish our sustainability report publicly
Health & Safety	• On the job training for maximum knowledge transfer of safety practices within the facilities
Work life balance	• As the business grows they aim to be open to be a good place for employees to work.
Part 3: Environment	
Environmental Efficiencies	• Operations are designed to only utilise facilities and utilities when needed • Waste prevention practices mean almost zero waste produced
Designing for the environment	• Extending the life of component parts by reusing them for refurbishment and repairs • Refurbishing all parts where possible • Remanufacture – refurbishing parts are used for manufacturing • Local sourcing of components where possible • Cardboard is recycled or reused as packaging • Transport costs related to returns is minimised • Monitoring travel and fuel consumption with a view to identifying reduction opportunities • Not involved in any hazardous processes or materials in any of our operations.
Part 4: Marketplace	
Policies	• Constantly provide a high quality of after-sales service as the core business • Stakeholder engagement with customers on a monthly basis • Trained and fulfil all IPC standards requirements • Provide direct support to consumers • Honest & open in all business dealings and advertising • Informal feedback processes with our customers • Face-to-face communication where possible • Timely and regular payment to all of our suppliers • Payments policy to clear invoices each month

Rlog-SME's responsible business practices	
Networks	• Research project involvement through, futureSME to learn and promote successful business practices in manufacturing SMEs
	• Member of Shannon Network Supply, an industry-led business network, to promote, develop and connect companies in the Shannon region of Ireland, as well as academia in UL and LIT
	• Regularly engage with the local authority's environmental support to help improve our business practices
Part 5: Community	
Employment	• Provide local employment • Awarded status of High Potential Start-Up company by Enterprise Ireland to help ensure the survival and continuation of our business
Local Suppliers	• Supporting local suppliers where possible • One of our main suppliers (Rehab Enterprises) is Ireland's largest single employer of people with disabilities,
Community Engagement	• Sponsoring of local community projects and charities • Open to any dialogue with research opportunities supporting sustainable business opportunities

Table 6.13: Rlog-SME's responsible business practices from CSR assessment

Rlog-SME's business model employs many DfE strategies. This is mainly done by extending the life of component parts through re-use, re -furbishing, re-manufacturing, packing re-use and local sourcing. Due to the recent migration of electronics manufacturing out of Ireland, customers are mainly overseas. However, to minimise transport costs, only essential short-haul and long-haul flights are taken. One of the main suppliers (Rehab Enterprises) is Ireland's largest single employer of people with disabilities. Rehab Enterprises provides integrated employment opportunities, with more than half of its 400-strong workforce having a disability.

6.4.3.2 Tool – Sustainability Reporting

The SME owner-manager was most interested in sustainability reporting to help to communicate the company's responsible business practices to customers, funders and potential new markets. The previous tool (CSR assessment) forms the basis of the sustainability report. The SME owner-manager did not wish to do this himself with the template provided, and requested the researcher write the document.

The owner-manager was pleased with the Sustainability Report when completed. He was surprised that although he did not purposefully try to be greener, or more sustainable, these practices were part of the fabric of the operations. He believed that it would give him a competitive advantage within the marketplace, and would be using it in various arenas such as manufacturing exhibitions and showcase events. He would also send soft copies with tender documents.

The sustainability report is in Appendix G and some selected screen shots can be seen below in Figure 6.12.

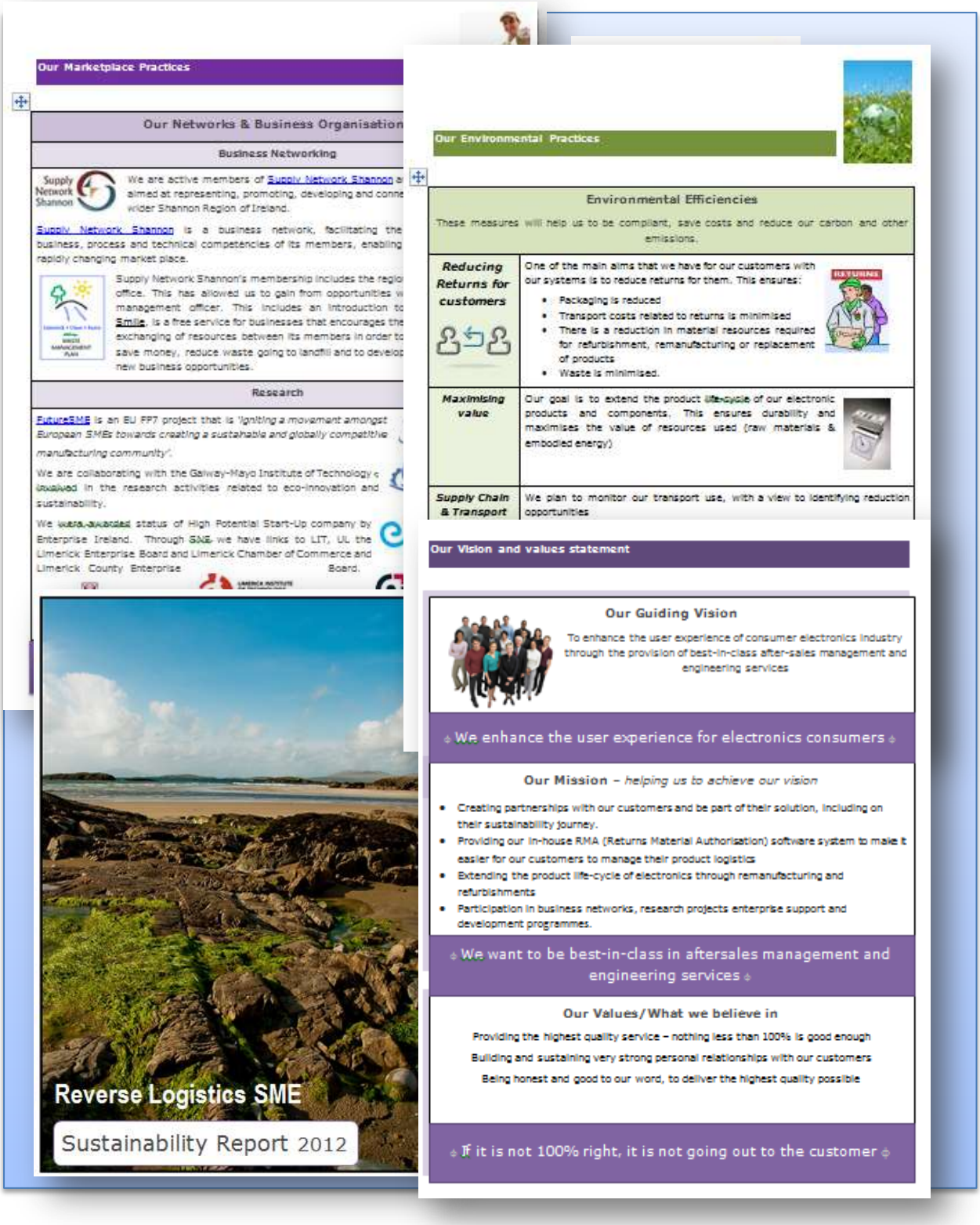


Figure 6.12: Reverse Logistics Sustainability Report Screen Shots

6.4.3.3 Tool – Carbon Footprinting

Carbon footprinting was of interest to the owner-manager. A synopsis of this tool was demonstrated using part of the LCA eLearning tool. A summary of what data was required to complete the calculations on the tool was described, and emailed (see below). The SME owner-manager wanted to carry out the footprint calculations using the previous three years of data.

#	Information	Year	Units	Description
1.	Copy of all fuel bills (buildings)	2010 2011 2012	kWh, litre, kg	Copies of detailed bills for gas, oil, wood etc., detailing all rates, costs and units
2.	Copy of all electricity bills	2010, 2011 2012	kWh	Copies from electricity suppliers detailing all rates, costs and units
3.	Copy of all **own fleet** transport bills (if applicable)	2010, 2011 2012	litre	Receipts or invoices detailing litres of petrol, diesel and/or biodiesel consumed
4.	Copy of all waste bills	2010 2011 2012	kg	Details of amounts or percentages disposed, recycled, reused, composted etc
5.	Copy of all water bills	2010 2011 2012	m^3, litre	Billed amount of water consumed
		Business Travel		
6.	Petrol car (rented)	2010, 2011 2012	km	Distance traveled in a rented petrol car
7.	Diesel car (rented)	2010 2011 2012	km	Distance traveled in a rented diesel car
8.	Train	2010 2011 2012	Passengers, km	The number of passengers and the distance travelled for each trip
9.	Taxi	2010 2011 2012	Passengers, km	The number of passengers and the distance travelled for each trip
10.	Bus	2010 2011 2012	Passengers, km	The number of passengers and the distance travelled for each trip
11.	Flights - domestic (<1.5 hours)	2010 2011 2012	No of flights per passenger	The number of passengers and the distance travelled for each trip
12.	Flights - short haul (1.5-6 hours)	2010 2011 2012	No of flights	The number of passengers and the distance travelled for each trip
13.	Flights - long haul (>6 hours)	2010 2011 2012	No of flights	The number of passengers and the distance travelled for each trip
		Outsourced Logistics (NOT own company vehicles)		
14.	Petrol car	2010 2011 2012	km	
15.	Diesel car	2010 2011 2012	km	
16.	Train	2010 2011 2012	km	
17.	Bus	2010 2011 2012	km	
18.	Motorbike	2010 2011 2012	km	
19.	No of units of "work" generated	2010 2011, 2012		You probably have your own unit rate such as work orders
20.	Average area of building	2010 2011 2012	m^2	The average area building footprint used during the year

Figure 6.13: Checklist for Carbon Footprint data for Rlog-SME

However, despite several efforts during meetings, phone calls and emails, there was no success with collecting the data. The bookkeeping and accounts were outsourced, and the data such as electricity bills, travel related expenses etc. were not immediately to hand. Several requests were made to the accountant to send copies of the data, but both the researcher and the owner-manager were not successful in getting the data from him for the case study.

6.4.3.4 Other Tools for Rlog-SME

To help manage the recommendations from the process, a personal SEco Strategy Wall and SEco Project Report were created for the company (see Figure 6.14).

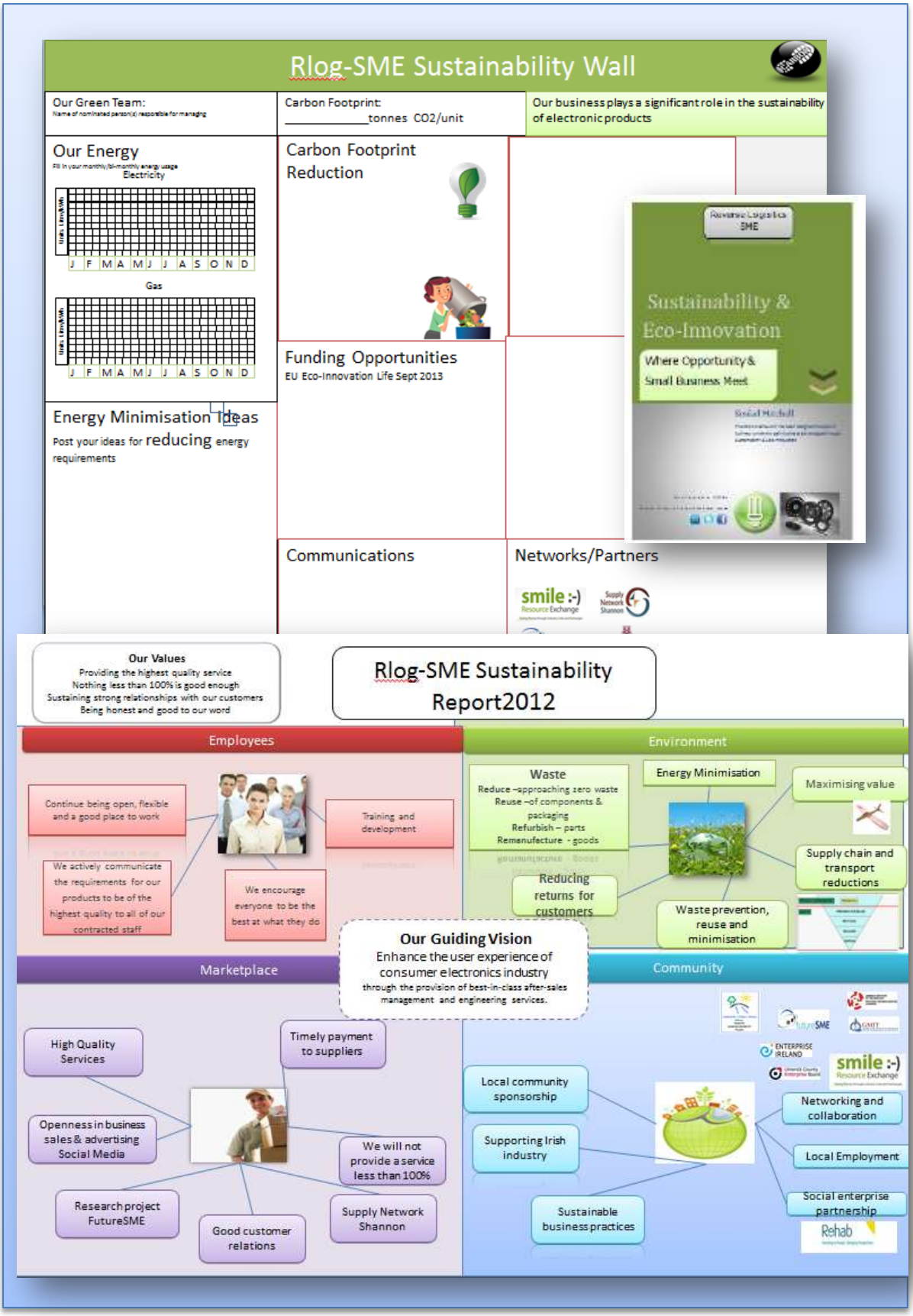


Figure 6.14: Rlog-SME Strategy Wall

During the on-going intervention with the SME owner-manager, one of the main learning points from the process was the revelation to the owner-manager that the entire business model of reverse logistics was built on the concepts of eco-innovation and sustainability. At no point in the past had the owner-manager considered it to be a "green business". The SWOT process revealed that the entire business model was built on an eco-innovation premise.

Reverse logistics as a subject is not well researched (Almeida & Lazzarotto, 2011), and part of the support given to the owner-manager was teaching him about the positive impact his business had. It was explained to the owner-manager that the increasing demand for short-lived electronic devices worldwide is creating a huge strain on the earth's natural resources, which means that mining industries are exploiting new lands and communities to access precious metals for the electronics industry. For example, the amount of gold in a wedding band now needs approximately 20 tonnes of earth's eco system to be extracted and destroyed to attain it (Sibaud & Arai, 2013).

6.4.4 Step 4: The Review

After a period of approximately 6 months from starting the intervention, a review took place with Rlog-SME.

A face-to-face review of the framework was completed with Rlog-SME in March 2013 in the form of a semi-structured interview, allowing the owner-manager to give his overall impression of the framework. This began with a short presentation which summarised what the process and the SEco Maturity Map was used to illustrate the sustainability maturity improvement.

The owner-manager admitted to benefiting from the SEco Framework. This owner-manager had not been involved in testing of the Pilot Framework. Nonetheless, he recognised that it was helpful to have someone from outside the business guide him through the process. He said that the guided support simplified and made sustainability issues more accessible. He appreciated that time was taken at the beginning of the process to understand his business, which allowed the support to be personalised. He expressed frustration with not calculating the carbon footprint, put this down to his accountant, and was planning to change this service provider.

The owner-manager was pleased that he had increased his level of sustainability maturity, and was interested in pursuing it further. The fast growth of his company left very little time to look at sustainability issues. However, he expressed that his preferred way to address this was through a guided process such as the SEco Framework. This eliminated a lot of time that is needed to explore and figure out what supports would be most suitable if this was self-guided. He trusted the process because it took into account his particular business operation, and supports were tailored to his own company and situation.

The questions asked in the review interviews were answered as summarised below in Table 6.14.

Question posed to the owner-manager	Response summary
Did your view of environmental issues change?	"*Yes, from thinking environmental issues were only for "tree-huggers" to realising good practices are linked to the business performance*".
How did the SEco Framework change your point of view?	The process has generated *"an increased awareness of what eco-innovation is, and has highlighted that the business model itself is an eco-innovation"*
Has the business benefited from the process?	"*Yes, it has been quite revealing, and generated a new found interest in the opportunities that it can bring to the business"*
Would you like to do more to embed the framework	*"As the business is in a rapid growth phase, it is difficult to find the time to focus on these issues at the current time"*
Do you see the value of the SEco Framework?	*"Yes, it certainly gives you a new perspective of the business you thought you knew very well*".
Any other feedback?	The framework has got him thinking about *"Creating partnerships with our customers and be part of their solution"*

Table 6.14: Rlog-SME's Review Summary

Rlog-SME was re-assessed using the SEco Maturity Map tool. In this time, the company moved from a *defensive* in sustainability maturity to a *compliant*, as illustrated below in Figure 6.15.

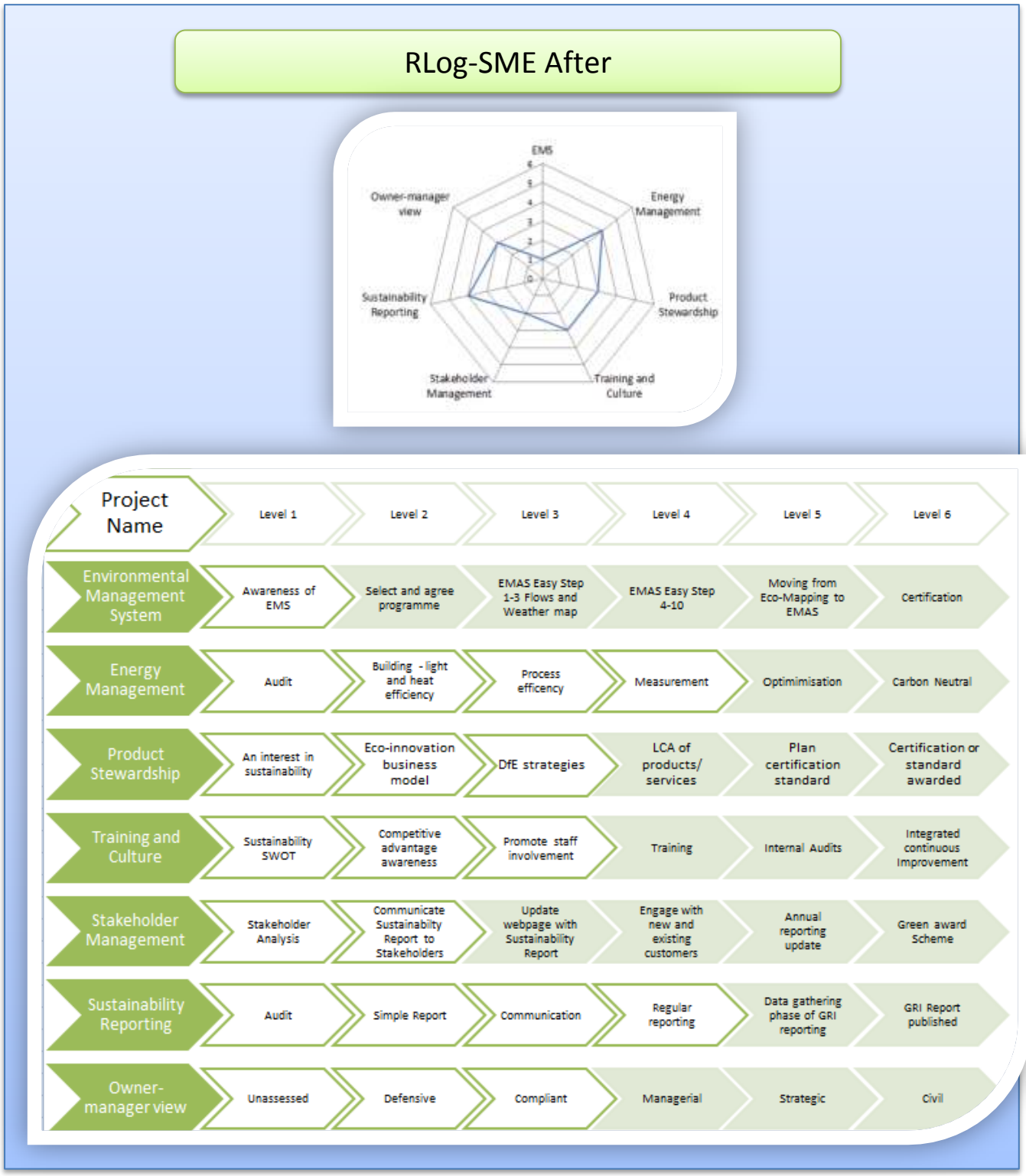


Figure 6.15: Rlog-SME's SEco Maturity Map reassessment after implementation stage

The SME increased its sustainability maturity in various ways.

- *Environmental Management Systems* increased by 1 level. The owner-manager increased his awareness of what an EMS was throughout the process. The researcher outlined the implementation process and resulting potential for certification to gain external recognition. However, the owner-manager was not interested in applying one at this time because he did not think that there would be any business advantage to him.
- *Energy Management* increased by 1 level. All sites were being monitored closely to ensure there was no excess energy consumed beyond the minimum required to conduct operations. Due to the rapid expansion period of the business, minimising costs is vital to the economic sustainability of the business. Outside of staffing costs (which are minimised by employing temporary employees as and when required), energy management is one of the few ways that the company can control operating costs.
- An advance in *Product Stewardship* came about mainly through awareness and learning through the process that the business is based on a model of DfE strategies, such as design for repair, design for reuse and design for remanufacturing. The business model itself is an eco-innovation, through the recovery and reuse of materials, and the extension of the life-cycle of electronic goods.
- *Training and culture* had increased three levels. The process allowed for a SWOT analysis which highlighted the owner-manager's awareness of the strengths of the company in relation to sustainability. Previously, he viewed the good resource management practices as a cost minimisation exercise. Throughout the process, he started to realise that his lean operations could be leveraged as a competitive advantage. He was also using the SEco Strategy Wall to engage staff in the head office of continuous improvement.
- *Stakeholder Management* increased 2 levels. The Stakeholder analysis completed with the owner-manager, which helped to highlight potential eco-opportunities. Furthermore, their sustainability report was communicated to various stakeholders, which helped to raise the company's profile in relation to their eco-innovation business model
- *Sustainability Reporting* had increased four levels because the owner-manager had undergone an assessment on various aspects of their business, which resulted in a Sustainability Report. The company brought this report to manufacturing exhibitions, and included the document in their sustainability report with tender documents. He also committed to producing a Sustainability Report on a regular basis.
- The *owner-manager* view increased to a *Compliant* level. There was still some work to do to improve environmental legislation awareness for example. He was no longer *Defensive*, but the owner-manager's views had not completely changed. After the period of six-months, the owner-manager did not progress as much as in Elec-SME.

6.4.5 Summary of Case Study 2

The implementation of the SEco Framework with Rlog-SME identified many opportunities to increase sustainability maturity through various eco-innovations. It resulted in the owner-manager realising how his business is tightly aligned with sustainability. According to Zadek's (2004) model, Rlog-SME moved to a "compliance" level. The main reason why they did not evolve as far as a "managerial" level, is the lack of awareness of legislation and lack of interest in investigating these issues pertaining to the business, which may be a major risk to the business success in future.

The most significant improvements, captured at the review included:

- **Business model awareness**: The owner manager had never considered his business to be green or in any way related to the environment, or "tree-hugging".

  > *"The process has resulted in a surprising realisation – that by just "doing what we do", we are playing a significant role in the continued sustainability of electronic consumer goods. The services we provide enable many other companies to be more sustainable by maximising the life of consumer products. This in turn helps to minimise the use of the earth's finite and valuable resources"*

- **Attitude change**: The owner-manager sees sustainability and eco-innovation in a new light, as well as the positive impact their business has.

