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# **Manufacturing SMEs doing it for themselves: developing, testing and piloting an online sustainability and eco-innovation toolkit for SMEs**

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# **Manufacturing SMEs doing it for themselves: developing, testing and piloting an online sustainability and eco-innovation toolkit for SMEs**

Public discourse frequently cites the damaging activities of large organisations on global environmental issues, but smaller organisations are rarely, if ever, featured. Small and Medium Enterprises (SMEs) make up 99% of all businesses in the EU, cumulatively causing more industrial pollution and producing more waste than larger businesses. However, large companies are more likely to address sustainability issues than smaller ones. SMEs need help to change. In a collaborative approach, an online sustainability framework was developed to overcome the barriers contributing to the slow uptake in environmental management in SMEs. The views of owner-managers were incorporated throughout the development process. Best practice environmental tools and training were identified, which were designed in an SME-friendly way and made available online. This paper describes the development of the pilot Sustainability and Eco-Innovation (SEco) toolkit, followed by an analysis of its use. This research finds that a self-led toolkit was not enough to nudge SMEs to address environmental issues, despite being approved by owner-managers at each step.

Keywords: business sustainability, SMEs, sustainable manufacturing, eco-innovation, environment, sustainability toolkit, SME owner-managers, systems thinking.

## **1. Introduction**

Business needs to be part of the solution to reverse the effects of environmental damage and climate change (Heltberg, Siegel and Jorgensen 2009, Sullivan and Gouldson 2017). It has been shown that sustainability improvements can play a significant role in slowing down and limiting the damage (United Nations 2010, IPCC 2018). Firms need to be more accountable and they need to address the vital changes needed to drive improvement (Murray 2018, Laurent, et al. 2019). On a positive note, sustainability is progressing in large corporations

and is fast becoming part of their value creation and linked to greater economic revenues (Murray 2018, Laurent, et al. 2019). It was thought that sustainability activities in large companies would lead to smaller organisations becoming greener - particularly those positioned in the supply chains of larger companies (Burke and Gaughran 2007, Humes 2011, Charlo, Moya and Muñoz 2015). However, there is little evidence of this happening to date. There has also been little public drive for SMEs to become greener (Hoskin 2011, S. Mitchell, P. O'Dowd, et al. 2011) with headline news on environmental damage typically featuring big companies, but as environmentally conscious consumers are growing in numbers (Scott 2019) this may change.

SMEs cumulatively contribute to more environmental damage and produce more waste than all larger organisations combined<sup>1</sup> (C. Constantinos, S. Y. Sørensen and B. P. Larsen, et al. 2010). SMEs need to be innovative and sustainable to remain competitive but, they are less likely than larger organisations to make transformational changes due to a shortage of resources and limited influence in their supply chain (Côté, Booth and Louis 2006, C. Constantinos, S. Y. Sørensen and P. B. Larsen, et al. 2010, Freel 2000, Bititci, Maguire and Gregory 2010). A focus on sustainability through eco-innovation is an appropriate approach for SMEs (Carrillo-Hermosilla, del Río and Könnölä 2010, Klewitz and Hansen 2014). Research has shown that SMEs who engage in low-risk, eco-innovation practices (e.g. better energy management) engage in further opportunities for improvement (Klewitz and Hansen 2011, Demirel and Danisman Ozturk 2019).

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<sup>1</sup> In Europe SMEs account for 64% of total industrial pollution and contribute approximately 60-70% of the total industrial waste

SMEs can be difficult to engage with on environmental issues (Côté, Booth and Louis 2006, Klewitz and Hansen 2014) and this is an under-researched area (Demirel and Danisman Ozturk 2019, Hampton 2018). Business support agencies are having limited success in assisting SMEs with environmental management, nonetheless they are unlikely to make much progress alone (Seidel, Seidel, et al. 2009, Hoskin 2011, Demirel and Danisman Ozturk 2019). Some supports are available, but most SMEs are slow to see the importance of sustainability to their business (Mitchell, O'Dowd and Dimache 2010, Demirel and Danisman Ozturk 2019). The bespoke services that SMEs need have not been forthcoming (Klewitz and Hansen 2014).