  > *"we realise that the electronics industry needs to follow a more sustainable path. One of the big challenges for consumer electronics companies is to reduce their environmental impact"*

- **Increase in Sustainability Maturity :** The company increased its sustainability maturity from *Unassessed* to a *Compliant* level (see Figure 6.16)

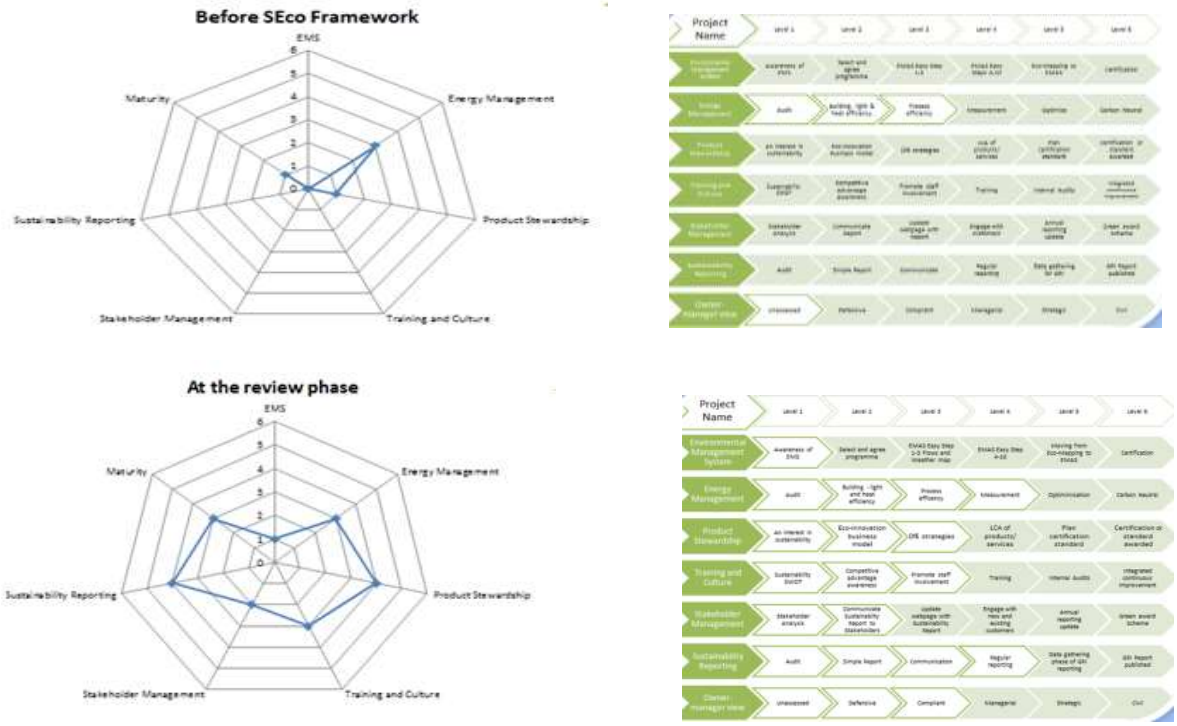


Figure 6.16: SEco Maturity Map review of the eco-innovation framework for Rlog-SME

- **Future outlook**: During the review phase the owner-manager has begun to think more about creating partnerships with customers including on their sustainability journey. They are very open to developing their sustainability in on open innovation format:

"we aim to continuously improve our role in the recovery, repair and refurbishment of the products and their component parts. We are also investigating our own operations, and we are open to improvements and future collaborations".

- **Update since 2013**: Since completion of the research, Rlog-SME continues to be involved in sustainability improvement:
    - The owner-manager has collaborated with stakeholders on two more research projects through its local business network (Supply Network Shannon) and local authority (Limerick County Council). One of these projects "*Resource Efficiency in Supply Chains"* included the owner-manager organisation an exhibition as part of seminar. This was the same project as Elec-SME participated in.
    - The owner-manager created an updated 2013 Sustainability Report, which was supported through the "*Resource Efficiency in Supply Chains" project.*
    - The owner-manager took part in a supported project, where a number of SMEs got together to collaborate to attend a major manufacturing exhibition called "Subcon" in the UK. The owner-manager took the Sustainability Report and poster to use as part of the exhibition
    - Similar to Elec-SME, without the guided support, the tools and supports provided online were not used.
    - The company is still in a rapid growth phase, expanding its operations to two more European countries and is building up relationships with customers in Taiwan. He is not communicating his Sustainability Report, as he believes that the report does not truly reflect the changes that have been implemented across the business. He said that he would need further support to do this.

6.5 Validating the enhanced SEco Framework

There is no universally agreed approach to validate frameworks or methodologies (Mulligan, 2006). To validate the SEco Framework, two methods were chosen (see Figure 6.17).

1. A systems analysis of the testing case studies. This will evaluate each step of the Framework, to see what (if any) parts of the Framework are influencing change, and how the barriers have been addressed (presented in Chapter 5, section 5.3.6).
2. A validation methodology developed by Cormican (2005), which is based on a synthesis of a wide range of literature on the validating frameworks and methodologies. This will assess the validity of the data collected (described in Chapter 3, Section 3.5.1, Table 3.3).

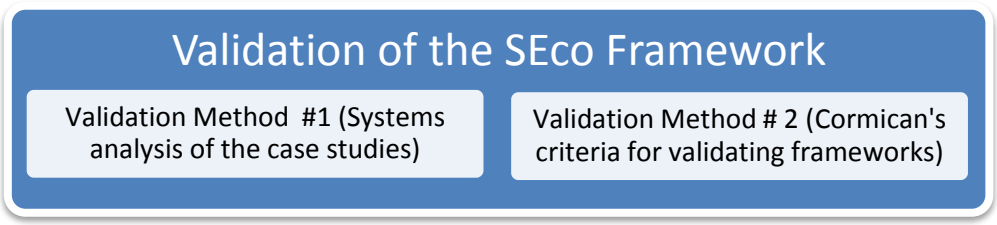


Figure 6.17: Validating the SEco Framework

6.5.1 Validation Method # 1: Systems Modelling of the SEco Framework

This section examines the use of the SEco Framework in the case studies using systems analysis to capture the dynamics of the situation. The two testing case studies were considered in this analysis. There are four causal loops. Each loop addresses the barrier of lack of resources and lack of support.

The first significant causal loop described in the systems model is the "Diagnostic influence" loop (see Figure 6.18).

- The *business profile* starts the dialogue with the SME owner-manager. This forms the foundation of a trusting relationship. Overcoming the barrier of negative perception of environmental management can lead to increased openness of the owner-manager throughout the intervention.
- Next, the *environment profile* addresses the lack of awareness of eco-innovation and highlights the SME owner-manager's own business activities in this area.
- The *SEco SWOT Analysis* leads to an increased confidence of the owner-manager, as it highlights the capabilities that are already present within the firm to implement and sustain eco-innovations. This increases knowledge and decreases the negative perception of the owner-manager.
- The *Stakeholder Analysis* assists in aligning the benefits of sustainability to the business, addressing the barriers of awareness, perception and knowledge.
- The SEco Maturity Map is drawn up to communicate the wide-ranging possibilities available to the business. This loop also contributes to increasing the sustainability maturity. This action addresses both awareness and knowledge.

Overall, the diagnostic influence loop addresses all of the barriers throughout the different parts of the process. This in turn leads to an increased awareness of the business links with sustainability and willingness to get involved in eco-innovations. The *sustainability maturity* therefore increases overall in this loop.

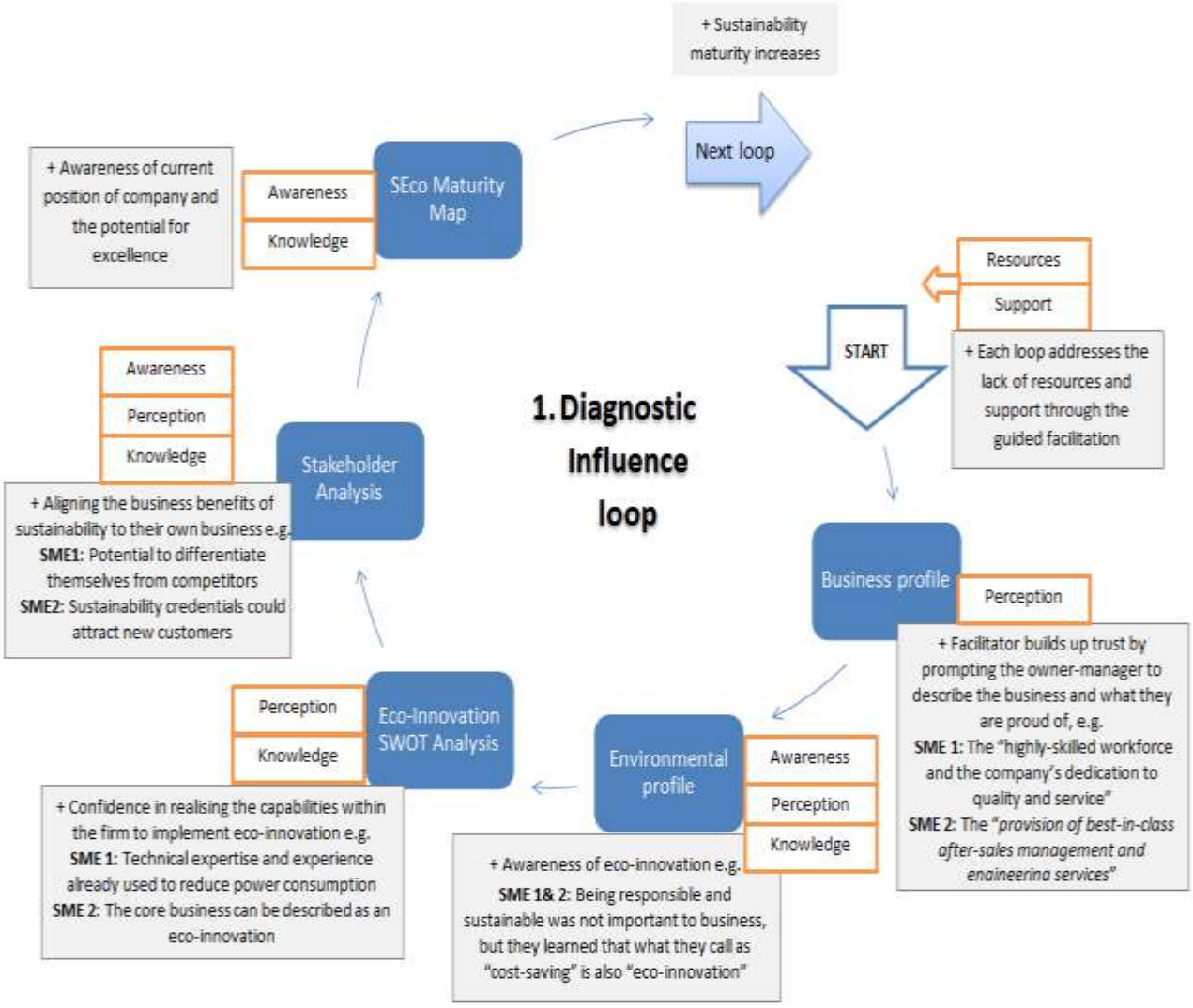


Figure 6.18: Diagnostic influence loop of the systems model highlighting the barriers addressed

The *Tools Selection* loop is step 2 of the SEco Framework (see Figure 6.19).

- The first action in this stage presents the owner-manager with a number of tools that can be used for no cost, at any time, and if requested, facilitated in a short timeframe. This addresses the resource issues, and increases the awareness that there are many supports available to the business.
- Each tool is described and connected with a business issue that it can address, which increases the awareness of the business benefits of sustainability through these tools.
- The owner-manager then selects which tools are most relevant to the business at the time. This helps to reduce the negative perception issue. The confidence of the SME also increases, as they are responsible for controlling the selection.

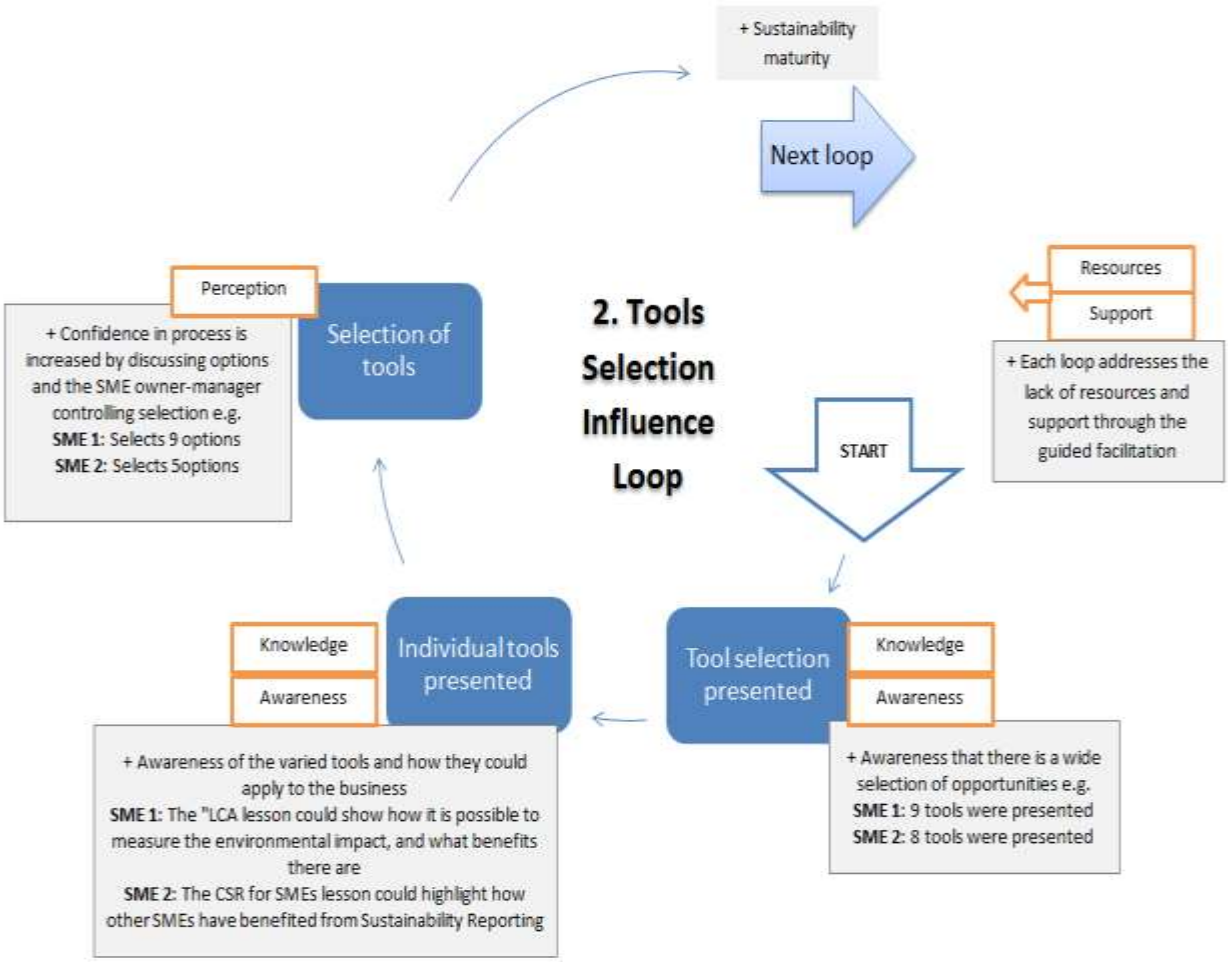


Figure 6.19: Tools selection influence loop of the systems model

The *Implementation* loop can vary for each SMEs, as different tools are selected (see Figure 6.20). However, feedback from the SME owner-managers identified that starting with three particular tools gave immediate "quick-wins".

- The CSR eLearning increases awareness of the importance and significance of responsible and sustainable business practices. The negative perception is addressed through SME case studies.
- The CSR assessment leads to an increasing confidence of the SME owner-manager in the process by taking a holistic approach of many responsible business activities they are involved with, as well as an awareness of what this is. As the owner-manager learns about what good practices the company is already involved in, the negative perception of the issues are addressed.
- The sustainability report is a powerful tool to allow the owner-manager to communicate the collective strength of the company's good practices. It helps to achieve external recognition which may help companies win new business.
- Each further tool will increase the awareness and knowledge of the alignment of sustainability to their business and the business benefits.

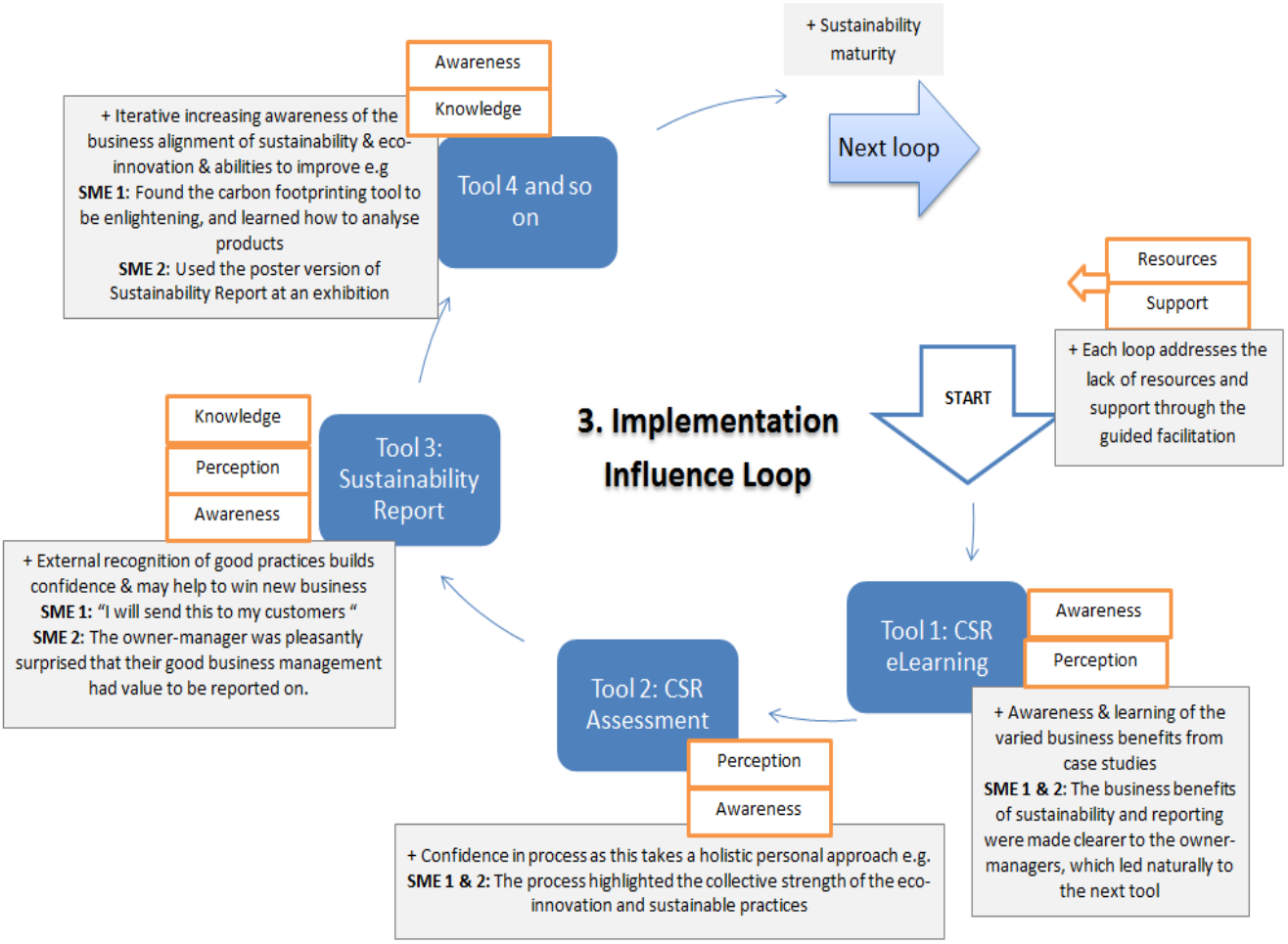


Figure 6.20: Implementation influence loop of the systems model

The *Review Influence* Loop increases the awareness of the improvements made, the knowledge gathered, and how few resources were needed to achieve them (see Figure 6.21).

- The reassessment of the company through the SEco Maturity Map feeds back the measure of Sustainability Maturity improvement. This process addresses the awareness of improvements made in a short time, without the requirement for resources. This adds to the knowledge of what sustainability means in the business.
- The summary of activity presented during the review process increases the awareness of what particular activity has benefitted the company.
- The interactive question and answer part of the review further increases the knowledge of the SME owner-manager
- A reassessment of interest in sustainability issues can confirm the change in perception (if present), awareness and knowledge. It also encourages the SME owner-manager to continue on the sustainability journey.

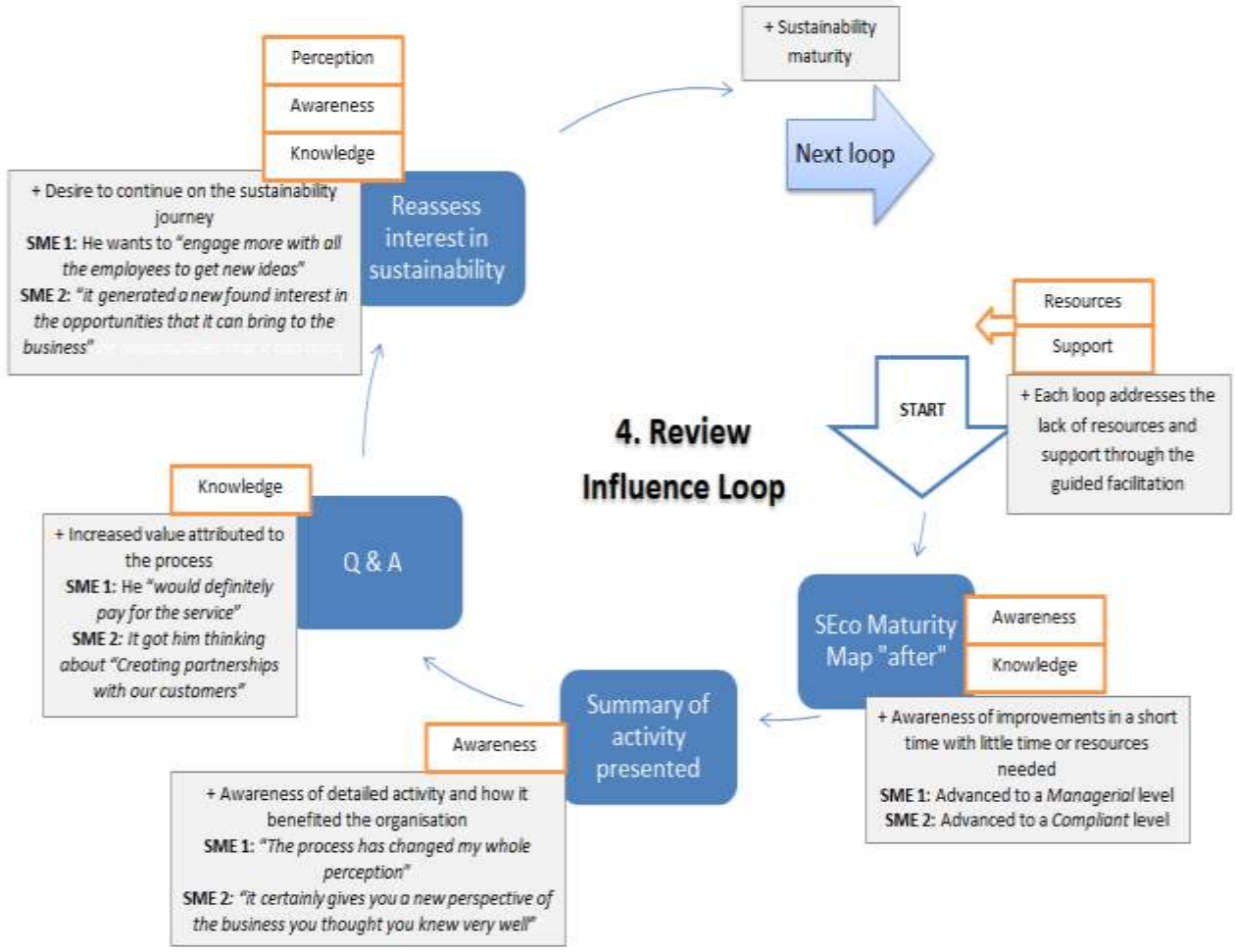


Figure 6.21: Review influence loop of the systems model

Looking at the enhanced SEco Framework in its entirety, this influence loop addresses all the barriers and increases the sustainability maturity at each stage of the process (see Figure 6.22). At all stages, the advisor (in this case the researcher) is gaining a holistic knowledge of the business, to be able to personalise and articulate the business benefits of sustainability. It is expected that each full loop

will lead to further levels of sustainability maturity. At the start of the process, the owner-manager may know very little about sustainability. The owner-managers should exhibit increased awareness and sustainability, and knowledge of what eco-innovations are.

- Each step addresses the issue of insufficient support. The SEco framework provides a methodology that has been designed with SMEs in mind. For these testing case studies, the barrier of a lack of resources is also addressed. The researcher was provided as an expert to consult with the owner-managers, and the framework is designed to be carried out where the minimum of time is required from the owner-manager.
- Each step of the framework (the diagnostic loop, the tool selection, the implementation and review) results in increased sustainability maturity.
- Each of the steps address the remaining barriers, as was described in each of the previous influence loops:
    - A lack of awareness of the potential impact of their activities is addressed, as well as a lack of awareness of what can be done to improve sustainability management in the company.
    - The negative perception that SME owner-managers have towards sustainability issues is addressed throughout the process in various ways.
    - The SME owner-managers increase their knowledge of sustainability issues in relation to how eco-innovations can benefit the company.

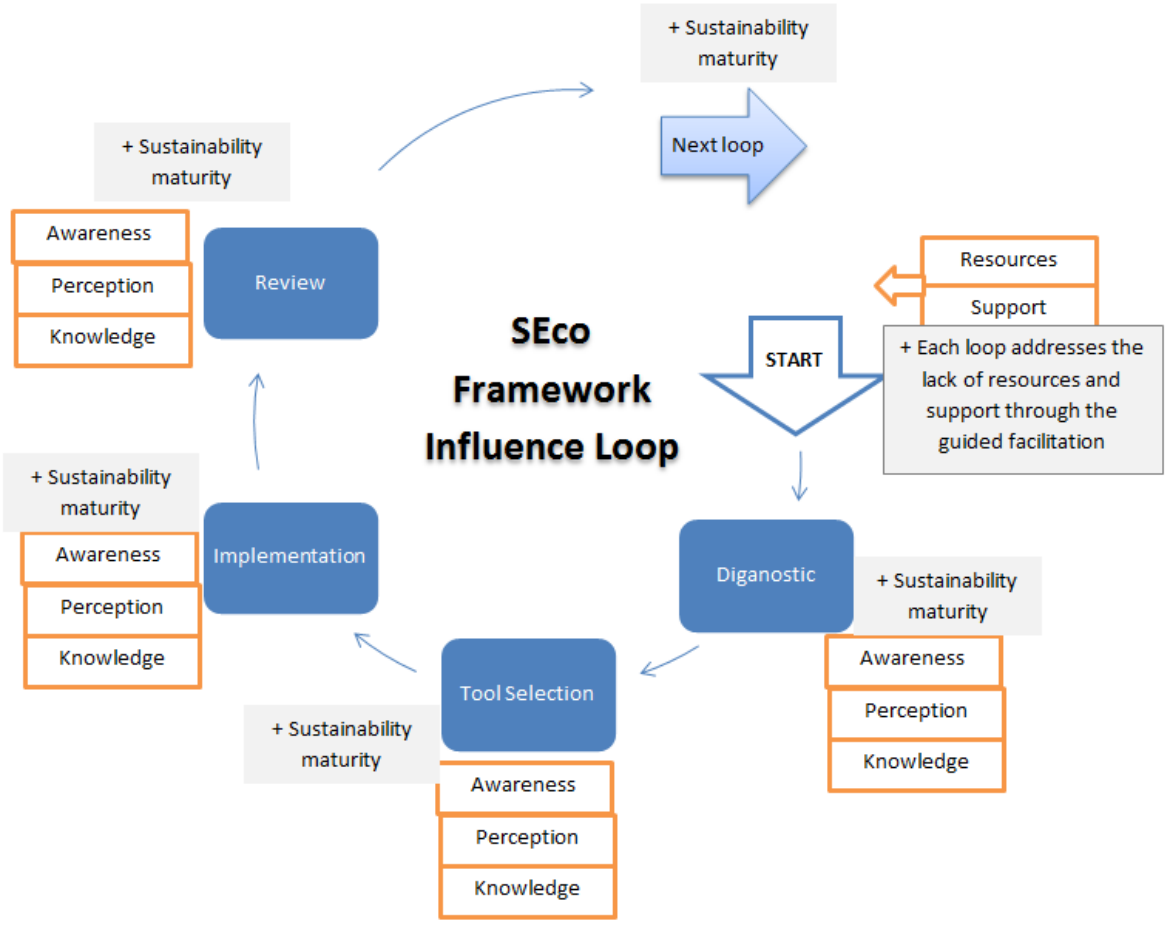


Figure 6.22: SEco Framework influence loop of the systems model

6.5.2 Validation Method #2: Cormican (2005)'s Method

The systems model of the case study demonstrates where the barriers have been addressed. However, the research investigation must also demonstrate the validity and reliability of the data collected (Flynn, et al., 1990; Yin, 2009).

Cormican's validation framework was applied to validate the enhanced SEco Framework. In summary:

- The enhanced SEco Framework proved to be effective and efficient. The balance between a potential for overlap is compromised by the broadness of the enahnced SEco Framework to suit a wide range of enterprise types. The expert responsible for the intervention eliminates redundancy by personalising the support throughout.
- The enahnced SEco Framework is universally applicable to the test group (small high-tech Irish SMEs) and comprehensive as it works across a broad domain of sustainability and eco-innovation. It is designed for SMEs and can be applied to a wide range of sectors.
- There are no risks to the SME as the process, as accuracy and reliability is assured because a trusted advisor guides it. However, if this expert is removed, there may be a risk.
- The process is stable and robust as well as being flexible and capable of a continuous evolution process. The Framework is capable of incorporating improvements learned from experience. However, the support of the facilitator is a key part of the process, and if removed may not be as successfully implemented.
- It was simple and easy to implement from the end-user viewpoint. Manageability is not a problem but is restricted by the cooperation of the owner-manager.
- The Framework was designed to be visible and comprehensible. Visual management tools are used and there is not jargon.
- The Framework is well supported, by an expert guiding the process and by the wide range of tools that can be applied.

Table 6.15 below gives further details about how the criteria are met, and where this has been demonstrated through the testing case studies.

Table 6.15: Validation Criteria used for validation of the enhanced SEco Framework

Criteria	Description (adapted for the enhanced SEco Framework Assessment)	Assessing the enhanced SEco Framework against criteria
• **Effective**	Does the methodology work?	Yes – it was carried out successfully in two small manufacturing SMEs. Further testing should confirm this finding further.
	Does it solve the problems for which it is intended?	Yes - It has addressed the research problem, and resulted in an increase in sustainability maturity in the SMEs in the test case studies. The identification of where the barriers were overcome can be seen in Secion 6.5.1., A systems Analysis of the Seco Framework
	Do projects that follow the methodology turn out successfully?	The projects were deemed successful by the SME owner-managers after the intervention. There was a significant increase in awareness and knowledge about the business benefits of sustainability at the review stage, indicated by the systems analysis and the SEco Maturity Map, and the SME-owner-manager's own account. However, one of the test companies failed to complete a task it had set out to do, the Carbon Footprinting.

Criteria	Description (adapted for the enhanced SEco Framework Assessment)	Assessing the enhanced SEco Framework against criteria
• **Efficient**	Are all the tasks and activities prescribed by the methodology strictly necessary?	Yes - the tasks and activities prescribed throughout the process are personalised to the particular SME in question.
	Are all legitimate short cuts exploited?	Partially – The process has been refined to ensure the least possible time is needed for the consultation with the SME and the use of the tools. Some tools can be (potentialy) complimentary; for example, one tool (e.g. carbon footprint measure) can be used to input into another tool (e.g. a sustainability report). However, there is potential to improve and create more short-cuts within the tools themselves (e.g. an automated sustainability reporting system could be developed, as this tool takes the most amount of time from the facilitator).
	Is there any redundant effort?	No - there is a form of personalisation in the process, provided the facilitator is sufficiently knowledgeable about the process. It does not require any redundant effort from the SME owner-manager.
• **Universally applicable** • **Comprehensive**	Does the methodology work across the whole of a domain?	Yes, this methodology works across a broad domain of eco-innovation, sustainability and environmental management in a manufacturing setting.
	If there are any restrictions on the range of situations that the methodology can handle, are these restrictions well understood?	No restrictions were identified - the methodology has been designed for a broad range of scenarios and levels of maturity. However, there is a potential that restrictions could be identified through further testing and analysis.
	Does the methodology work in any organisation size or culture, or does it assume a particular organisation or management style.	It has only been tested in small Irish high-tech SMEs, with owner-managers over 40. However, an assumption could be made that if the Framework is suitable for small manufacturing SMEs, it could also be suitable for medium sized SMEs. Furthermore, a successful outcome was recorded with SME owner-managers that were initially quite cynical of the benefits of sustainability. It will suit similar sized organisations and any management style that is willing to engage with the process.
	Does the methodology have limits of the size or complexity of projects it can handle?	Partially - the methodology has been designed with SMEs in mind, and fits the demographic well. It may be less suitable for large SMEs.
• **Reliable** • **Accurate**	What risks are involved in using the methodology?	No risks were identified in the testing case studies. However, a potential risk could be around customer/stakeholder expectations, when the support of the expert is removed, the organisation may become “static”. Furthermore, the expertise of the facilitator is a key part and is a potential risk.
	How are the risks minimized?	By being guided by an expert, by building a trusting relationship through the process, and managing the SME owner-manager expectations.
	At what stage of a project can we be reasonably certain of success?	The implementation and application of a the sustainability report was a successful step in both cases. However, it is at the final step, the review, where the facilitator assesses the success of the intervention.

Criteria	Description (adapted for the enhanced SEco Framework Assessment)	Assessing the enhanced SEco Framework against criteria
	What quality control procedures are there, and how do they work?	The process is guided by an expert at all stages, who can verify the suitability of tools and methodologies.
• **Stable** • **Robust** • **Flexible** • **Evolving**	Is the methodology tolerant of minor errors and alterations?	Yes – alterations can be made, to personalise aspects to the SME's liking. An SME owner-manager should not be exposed to an error that would be a risk to the business.
	Does the methodology allow for human imperfection?	Yes – provided that the process is guided by an expert. Furthermore, all calculations within the tools, and templates are provided and have been tested within the target demographic (SME owner-managers). See testing of the SEco Pilot Framework in Chapter 4, Section 4.9 and 4.10.
	Does the methodology contain a self-preservation mechanism, to maintain its relevance within the organization?	No –The methodology is cyclical, and can manage a continuous improvement process to remain relevant. However, there is no evidence that the SME will maintain the relevance without the support of the expert facilitator.
	Is the methodology capable of incremental change, to cope with new ideas or technological opportunities?	Yes – the methodology has no restrictions to incremental change and can cope with new ideas or opportunities.
	Is the methodology capable of incorporating improvements learned from experience?	The process and tools can be personalised through learned experiences. For example, the diagnostic or any of the individual tools can be changed, added to, or removed. There is also potential to create sector specific versions of the SEco Framework for market segmentation. The simple platforms (Microsoft Office) used for the tools have made this possible, but less so for the eLearning.
• **Simple & easy to learn and use** • **Acceptable to participants**	Is the methodology targeted at a well-defined population?	Yes – this is targeted at manufacturing SMEs, and has been tested in small, Irish, high-tech companies.
	Is the methodology based on a coherent set of concepts and techniques?	Yes – a comprehensive suitability analysis was conducted in the design of the framework and associated tools (in Chapter 2 Literature Review and Chapter 4 SEco Pilot Development)
	Are all the concepts and techniques strictly necessary?	Yes, they are necessary for the facilitator, to cover a broad range of organisations. However, not all of the tools would be necessary for each SME.
	Does the methodology conform to the prevailing conceptual paradigms and values?	Yes- the methodology was designed to be applied in an SME, with consideration of their characteristics, barriers to adoption as identified in the literature (Chapter 2)
	Is it easy to motivate people to adhere to the methodology?	Yes– the methodology has been designed to guide the SME owner-manager to easily adhere to the methodology as shown in the 2 test case SMEs. However, if the organisation is not managed well, it may be difficult to apply some tools (e.g. carbon footprint was never completed in test case 2)
	Is the methodology scalable (does the complexity of the methodology grow in proportion to the problem?	The SEco Framework should allow for complexity to apply to larger or more complex SMEs. However, this was not tested beyond one cycle to assess this possibility.

Criteria	Description (adapted for the enhanced SEco Framework Assessment)	Assessing the enhanced SEco Framework against criteria
• **Manageable**	Does the methodology provide guidelines for the management environment of the project (including project management, inter-project coordination, risk assessment and quality management)?	The process is supported by an facilitator throughout, and the steps are clearly outlined. However, there are no project management guidelines specifically, but the SEco Report helps the facilitator and SME owner-manager track progress.
	Does the methodology clearly state what it regards as success or failure for a project, and provide suitable measures?	Yes – the sustainability maturity level will increase to indicate success, and decrease or remain the same, to indicate a failure.
	Is the methodology self-monitoring? In other words, does it provide the project manager with information about the effectiveness of the process?	Yes – the review phase is inbuilt into the methodology to assess the effectiveness from the facilitator and SME owner-manager perspective.
• **Visible** • **Comprehensible**	Does the methodology make its reasoning clear and visible to the participants, so that they can intelligently judge the relevance and completeness of each piece of work?	Yes – each supporting application (tool and eLearning) uses SME case studies and examples to clarify expectations from the SME. Furthermore, the SEco Maturity Map clearly measures the change. The SEco Strategy Wall and SEco Report help to visually communicate progress and relevance.
	Do participants attribute their successes (if any) to the methodology?	Yes – each participant attributed the success to the guided SEco Framework, and all stated that they would not have applied the tools without this.
• **Well supported**	To what extent are relevant tools, skills and services currently available to support this methodology?	There is a suite of tools, designed for manufacturing SMEs to support the methodology
	What are the future prospects for the development and commercial dissemination of such tools, skills and services? In other words, is the methodology automatable?	The Pilot Framework was originally developed to be "automatable", or self-guided, which is still possible. However, the success of the methodology was a result of the expert face-to-face support. The methodology could be developed as a commercial offering to support SMEs to be more responsible and sustainable.

6.5.3 Summary of Validation

Chapter 3 introduced validity into the research design. Each of the outcomes of validity types will now be discussed.

6.5.3.1 Construct Validity

Yin (2009) recommends multiple sources of evidence and a chain of over-lapping evidence to improve the construct validity of the research process. A synthesis of several elements from

engineering and management literature, together with data from SME owner-managers was applied throughout. Cross-validation was integrated through information gathered at different sources, namely, interviews, observations and literature. The construct validity has been improved throughout the research process, as recommended by Bryman (2008), by ensuring the measure used truly reflected the concept it was representing. In this case, the main measure is the sustainability maturity of manufacturing SMEs. Construct validity of the SEco framework was assessed through the criteria of the Cormican (2005)'s framework.

6.5.3.2 Internal Validity

The internal validity shows a connection between sustainability maturity and the intervention at the review stage, which increased significantly in both cases. The enhanced SEco Framework is valid internally through its effectiveness within manufacturing SMEs, in solving the problem for which it was intended, and through the minimisation of risk.

6.5.3.3 External Validity

The replication of the testing activities of the SEco Pilot Framework, and the two testing case studies of the enhanced SEco Framework, provide evidence to establish the external validity. The external validity of the framework itself is also shown through its applicability and transferability to other European SMEs, particularly small, Irish high-tech manufacturing SMEs.

6.5.3.4 Ecological Validity

Each stage of the research process involved SME-owner managers to ensure that the findings apply to their natural settings. The SEco Framework is robust enough to allow for human imperfection and is flexible enough to suit particular characteristics of SMEs. It suits the demographic by being simple and acceptable to participants. The methodology makes its reasoning clear and visible to the participants through various supporting tools. The owner-managers attributed their success to the SEco Framework.

6.5.3.5 Reliability

The reliability of the SEco Framework is the result of a two-stage development process. This allowed for the opportunity to collect ongoing feedback and modify each element within the Framework, as well as the Framework itself. The order in which the Framework is applied creates a consistency, resulting in an inherent reliability. The SEco Framework also allows for repeated cycles. Care was taken over the stability of the data and measures used.

6.5.3.6 Replication

The detailed procedures within the SEco Framework itself and the multiple cases used in this research study allows for its replicability by other researchers.

6.6 Analysis and Discussion

The testing case studies identified that the main barriers SMEs experience in implementing sustainability practices were overcome throughout the interventions. The test companies both featured SME owner-managers that were initially quite cynical about sustainability. Section 6.6 demonstrates the validity of the enhanced SEco Framework and data collected. The testing cases related to the situation where a company has increased its sustainability maturity. An analysis of these cases will now be discussed, highlighting the key points of success and also where it may be deemed less successful.

Building a trusting a relationship between the SME owner-manager and the facilitator played a major role in accessing sustainability and eco-innovation opportunities through the enhanced SEco Framework. This relationship building process starts with the first stage of the Framework and continues throughout each step of the process.

The Diagnostic stage built a holistic profile of the SMEs in relation to environmental sustainability and contextualised their practices and behaviours. The *business profile* highlighted characteristics that predicted the potential for opportunities and gave the researcher a good understanding of where the owner-managers perceived value. Neither of the owner-managers were driven to be more sustainable for altruistic reasons. At the outset, they both considered environmental issues as being 'external' and not conducive to profitable business. However, without recognising it themselves, both of the organisations were very active in eco-innovative practices, and neither realised that what they called "cost-saving" or "efficiency measures" were considered greener practices. This revelation played a major part in getting the owner-managers to think differently about how better environmental practices could be aligned to the business.

Both SMEs tested expressed a lack of knowledge around their environmental impacts. They did not know how to measure this, which is a typical SME characteristic. Both owner-managers were interested in carrying out a carbon footprint. This may be because this term is used in everyday language and they were not intimidated by it. Elec-SME found it thought-provoking to carry this out, and appreciated the ease at which this could be done. Rlog-SME never completed the assessment due to the difficulty with accessing the relevant data. The LCA was very interesting to Elec-SME's owner-manager who carried out an assessment on one product line. It was a key learning point for him to know that he could easily do this for any of his products in the future. He considered this ability as a competitive advantage.

A strategic understanding of potential eco-innovation opportunities for both companies was revealed in the Diagnostic. The position in the value-chain is an important factor in whether the SME is influential in the design stage, as this is where the majority of environmental impacts are decided. The SEco SWOT and Stakeholder Analysis played a major part in identifying the capabilities and collaboration potential. Most SMEs are positioned within the value-chain of larger organisations, which was true in both SMEs. Neither were responsible for the design of the products they manufactured/repaired/re-manufactured. Nevertheless, there were still opportunities to influence design-related impacts. Both owner-managers admitted that trusting customer relationships were a key part of their business success, and through these, they asserted their influence and knowledge. Elec-SME's owner-manager advised his customers on the selection of components and materials. He also had the autonomy to design efficient processes. Rlog-SME plays its part in the value chain through its entire operating model by ensuring DfE strategies are carried out, eliminating waste and extending the life cycle of its customers' products.

The owner-managers differed in the area of environmental legislation despite having similar business experience. Elec-SME's owner-manager claimed to know and comply with all environmental requirements. He was also adamant that he would not seek help on legislation from any business support agencies (such as the local enterprise boards or the EPA's green business supports). Instead, he relied on his own ability to research this online. Rlog-SME said that he didn't know anything about environmental legislation, but would be willing to seek assistance through a

trusted business acquaintance in the local authority. Neither were interested in the tool to support their business outside of appreciating that this was available to them if they needed it. They seemed to trust that they knew their area of business well enough to avoid a diversion of resources to investigate this issue.

One of the important parts of the tools implementation phase was the level of support given by a facilitator as a trusted advisor (played by the researcher in the case studies). The facilitation of the CSR assessment was a good way for SMEs to see the positive side of sustainability, rather than seeing it as something only large companies do. The eLearning lesson on CSR helped the SME owner-manager to understand the business benefits of acting in a responsible way, and communicating it to important stakeholders. However, during the case studies, the eLearning lessons were used more as demonstration tools because the owner-managers could not see the value of time spent on the full lessons. They both preferred the information to be distilled for them to apply to their own business, indicating the important role of the facilitator.

The initial “buy-in” was attained from the sustainability reporting process, which was an unexpected outcome. This success contrasted with that of the carbon footprinting. The meetings with the SME owner-manager served as a time set aside to work on their sustainability progress and actions. If the owner-managers were left to their own devices, it is likely that none of the implementation would have happened.

The difference between the results of the Pilot SEco Framework in Stage 2 and the enhanced SEco Framework developed in Stage 3 was that the SME owner-managers are more likely to adopt more sustainable practices if they are guided and supported through a process. The enhanced SEco Framework is, in part, a relationship building process. A key difference between the Pilot and the enhanced SEco Framework is that it is implemented with the assistance of a facilitator. A set of tools that had been designed for them, tested by them and approved by them was not enough for them to make changes on their own. The owner-manager awareness of external trends, and potential to collaborate with other stakeholders was increased through the implementation of the framework. Feedback from the end-users indicated that simplification through visual aids, face-to-face guidance, and a holistic approach made it more attractive.

If sustainability and eco-innovation can be presented to them in a personalised way that emphasises the business benefits, this can change the mind-set of the owner-manager. Both participants admitted to viewing sustainability in a different way as a direct result of the intervention.

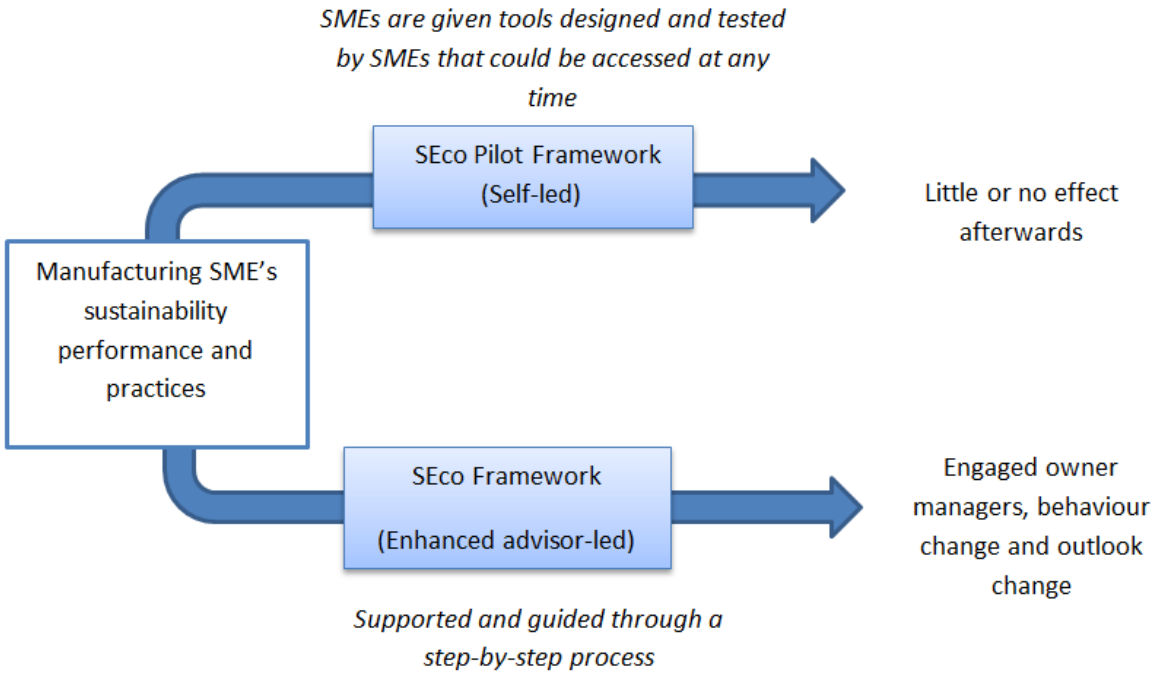


Figure 6.23 Difference between the effectiveness of Pilot and the enhanced Framework

The testing case studies showed how the SEco Framework overcomes the various barriers that were identified in Chapter 2 (Literature Review, Section 2.5). How this happened throughout the implementation of the SEco Framework was discussed in detail in the systems analysis validation and the influence loops (see Section 6.5.1). In summary, the barriers were overcome:

- Lack of awareness: the entire process heightens the awareness within the SME from realising that they do have an impact to recognition that eco-innovation and sustainability can be aligned to the business goals
- Lack of knowledge: the implementation of simple visual tools increases the knowledge required to make positive changes.
- Shortage of resources: The tools and consultation were provided for free, and in-house expertise is not a requirement to deliver the process in the minimal time necessary.
- Negative perception: Both case studies saw a change in mind-set of the SME owner-managers who both had negative perceptions in relation to business.
- Insufficient support: The enhanced SEco Framework was designed and tested to act as a support to the SME in a manner that suits a busy owner-manager and can be applied easily in their business
- Limited research: the case study contributes to the limited research in the area.