The FutureSME project was set up in an attempt to address this issue. A European FP7 project; involving a 26-partner consortium, 13 of which were manufacturing SMEs, the aim of the project was to develop sustainable production models. With the purpose of reaching a wide audience of SMEs throughout Europe, an online self-led approach was chosen for the pilot toolkit (rather than an advisor-led approach).

This paper discusses the design and development of an online business sustainability methodology for SMEs, created as part of the Future SME project to prompt eco-innovation. It was carried out in three:

- (1) A background investigation into
  - barriers contributing to the slow uptake of environmental practices in SMEs
  - suitable tools to support sustainability improvements in manufacturing SMEs
- (2) The development of a self-led pilot sustainability and eco innovation (SEco) framework appropriate for a wide range of manufacturing SMEs
- (3) Tracking the use of the online framework.

## 2. Background

Despite the increasing awareness of environmental problems<sup>2</sup> (Abramovici, Bellalouna and Goebel 2010, Neely 2009, Westkämper, Alting and Arndt 2000), most SMEs are still not engaging in actions to improve environmental performance (Dimache, O'Dowd and Mitchell 2009, Klewitz and Hansen 2014, Demirel and Danisman Ozturk 2019). A company is more likely to be sustainable if it is a larger firm (Uhlener, et al. 2010). This is possibly because SMEs encounter many difficulties when compared to larger enterprises generally, such as their administrative burden (which can be up to ten times as costly), financial issues, limited resources, access to appropriate information and deficiencies in skills (S. Mitchell 2015, 15-17).

### *2.1 Barriers contributing to the slow uptake of environmental practices in SMEs*

The issue of sustainability in SMEs has been largely ignored until recently, with little research being conducted in the area (ACCA 2013, Klewitz and Hansen 2014, Demirel and Danisman Ozturk 2019). The lack of environmental improvements in SMEs may indicate that SMEs just don't realise its potential or what to do to access the benefits (Stringer 2013, Demirel and Danisman Ozturk 2019). This slow uptake is a problem. SMEs need to be supported to become more sustainable (ECAP 2010, ACCA 2013) and these supports should be tailored for them (ECAP 2010, ACCA 2013). According to a recent study, current supports are inadequate and there is little evidence indicating their effectiveness (Romero-Martinez, Ortiz-de-Urbina-Cria and Soriano 2010, Arbačiauskas, Gaižiūnienė, et al. 2010, Uhlener, et al. 2010, Hampton 2018).

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<sup>2</sup> Such as climate change, consumption of limited resources, legislative and customer pressure on manufacturers to reduce the impact of their products

This study has categorised evidence from the literature (Figure 1) into six main contributing factors as the main barriers to engagement:

- (1) *A lack of awareness* of the impact their actions have on the environment (ECAP 2010, NetRegs 2010, Wooi and Zailani 2010)
- (2) *A lack of knowledge* of sustainability including the legislation pertaining to environmental issues (Côté, Booth and Louis 2006, ECAP 2010, Fernández-Viñé, Gómez-Navarro and Capuz-Rizo, Eco-efficiency in the SMEs of Venezuela. Current status and future perspectives 2010)
- (3) *A shortage of resources*, both financial and human resources, to address the issues (Fliess and Busquets 2006, Aragón-Correa, et al. 2008)
- (4) *The negative perception* that there is no immediate benefit to their organisation (Wooi and Zailani 2010)
- (5) *Insufficient supports and tools* to affect change (Arbačiauskas, Gaižiūnienė, et al. 2010, Romero-Martinez, Ortiz-de-Urbina-Cria and Soriano 2010)
- (6) *Limited research in SMEs and the environment* (Labonne 2006, Daddia, Testaa and Iraldoa, A cluster-based approach as an effective way to implement the Environmental Compliance Assistance Programme 2010, ACCA 2013, Hampton 2018).