The framework was developed from a holistic and industrial engineering approach. It has taken all aspects of the business into consideration, such as the manufacturing process, the importance of business benefits and the human aspect. The intervention process involved in carrying out the testing case studies revealed various factors that influence positive environmental behaviour, which include:

- **Appropriate consultation -** a good foundation for consultation in a way that understands the difficulties SMEs experience.
- **Personalised support -** The SME is likely to react positively if the support is directly related to their activities rather than taking a generalised approach.
- **A trusting relationship -** This is a vital factor to get the SME to open up about its business to an external facilitator to realise and follow up on opportunities to improve (This has been echoed by other facilitators of similar support in agencies in Ireland).
- **Timely delivery -** An SME owner-manager will not go out of their way to address the subject of the environment in their business, as they are too busy running their business. 1 – 1.5 hrs seemed like the ideal time to spend with the SME at any one time.
- **Ease of implementation and personalisation -** The tools to support the process should be easily adapted to any businesses.
- **Use of appropriate language -** The use of jargon and academic language should be avoided at all costs (the only term the researcher and owner-managers struggled with was "CSR").
- **Respecting the knowledge of the SME owner-manager -** Depending on the maturity of the business, the owner-manager will always know more about their business than the facilitator.
- **No data to be uploaded online –** the SMEs consulted throughout the process did not trust the online environment to protect sensitive data.
- **Continuous and face-to-face support –** So that the SME owner-manager is not left with the burden of managing the process alone and to continuously be the "nudge" to improve.
- **Visual supports -** Ease of communication, such as the sustainability report and SEco Strategy Wall.

The case studies illustrated how the enhanced SEco Framework, and engineering solutions played a role in creating eco-innovation supports and tools that met the needs of SMEs. Tools such as life cycle methods (LCA, LCC) are universally accepted engineering methods to analyse environmental impact. These have been made more accessible to SMEs in their design and through close alignment with the business case.

The SEco Maturity Map tracked seven sustainability elements, and both case study SMEs improved significantly. Details of the companies' practices continually emerged throughout the process, and the owner-managers put more trust in the process at each stage. At the start of the process, the owner-managers had little or no interest in environmental improvements and could not see how it could bring any value to their business. The D*iagnostic* helps with tools such as the CSR assessment and Sustainability Report are also key to building up the relationship and knowledge, to allow an advisor to prescribe and support tools to meet the needs of the particular SME. This *Stakeholder Analysis* process enabled the researcher and the owner-manager to identify potential partners that could be interested in the environmental performance of the company.

SMEs need to be constantly competitive and adaptive to survive in the ever-changing business environment. This was reflected in both cases, as in the recent changes in the external environment (large major customer moving to a cheaper country for operations). Since this happened, there had been many eco-innovations in the form of cost reductions related to energy use and resource minimisation, but were not recognised as such by the owner-manager.

The *Sustainability Maturity* was assessed at the start and the end of each case using the SEco Maturity Map, and a significant improvement was made in each case in a relatively short time. This *Sustainability Maturity* can also be seen as the business value that the owner-manager places on sustainability. The higher the maturity, the more active the SME is in sustainability and eco-innovations. Neither of the owner-managers valued sustainability practices at the outset and were assessed with a low sustainability maturity. Both owner-managers were significantly more interested in the possible opportunities sustainable practices might bring to the business at the end of the intervention. Both also expressed an interest in continuing with the process.

The SME characteristic of being focused on short-term gain was apparent throughout the interventions, and convincing the owner-managers of the immediate value of eco-innovations was important. Both SME owner-managers were very 'resource conscious' and had managed to bring their businesses through a very difficult period, following the recession in 2008. Therefore, there was a lack of "low hanging fruit" in both cases. There was no immediately obvious potential for a positive financial impact without a capital investment. Eco-innovation opportunities were presented (e.g. in the redesign of Product A following the LCA in Electronics SME). The timing was not right for the owner-managers to make major investments given the difficult financial marketplace. As a result, the case studies focused mainly on sustainability maturity and leveraging eco-innovative practices in the supply chain. To achieve a sustained change in practices and improvement in environmental impact, a much longer intervention is needed. It may take some SMEs longer to make big changes (such as new products and processes). This framework encourages the SME to think about the business value of sustainability, through feedback and creating more positive awareness through learning and evaluation of the company's current practices. The SMEs did not sustain the engagement with the Framework when the support of the facilitator was removed. Further testing would be required to see at what level a company needs to reach before it becomes self-sustaining without support, if ever.

6.7 Conclusions of Chapter 6

The aim of Chapter 6 was to test and validate the enhanced SEco Framework. The purpose of the enhanced SEco Framework was to address the research problem, the slow uptake in environmental practices in SMEs, caused by a lack of awareness and knowledge, a shortage of resources, a negative perception and insufficient support. This chapter showed how these barriers were overcome through the interventions detailed in the case studies, the modelling of the systems dynamics at play and the validation of the Framework.

The enhanced SEco Framework proved to be an appropriate methodology for typical high technology manufacturing SMEs. It guided the owner-managers through the various stages leading to an increase in the sustainability maturity levels. It was important to understand the mind-set of the SME owner-managers to eliminate factors, such as the belief that sustainability is costly and of no business benefit. The enhanced SEco Framework helped the researcher to 'pitch' the eco-innovation opportunities appropriately and ensured that suitable support was given to them.

Even though the manufacturing SMEs did not create new products, or implement major change within the operations, the sustainability maturity increased through awareness raising and learning through the mentoring process.

The most significant outputs resulting from the testing and validation of the SEco Framework included:

- SME owner-managers who may consider environmental issues to be 'external' and not conducive to profitable business can be convinced of the benefits and business alignment through the enhanced SEco Framework.
- The enhanced SEco Framework process, which was delivered one-to-one by a facilitator addressed this negative perception.
- The diagnostic process played a key role in identifying sustainability opportunities.
- A trusting relationship between the owner-manager and the facilitator was a key part of the success.
- The CSR assessment and sustainability reporting were the key tools that gained the "quick win" for both SMEs. There was an absence of typical "low-hanging fruit", such as energy efficiency and waste management, and this was the most significant tool to get better engagement.
- Successful interventions relied on content that supported the business strategy, encouraged dialogue and used the company data.
- The mature, experienced owner-managers in the test cases, were involved in industry networks, where they gathered their knowledge related to legislation issues.
- Many SMEs are involved in providing manufacturing services/solutions and are not directly involved in the design phase. However, there are still ways in which the design can be influenced at this stage from an experienced manufacturer, such as in optimising material choice or process design based on their knowledge and experience.
- Environmental sustainability interests are driven by the owner-manager's personal view.
- Many eco-innovations have already been capitalised upon in both cases. The recent economic downturn, and the loss of major customers moving to lower cost countries had driven energy saving projects, better resource management and reuse of packaging materials.
- Despite the fact that the environmental diagnostic revealed little interest in environmental/social responsibility issues, the stakeholder analysis revealed many good practices.

The focus of the testing case studies was also on the usefulness of the enhanced SEco Framework. The test case studies showed that the enhanced SEco Framework could successfully facilitate improvements in the sustainability maturity of a manufacturing SME, by raising awareness and creating eco-innovation opportunities that the SME owner-manager can understand and implement.

- The framework was sufficiently detailed to help an SME manager to find eco-innovation opportunities.
- The framework provided appropriate tools to capitalise on the eco-innovations identified.

The next and final chapter concludes the research by summarising the work carried out in the thesis, and extracts the key learning points resulting from this work.

7 Conclusions, recommendations and contribution to knowledge

7.1 Introduction/Thesis Summary

7.2 Conclusions and Review of Research Questions

7.3 Contribution to knowledge

7.4 Limitations of the Research

7.5 Recommendations for Future Work

7.1 Introduction/Thesis Summary

This chapter provides a concluding discussion on the contributions, implications and limitations of the research conducted. The overall aim of this research was to address the research problem, *the slow uptake of sustainability practices in SMEs.* There is a lack of research in the area of SMEs and sustainability, and previous studies on have not sufficiently considered the owner-managers (who are the main decision makers). In this study, 26 individual manufacturing SME owner-managers were engaged with in total, 13 of these continually consulted with throughout the research project, and 2 SMEs participated in the testing of the SEco Framework. This has resulted in new insights into SMEs and sustainability. The research involved an investigation of the application of tools, the provision of practical support, and developing an insight into the behaviour of owner-managers and the capabilities of SMEs. The main output is a Sustainability and Eco-Innovation (SEco) Framework, to advance sustainability maturity levels in European, particularly Irish, manufacturing SMEs.

This research began with setting the context, described in Chapter 2, the Literature Review. The rate of environmental degradation caused by human activity is threatening our planet. Industry can play a major role in driving change. The majority of business research in this area is carried out on larger companies. However, SMEs represent 99% of all businesses operating in Europe and 70% of environmental damage is attributed to their activities. SME research, particularly in the areas of sustainability, is inherently complex. In the context of the economic downturn which began in 2008, the European Commission has been aware that SMEs are key to Europe's future economic success. SMEs also employ the majority of the workforce in the EU (250 million jobs) but they are struggling to compete in an increasingly globalised marketplace. As sustainability is gaining ever-increasing popularity amongst large companies, and support organisations, new methodologies are being developed all the time. However, many of these are not critically analysed, and often focus only on superficial '*greenness'* rather than *sustainability maturity*. Furthermore, tools and supports are widely available to SMEs but are often not suited to them, or SME managers simply do not know where to start.

Chapter 3 (Research Methodology) highlighted the appropriateness of a multi-disciplinary approach in addressing the problem. The research considered the whole *system,* and integrated engineering solutions with aspects from business and management research. Sustainability and environmental management research incorporates both a scientific and engineering foundation, but a *positivist* epistemological approach was deemed restrictive in its application to an organisation in this case (a manufacturing SME). Therefore, a *critical realism* approach was adopted. This helped to enhance understanding, through concepts (theoretical ideas) within measurable constructs like testing case studies and validation methodologies. An *action research* approach was taken to allow for the importance of practical considerations of SMEs to be incorporated into the research process. This also allowed for a staged approach in the design and development of the Framework. The SEco Framework was tested in two companies, a method that worked well with the action research approach. The results were validated using Cormican's method and a systems analysis, to gain insights into the complex phenomena and dynamics involved in sustainability improvement research. The staged research design was carried out as follows:

Background: Literature Review (Chapter 2). The literature review defined the research problem and identified eco-innovation as a suitable approach to foster sustainability improvements in SMEs. A set of key tools and methodologies was derived from the literature to address the issues in SMEs. To be

applicable for the target end-user (manufacturing SMEs), these ranged from design-related tools to product service systems.

Stage 2: SEco Pilot Framework (Chapter 4)**.** This stage involved primary research with SME owner-managers to derive end-user requirements. These requirements were applied to the set of tools and methodologies identified in the literature review. The SEco Pilot Framework resulted in a self-led set of tools and supports, which were tested and approved by the SME end-user group. However, there was little evidence to show that the self-led Pilot Framework engaged the SME target group voluntarily.

Stage 3: Enhanced SEco Framework (Chapter 5 & 6). To address the gaps identified in the Pilot Framework, improvements were made to create an intervention-based methodology. The SEco Framework was an enhancement of the SEco Pilot, and the result of a synthesis of several elements of existing methods and new research with SME owner-managers.

Figure 7.1 provides a summary of the elements and outcomes of the research.

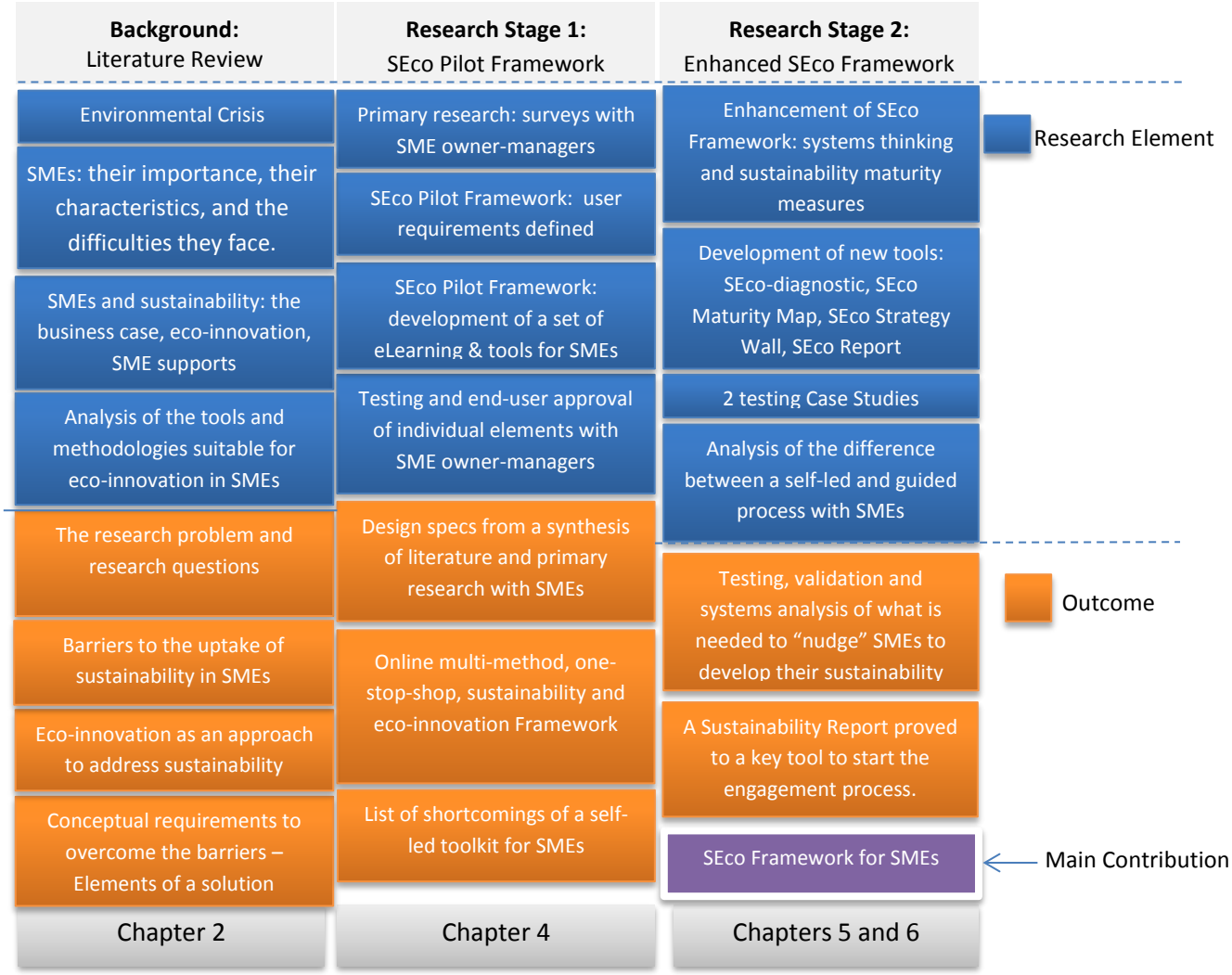


Figure 7.1: Overview of the research elements and outcomes of this research

The main research contribution is the facilitated SEco Framework process, which was been developed because of insights gained throughout the research project. One of the main findings was

that a self-led toolkit was not sufficient to motivate SME owner-mangers to engage with sustainability issues.

7.2 Conclusions and Review of Research Questions

This contributes to the literature on sustainability in SMEs and on the adoptability of various tools and methodologies within a manufacturing SME setting, by:

- Reviewing sustainability practices to see what can benefit manufacturing SMEs
- Applying engineering solutions to solve environmental problems in SMEs
- Gathering new insights into environmentally sustainable performance and behaviours in manufacturing SMEs
- Contributing to the sparse, but growing, body of knowledge in the area of SMEs, eco-innovation and sustainability.

This thesis addressed the factors contributing to the research problem, "*the slow uptake of eco-innovation practices in SMEs"*. A thorough literature review in Chapter 2 identified the gap related to SMEs and sustainability, which helped pose the research questions.

Research Question 1, "*What factors influence positive environmental behaviour in manufacturing SMEs and why?"*

The literature review in Chapter 2 highlighted various barriers to the uptake of sustainability and eco-innovation practices in SMEs. Chapter 4 combined a set of conceptual requirements together with the needs of SME owner-managers. The testing activities in both the SEco Pilot Framework stage and the testing of the enhanced SEco Framework, gave many insights into how positive environmental behaviour was adopted. The resulting factors, which influence positive environmental behaviour in SMEs are synthesised as follows:

- That the SME owner-manager has an awareness of:
    - Why sustainable business practices are important to business;
    - How eco-innovations can positively benefit their individual business;
    - How and where negative environmental impacts of manufacturing activities occur;
    - Where to start making improvements.
- That SMEs have access to a support system which:
    - Can guide the SME owner manager through the improvement process;
    - Can communicate how to gain access to eco-innovations in their business;
    - Can measure environmental impacts of products, services and/or business activities;
    - Can highlight key areas to improve and reduce environmental impact;
    - Can create awareness of environmental legislation and sign-posting towards succinct information in the area of legislation and standards;
    - Provides continuous learning opportunities to improve, no matter where the SME is on their sustainability journey of maturity;
    - Is of little or no cost, and takes minimum time to implement;
    - Demonstrates successful case studies of real SMEs;
    - Respects confidentiality;
    - Can be personalised;
    - Is delivered in a consultative manner.

- That the intervention is conducted by an expert, who understands manufacturing in a manner that:
    - Starts with learning about the business, and what is important to the SME owner-manager before proposing solutions;
    - Incorporates the dynamics of the SME system;
    - Shows empathy with the difficulties faced by SME-owner-managers in addressing the issues;
    - Creates awareness and better understanding of eco-innovation and sustainability.

Research Question 2 ***"What engineering solutions are needed to create sustainability and eco-innovation supports that meet the needs of SMEs?"***
The literature review in Chapter 2 established the best-in-class tools and methodologies, which were suitable for sustainability and eco-innovation management in a wide range of manufacturing SMEs. A broader holistic or systems approach assisted in identifying business opportunities related to manufacturing and the environment. These tools include:

- Life cycle management tools (LCA, LCC and carbon foot-printing)
    - Which have the ability to measure life-cycle impact of products, services and activities to equip the SME for better informed decisions;
- Design for the environment (DfE) strategies and methods
    - Which provide an organised structure to integrate sustainability practices (eco-efficiency, pollution prevention and clean production);
- Environmental Management Systems
    - Which provide a roadmap for SME owner-managers to assess their compliance and environmental impact and integrate these into their management systems;
- Sustainability reporting
    - Which allows the SMEs to become more competitive in a globalised marketplace, through creating awareness of what CSR is. The owner-manager is given the capability to create a report to effectively communicate their sustainability practices;
- Auditing tools
    - To measure, monitor and manage environmental-related costs caused by business activities;
- Product Service Systems tool
    - To create awareness of and to explore new business models through servitisaiton of products and value propositions;
- The SEco Framework
    - To enable SMEs to identify eco-innovation opportunities through a guided, four-step intervention process.

Research Question 3 ***"How will the supports affect the environmental sustainability in the firm?"***
This was answered in the documented testing in Chapter 6. The SEco Framework was successful in changing the SME owner-managers' viewpoints of sustainability from negative perceptions to more positive ones. It engaged them in sustainability practices, which they would not otherwise have been involved in.

The SEco Framework intervention was tested in two SMEs. It demonstrated the capability to assess, monitor and improve the sustainability maturity of the companies. The guided intervention process

identified business benefits for each SME. It addressed the barriers (identified in Chapter 2) by increasing awareness and knowledge and reducing the negative perception (demonstrated in Chapter 6, a systems analysis of the SEco Framework)

7.3 Contribution to knowledge

The research project contributes to the body of knowledge in the area of SMEs and the environment, by developing a framework to support resource-poor SMEs to increase their sustainability maturity through eco-innovation.

This project has answered calls for research by giving new insights into this specific topic. The issue of sustainability in SMEs is a much under researched area, particularly that which engages with SMEs owner-managers in the design, development and testing of suitable supports (McDonough & Braungart, 2013; Bawden, 2013; ACCA, 2013). This is a distinctive study in this area in particular in Ireland. It has contributed to theory through the in-depth engagement of 13 manufacturing SME owner-managers over a 4-year period throughout the research process and the design, development, testing and validation of a broad ranging framework.

This exploration has deepened the current understanding of facilitator-led relationships within SMEs relating to sustainability. It has proposed a framework to engage with SMEs and uncovered novel relationships that are possible to engage with SME owner-managers that is suited to their particular needs and characteristics. The development of the SEco Framework provides a model which has been tested and validated as a suitable approach to work with SMEs.

The examination of maturity models in the area of sustainability and corporate social responsibility has led to the development and testing measurement tool, the SEco Maturity Map. This has contributed to the theory and given new insights into suitable variables to assess, measure and communicate improvements to manufacturing SMEs. In the past, measurements mostly focused on quantitative rather than qualitative measures. The innovative approach presents sustainability data from SMEs in a graphical format.

The two key research contributions include new insights into SMEs and a novel Sustainability and Eco-Innovation Framework for SMEs. These are summarised in Figure 7.2.

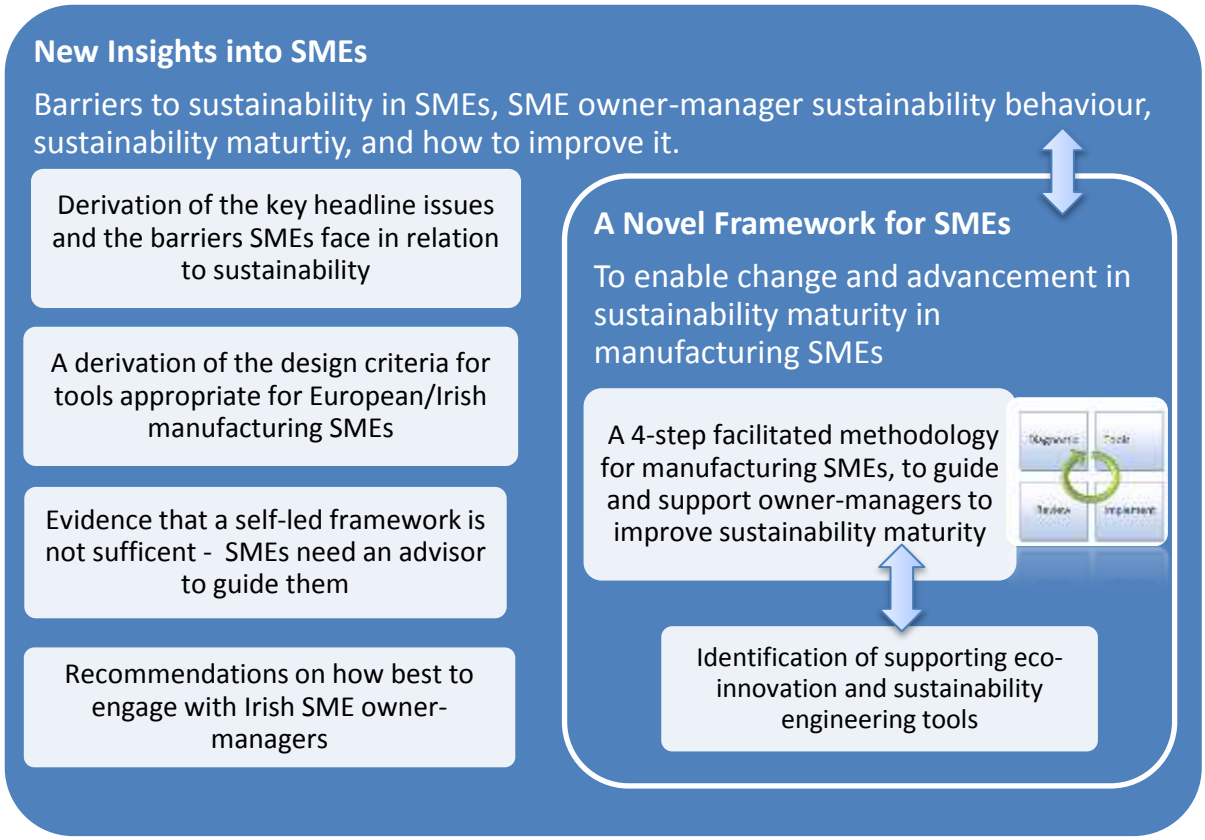


Figure 7.2: Key research contributions

Each of these will now be looked at in more detail.

7.3.1 Contribution: Insights into SMEs

This research project gave a unique insight into SMEs in relation to their environmental sustainability. This was gained through the literature review and a four-year involvement with manufacturing SME owner-managers.

Derivation of the headline issues and the barriers that European Manufacturing SMEs face in relation to sustainability.

Chapter 2 presented the key issues contributing to the research problem. It is well know that SMEs are at a disadvantage when competing with larger organisations, the most significant being their lack of resources (see Figure 2.3). SMEs also fail to see the competitive value of sustainability. Larger companies are leading the way (see section 2.4). SMEs in particular experience issues related to compliance (see 2.4.4), and issues related to slow uptake of supports that are available (Table 2.3). When these matters were synthesised, six key issues emerged as the key headline barriers to the uptake of sustainable practices in SMEs, which were:

1. A *lack of awareness* of the impact their actions have on the environment
2. A *lack of knowledge* of sustainability and the legislation pertaining to environmental issues
3. A *shortage of resources*, both financial and human resources, to address the issues
4. The *negative perception* that there is no immediate benefit to the company
5. *Insufficient supports and tools* to affect change
6. *Limited research* in the area, in particular research that considered the owner-manager.

The development process led to findings that agreed with the literature. For example, the SMEs involved in the research project are not yet under pressure to be more sustainable (in the same way as larger companies) (Côté, et al., 2006), and their sustainability is not managed in a formally defined process (Hoskin, 2011). Furthermore, the test SME demonstrated little understanding of sustainability issues (Stringer, 2013).

There was also evidence that contradicted the literature. For example, less than one quarter of SMEs are reported to be engaged in reducing their impact (Constantinos, et al., 2010). The engagement with 13 SMEs on the project revealed that they were all involved in eco-innovative practices to some extent. However, the SME owner-managers did not identify these activities as sustainability-related. They saw these actions simply as 'cost-saving' measures, which had been implemented, in particular, because of the global recession in 2008. This also led to the finding that the 'quick wins' that are highlighted by support agencies, as the first phase to engage with SMEs (OECD, 2011; Enterprise Ireland, 2013) have already been implemented through such cost-saving measures.

The research revealed that many (97%) of the SME owner-managers surveyed in the development stage had a desire to run a more sustainable business, but only 9% cited cost as the main driver (Mitchell, et al., 2011). This is not widely reported on, and cost is often cited as a driver for sustainability and eco-innovation (Gallup, 2011; Hoskin, 2011). However, it was difficult to convince SME owner-managers that sustainability was good for their business. The survival of the business came first despite these aspirations. Owner-managers saw sustainability as external to, or even going against, their business objectives. They did not relate sustainability to cost reductions or regard it as having the potential to affect sales.

The literature review also documented that despite the many supports that have been developed for SMEs, these are not being accessed (see Chapter, Section 2.4.4, Table 2.3). An analysis of the supports available in Ireland by the researcher revealed that the majority of supports were not suited to SMEs (see Chapter 2, Section 2.4.4 and Table 2.4.)

A derivation of the design criteria for supporting European manufacturing SMEs to address sustainability issues

To overcome the barriers that SMEs face, a number of conceptual requirements were developed from the literature for the SEco Framework, which can be applied to similar support offerings:

- To overcome the *lack of awareness* about the environmental impacts of SMEs, the supports must **measure** and **communicate** this effectively.
- To overcome the *lack of knowledge* about sustainability, the supports must connect SMEs with appropriate **information.** This should be **easily accessible,** to avoid creating any obstacles and to maximise the reach of SMEs and compensate for lack of resources and knowledge**.**
- To overcome the *shortage of resources*, the supports must be **simple** to minimise the resources (time) needed to implement from the SME owner-manager in addition to being **low cost**. The use of **familiar platforms** (e.g. Microsoft Word and Excel) is also important because most SMEs already trust this software, and it reduces the learning time and cost needed to start.

- To overcome the *negative perception* that sustainability hinders business activities, a tool must lead to an improved perception that it can **benefit the business**. A focus on **cost savings and competitiveness** helps to align sustainability to business value and make it more attractive to SMEs. SMEs should be made aware of successful **case studies in SMEs,** as many find it difficult to relate to the issues as they are not experts in the area. The supports should also be **low risk** to the business, as SMEs do not have financial comfort that large companies do to absorb losses. They should also r**espect confidentiality,** as SMEs are wary about their data being accessed by third parties.
- To overcome the *insufficient supports and tools*, the supports must help SMEs to improve their practices, using tools and methodologies designed with them in mind, which should be **practical,** so they can be applied directly in the business. Supports should have an **eco-innovation focus,** as it has been shown that SMEs who engage in low-risk, eco-innovation practices see further opportunities for improvement.
- To overcome the *limited research* in the area of SMEs and the environment, the supports must allow for feedback and contribute to knowledge in this area.

Evidence that a self-led framework is not enough – European SME owner-managers need an advisor to guide them to improve sustainability maturity

The initial Pilot SEco Framework was developed to be self-led, with online tools and methodologies, designed to reach a large audience of SMEs across Europe. However, the set of tools and methodologies that was developed (with the approval of the end-users) did not lead to their engagement with these tools and methodologies. None of the 13 SME end-users on the Future SME project was interested in engaging with the online tools after the Pilot development and only 2% of all downloads from the FutureSME website were by SMEs.

SME owner-managers need to be to be given personalised advice that suits their business. Testing activities revealed that the SME owner-managers need to be directed immediately to something that is of interest in their business to keep their attention. They do not have time to learn about a broad range of issues that 'might' have relevance to the company.

Owner-managers do not know where to start. The majority of SMEs involved in this research project did not have the basic skills to address the issues, and they did not have time to figure it out for themselves. A formal intervention methodology is needed to support SMEs to engage with sustainability and identify eco-innovation opportunities.

The testing case studies revealed interesting behaviours of owner-managers. For example, the eLearning that was developed for and tested by SMEs was still not very attractive to them. They wanted immediate answers without having to invest time in a full lesson. Furthermore, the SME managers involved in the testing case studies, who were originally quite sceptical of the benefits of sustainability, did engage when they were guided through a process by a mentor, and advanced the sustainability maturity of their business.

The SEco Pilot Framework was similar in concept to the ECAP website for SMEs across Europe, presented in Section 2.4.3. This website is also an online repository of guidance and information (European Commission, 2014-b). The findings from this research project indicate that without

further guidance and support, this is not an effective approach to reach or convince resource-poor SMEs, who are not already convinced about the business benefits and lack the basic skills to start.

Insights and recommendations on how best to engage with small, European (particularly Irish) owner-managers of manufacturing SMEs

The four-year engagement with manufacturing SMEs revealed insights into how best to engage with them, which may be useful to consider when designing supports, due to lack of uptake (as mentioned above). The lack of sufficient supports available to SMEs contributes to the research problem, which was identified in Chapter 2 (Arbačiauskas, et al., 2010; Romero-Martinez, et al., 2010).

One of the most important factors in developing an open dialogue with the SME owner-managers is firstly to gain their trust. A facilitator should be aware of SME characteristics and the difficulties they face. They need to spend some time getting to know the owner-manager through dialogue. The eco-innovation diagnostic guides the facilitator to do this effectively and efficiently. It is important for the facilitator to know what is important to the SME. SME owner-managers are more comfortable talking and acting on sustainability and eco-innovation with a consultant or expert who has taken the time to understand how their business operates.

Sustainability Reporting was a key trigger of engagement in sustainability improvement with the SME owner-managers. They could see that being able to communicate this effectively to their customers could give them a competitive advantage and was the most popular tool. It allowed the facilitator to deliver something tangible in a short time period, which helped the SMEs to differentiate them from their competitors.

Visual communication, such as using simple wall charts, also proved to be a useful method to support ongoing management of sustainability. The SEco Strategy Wall and SEco Maturity Map applied in the test SMEs, helped the researcher to assist the owner-manager to understand and communicate better to other employees, and to keep track of opportunities, progress and updates.

There is a limited amount of time an advisor should spend at any one time on environmental interventions in SMEs. The application of the SEco Framework indicated that this time should not exceed two hours on the initial diagnostic phase, or one hour thereafter, and communication should be two-way.

These insights contribute to the limited research in the area of SMEs and sustainability (Labonne, 2006; Daddia, et al., 2010; ACCA, 2013).

7.3.2 Contribution: A Sustainability and Eco-Innovation Framework for SMEs

A 4-step guided methodology for European manufacturing SMEs, to direct and support owner-managers to improve sustainability maturity

The main contribution in this thesis is an over-arching framework, sequenced in four steps, which was designed and tested with manufacturing SMEs in mind. The application of this new and previously untested framework, and the findings from the case studies, provide new knowledge and insights into SMEs.

The SME Eco-Innovation (or SEco) Framework is a four part iterative process (see Figure 7.3). The first part involves an eco-innovation diagnostic to uncover opportunities for the company. Tools to support the process are selected from the toolset (Figure 7.4), and implemented over time. Finally, a review is carried out to measure progress in the company.

The implementation of the SEco Framework was shown to be successful in the two testing case studies, and led to an advancement of their Sustainability Maturity. It addressed the development of an eco-innovation culture within the organisation, and provided a wide range of tools that could be used for many situations.

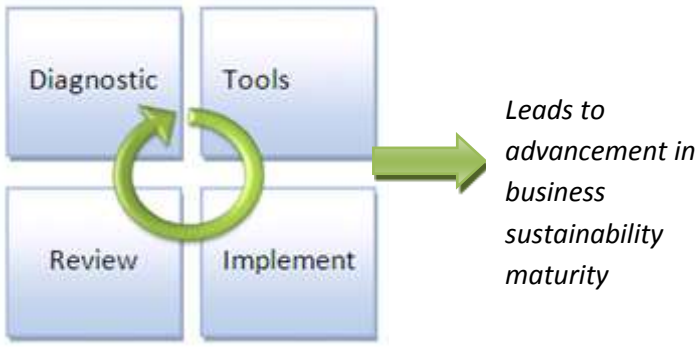


Figure 7.3: The SME Eco-Innovation Framework

Each step of the SEco Framework has a number of tools associated with it, to allow the facilitator to effectively engage with SME owner-managers on the issues (see Figure 7.4). The diagnostic is very concise and has five elements within it, to ask only the necessary questions to prompt responses and gather information on SMEs. Improvements are measured and communicated using the SEco Maturity Map. It measures the baseline (in Stage 1) and is used again during the Review at the final stage. To keep the owner-manager engaged when the facilitator is not there, the SEco Strategy Wall and SEco Project Report are used. They provide a guide to the SME owner-manager on where the SME is going, where it has come from, and at what stage it is currently. The review process helps SME owner-managers to understand how they can leverage environmental improvements. At this stage, the facilitator and SME owner-manager have gained a systems view, including awareness and knowledge about sustainability and how it positively relates to the business.

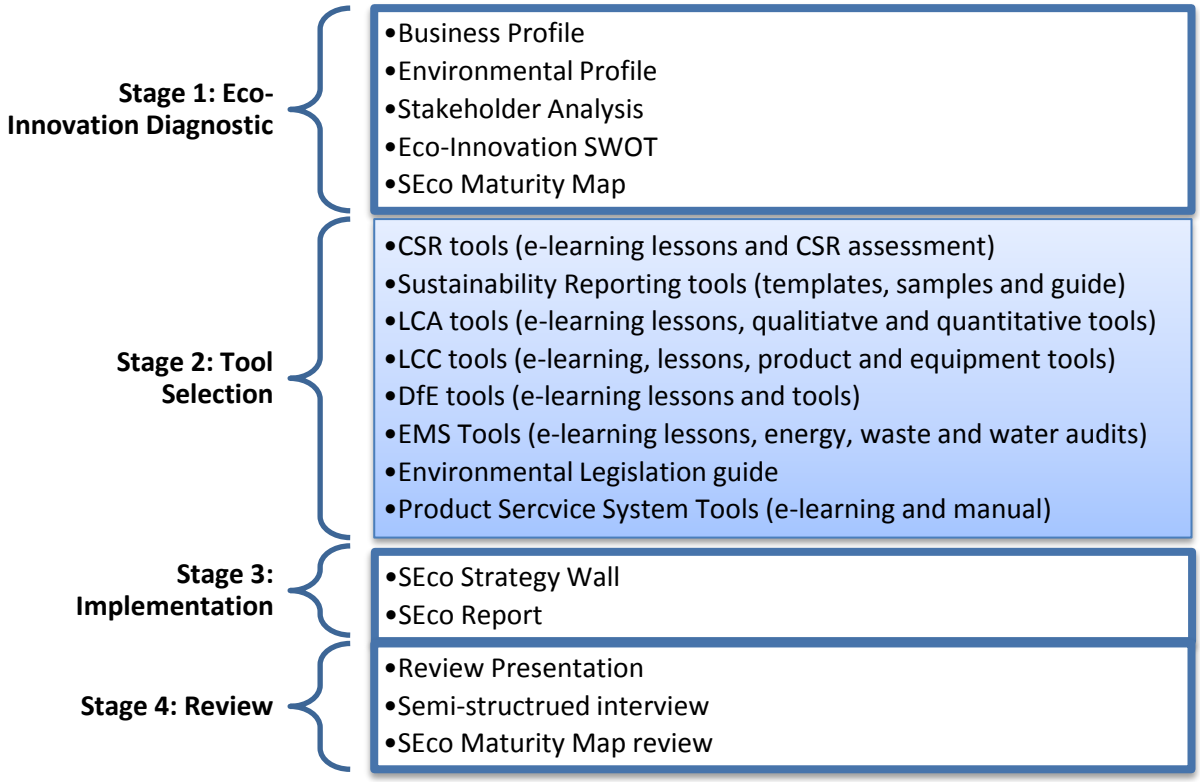


Figure 7.4: Tools embedded within the SEco Framework

Visual communication proved to be a useful tool to support ongoing management of sustainability. The SEco Strategy Wall and SEco Maturity Map helped the researcher to understand and communicate better to other employees and keep track of opportunities, progress and updates. Involvement of staff is helped by the SEco Strategy Wall. It is a constant reminder, a way to gather ideas, and a statement of intent.

The advancement in sustainability maturity gave owner-managers the assurance that their environmental credentials were worth communicating and were of business value. The responses during the influence loops, which were reviewed during the validation stage, demonstrated that the Framework was successfully designed to influence the SME owner-manager and to overcome the many barriers associated with the research problem. It helped to change the thinking that business success and sustainability are opposing objectives.

The SEco Framework addresses gaps in other tools and supports that have been designed for SMEs and/or manufacturing companies. Table 7.1 below compares the main alternative supports that have been developed, and highlights where the SEco Framework has addressed these gaps.

Methodology	Description	Current Gap(s)	Addressed by the SEco Framework	Reference
European Compliance Assistance Programme (ECAP)	Environmental legislation compliance support through environmental management assistance	• Online, self-led • Limited emphasis on EMS implementation	• Facilitated by an expert • EMS is not the main aim • Broader and more personal to benefit the specific business	(European Commission, 2014-b)
Ireland's Green Business Initiative *(EPA, SEAI, Enterprise Ireland and the IDA)*	Energy, Eco-Efficiency, Clean Technology, Online information/ advice	• Limited support for a broad range of SMEs e.g. need to meet criteria to qualify (see Table 2.4 in Chapter 2)	• No qualification criteria required • A broad range of possibilities are available	(EPA, 2012-a)
OECD Sustainable Manufacturing Toolkit	Booklet guide to sustainable manufacturing in 7 steps	• Online, self-led • No tools to support implementation	• Facilitated by an expert • Full suite of tools designed for SMEs	(OECD, 2011)
Seidel's "Strategic Framework"	Facilitated process to progress environmental management in manufacturing SMEs	• Focused on an EMS (ISO14001) • Needs a lot resources (time) to facilitate • Suited to medium SMEs	• EMS is not the main aim • Minimum time needed from facilitator • Suited to micro, small and medium SMEs	(Seidel, 2011)

Table 7.1: SEco Framework positioning compared to others

As discussed in Chapter 5, elements of the SEco Framework are based on Seidel's "Strategic Framework" to progress environmental management in manufacturing SMEs (Seidel, 2011). The key similarities include a facilitator-led approach, and sustainability maturity mapping to measure the baseline and to communicate advancement through the process. Both also included a Stakeholder Analysis and a sustainability SWOT at the initial stages. However, there are also some key differences. Firstly, Seidel's intervention method was focused primarily around the implementation of an Environmental Management System (ISO 14001). It was tested and developed with medium sized SMEs in New Zealand. It also involved the facilitator being on-site for long periods to implement the necessary changes to reach the objectives set.

There are many free tools available for sustainability in business (some particularly for manufacturing, some for SMEs and some that focus on eco-innovation). However, many of these lack key elements to overcome the barriers for SMEs. The OECD's sustainable manufacturing guide is outlined in 7 steps and is in booklet form (OECD, 2011). However, it is too generic, too high level and not customisable to different business types or owner-manager preferences. It has no tools to support any analysis (at time or writing). The SEco Framework is also more appropriate than Seidel's

for the target group of Irish manufacturing SMEs. It is less resource-intensive, and therefore is more suitable for smaller SMEs. The diagnostic process was designed to gain the trust with Irish SME owner-managers through the inclusion of the business and environmental profiling of the company.

One of the key success factors for the SEco Framework was the Sustainability Report, which is also not included in Seidel's Framework. The OECD toolkit does mention sustainability reporting, but only signposts to the GRI website. Elements of the SEco Framework also have the option of being self-led (although the there was little evidence of its uptake). It has a wide range of tools and eLearning that have been designed for SMEs, that they can access online. It is much more comprehensive than the online resource from the OECD's online toolkit.

SME owner-managers often see environmental goals as external to or even going against the business objectives. The difference the SEco Framework made was that it could effectively create the opportunity, because of the way the facilitated process was designed, to answer the question: "Why should I as an owner-manager of my business act on sustainability?" The process helps the advisor to understand how sustainability aligns with the business objectives in a short amount of time, which is deficient in self-led supports (OECD, 2011; European Commission, 2009-a)

Identification of a set of supporting eco-innovation and sustainability engineering tools for European manufacturing SMEs

The SEco Framework was supported by set of tools, suitable for SMEs. These were identified through the literature review of best practice tools and methodologies and the SEco Pilot Framework development process, involving input from 13 SME owner-managers. The final format of the tools received peer approval through individual testing activities and a stage gate process.

The set of tools is particularly relevant to manufacturing companies. The design was informed by the literature review combined with input from SME owner-managers. It applied the guidelines shown in 7.3.1. The set of tools is broad enough to cover issues from the design stage (LCA, DfE) to day-to-day management (auditing tools), as well as considering future opportunities and servitisation of products (PSS tool). The modularisation of the tools (e.g. grouped by LCA tools and LCA eLearning) allows it to be viewed in small enough parts to make it more accessible and understandable to SMEs and facilitators alike. The set of tools included:

- Life Cycle Assessment (LCA)
    - Met Matrix– a simple qualitative LCA useful at the concept development stage
    - Eco-compass – a more detailed qualitative LCA to compare product designs
    - Eco-indicator '99 – a quantitative LCA which converts environmental impact into a score (mPt), to find where the largest environmental impacts are, and to compare product or sub-assembly designs.
    - Carbon Footprinting – a tool to identify CO_2 emissions and opportunities for reductions and cost savings
- Life Cycle Costing (LCC)
    - Product LCC tool to analyse the cost of ownership of a product that the SME is manufacturing, which can be used to identify preventable costs and communicate the performance of a product to customers

    - Equipment LCC tool to analyse equipment that an SME is purchasing to support buying decisions based on cost of ownership
- Design for Environment (DfE)
    - EcoDesign Checklist is a simple tool to make a quick assessment of current product design to identify where there are problems
    - LiDs Wheel is a more advanced tool to apply DfE strategies or techniques to achieve an environmentally superior product
- Product Service System (PSS)
    - An advanced decision support methodology if an SME is considering the shift to servitisaion, which is in manual format.
- Corporate Social Responsibility (CSR)
    - A guide to Sustainability Reporting for SMEs
    - A CSR assessment for SMEs to give direction on how to approach CSR and raise awareness.
- Environmental Management and auditing tools to track costs and usage and identify opportunities for improvements
    - Energy Audit Tool to track energy related costs and usage
    - Water Audit Tool to track water related costs and usage
    - Waste Audit Tool to track waste related costs and usage
- Legislation
    - A simple guide to give an overview of environmental legislation and signposting to find further information and resources.
- eLearning in all the above to support the implementation of the tools, raise awareness of the issues and address the lack of knowledge among SMEs.

All of these tools are available to download on www.futuresme.eu.

7.3.3 Implications for Practice

It is well known that the global environmental crisis has serious implications for the future of our planet. It is also clear that it is impacting on the global economy. The world economic forum at Davos in 2013 called for a greening of the global economy to the tune of $14 trillion (Mitchell, et al., 2010). Sustainability leads to increased efficiencies and competitive advantage for businesses and SMEs. It increases their economic performance, and therefore the economic performance of the country in which they are operating. Sustainable practices in business allow communities to thrive, and natural resources to be conserved, creating economic value in a way that creates value for society at large (Porter & Kramer, 2011).

SMEs and manufacturing businesses are very important to the European area in terms of economic activity, employment and social inclusion. Manufacturing has significant environmental impacts. SMEs contribute to 70% of all industry-related environmental impacts in the EU. Identifying the environmental practices and behaviour of manufacturing SMEs is important because it informs policy makers, and support agencies, who wish to encourage good environmental practices in Europe.

Research into policies needed to improve sustainability management in business lacks the data necessary to support positive actions. Much of the methodologies already available are not used by SMEs. This research study represents a step toward improving methodologies to support

manufacturing SMEs to improve their sustainability maturity (in particular small and micro SMEs). SMEs are considered a "*hard to reach*" demographic when it comes to creating supports. The SEco Framework is an approach that could be considered to reach more SMEs.

Recommendations for SME Owner-Managers

Although the findings in this research identified that a self-led toolkit did not engage SME 0wner-managers, it is possible that some highly motivated owner-managers may want such an option. For owner-managers that would prefer to approach the issues of sustainability without the support of an expert through the SEco Framework, the actions in Table 7.1 are recommended. These are based on the Pilot Toolkit, how much the SME owner-manager may already know, or what problem area or specific issue needs addressing.

Problem area	Issue that needs addressing	Step 1: Recommended eLearning	Step 2: Application with associated Tool
Starter level	• A general overview of sustainability • How to get started • Benefits for business • SME case studies • Articulating good practices	• Corporate Social Responsibility (CSR) for SMEs	• CSR Assessment Tool • Sustainability Reporting Tool
Legislation	• Information on environmental legislation and compliance	• Overview of Environmental Legislation for Managers	• Environmental Legislation Tool
Product /Service Design	• An analysis on the environmental impact of a product/service	• Life Cycle Analysis for SMEs	• Met Matrix • Eco-compass • Eco-indicator 99
	• Calculate Carbon Footprint	• Life Cycle Analysis for SMEs	• Carbon Footprint tool
	• How to attain business benefits, such as cost savings • How to appealing to a wider customer base	• Design for Environment	• EcoDesign Checklist • LiDS Wheel
	• Assess the life-cycle cost of a product or service • Communicate the life-cycle cost of a product e.g. to customers to highlight its competitive advantage	• Life Cycle Costing	• Product LCC tool
Equipment Purchase	• Calculate the total life cycle cost, or total cost of ownership (TCO) of equipment (e.g. production equipment, fleet car etc.)	• Life Cycle Costing	• Equipment LCC tool

Problem area	Issue that needs addressing	Step 1: Recommended eLearning	Step 2: Application with associated Tool
Environmental Management	• Implement an environmental management system	• Environmental Management Systems (EMS)	• Energy Tool • Water Tool • Waste Tool
Product Service System	• Understand the PSS concept and how it could benefit the business • Support decision to transition along the PSS route	• Product Service System	• PSS – TraPSSs methodology

Table 7.2: Matrix of recommendations for SMEs based on issue that needs addressing

7.4 Limitations of the Research

There were various limitations with this research which included:

- The research was conducted amidst a new economic recession (which began in 2008), which constrained SME resources more, and limited their ability to make capital investments to improve sustainability.
- The insights refer to a particular profile of owner-manager. Most of the SME owner-manager participants were over 35 years old, and the majority were male.
- A focus on the manufacturing sector and sub sectors of the end user testing group
- A focus on small SMEs with less than 50 employees
- These findings can be applied to Irish manufacturing SMEs research, and are generalisable only to the extent of current conditions and regulations, which may change dramatically in the near future, particularly considering the most recent IPCC report which is urging immediate action, and the Irish government's newly published action plan on CSR
- The two test companies were brought through one cycle. More insights would expected to be gained through subsequent cycles.
- There were two test companies, due to the challenge of identifying suitable SMEs willing to participate, given the ongoing recession.
- This testing period was limited; therefore, it was less likely to see major changes, such as the development of new products or major changes in products being manufactured.

7.5 Recommendations for Future Work

Additional research could further test the efficacy of this model, and develop it for different contexts.