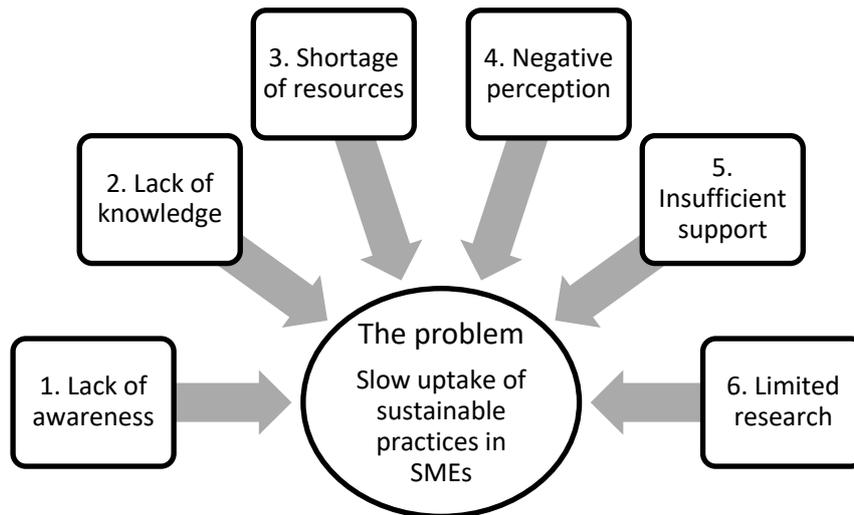


Figure 1: The problem of a ‘slow uptake of sustainable practices in SMEs’ and barriers to engagement.

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; ACCA, 2013).

Table 1 lists the conceptual requirements for the Pilot Framework to overcome the barriers.

Table 1: Conceptual requirements for the Pilot Framework

Barriers for SMEs	The Pilot Framework conceptual requirements
<b>Lack of awareness</b>	Communicate how and where the environmental impacts of manufacturing activities occur, and the ability to measure, thus acting to improve and reduce environmental impact.
<b>Lack of knowledge</b>	Connect SMEs with knowledge and information on environmental legislation.
<b>Shortage of resources</b>	Be of little or no cost and take little time to implement.
<b>Negative perception</b>	Lead to an improved perception that environmental issues can benefit the business.
<b>Insufficient supports and tools</b>	Support voluntary SME improvements.
<b>Limited research</b>	Allow for feedback to contribute to knowledge.

## ***2.2 Suitable tools to support sustainability improvements in manufacturing SMEs***

It has been shown that sustainable business practices and eco-innovation<sup>3</sup> tactics could play a part in addressing the issue in SMEs (including product, process or organisational innovation) (ECAP 2010, Klewitz and Hansen 2011, Carrillo-Hermosilla, del Río and Könnölä 2010). SMEs need a different approach than those designed for larger enterprises to effect change (Côté, Booth and Louis 2006, Seidel, Seidel, et al. 2009, ECAP 2010, Hampton 2018). There is evidence that low-risk changes can lead to radical innovation, such as the adoption of life-cycle thinking, or new manufacturing models (Klewitz and Hansen 2011, Demirel and Danisman Ozturk 2019). A response to a stimulus outside the company is the most likely driver of eco-innovation in SMEs, often from an actor in the value chain, e.g. a large customer (Seidel, Seidel, et al. 2009, Hoskin 2011, Klewitz and Hansen 2014). Other stimuli include NGO involvement, legislation and cost (Williamson, Lynch-Wood and Ramsay 2006, Klewitz and Hansen 2011, Hoskin 2011).

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<sup>3</sup> 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*” (Carrillo-Hermosilla, del Río and Könnölä 2010).