Suggestions for further research are as follows:

- To carry out a longer test through subsequent cycles to see how the application of the SEco Framework can further increase the Sustainability Maturity of manufacturing SMEs, and if more or less intervention is required by a facilitator through each cycle.
- To apply the SEco Framework to a wider demographic of SME owner-managers, business typologies and countries throughout Europe for further analysis, which could lead to sectorial and regional versions of the Framework.

- To carry out further research, which engages a wider range of stakeholders beyond the SME and the facilitator. For example, one important stakeholder could be customers, for the owner-manager to further see the value of the toolkit and to look for ways for the owner-manager to communicate their sustainability credentials effectively.
- To investigate the possibility that younger SME owner-managers who have grown up "online" need the same level of facilitation throughout the process.
- Specific modifications to the individual tools in the Framework could include
    - Sustainability Reporting & CSR Assessment Tool: to create on online application that will automatically populate answers from the assessment into a draft sustainability report, that could be fine-tuned afterwards (this would save a lot of time).
    - More visualisation, scenario planning and simulation incorporated into the tools, which would help with forward planning and strategy development.
    - Create industry-specific versions of the tools e.g. an LCA for the food and drink industry (similar to the www.lca2go.eu for SMEs aimed at various sectors such as electronics and smart textiles).
    - Create apps that can be used on smart phones. This could make it easier for SME owner-managers to input data to use the LCA tools wherever he or she is (rather than doing it on a laptop or PC).
- New tools could include
    - An audit tool specifically for assessing lighting and investment analysis of replacing bulbs and/or fittings. This would aligns with the implementation of an environmental management system such as EMAS-easy, and could deliver cost-savings to the SME.
    - A tool to assess investment in renewable energies, including payback periods, grants available and recommended installers. This could allow businesses who are already efficient to see what opportunities are possible with capital investment, and help future-proof the business against the potential increase in energy derived from fossil fuels.
    - A guide to engaging staff on sustainability and eco-innovations for SMEs, as this could cause a multiplier effect of benefits received from sustainability.
    - A funding tool to track and alert SME owner-managers of funding opportunities that they could potentially access and create opportunities to collaborate with other businesses and support agencies (SMEs need all the support and resources available).

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Appendix A: The FutureSME project

The FutureSME project

This research was funded by the European Commission Framework 7 project, *futureSME*. The aim of the project was to develop new manufacturing models for Small and Medium Enterprises (SMEs) in Europe and to enable them to be more competitive. The lead partner on the project was the University of Strathclyde, based in Glasgow, Scotland, led by Professor Umit Bititici, Director of the Strathclyde Institute for Operations Management and the Professor of Technology and Enterprise Management at the University. There were two main types of partners, those involved in research and development and SMEs representing end-users.

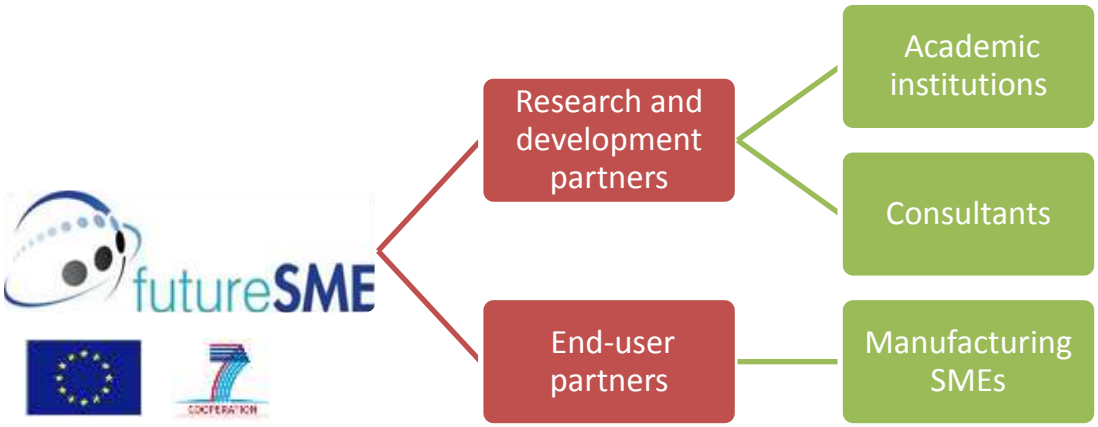


Figure 1: Types of partners in FSME

The FutureSME consortium

The consortium consisted of 26 partners in total, 13 working in the area of research and technology development (RTD) including GMIT. The other 13 partners were manufacturing SMEs, representing the end-users, responsible for testing and validating the project outcomes, to ensure they are of practical use to SMEs generally. The partnership was spread across 8 European countries: Czech Republic, Ireland, Italy, Poland, Turkey, Slovakia, Sweden and the UK. For a full list of consortium members, see Table 1.

Future SME Consortium		
Partner Name	**Role**	**Country**
University of Strathclyde	RTD (lead partner)	UK
Lean Enterprise Institute Polska (LEIP)	RTD	Poland
Galway-Mayo Institute of Technology (GMIT)	RTD	Ireland
Chalmers Tekniska Hoegskola AB	RTD	Sweden
Tsunami Training Ltd.	RTD	Ireland
Scottish Enterprise – (Scottish Manufacturing	End-user	UK

Future SME Consortium		
Partner Name	**Role**	**Country**
Advisory Service... SMAS)	(Business support organisation)	
Supply Network Shannon (SNS)	End-user (business network)	Ireland
Ernst & Young Business School (previously RSO)	RTD	Italy
Simply Collaboration Ltd.	RTD	UK
Atlantic Simulation & Training Technologies ltd (Astech)	RTD	Ireland
Lalui Leadership SRO	RTD	Czech Republic
Forel International School	RTD	Slovakia
Technical University of Ostrava (VSB)	RTD	Czech Republic
Roche Manufacturing Ltd. (RoCo)	End-user (SME)	Ireland
Eirebloc Ltd.	End-user (SME)	Ireland
Houston Co-pack Ltd.	End-user (SME)	UK
Linn Products Ltd.	End-user (SME)	UK
Nimbus srl	End-user (SME)	Italy
Crea-Si	End-user (SME)	Italy
Perfecta Centrum Reklamy	End-user (SME)	Poland
Black Point Spolka Akcyjna	End-user (SME)	Poland
NAM System as	End-user (SME)	Czech Republic
Ingeteam	End-user (SME)	Czech Republic
Akyuz Plastic Sam Ve Tic AS	End-user (SME)	Turkey
Deka Elektroteknik	End-user (SME)	Turkey
Friterm Termik Cihazlar Sanyi ve Ticaret AS	End-user (SME)	Turkey

Table 1: Project partners/beneficiaries

The FutureSME project plan

The project launched in January 2009, with the GMIT postgraduate programme starting in mid 2009. The work on the project was carried out by the 13 research and development partners, and was divided into different stages called 'work packages' (WPs) as illustrated below in Figure 2.

Initial research in WP1 set out to identify the particular areas of interest relevant to SMEs in Europe. WP2 involved more in depth research into the selected areas as well as drafting production model architecture relevant to SMEs. Detailed specifications were drawn up based on user needs. WP3 adapted these specifications which were developed into pilot methodologies and related tools. Following initial testing of the pilot tools by the SMEs within the futureSME consortium, these tools and methodologies were further developed into a prototype model (WP4), and were translated into local languages in the partner countries (WP5). A programme for schools was carried out for WP6.

A stage-gate review process occurred at the end of these WPs to ensure the needs of SMEs were met in a usable and practical way. Most of the WPs worked in sequence, but WP8 Project Management and WP7 Valorisation, happened in parallel, as well as various dissemination activities.

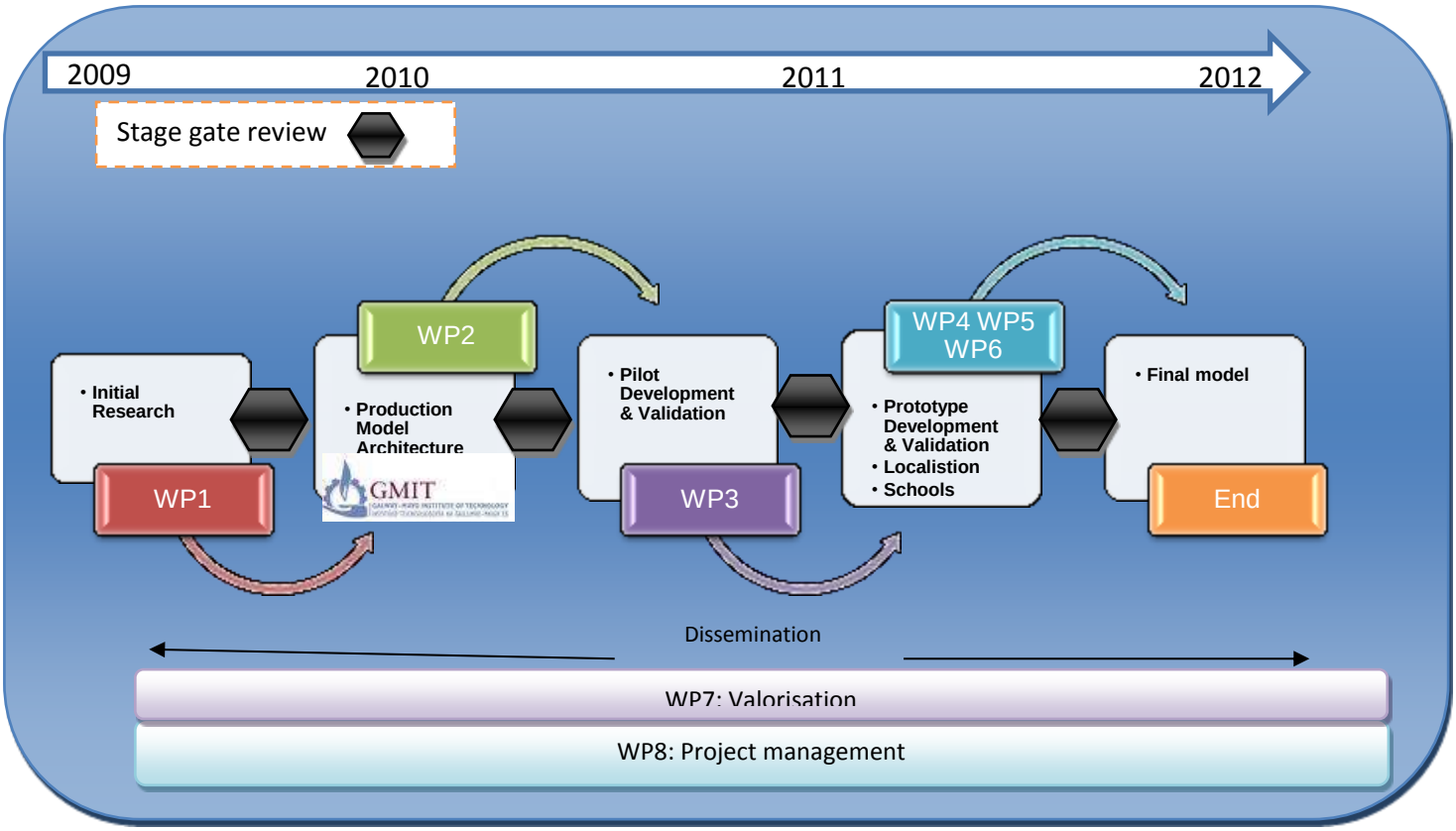


Figure 2: The FutureSME project plan

GMIT's role in the FutureSME project

The futureSME consortium researched various areas relevant to SMEs, with Strathclyde University being responsible for the project management. As an RTD member of the project, GMIT participated in the monthly technology board meetings (TBMs), which were convened (mainly) online. GMIT organised and hosted the second futureSME all-partner meeting and SME seminar in GMIT in September 2009. GMIT was also responsible for the co-ordination of WP2. This involved liaising with all futureSME partners, synthesising their research outputs towards the publication of the futureSME production model draft architecture, for the third all-partner meeting in Rome in March 2010.

The main role of GMIT was to develop innovative methods, tools and systems related to environmental performance, in order to assist SMEs with proactively incorporating best practices within their companies. This included environmental regulation compliance capabilities, education on awareness of the impact their business activities have on the environment with tools to suit their needs.

The FutureSME philosophy

> *"The FutureSME needs to be an open minded, energetic and empowered organisation that is continuously adapting, changing and evolving within its global network. It produces rapid and innovative responses to opportunities and threats as they emerge within its operating environment"*
>
> Future SME Consortium (FutureSME, 2011)

A fundamental principle emerged from the research carried out by the FutureSME consortium - that the future is uncertain and unpredictable; trying to come up with prescriptive business models for SMEs would be unrealistic and unachievable. The only business models that can and should be considered are ones that develop an SME's capability to continuously evolve and adapt to the emerging environment (Bititci, et al., 2010).

The key to an SME reaching this goal is by becoming an *adaptive enterprise*. Adaptive enterprises are

> *"... High value focused firms that are operationally excellent and demonstrate high levels of resilience with the ability to transform its business model in response to opportunities and threats in their operating environment"*
>
> *Umit Bititici* (FutureSME, 2011).

To become an *adaptive enterprise*, an SME needs to develop strategic, operational, managerial as well as adaptive capabilities to deliver success for their businesses. The futureSME project aimed to improve SMEs in these four capability areas, in particular focused on the mental models and mind-sets of the SME, and using methods, tools and techniques to implement this change (Scottish Enterprise, 2011).

'Adaptive capability' helps an SME to become more sustainable. It is defined as the ability to mobilise the managerial, operational and strategic capabilities in an integrated way - to identify and evaluate the significance of emerging opportunities and threats coupled with the ability to formulate and implement innovative responses, rapidly reconfigure and change the organisations resource base, in order to adapt to and shape the emerging environment (FutureSME, 2011). The characteristics of an adaptive enterprise are

- Strategic, operation and managerial capabilities are prerequisites
- Change is part of the culture
- Employee empowerment
- Continuous improvement
- Visual management
- Scanning the external environment for opportunities and threats
- On-going strategic review
- The practice innovation throughout the organisation

FutureSME outputs

The main output of the futureSME project is:

1. A model for transforming SMEs, which is an accredited methodology to manage change within SMEs, and to allow them to be an *adaptive enterprise.*

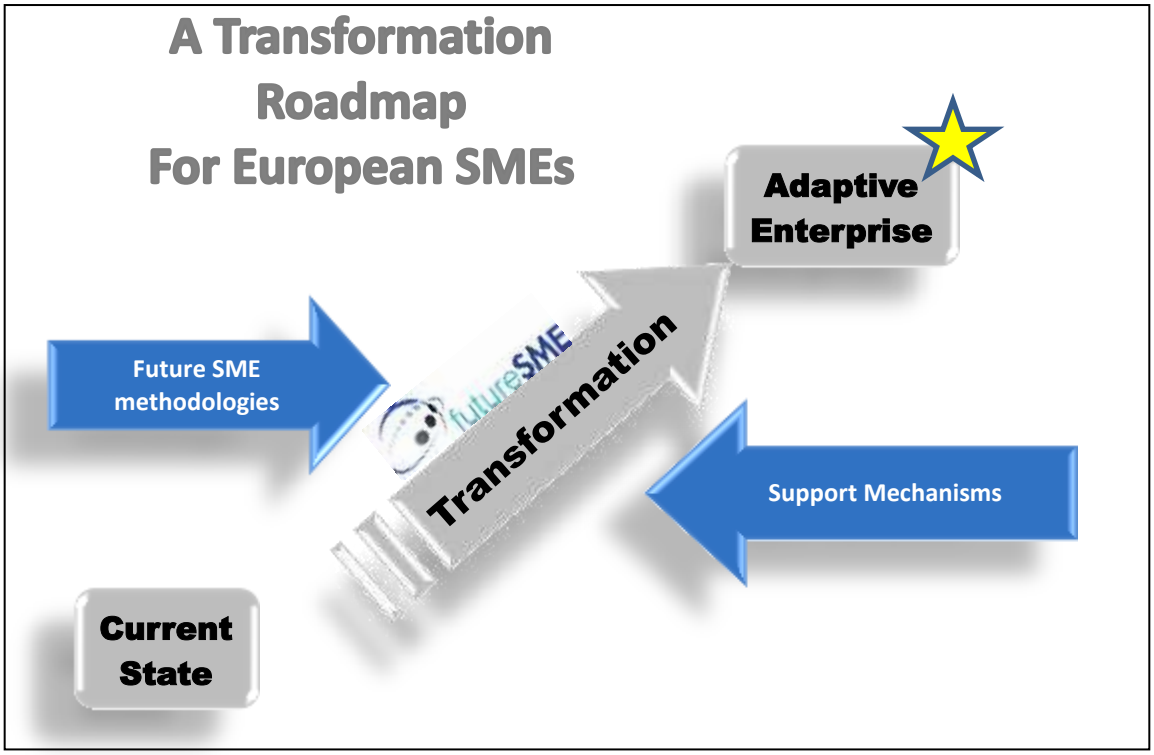


Figure 3: FutureSME Transformation model

2. A FutureSME public web page with free information, introductory tools and videos

Figure 4: FutureSME public web page www.futuresme.eu

3. FutureSME members web portal – registration required to access the ‘apps store’, which contains tools, eLearning, manuals.

Figure 5: FutureSME members’ area web portal

4. The FutureSME Capability Development Programme -3-day programme for SMEs piloted in Scotland, and due to be piloted in Italy, Poland and the Czech Republic

5. Various publications and dissemination activities.
6. Tools, methodologies and eLearning in the four capability areas

How FutureSME works

FutureSME developed a process to transform SMEs in a four step process as seen below in Figure 6:

1. **Problem**: An SME starts with a particular issue, which could be a problem or an opportunity that it needs help with
2. **Assessment**: A rigorous facilitated diagnostic process is carried out with the management team
3. **Tools**: The necessary tools and supports are given to the SMEs for them to implement and build their capacities in the capability areas
4. **Holistic Growth**: Continuous evaluation from a strategic level will help sustain the capabilities and the business towards holistic growth

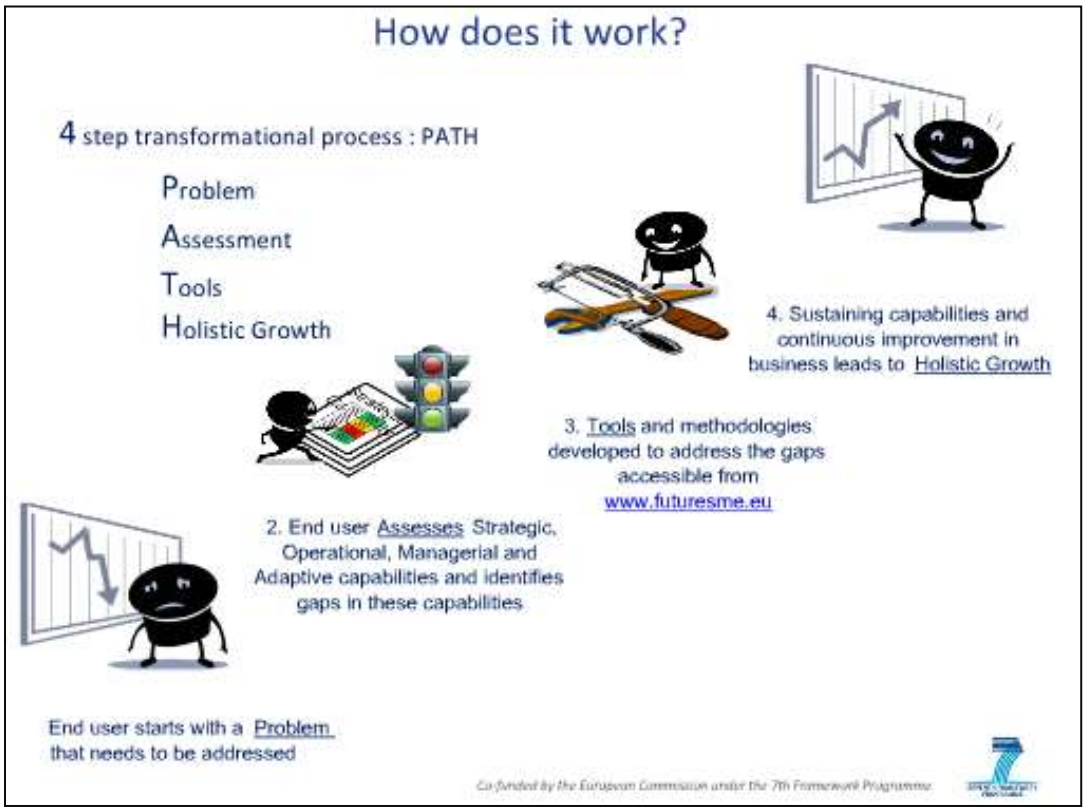


Figure 6: The FutureSME transformational PATH

The outputs from the research are built into the futureSME web portal. This can either be accessed by SMEs themselves, or through business support organisations, consultants or advisors. Once registered, the online resources are arranged around the capability areas. Each capability area has a number of sub content areas. For example, strategic capability has five sub areas, which are; (1) visual strategy, (2) high-value manufacturing, (3) operating model, (4) finance and (5) business sustainability. The content developed by the GMIT is located in the business sustainability area.

Figure 7: Screen shot showing where the GMIT's business sustainability content is located

For more information, visit www.futuresme.eu.

Appendix B: List of manufacturing SMEs, agencies and activities related to the research

Table 2 lists the 28 research-related industry involvements with manufacturing SMEs

Table 3 lists the 30 specialists and support organisations consulted with throughout the process

Error! Reference source not found. summaries 21 publications, policy engagement, consultations, collaborations and the dissemination channels.