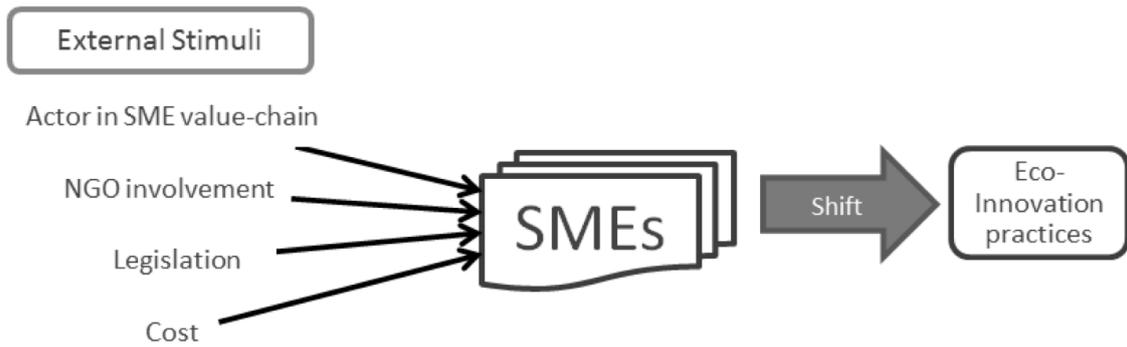


Figure 2: External stimuli affecting eco-innovative practices in SMEs

Eco-innovation can be described in terms of *dimensions*, which can involve incremental or radical change. The *dimensions* 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. While the design dimension is the most significant in establishing the environmental impact, the other dimensions are more important for acceptance within its context (Carrillo-Hermosilla, del Río and Könnölä 2010).

An analysis of the literature examined the most suitable tools and training to equip SME owner-managers to improve environmental management practices. The most appropriate tools and methodologies that can help eco-innovations are outlined below and summarised in Table 2. **Error! Reference source not found..**

- **Life Cycle Management (LCM)** tools, to measure environmental impact of products, services and activities, which include:
  - **Life Cycle Assessment (LCA)** for the most comprehensive and widely accepted environmental methodology measurement tool (Westkämper, Alting and Arndt 2000, ISO 2006, UNEP 2012, Orangebox 2013, ADME 2014)
  - **Life Cycle Costing (LCC)** to evaluate the environmental cost of a product or service over its entire life (Norris 2001, Kloepffer 2008)
  - **Carbon Footprinting** as the most widely used sustainability measurement method (UNEP 2012, Cucek, Jiri Jaromir and Kravanja 2012)
- **Design for Environment** methods (DfE) to guide the design process towards more sustainable products, services and processes (Westkämper, Alting and Arndt 2000, Allen, et al. 2001, Tukker and Tischner 2006)
- **Environmental Management Systems (EMS)** to provide a framework to guide and implement best practice environmental management (ECAP 2010, EMAS 2013, EMAS-easy 2013)
- **Corporate Social Responsibility (CSR)** assessment and reporting tools to create awareness of the benefits and gain a competitive advantage by articulating sustainable business practices (Russo and Tencati 2009, Blowfield and Murray 2011, Killian 2012)
- **Product service systems (PSS)** tools to explore new business models (Tukker and Tischner 2006, Dimache, Mitchell and O'Dowd 2009)
- Tools to **audit** and measure environmental indicators (waste, water and energy) (Deming 1986, Warr and Orsato 2008)
- Tools to support environmental **legislation** compliance (Predescu, Vilag, et al. 2010, ECAP 2010)

- Eco-Innovation and sustainability **training** to support all the above (McPhearson 2008, SIMPEL 2008).

Table 2: Tools to support better environmental performance through eco-innovation

	Eco-innovation Dimensions			
	<b>Design</b>	<b>User</b>	<b>Product service</b>	<b>Governance</b>
<b>This dimension addresses</b>	Environmental impact	Acceptance within its context		
<b>Applicable Tools, training and methodologies</b>	<ul style="list-style-type: none"> <li>• Life Cycle Management (LCM)</li> <li>• Design for Environment (DfE)</li> </ul>	<ul style="list-style-type: none"> <li>• Auditing tools</li> <li>• Legislation tools</li> </ul>	<ul style="list-style-type: none"> <li>• Product Service Systems</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainability Reporting</li> </ul>

### 3. Methodology

The research approach in this paper is influenced by the broad themes under investigation which span various fields (engineering, business and management). An interdisciplinary method is appropriate to examine the complex research problem. Three elements form the overall research approach (see Figure 3); *Systems thinking* views problems in the context of their internal and external environment and can capture interactions and feedback (Meadows 2009, Sterman 2002, Maani and Cavana 2007, Seidel 2011); An *action research* approach allows collaboration with members of the research setting (such as SME owner-managers) in the development of a solution; and *triangulation* involves several data collection methods to increase the validity of the process and the conclusions drawn.

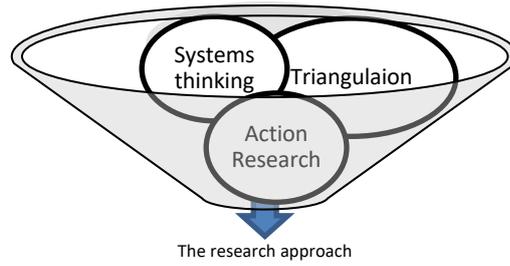


Figure 3: Elements combined to form the overall research approach in this study

The specifications for the Pilot SEco Framework were drawn from several sources and methods. The triangulation approach (Figure 4) includes a review on environmental best practice in SMEs, followed by online questionnaires. Interviews with SME owner-managers made the quantitative questionnaire data more meaningful. A synthesis of the data was prepared using NVivo.

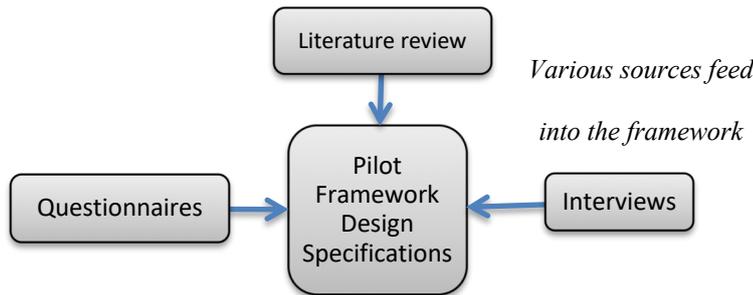


Figure 4: Triangulation in the SEco Pilot Framework development

#### 4. Development and testing of the SEco Pilot Framework

The development process took place over four years. The views of SME owner-managers were considered throughout.

##### *4.2 The development process – design specifications*

The tool suitability analysis (in section 2) contributed to the development of a *one-stop-shop* Pilot Framework to suit a broad range of manufacturing SMEs. The tables below illustrate a traceability matrix which correlates requirements against proposed design specifications, in this case the relationships to business benefits and eco-innovation dimensions. Table 3 and Table 4 lists the design specifications of the *Tools* and *Training*. 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 3: Traceability matrix - design specification (tools)

URS	Functional Specification (FS)	Appropriate Tool(s)	Eco-innovation	Eco-innovation dimension
<b>1. Life Cycle Management Tools</b>	<b>1.1</b> Evaluate the impact of a product/ process/ activity	Life Cycle Analysis	<ul style="list-style-type: none"> <li>Identifies areas for improvement</li> <li>Communicates a greener product/service</li> </ul>	<ul style="list-style-type: none"> <li>Design</li> <li>User</li> </ul>
	<b>1.2</b> Measure the overall cost and impact of products and processes	Life Cycle Costing	<ul style="list-style-type: none"> <li>Identifies areas for improvement</li> <li>Identifies cost benefits</li> <li>Communicates a greener product/service</li> <li>Aids entire life-cycle purchasing decisions</li> </ul>	<ul style="list-style-type: none"> <li>Design</li> <li>User</li> </ul>
<b>2. Design for Environment (DfE) methods</b>	<b>2.1</b> Evaluate compliance with legislation	Design for Environment	<ul style="list-style-type: none"> <li>Avoids environmental fines</li> <li>Meets customer requirements</li> </ul>	<ul style="list-style-type: none"> <li>Design</li> <li>Governance</li> </ul>
	<b>2.2</b> Evaluate the compliance with customer requirements		<ul style="list-style-type: none"> <li>Identifies areas for improvement</li> <li>Meets customer requirements</li> </ul>	
	<b>2.3</b> Measure and minimise the carbon footprint of products and processes		<ul style="list-style-type: none"> <li>Identifies areas for improvement</li> <li>Provides data to communicate a greener product/service offering</li> </ul>	<ul style="list-style-type: none"> <li>Design</li> <li>Product service</li> </ul>
<b>3.Environmental Management Systems</b>	<b>3.1</b> Conduct a gap analysis on environmental practices	Environmental Management System	<ul style="list-style-type: none"> <li>Improves environmental management, performance and compliance</li> </ul>	<ul style="list-style-type: none"> <li>User</li> <li>Governance</li> </ul>
	<b>3.2</b> Implement a structured environmental management		<ul style="list-style-type: none"> <li>Provides evidence for tendering and guides sustainable procurement</li> </ul>	
<b>4. Sustainability Reporting tools</b>	<b>4.1</b> Raise awareness of the benefits	Sustainability Assessment	<ul style="list-style-type: none"> <li>Improves awareness of current practices and gaps to guide improvements</li> </ul>	<ul style="list-style-type: none"> <li>User</li> <li>Governance</li> </ul>
	<b>4.2</b> Provide a method to report sustainability practices	Sustainability Reporting Manual	<ul style="list-style-type: none"> <li>Maintains transparency in the business</li> </ul>	