Table 2: Manufacturing SMEs engaged with

	Company	FSME partner Yes/No	Manufacturing Industry Sector	Aim of interaction/ research activity	Location	Year(s)
1.	Eirebloc	Yes	Manufacturing of wood products	Surveys, interviews, focus groups, testing of individual tools, stage gate reviews	Macroom, Co. Cork	2009-2012
2.	RoCo	Yes	Bespoke machinery manufacturing, particularly for the construction and agriculture sector	Surveys, interviews, focus groups, testing of individual tools, stage gate reviews	Mountbellew, Co. Galway	2009-2012
3.	BlackPoint	Yes	Re-manufacturing of high quality printer cartridges	Surveys, stage gate reviews	Poland	2009-2012
4.	NAM Systems	Yes	Technology and services for mobile tracking	Surveys, stage gate reviews	Czech Republic	2009-2012
5.	Akyuz	Yes	high quality plastics housewares, kitchenware & garden furniture	Surveys, Testing of eLearning, stage gate reviews	Turkey	2009-2012
6.	FriTerm	Yes	Specialized finned heat exchangers	Surveys, stage gate reviews	Turkey	2009-2012
7.	Crea-Si	Yes	Prototypes for the fashion industry	Surveys, stage gate reviews, testing tools	Italy	2009-2012
8.	Nimbus	Yes	Aeornautical systems for civil applications	Surveys , stage gate reviews	Italy	2009-2012

	Company	FSME partner Yes/No	Manufacturing Industry Sector	Aim of interaction/ research activity	Location	Year(s)
9.	Houston Bottling & Co-Pack	Yes	Whiskey bottling and packing	Surveys , stage gate reviews, testing	UK	2009-2012
10.	DEKA	Yes	White goods	Surveys , stage gate reviews	Turkey	2009-2012
11.	Perfecta	Yes	Point of sale products	Surveys, stage gate reviews	Poland	2009-2011
12.	Linn	Yes	Highend hifi systems and music recording	Surveys, stage gate reviews	UK	2009-2012
13.	Ingeteam	Yes	Industrial control systems	Surveys, stage gate reviews	Czech Republic	2009-2012
14.	EDUVision	No	High tech education equipment	Case Study	Ireland	2010-2012
15.	Naughton Kitchens	No	Furniture manufacturing	Testing of tools, SEco Framework, interviews, case study	Co. Roscommon	2012
16.	Thormac Engineering	No	Plastics	Surveys, Testing of tools, SEco Framework, interviews	Shannon, Co. Clare	2011-2013
17.	Advanced Technical Concepts	No	Plastics	Surveys, research for conference paper, interview, tool development	Shannon, Co. Clare	2011
18.	Larkin Engineering	No	Street furniture	Surveys, interview, tool development, testing of tools	Tuam, Co. Galway	2011-2012
19.	Rocsommon Chocolate Company	No	Food manufacturing	Interview, SEco development , testing, case study	Four Roads, Co. Roscommon	2012-13
20.	JFDesign	No	Interior architecture	Testing of tools	Athlone, Co. Westmeath	2012-13
21.	iQuTech	No	Electronics - reverse logistics	Testing of tools, interviews, case study	Limerick	2012-2013
22.	RTR Electronics	No	Electronics	Testing of tools, SEco Framework, interviews, case study	Limerick	2011-2013
23.	The CityBin Company	No	Waste management	Waste management in SMEs research, developing waste reporting tool	Oranmore	2010-2011
24.	Pharma	No	Bespoke stainless	Testing of tools	Sligo	2012

	Company	FSME partner Yes/No	Manufacturing Industry Sector	Aim of interaction/ research activity	Location	Year(s)
	Stainless		steel for pharma use			
25.	JBFoods	No	Food manufacturing	Testing of tools, SEco Framework	Leitrim	2011-2013
26.	Chimneysafe	No	Safety, products	Testing and development of tools	Portumna, Co. Galway	2012
27.	Aaron PCB	No	Electronics	Testing and development of tools, SEco Framework testing	Shannon, Co. Clare	2013
28.	Aqua Design	No	Precision engineering design and build	Testing and development of tools, SEco Framework testing	Kilorglan, Co. Kerry	2013

Table 3: Other industry involvement

	Organisation Name	FSME partner Yes/No	Organisation Type	Aim of interaction/ research activity	Country	Year
1.	Supply Network Shannon	Yes	Business Network	Access to SMEs, Stage gate reviews	Ireland	2009-2014
2.	Galway City Council	No	Business Support Organisation	Research on supports to SMEs	Ireland	2011
3.	GreenBusiness.ie	No	Business Support Organisation	Research on supports to SMEs	Ireland	2009-2012
4.	SEAI	No	Academia	Research on supports to SMEs	Ireland	2011
5.	Organisation of Responsible Business	No	Consultancy	Research on supports to SMEs	UK	2012
6.	Business in the Community, Ireland (BITC)	Now	Non-Governmental Organisation/ Business Support Organisation	Research on supports to SMEs	Ireland	2010-2012
7.	SMILE Resource Exchange	No	Business Support Organisation	Research on supports to SMEs	Ireland	2010-2013
8.	Tsunami	Yes	Consultancy	eLearning development,	Ireland	2009-2012

	Organisation Name	FSME partner Yes/No	Organisation Type	Aim of interaction/ research activity	Country	Year
				instructional design		
9.	Ernst & Young	Yes	Consultancy	Access to EC activities, developing testing methodologies	Italy	2009-2012
10.	Astech	Yes	Software firm	FutureSME project	Ireland	2009-2012
11.	Limerick Co. Council	No	Business Support Organisation	Waste management research, access to SMEs	Ireland	2011-2014
12.	MacroomE	No	Business Support Organisation	Research on supports to SMEs	Ireland	2011-2014
13.	Lalui Leadership	Yes	Consultancy	Research on supports to SMEs, development of tools	Ireland	2009-2012
14.	Lean Enterprise Institute Poland (LEIP)	Yes	Consultancy & Educational	Testing activities	Poland	2009-2012
15.	Scottish Enterprise	Yes	Business Support Organisation	Research on supports to SMEs	Scotland	2009-2012
16.	Environmental Protection Agency	No	Government regulator	Research on supports to SMEs, waste management research	Ireland	2011-2012
17.	Global Reporting Initiative	No	Non-Governmental Organisation	Research on supports to SMEs	Global	2012
18.	Roscommon Enterprise Board	No	Business Support Organisation	Research on supports to SMEs, access to SMEs to carry out research	Roscommon	2011-2012
19.	Simply Collaboration	Yes	Consultancy	FutureSME project	London	2009-2012
20.	JuanVillaMayor	No	Consultancy	Research on CSR supports to SMEs	Spain	2012
21.	Coethica	No	Consultancy	Research on CSR supports to SMEs	Liverpool	2012
22.	European Commission – Environment – ECAP – Brussels	No	European Commission	Research on supports to SMEs in EU (EMS and legislation compliance)	Brussels	2010
23.	European Commission – Environment –	No	European Commission	Research on supports to SMEs in EU (EMS and legislation	Brussels	2011

	Organisation Name	FSME partner Yes/No	Organisation Type	Aim of interaction/ research activity	Country	Year
	ECAP – Capacity Building Ireland			compliance)		
24.	University of Strathclyde	Yes	Academic	PhD peer support	Glasgow	2009-2012
25.	DesignCore Carlow IT	No	Academic	Research on sustainable design supports to SMEs , PhD peer support	Ireland	2011-2013
26.	Better CSR Advice to SME	No	EU Project	Sharing and learning research findings, and practices	Berlin	2012-2013
27.	University of Limerick	No	Academic	Presentation of research findings, guest lecturing	Limerick	2012-2013
28.	Chalmers Technology, Gothenburg	Yes	Academia	Presentation of research findings, PhD peer support	Gothenburg	2009-2012
29.	Institute of Industrial Engineers	No	Institute	Research on supports to SMEs	Waterford	2011
30.	Limerick Institute of Technology	No	Academia	Research on supports to SMEs , sustainable manufacturing, providing advice	Limerick	2013

Table 4: Publications, policy engagement and dissemination

	Details	Year	Type of engagement	Country
1.	Athone IT, posterfest, 2009 'Future Industrial Models for SMEs. Dimache, A., Mitchell, S., O'Dowd, P., & Harvey, N.	2009	Academic poster festival	Ireland
2.	Environmental Compliance and Assistance Programme, Capacity Building, Limerick, 2009	2009	Capacity Building for business support organisations supporting SMEs	Ireland (as part of an EC Initiative)
3.	Mitchell, S., O'Dowd, P., &	2010	Peer-reviewed conference paper	Ireland

	Details	Year	Type of engagement	Country
	Dimache, A. (2010). Environmental challenges and opportunities for European manufacturing SMEs. *International Manufacturing Conference 27.* Galway: GMIT.			
4.	Dimache, A., Mitchell, S., & O'Dowd, P. (2010). TRAPSS (Transition along the product-service system route)- a smart solution for manufacturing SMEs. *International Manufacturing Conference 27.* Galway: GMIT.	2010	Peer-reviewed conference paper	Ireland
5.	ECAP Final evaluation meeting of ECAP programme, European Commission, Brussels, 2010	2010	EC Programme Evaluation	Belgium
6.	The Issue of waste in European Manufacturing SMEs. *13th International Waste Management and Landfill Symposium.* Cagliari, Sardina, Italy. Mitchell, S., Dimache, A., & O'Dowd, P. Roche, T. (2011).	2011	Peer-reviewed conference Paper (awarded "Best paper on waste management policy")	Italy
7.	Business Sustainability Methodology for European Manufacturing SMEs. *1st International Conference on Sustainable Intelligent Manufacturing.* Leiria, Portugal. Dimache, A., Mitchell, S., & O'Dowd, P. (2011).	2011	Peer-reviewed conference paper	Portugal

	Details	Year	Type of engagement	Country
8.	RX3 Seminar – GMIT provides a guest speaker on Life Cycle Analysis & business, Galway, 2011	2011	Awareness raising seminar for SMEs	Ireland
9.	SME advisors on CSR, Invited participant for knowledge sharing, Berlin 2012	2012	Knowledge sharing conference	Germany
10.	GMIT, Letterfrack, Guest Speaker, *SMEs and waste management, 2012*	2012	Guest Lecture on SMEs and waste management	Ireland
11.	Kemmy Business School, UL, Guest Speaker, *SMEs and CSR 2012*	2012	Guest lecture on SMEs and sustainability	Ireland
12.	Kemmy Business School, UL, Part time lecturer, *Corporate Social Responsibility* for Masters students	2013	Lecturer on CSR	Ireland
13.	Presentation for the South West Regional Authority in Cork City Council Chambers to the DESUR European Project to a Spanish and Irish consortium focused on knowledge sharing of CSR in SMEs and relevant support structures	2013	Presentation on the Irish landscape on supports for SMEs	Ireland
14.	EPA Cleaner Green Production Programme – Resource Efficiency in the Supply Chain	2013	Presentation at seminar titled “	Ireland
15.	EPA Cleaner Green Production Programme – Resource Efficiency in the Supply Chain	2013	Presentation at seminar titled “	Ireland
16.	EPA Cleaner Green Production Programme – Resource Efficiency in the Supply Chain	2013	Sustainability Reporting for SMEs	Ireland
17.	EPA Cleaner Green Production Programme –	2014	Presentation at seminar titled “Resource	Ireland

	Details	Year	Type of engagement	Country
	Resource Efficiency in the Supply Chain		Efficiency in the Supply Chain"	
18.	EPA Green Enterprise Project – Southern region workshop in Tralee	2014	Awareness raising, knowledge gathering workshop for SMEs on communicating sustainability practices to their customers	Ireland
19.	EPA Green Enterprise Project – Southern region workshop in Cork	2014	Awareness raising, knowledge gathering workshop for SMEs on communicating sustainability practices to their customers	Ireland
20.	EPA Green Enterprise Project – Southern region workshop in Waterford	2014	Awareness raising, knowledge gathering workshop for SMEs on communicating sustainability practices to their customers	Ireland
21.	EPA Green Enterprise Project – Southern region workshop in Kilkenny	2014	Awareness raising, knowledge gathering workshop for SMEs on communicating sustainability practices to their customers	Ireland

Appendix C – Questionnaire used for Survey # 1

Section 1 – The SME and the environment

1. List the MAIN DRIVERS for your company as an SME in responding to environmental issues

_____

2. Where is the pressure coming from primarily?

☐ Competitors End users ☐ EU Directives ☐ Government agencies

☐ Government/Legislation ☐ Large customers ☐ Other (please specify) _____

3. What is the impact of environmental issues on your company?

☐ Constraints on business practices ☐ Cost increase ☐ No impact

☐ Product compliance issues and limitations ☐ Revenue decrease ☐ Revenue increase

☐ Other (please specify) _____

4. What is the most important environmental issue for your organisation?

☐ Emissions to air ☐ Emissions to water ☐ Energy Raw materials

☐ Transport ☐ Waste ☐ Water (consumption)

☐ Other (please specify)_____

5. What is the most influential legislation, directive or standard, affecting your organisation?

☐ Building Energy Rating for commercial buildings ☐ Carbon taxes ☐ ELV

☐ ISO14000 ☐ REACH ☐ WEEE ☐ Other (please specify)_____

Section 2 – Environmental Change: an opportunity or a threat?

6. Does your organisation view environmental change as an opportunity or a threat?

☐ Opportunity ☐ Threat ☐ Both ☐ Neither

6.a If you do view it as an OPPORTUNITY how you would you rate its impact?

☐ Minor/not much impact ☐ Average/some impact ☐ Major/a huge impact

☐ N/A - do not view as an opportunity

6.b If you do view it as a THREAT how you would you rate its impact?

☐ Minor/not much impact ☐ Average/some impact ☐ Major/a huge impact

☐ N/A - do not view as an threat

Please enter a comment to clarify if necessary

_____

7. Compared to other threats/opportunities currently facing your company, environmental change is....

○ of greater significance ○ as significant ○ of lesser significance

8. What has been the response of your organisation to these threats/opportunities?

☐ New Management Systems ☐ New products ☐ New staff or roles

☐ Physical changes to structures ☐ Strategies ☐ Other (please specify) _____

9. Do you use any of the following tools/methodologies?

☐ Design for the Environment (DfE) ☐ Life Cycle Analysis (LCA)

☐ Life Cycle Costing (LCC) ☑ Product Services System Offering

Section 3: Future plans

10. Do you have any future plans to benefit from the minimising environmental factors?

◉ No plans at present ○ Yes I have plans

11. Does your organisation have a policy in regard to broad environmental issues e.g. climate change, global warming, peak oil, Kyoto, carbon emissions, footprint and tax, etc?

○ No ○ Plan to in the next 12 months ◉ Yes, we have a policy

Please enter a comment to clarify if necessary

_____

12. Does your organisation presently measure your energy and water usage, waste or any other environmental indicators?

○ No ○ Yes

If "Yes" what do you measure?_____

13. Do you consider your organisation as a whole, fully aware of your environmental impact on the environment, and where possible reduces this impact?

○ No ○ Yes

Please enter a comment to clarify if necessary

_____

14. Looking forward 10-15 years, what future trends in the environmental area do you think will be most significant?

☐ Emerging technologies ☐ Resource shortages ☐ Rising costs

☐ Other (please specify)_____

15. What help does your SME need to deal with environmental issues?

◉ I do not need any help ○ I would like help with_____

16. What measures do you think the government and the EU should put in place to help SMEs deal with environmental change? (tick all that apply)

☐ Incentives ☐ Grants ☐ Training ☐ Other____

Appendix D – Questionnaire for Survey # 2

FutureSME Survey

* Required Question(s)

*** 1. Please enter the information indicated below.**

Job Title:

Country: -- Select a country --

*** 2. Please indicate your gender**

- Female
- Male

*** 3. What business sector do you operate in?**

50 characters left.

*** 4. How many employees are in your organisation?**

- 1- Just me
- 2-10
- 11-49
- 50-99
- 100-149
- 150-199
- 200-250
- 250+

* **5. What does the term "Social Responsibility" mean to you?**

1,000 characters left.

* **6. Considering the definition of "Social Responsibility" as...**

"The obligation of an organisation towards the welfare and interests of the society, which provides it the environment and resources to survive and flourish, and which is affected by the organisation's actions and policies"

...do you believe your company is "Socially Responsible"?

- Yes
- No

* **7. Why do you think your company is/is not "socially responsible"?**

350 characters left.

* **8. Would you like your company to be more "socially responsible"?**

- Yes
- No

* **9. If "yes" name three things you would like to change?**

If "no" why not?

350 characters left.

10. If you have any other thoughts on the issue, please include them here.

Appendix E - Questionnaire for Survey #3r

*Required Question(s) Progress:

*

Please enter the country your main business operations are based (if you operate in more than one country enter where the head office is).

Country: – Select a country –

*

How many people are employed in your business?

- 1- just me
- 2-9
- 10-19
- 20-49
- 50-99
- 100-149
- 150-199
- 200-250

*

What business sector applies to you?

50 characters left.

*

Are you?

- Female
- Male

*

What age range are you in?

- Under 30
- 31-40
- 41-50
- 51-60
- Over 60
- Prefer not to say

Is your primary business premises...?

- ○ Leased
- ○ Owned

What level of education did you complete?

- ○ No formal education
- ○ Primary education
- ○ Secondary/high school
- ○ Apprenticeship or technical qualification
- ○ University level education
- ○ Other

What influenced you to become the owner / manager of a business?

- ☐ To be my own boss/have an independent lifestyle
- ☐ It just happened/could not find a regular job
- ☐ Family influences (e.g. parents had a business)
- ☐ To make more money
- ☐ To be financially independent
- ☐ To fulfill my passions
- ☐ A windfall / came into money
- ☐ I am an inventor
- ☐ Other

*

Are you interested or concerned about environmental issues?

- [ ] Yes - it saves me money
- [ ] Yes - to ensure my family has a safe environment in which to live
- [ ] Yes - I am concerned about the environment in general
- [ ] No - I do not have the time to worry about it
- [ ] No - it costs me money
- [ ] No - this does not concern me at all
- [ ] Other

---

*

Select the MAIN concern you have around environmental issues

- ( ) It saves me money
- ( ) It will ensure my family has a safe environment in which to live
- ( ) I am concerned about the environment in general
- ( ) I do not have the time to worry about it
- ( ) It costs me money
- ( ) This does not concern me at all
- ( ) Other

---

*

Do you segregate your waste and recyle at home?

- ( ) Yes
- ( ) No
- ( ) Sometimes
- ( ) Other

Do you know if your business has an environmental impact?

- ○ Yes - I know exactly what impact I have and can back this up with with life-cycle data on my business activities
- ○ Yes- I know exactly what impact I have through other measures e.g. carbon footprint
- ○ Yes - I have some idea that we have some impact but do not measure this
- ○ No - I do not know what impact I have, but I would like to know
- ○ No - I do not know what impact I have and I don't really wish to know
- ○ Other

*

In your opinion, what impact does your business have environmentally?

1 Little or none	2 Some impact	3 Medium impact	4 More than average	5 A significant impact
○	○	○	○	○

*

Who is responsible for environmental practices, such as waste management?

- ○ Me as the owner-manager
- ○ Somebody else
- ○ Nobody in particular
- ○ Other

*

Rate from 1 - 5 how important waste is, in relation to your business?

1 Not important	2	3 Somewhat important	4	5 Very important
○	○	○	○	○

What waste practices are currently taking place in your business?

(tick all that apply)

- ☐ Actively reducing or eliminating waste
- ☐ Reuse of waste in some form
- ☐ Recycling
- ☐ Other Recovery (e.g. energy recovery)
- ☐ Disposal
- ☐ No waste management systems in place - all waste goes into one bin
- ☐ Other

*

Do you alter or treat your waste before collection?

- ☐ No
- ☐ Compacting (using dedicated machinery)
- ☐ Shredding materials (e.g. paper or textiles)
- ☐ Filtering (e.g. waste oil)
- ☐ Baling (e.g. baling cardboard or paper)
- ☐ Decontaminating (e.g. autoclaving potentially biohazaradous materials)
- ☐ Other

If you are involved in any other recovery (e.g. energy recovery) activities related to waste (not including recycling or reusing), please describe below

Do you re-use waste on site? (do not include recycling, this is covered in the next section)

(tick all that apply)

- ☐ Yes - I compost it
- ☐ Yes - I burn/incinerate it
- ☐ Yes - I reuse it in my processes
- ☐ Yes - I use it to make my products
- ☐ No - I don't re-use any of my waste on site
- ☐ Other

Comment:

500 characters left.

*

What do you reuse?

(tick all that apply)

- ☐ Paper
- ☐ Plastic
- ☐ Wood
- ☐ Cardboard
- ☐ Green waste (such as food or garden waste)
- ☐ Agricultural or animal by-products
- ☐ Textiles
- ☐ Construction waste
- ☐ N/A We don't reuse waste in our business
- ☐ Other

Comment:

500 characters left.

*

What percentage of waste is re-used?

- ○ None
- ○ 1-24%
- ○ 25-49%
- ○ 50-74%
- ○ 75-100%
- ○ Don't know

How is 'general waste' (unsegregated material going to landfill) collected from your premises?

(tick all that apply)

- ☐ Local council /government authority waste service
- ☐ Private waste contractor
- ☐ I bring it home
- ☐ I take it myself to a a collection site
- ☐ Other

---

*

What percentage of your waste is general waste?

- ○ None - all waste is reused, recycled or recovered
- ○ 1-24%
- ○ 25-49%
- ○ 50-74%
- ○ 75-100%
- ○ Don't know

---

*

On average, how much general waste is generated in your business per week?

(tick all that apply)

- ☐ None
- ☐ 1 x 240litre (domestic size wheelie bin) per week
- ☐ 2 - 4 x 240litre (domestic size wheelie bin) per week
- ☐ 5 or more x 240litre (domestic size wheelie bin) per week
- ☐ 1 x 1100litre (industrial size bin) week
- ☐ 2-4 x 1100litre (industrial size bin) per week
- ☐ 5 or more x 1100litre (industrial size bin) per week
- ☐ 30-40 bin-bags (1 x small skip) per week
- ☐ 50-60 bin-bags (1 x regular size skip) per week
- ☐ 60-80 bin-bags (1 x large skip) per week
- ☐ 80-100 bin-bags (1 x maxi skip) per week
- ☐ 100-120 bin-bags (1 x extra large skip) per week
- ☐ Don't know
- ☐ Other

*

How are 'recyclables' (material NOT going to landfill) collected from your premises?

(tick all that apply)

- ☐ Local council /government authority waste service
- ☐ Private waste contractor
- ☐ Through a charity
- ☐ Supplier takeback
- ☐ I take it myself to a a collection site
- ☐ I bring it home
- ☐ N/A all our waste goes into one bin and is not recycled
- ☐ Other

Comment:

500 characters left

*

On average, how much recycling waste is generated in your business per week?

(tick all that apply)

- ☐ None
- ☐ 1 x 240litre (domestic size wheelie bin) per week
- ☐ 2 - 4 x 240litre (domestic size wheelie bin) per week
- ☐ 5 or more x 240litre (domestic size wheelie bin) per week
- ☐ 1 x 1100litre (industrial size bin) week
- ☐ 2-4 x 1100litre (industrial size bin) per week
- ☐ 5 or more x 1100litre (industrial size bin) per week
- ☐ 30-40 bin-bags (1 x small skip) per week
- ☐ 50-60 bin-bags (1 x regular size skip) per week
- ☐ 60-80 bin-bags (1 x large skip) per week
- ☐ 80-100 bin-bags (1 x maxi skip) per week
- ☐ 100-120 bin-bags (1 x extra large skip) per week
- ☐ 1 Bale of recyclables (2 square metres) per week
- ☐ 2-5 Bales of recyclables (2 square metres) per week
- ☐ 5-10 Bales of recyclables (2 square metres) per week
- ☐ Don't know
- ☐ Other

Appendix F – ELEC-SME Sustainability Report

ELEC-SME

Sustainability Report 2012

Welcome address by Elec-SME owner manager, (name removed)

Hello there,

This is our first Sustainability Report, and it contains the details of our social responsibility efforts. This report is not a measurement, but a simple statement of our practices.

Through working with the FutureSME project, in particular on business sustainability, we are realising that many Small and Medium Enterprises (SMEs) are more socially responsible than they think. We have collected our responsible business practices to share with our employees, customers, suppliers, local community and whoever else might be interested.

We have never thought of doing a Sustainability Report before, but on reflection it has been a positive experience. It has allowed us the opportunity to communicate that the most important success factor for our business over the years has been that of honesty in everything that we do.

As an SME we realise that the cumulative efforts of smaller companies can make a big difference. We would encourage other SMEs to share their efforts too.

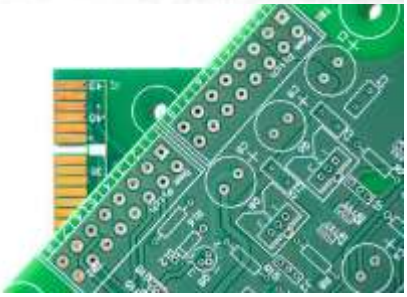
Owner-manager.

Headshot of Elec-SME owner-manager

"The most important success factor for our business over the years is **honesty** in our business practices".

Company Profile

No of Employees:	14
Our main operations are:	Electronics manufacturing, screening and asset recovery.
Location:	Mid-West Region



Layout of report

This report contains our responsible practices that we would like to communicate about our employees, the environment, our marketplace and the community. These practices are a result of the values by which we work.

Our Vision and values statement

Our Vision is

To provide the electronics industry with Best-in-Class manufacturing solutions

Our Mission

We aim to achieve our vision through our professionalism, enthusiasm, highly skilled workforce and dedication to quality and service.

Our Values/What we believe in

Honesty

Dedication

Professionalism

Enthusiasm

Quality

Integrity

Our Employees and workplace polices

Training and development	
Current activities	**Future plans**
We encourage and fund employee training to improve their skills in the electronics manufacturing industry.	We aim to continue to support our employee development and training skills, which will be driven by demand required in the industry.

Communication	
Current activities	**Future plans**
We communicate with all our employees on a regular (weekly) basis on quality and customer requirements, as well as general company and marketplace activities.	We will continue to maintain our transparency and trusting relationships with our employees, by keeping them all frequently informed of what is happening and how the company is doing.

Health and Safety	
Current activities	**Future plans**
We have assessed workplace risks and hazards of our operations, and have published a Health and Safety Statement for the workplace.	We review our Health and Safety Statement every 3 years, and continue to provide a safe workplace for our employees.

Our Employees and workplace polices

Work-Life Balance	
Current activities	**Future plans**
We support flexible working hours where possible so employees can work up time to fit their personal and family requirements.	We continue to promote a good work-life balance with our employees.

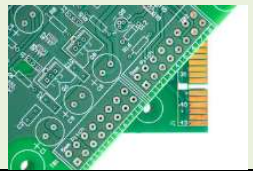
Workplace Discrimination
We always have, and continue to ensure, that no person is discriminated against based on any of the nine grounds outlined in the The Employment Equality Act, 1998 and the Equal Status Act, 2000*. This includes our recruitment process and day-to-day working activities.