URS	Functional Specification (FS)	Appropriate Tool(s)	Eco-innovation	Eco-innovation dimension
	4.3 Provide a template	Sustainability Reporting Template	<ul style="list-style-type: none"> <li>Simplifies the reporting process</li> </ul>	
5. Auditing tools	5.1 Measure and minimise waste	Waste audit tool	<ul style="list-style-type: none"> <li>Identifies opportunities for waste, water and energy prevention by tracking usage patterns</li> </ul>	<ul style="list-style-type: none"> <li>User</li> <li>Governance</li> </ul>
	5.2 Measure and minimise water	Water audit tool		
	5.3 Measure and minimise energy	Energy audit tool		
6. Legislation tool	6.1 Outline the purpose of environmental legislation	Environmental Legislation tool	<ul style="list-style-type: none"> <li>Reduces compliance costs</li> <li>Reduces the possibility of fines</li> <li>Provides guidance at the design phase</li> </ul>	<ul style="list-style-type: none"> <li>User</li> <li>Governance</li> </ul>
	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	<ul style="list-style-type: none"> <li>Identifies the opportunities for developing sustainable servitised business models</li> </ul>	<ul style="list-style-type: none"> <li>Design</li> <li>Product Service</li> </ul>
	7.2 Provide a decision support methodology for those considering the shift to a servitised model		<ul style="list-style-type: none"> <li>Extends the life cycle of products by designing more durable products</li> </ul>	

Table 4: Traceability matrix - design specifications (training)

User Requirement Specification	Functional Specification (FS)	Appropriate Training	Eco-innovation	Eco-innovation dimension
<b>8. Lesson 1 Introduction to eco-innovation and Sustainability</b>	<b>8.1</b> Create awareness of eco-innovation and sustainability	Sustainability eLearning Lesson	<ul style="list-style-type: none"> <li>Identifies opportunities for sustainable business practices</li> </ul>	<ul style="list-style-type: none"> <li>User</li> <li>Governance</li> </ul>
	<b>8.2</b> Demonstrate the benefits of using case studies		<ul style="list-style-type: none"> <li>Identifies benefits of sustainable business practices</li> </ul>	
	<b>8.2</b> Provide skills to implement		<ul style="list-style-type: none"> <li>Implements skills for sustainable practices</li> </ul>	
<b>9. Lesson 2 LCA</b>	<b>9.1</b> Create awareness of LCA	LCA eLearning Lesson	<ul style="list-style-type: none"> <li>Identifies opportunities for improving the design of products and services</li> </ul>	<ul style="list-style-type: none"> <li>Design</li> <li>User</li> <li>Governance</li> </ul>
	<b>9.2</b> Demonstrate the benefits of LCA		<ul style="list-style-type: none"> <li>Identifies benefits of using an LCA</li> </ul>	
	<b>9.3</b> Provide skills to implement an LCA		<ul style="list-style-type: none"> <li>Implements skills to carry out an LCA</li> </ul>	
<b>10. Lesson 3 LCC</b>	<b>10.1</b> Create awareness of LCC in the design of products and services and the purchase of equipment	LCC eLearning Lesson	<ul style="list-style-type: none"> <li>Identifies opportunities to improve the design of products/services and the purchase of equipment</li> </ul>	<ul style="list-style-type: none"> <li>Design</li> <li>User</li> <li>Governance</li> </ul>
	<b>10.2</b> Demonstrate the benefits of implementing an LCC		<ul style="list-style-type: none"> <li>Identifies the benefits of using an LCC</li> </ul>	
	<b>10.3</b> Provide skills to implement an LCC		<ul style="list-style-type: none"> <li>Implements LCC skills for design and equipment procurement purposes</li> </ul>	

User Requirement Specification	Functional Specification (FS)	Appropriate Training	Eco-innovation	Eco-innovation dimension
11. Lesson 4 DfE	11.1 Create awareness of DfE in the design of products and services	DfE eLearning Lesson	<ul style="list-style-type: none"> <li>Identifies opportunities for improving the design of products and services</li> </ul>	<ul style="list-style-type: none"> <li>Design</li> <li>User</li> <li>Governance</li> <li>Product Service</li> </ul>
	11.2 Demonstrate benefits		<ul style="list-style-type: none"> <li>Identifies the benefits of using an DfE</li> </ul>	
	11.3 Provide skills to implement		<ul style="list-style-type: none"> <li>Implements the skills for DfE methods</li> </ul>	
12. Lesson 5 PSS	12.1 Create awareness of PSS in the design of products and services	PSS eLearning Lesson	<ul style="list-style-type: none"> <li>Identifies opportunities for improving the design of products through servitisation</li> </ul>	<ul style="list-style-type: none"> <li>Design</li> <li>Product Service</li> <li>User</li> <li>Governance</li> </ul>
	12.2 Demonstrate benefits of PSS		<ul style="list-style-type: none"> <li>Identifies the benefits servitisation</li> </ul>	
	12.3 Provide skills to transition towards a servitised model		<ul style="list-style-type: none"> <li>Provides a decision support methodology to assess a servitised business model</li> </ul>	

### ***4.3 SME owner-managers contributing to the development process***

Thirteen SME owner-managers acted as ‘*end-users*’ in the development process. No appropriate environmental measurement methods were being used in the firms, even though many claimed to know their environmental impact. Feedback on the SEco Pilot Framework was gathered from them throughout. To gather initial views of SME owner-managers on issues, three surveys were conducted using questionnaires and interviews:

- Survey #1 ‘Environmental challenges and opportunities for SMEs’ (see (Mitchell, O’Dowd and Dimache 2010))
- Survey #2 ‘An analysis of corporate social responsibility (CSR) in SMEs’ (see (S. Mitchell, A Sustainability and Eco-Innovation (SEco) Framework for Manufacturing SMEs 2015))
- Survey #3 ‘The issues of waste in European SMEs’: (see (S. Mitchell, P. O’Dowd, et al. 2011)).

In summary, these investigations found:

- (1) Despite reports of eco-efficient practices, environmental management is considered costly by the owner-managers
- (2) Compliance to legislation is seen as a burden and a future threat
- (3) There are no structures in place to monitor environmental costs
- (4) SMEs need to be “nudged” towards good practices
- (5) Owner-managers have good intentions, but they are not always acted upon
- (6) Many owner-managers did not know where to start
- (7) Most of the SME owner-managers claimed to know their environmental impact, but there was no evidence to back up this claim.

#### 4.4 Building the pilot Framework and presentation of the individual elements

For the solution to be successful, the *barriers* to better practices need to be addressed.

Table 5 summarises how the conceptual requirements are met in the Framework.