**Discrimination is described in the Acts as the treatment of a person in a less favourable way than another*

Our Environmental Practices

Environmental Efficiencies These measures help us to save costs and reduce our carbon emissions.			
	Current activities	**Future plans**	
Energy 	We are conscious of our Energy consumption, in particular our soldering equipment which has a heating element. When sourcing new equipment we continue to assess the energy demand and choose the most efficient one. This reduces our carbon footprint, as well as reducing our overhead costs in the long run.	There are plans to audit the lighting in our facility and associated power consumption, with a view to reducing our energy demand further.	
Waste 	Very little waste is produced in our operations. Many of our sub-assembly parts are packed in reusable containers. We reuse all packaging. All office paper is recycled.	We will continue to strive to reduce the little waste that we do produce.	
Transport 	To minimise our transport costs, and associated emissions we have reduced the number of shipments per week.	We continue to monitor our shipments and consolidate where we can.	
Pollution 	We use lead-free components, and comply with all electronics legislation related to the industry.	*Biodiversity* 	Our operations have little or no impact on the surrounding biodiversity.

Our Environmental Practices

Designing for the environment		
We manufacture products that have been designed by other companies, but still influence the design.		
	Current activities	**Future plans**
Advisory role 	Our knowledge of electronics manufacturing allows us to advice our clients on best practices to minimise components necessary, thus reducing raw material requirements.	We will continue to act in an advisory role and contribute to better designed products and processes that minimise resource use. We have plans to support clients who wish to design a 'greener product'.
Processes 	We design our processes in a way that minimises energy consumption and waste.	We strive to continuously improve our processes to have a lesser environmental impact.
Sourcing 	We source the majority of our components locally, so they don't need to travel many miles to get to us. As they are quite close, we also know that these products have come from a clean environment with good workplace practices.	We will continue to maintain our good supplier relationships and source components from local suppliers where possible.
Repair, Rework & Recover 	We provide a repair, rework and recovery service for electronic circuit boards. These services reduce the need for virgin materials to be sourced to manufacture new products.	We continue to master our expertise in the repair, rework remanufacture area. This allows us to extend our business offering but has major environmental benefits also.

Our Environmental Practices

Environmental declarations		
	Current activities	**Future plans**
Website 	We are planning to publish our sustainability report on our website. This will allow us to communicate our good environmental practices, but also to encourage other SMEs to do similar.	We are currently undergoing a process with the FutureSME project to identify opportunities in eco-innovation.

.

Our Marketplace Practices

Our Policies	
Customers	• Customer warranties and agreements are transparent, clearly laid out and easy to understand. • We visit our customers every month to receive feedback and to talk about any opportunities that may be of mutual interest.
Advertising	• We are and open in all our business advertising. • We outline our capabilities honestly – in fact honesty is a key success factor in our business.
Suppliers	• We ensure timely payment to our suppliers; our policy is to pay invoices on the same day each month.
Networks	• We are working with a research project, futureSME to learn and promote successful business practices in manufacturing SMEs, including social responsibility in smaller organisations. • We are a member of Shannon Network Supply, an industry-led business network, to promote, develop and connect companies in the Shannon region of Ireland. • We regularly engage with the local authority's environmental support to help improve our business practices.

Community Involvement

Employment

- *We have taken on students for work experiences from secondary schools in the past.*
- *Our ongoing responsible business practices have ensured the survival and continuation of our business during the economic downturn of the last few years. Despite the fact that the number of employees has decreased somewhat due to the recession, we still continue to provide skilled employment in the local area.*

Local Suppliers

- *We use local suppliers where possible such as:*
  - *Components –e.g. Embassy Components in Tipperary*
  - *Printed Circuit Boards e.g. ShipCo in Cork*
  - *Solders – SVS based in Galway*
- *We will continue to support local industries, by using local suppliers where possible.*

Community Engagement

- *We sponsor local community projects, on an ad-hoc basis.*
- *In the past we have sponsored the drama club, camogie club and soccer clubs.*
- *We would be willing to have an open dialogue with community groups about our manufacturing facility if the need arose.*

A note from futureSME

This Sustainability Report was completed with the help of the futureSME project which waswas set up to develop the competitive capacity of European manufacturing SMEs. For the full online resource pack, go to www.futuresme.eu.

Sustainability & Social Responsibility in SMEs

Social responsibility is not a new concept in European SMEs. It is estimated that around half of all SMEs are engaged in various activities within their communities. These include charitable donations to community projects, sponsorship for local football teams, working with non-profit organisations, and doing pro-bono work.

Expectations for sustainability come from your customers, your employees, government bodies, and other businesses with which you interact.

Many people think that social responsibility or corporate social responsibility is about large companies making extravagant donations to charities. Of course, what you are able to do is dependent on your size and budget, but it is mostly about running your business in a sustainable and responsible way. It is also about building relationships with your employees, suppliers, customers, and the community. What is in your Sustainability Report will be personal to you, and will depend on your size, operations, and location.

Communicating Sustainability in SMEs

Many SMEs are reluctant to communicate their socially responsible activities because they think this is just what large companies do, they are too modest to do so, or they simply have not considered it. You may not realise it, but many customers and your community ARE interested in what you are doing to be socially responsible. The exercise of communicating your socially responsible practices can make you and your employees feel proud about what you are doing, and can be good for company morale. In fact, it is argued that, when smaller companies communicate their good practices, it results in a bigger impact than when larger companies do the same thing. The reason for this is that smaller companies are usually closer to the community than larger ones.

An SME is not expected to be doing everything

As an SME, you are not expected to be involved in all areas of social responsibility and sustainability. Moreover, you are not expected to do all the things that larger companies are doing. Most SMEs are already involved in social responsibility and sustainability to some extent. A sustainability report from an SME will never be the same as one from a large company, or even other small companies. Do not focus on what other people are doing. Instead, reflect on what you are doing and what you plan to do in the future.

Be yourself, be transparent, and create your own sustainability report.

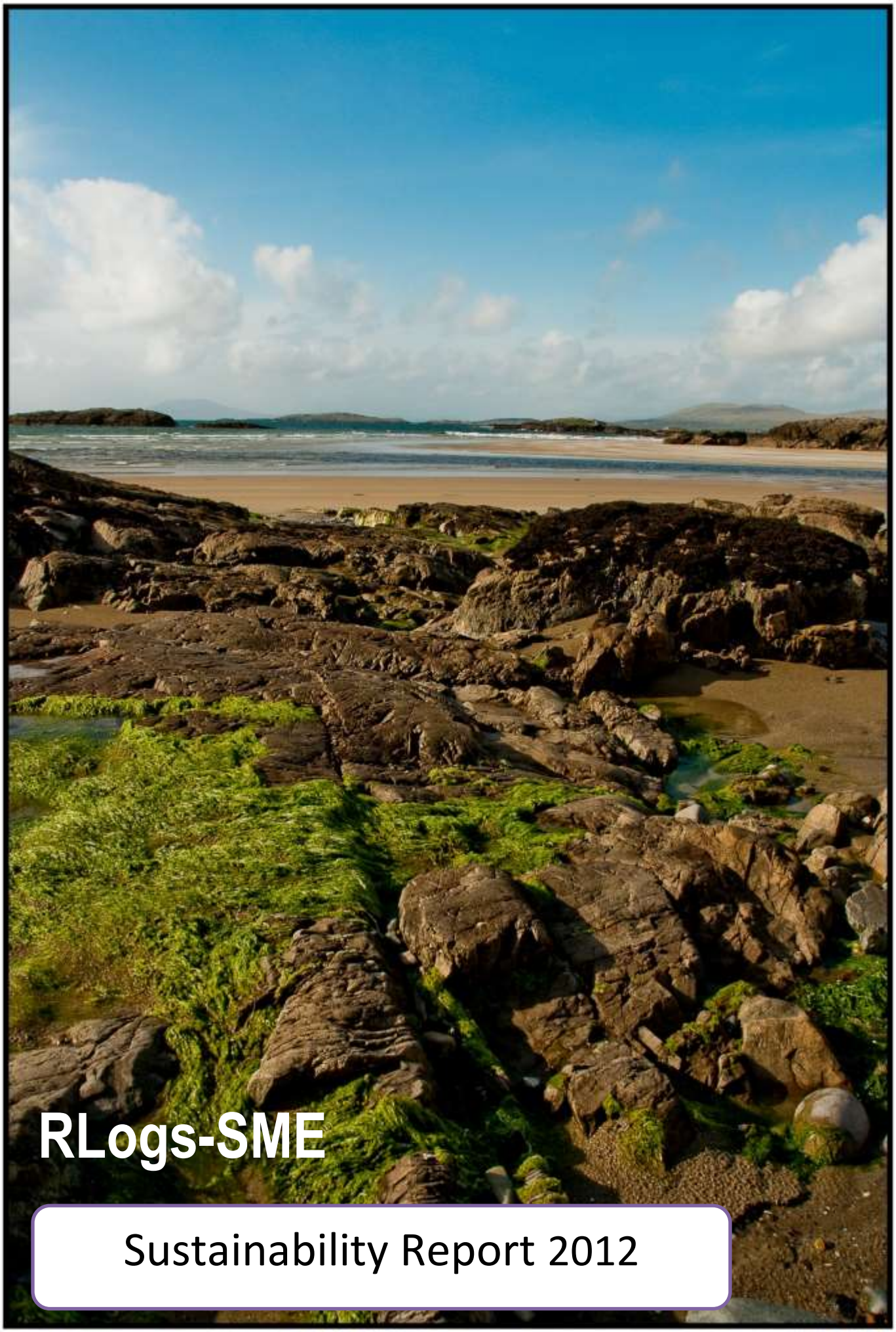
If you want further information....

Log on to www.futuresme.eu **to find out how you can**

- Complete a Social Responsibility Assessment
- Get a Sustainability Report Guideline
- Access various environmental learning tools and supports
- Access many other supports from visual strategy to innovation, which have been designed specifically for SMEs.

For more information on Business Sustainability and Social Responsibility visit www.futuresme.eu/businesssustainability

Appendix G – RLOGS-SME Sustainability Report



Sustainability Report 2012

Welcome address from the owner-managers

The process of generating this report has resulted in a surprising realisation – that by just "doing what we do", we are playing a significant role in the continued sustainability of electronic consumer goods. The services we provide enable many other companies to be more sustainable by maximising the life of consumer products. This in turn helps to minimise the use of the earth's finite and valuable resources.

Headshot of owner-manager #1

Photo of owner-manager #2

ϕWe realise that the electronics industry needs to follow a more sustainable pathϕ

Technology is advancing at such a fast rate. The Electricons Sector is currently the second largest growing industry in the world. Technology is helping better people's lives in amazing new ways every day.

However, we realise that the electronics industry needs to follow a more sustainable path. One of the big challenges for consumer electronics companies is to reduce their environmental impact. According to the EC, the sector has the largest potential for eco-innovations, which is why we have decided to start our own sustainability journey with this report.

ϕOur services play a significant role in the sustainability of electronic goodsϕ

Firstly, we aim to continuously improve our role in the recovery, repair and refurbishment of the products and their component parts. We are also investigating our own operations, and we are open to improvements and future collaborations with others.

Business Profile – Our Services

Reverse Logistics / Aftermarket Services

- Product Lifecycle Management, Technical Support, Call Centre, Field Service, CAR - Collect & Return, RFE – Return for Exchange, RMA – Returns Materials Authorization
- Re-manufacturing, Refurbishment, De-Branding, Recycling – Piece Part Harvesting & WEEE compliant disposal.

Mobility Sector - Product Configuration - ODM/Finished Product Services

- Inventory Balancing - BTO / Localisation / Regionalisation / Globalisation
- Prototyping – See Supply Network Shannon Outsource Cluster
- FAE / Account Management – Foreign Client Representation.
- EOL Product Management – "End of Life" Management – Batch Manufacturing, Refurbishment, Client service Continuity, eol product Reverse Logistics Management
- Excursion – Field Incident Management
- Software & Image Upgrades

Technical Value Add

- Product Configuration - ODM / Finished Product Services
- Prototyping – See our Outsource Cluster offering
- Pre manufacturing / Manufacturing Services:
- Excursion – Field Incident Management
- Reverse Logistics / Aftermarket Services

Non Technical Value Add

- Field Returns Consolidation & De-consolidation – RFE & RMA management. Re labelling – Packaging for EU / Local requirements.
- Over boxing – Retail bundle packaging for special events / offers.
- Kitting – Technical & Non Technical pick pack and ship operations.

Our Operations

Employees: 	Numbers vary considerably as per demand. Full Time permanent: 6 Contract Staff: 65 - 200
Our main operations: 	Rlogs-SME formed in 2009 when two specialist companies merged. We provide a wide range of after-sales services to the electronics-manufacturing industry, such as returns, repairs, refurbishment, customisation to local markets and managing product recalls for many multinational electronics manufacturers.
Location:	Headquarters: Limerick, Ireland Business Operations: Holland, Czech Republic, UK and Poland
For more information: 	www.ReverseLogistics.com Contact us for further information Tel: + 353 55 55555

Layout of report

This report contains our responsible business practices that we would like to communicate about

- Our employees,
- The environment,
- Our marketplace and
- The community.

These practices are centred on the values by which we work.

Our vision and values statement

Our Vision and values statement

Our Guiding Vision

To enhance the user experience of consumer electronics industry through the provision of best-in-class after-sales management and engineering services

ϕ We enhance the user experience for electronics consumers ϕ

Our Mission – *helping us to achieve our vision*

- Creating partnerships with our customers and be part of their solution, including on their sustainability journey.
- Providing our in-house RMA (Returns Material Authorisation) software system to make it easier for our customers to manage their product logistics
- Extending the product life-cycle of electronics through remanufacturing and refurbishments
- Participation in business networks, research projects enterprise support and development programmes.

ϕ We want to be best-in-class in aftersales management and engineering services ϕ

Our Values/What we believe in

Providing the highest quality service – nothing less than 100% is good enough

Building and sustaining very strong personal relationships with our customers

Being honest and good to our word, to deliver the highest quality possible

ϕ If it is not 100% right, it is not going out to the customer ϕ

Our employees and workplace policies

Our Employees and workplace polices

Training and development	
Current activities	**Future plans**
As a start-up company, we do not currently have a long-term plan in place for employees development. However, we do encourage and fund training and development for staff members when it is affordable and relevant to the business. 	We encourage everyone to be the best as what they do. We plan to keep up to date with staff development, and consider the long-term training strategies for our staff. We will try to facilitate the enhancement of careers within IQuTEch. ϕ We encourage everyone to be the best at what they do ϕ

Communication
• Our core team is quite small. We work closely together, so communication is an easy process. • We actively communicate the requirements for our products to be of the highest quality to all our temporary contracted staff. Our motto is "If it's not right, don't send it out to the customer", even if process induced damage occurs. This leads to an open and honest workforce. An operational mistake will not slip through the net to the customer because it is more important to have it 100% right. • All of our staff work to the customer's specifications, as a Standard Operating Procedure is used to communicate each order. 

ϕ We actively communicate the requirements for our products to be of the highest quality to all of our contracted staff ϕ

Our Employees and workplace polices

Work-Life Balance	
Current activities	**Future plans**
Employees maintain a good work-life balance. Due to the nature of our business, we need our workforce to be flexible and be prepared to work at short notice. As an employer, we are as flexible as possible to the needs of our employees and ensure they take holidays and realise time off for personal reasons may always be necessary.	As our business grows, we aim to remain open and flexible and a good place for employees to work.  ϕ *Continue being open, flexible and a good place to work* ϕ

Health and Safety	
Current activities	**Future plans**
On-the-job training is provided to all employees for maximum knowledge transfer of safety practices within our industry facilities. 	We will publish a new Health and safety statement in 2013. This aims to assess workplace risks for the protection of all our employees. 

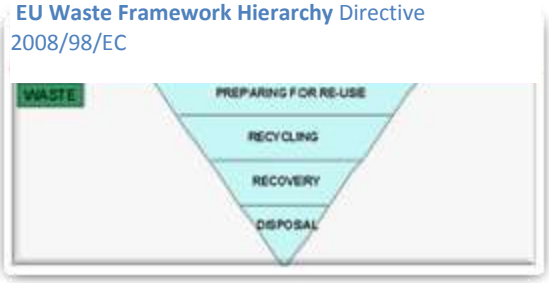
ϕ *On-the-job training provides knowledge transfer of safety practices* ϕ

Workplace Discrimination
We always have, and continue to ensure, that no person is discriminated against based on any of the nine grounds outlined in The Employment Equality Act, 1998 and the Equal Status Act, 2000*. This includes our recruitment and daily practices.

**Discrimination is described in the Acts as the treatment of a person in a less favourable way than another person is, has been or would be treated. The nine grounds are gender, civil status; family status; age; disability; race; sexual orientation; religious belief; and membership of the Traveller Community.*

Our environmental practices

Our Environmental Practices

Environmental Efficiencies These measures will help us to save costs and reduce our carbon emissions.		
	Current activities	**Future plans**
Energy 	***Building Energy consumption*** The design of our operations* ensures that we only utilise facilities and utilities when orders are received. Therefore we only consume the minimum amount of building energy when processing customers orders.  (*Our business model - leasing facilities on an hourly and space (m^2) basis when required.)	We plan to monitor our energy consumption more closely. This ensures our energy demands are continuously benchmarked and reduced.  ϕ *Keeping these costs at a minimum helps us to remain competitive and sustainable* ϕ
Waste 	***Waste Minimisation Practices*** • ***Reduction:*** Producing almost zero waste from our processes • ***Reuse:*** Extending the life of component parts by reusing them for refurbishment and repairs • ***Refurbishing*** all parts where possible • ***Remanufacture*** – refurbishing parts are used for manufacturing ***Cardboard****: All our cardboard is recycled or re-used as packaging.*	remain a competitive and sustainable business. This in turn will help us to reduce the carbon footprint of our products and operations. **EU Waste Framework Hierarchy** Directive 2008/98/EC 

Our Environmental Practices

Environmental Efficiencies These measures will help us to be compliant, save costs and reduce our carbon and other emissions.	
Reducing Returns for customers 	One of the main aims that we have for our customers with our systems is to reduce returns for them. This ensures: • Packaging is reduced • Transport costs related to returns is minimised • There is a reduction in material resources required for refurbishment, remanufacturing or replacement of products • Waste is minimised. 
Maximising value	Our goal is to extend the product life-cycle of our electronic products and components. This ensures durability and maximises the value of resources used (raw materials & embodied energy) 
Supply Chain & Transport 	We plan to monitor our transport use, with a view to identifying reduction opportunities We are very mindful of costs and competitiveness. Keeping fuel consumption to a minimum helps us to reduce costs and remain competitive. **Flights** Due to the recent migration of electronics manufacturing out of Ireland, our customers are mainly overseas. However we ensure only the required short-haul and long-haul flights are taken when and if necessary.

ϕ *Our goal is to extend the product life-cycle of electronic products and components* ϕ

Future plans	
Carbon Footprint 	Future Plans • We aim to measure our Carbon Footprint using the Greenhouse Gas (GHG) Protocol methodology. • We will publish our carbon data publicly • We will re-measure our footprint and declare on an annual basis, with a aim for continuous reductions 
Pollution 	• *We dispose of all what little waste goods we generate in an environmentally friendly manner.* • *We strive to keep up to date and comply with all environmental laws* • *We are not involved in any hazardous processes or materials in any of our operations.*
Communications 	*We will publish our sustainability report publicly on our website, as well as communicating this to other relevant parties within our marketplace and business community.*

ϕ We will publish our sustainability report publicly and communicate it directly to relevant parties ϕ

Our Marketplace practices

Our Marketplace Practices

Our Policies

Transparency with our customers and consumers

High Quality Services

- We are in the aftersales service and constantly provide a high quality service for consumers of electronic goods for our customers (multi-national ODM).
- We will not provide a service that is less than 100% right
  - We are trained and fulfil all IPC standards requirements
  - We provide direct support to consumers

Sales and Advertising

We are honest & open in all our business dealings and advertising. Everything we declare that we can do on our website, we are fully able to deliver.

Feedback and communication

We have an informal feedback processes with our customers, depending on their requirements and what delivers best practice from both sides.
We try to have face-to-face communication where possible, such as with Dell Ireland.

Social Media

We are currently investigating the use of social media, to see if it can enhance our services in any way for our customers.

Payment Policy

Our practice is to ensure timely and regular payment to all of our suppliers

ϕ *We are open and honest in all our business dealings and advertising* ϕ

Our Marketplace Practices

Our Networks & Business Organisations

Business Networking

We are active members of Supply Network Shannon an industry-led initiative aimed at representing, promoting, developing and connecting companies in the wider Shannon Region of Ireland.

Supply Network Shannon is a business network, facilitating the development of the business, process and technical competencies of its members, enabling them to flourish in the rapidly changing market place.

Supply Network Shannon's membership includes the regional waste management office. This has allowed us to gain from opportunities with the regional waste management officer. This includes an introduction to Smile, is a free service for businesses that encourages the exchanging of resources between its members in order to save money, reduce waste going to landfill and to develop new business opportunities.

Research

FutureSME is an EU FP7 project that is *'igniting a movement amongst European SMEs towards creating a sustainable and globally competitive manufacturing community'.*

We are collaborating with the Galway-Mayo Institute of Technology - involved in the research activities related to eco-innovation and sustainability.

We were awarded status of High Potential Start-Up company by Enterprise Ireland. Through SNS we have links to LIT, UL the Limerick Enterprise Board and Limerick Chamber of Commerce and Limerick County Enterprise Board.

ϕ We are an innovative company and are involved in many research activities, such the development of new business models and sustainability *research* ϕ

Community Involvement

Community Involvement

Employment	
Current activities	**Future plans**
 We believe that the provision of employment for our local community is a very important aspect of our social responsibility We currently provide 6 full-time positions, an average of 65 contracted staff, and up to 200 casual staff depending on demand.	 Recently awarded the status of a High Potential Start-Up company by Enterprise Ireland, our current business strategy will help us to grow our business and maintain our competitiveness. This will lead to improved employment security for employees. Our sustainable business practices will help ensure the survival and continuation of our business.

Community Engagement	
Current and past activities	**Future plans**
 To date we have sponsored the local community organisations in the past on an ad-hoc basis.	We are open participating in future research opportunities - in particular those supporting sustainable business models (such as futureSME). We hope to continue our support of local community organisations and charities where feasible.

Community Involvement

Social Enterprise Partnerships
One of our main suppliers (Rehab Enterprises) is Ireland's largest single employer of people with disabilities, Rehab Enterprises provides integrated employment opportunities, with more than half of its 400-strong workforce having a disability.
Supply Chain
The use of local suppliers ensures that our products and services are delivered efficiently. We always use local suppliers where possible for everything. When we can't source something locally, we seek suppliers in Europe before going to the Chinese marketplace.

ϕ The use of local suppliers ensures that our products and services are delivered efficiently ϕ

A note from futureSME on Sustainability Reporting

This Sustainability Report was completed with the help of the futureSME project which was set up to develop the competitive capacity of European manufacturing SMEs. For the full online resource pack, go to www.futuresme.eu.

Sustainability & Social Responsibility in SMEs

Social responsibility is not a new concept in European SMEs. It is estimated that around half of all SMEs are engaged in various activities within their communities. These include charitable donations to community projects, sponsorship for local football teams, working with non-profit organisations, and doing pro-bono work.

Expectations for sustainability come from your customers, your employees, government bodies, and other businesses with which you interact.

Many people think that social responsibility or corporate social responsibility is about large companies making extravagant donations to charities. Of course, what you are able to do is dependent on your size and budget, but it is mostly about running your business in a sustainable and responsible way. It is also about building relationships with your employees, suppliers, customers, and the community. What is in your Sustainability Report will be personal to you, and will depend on your size, operations, and location.

Communicating Sustainability in SMEs

Many SMEs are reluctant to communicate their socially responsible activities because they think this is just what large companies do, they are too modest to do so, or they simply have not considered it. You may not realise it, but many customers and your community ARE interested in what you are doing to be responsible. The exercise of communicating your socially responsible practices can make you and your employees feel proud about what you are doing, and can be good for company morale. In fact, it is argued that, when smaller companies communicate their good practices, it results in a bigger impact than when larger companies do the same thing. The reason for this is that smaller companies are usually closer to the community than larger ones.

Did you know?

In Europe, SMEs are responsible for 70% of industry-related environmental damage and 60-70% of industrial waste. This is due to the sheer amount of SMEs- making up 99% of all businesses in Europe.

An SME is not expected to be doing everything

As an SME, you are not expected to be involved in all areas of social responsibility and sustainability. Moreover, you are not expected to do all the things that larger companies are doing. Most SMEs are already involved in social responsibility and sustainability to some extent. A sustainability report from an SME will never be the same as one from a large company, or even other small companies. Do not focus on what other people are doing. Instead, reflect on what you are doing and what you plan to do in the future.

Be yourself, be transparent, and create your own sustainability report.

If you want further information....

Log on to www.futuresme.eu to find out how you can

- Complete a Social Responsibility Assessment
- Get a Sustainability Report Guideline
- Access various environmental learning tools and supports
- Access many other supports from visual strategy to innovation, which have been designed specifically for SMEs.