Table 5: Conceptual requirements and where they are met in the development process

Barriers faced by SMEs	The Pilot Framework needs to...	Proposed requirements	How barriers are being addressed
<b>A lack of awareness of their impact</b>	<ul style="list-style-type: none"> <li>Communicate how and where the impacts occur</li> <li>Measure, improve and reduce environmental impact</li> </ul>	<ul style="list-style-type: none"> <li>Training on the impact of products, processes, activities, and sustainable design</li> </ul>	LCA, LCC & DfE training modules
		<ul style="list-style-type: none"> <li>Tools to measure and monitor impacts, to inform operational, organisational and design decisions</li> </ul>	LCA, LCC, DfE & auditing tools
<b>A lack of knowledge on legislation</b>	Connect SMEs with accessible legislation information	<ul style="list-style-type: none"> <li>Training on legislation, EMS and signposting to resources</li> </ul>	Legislation awareness and EMS training
<b>A shortage of resources</b>	Be of little or no cost, or time to implement	Framework needs to be: <ul style="list-style-type: none"> <li>Simple</li> <li>Low cost</li> <li>Low risk</li> <li>Compensate for lack of resources and knowledge</li> </ul>	Provided online, free of charge
<b>The negative perception of benefits</b>	Create a perception that environmental issues can benefit	It should highlight: <ul style="list-style-type: none"> <li>Cost savings</li> <li>Competitive advantage</li> <li>Opportunities for sustainable business models</li> <li>Successful case studies</li> </ul>	Auditing tools, PSS, and case studies in training modules
<b>Insufficient supports and tools</b>	Support voluntary improvements and avoid elements only suitable for larger organisations	Tools and training should: <ul style="list-style-type: none"> <li>Be practical</li> <li>Be easily accessible</li> <li>Respect confidentiality</li> <li>Not need expert knowledge</li> </ul>	Varying levels of expertise, Highlight benefits, Easily accessed online
<b>Limited research</b>	Allow for feedback to contribute to knowledge	<ul style="list-style-type: none"> <li>Attractive to SMEs and feedback experiences to allow for improvements</li> </ul>	Testing to inform design

The SEco Pilot Framework comprises seven tool and training categories listed in

Table 7. Many of the elements were based on existing tools packaged in an SME-friendly manner. The tools are simple and downloadable. The training material supports the tools, and/or generates awareness. **Error! Reference source not found.**

For the Framework to be attractive to SMEs, it highlights the business benefits through eco-innovation. To conceptualise this, the Framework is presented with four key facets: cutting costs, being compliant with legislation, gaining a competitive advantage and finding new business opportunities. Table 8 maps this structure to the features, recommended tools and training and eco-innovation type to address sustainability. The Framework was presented online, see below (Figure 5) for a screenshot of the webpage. The training modules (eLearning) were created using an andragogic and a heutagogic approach. Common issues reported in relation to eLearning and SMEs were addressed (see **Error! Reference source not found.**), such as cost, additional support, modified to their requirements and visibility of benefits. The common structure of lessons is illustrated in Figure 6.

Table 6: How reported issues with eLearning in SMEs were addressed

<b>Common issues reported with eLearning in SMEs (Averlill and Hall 2008, SIMPEL 2008) (McPhearson 2008, Engert, Akhmetova and Nevskaya 2008)</b>	<b>How these were addressed in the Pilot SEco Framework</b>
Cost and upfront payment	Provided for free
Content not tailored to SMEs	Owner-managers consulted at every stage of development
Pre-training required	The platform used does not require any training
Employee is too busy to undertake the learning	Clear business benefits highlighted at the outset.

Table 7: Summary of Pilot Framework Specifications

<b>SEco Pilot Framework Specifications</b>		
<b>Sustainability training</b>		
<b>Training Modules (7)</b>	<b>Platform</b>	<b>Source or author</b>
Legislation, Life Cycle Analysis (LCA) Life Cycle Costing (LCC), Design for Environment (DfE) Product Service Systems (PSS), Environmental Management Systems (EMS), Corporate Social Responsibility (CSR)	Articulate	Mitchell and Dimache
<b>Sustainability tools (7 categories)</b>		
<b>Tool</b>	<b>Platform</b>	<b>Source or author</b>
Legislation Paper	PDF	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	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	Dimache
Environmental Management Systems 1. Energy Tool 2. Water Tool 3. Waste Tool	Excel	Mitchell
Corporate Social Responsibility (CSR) 1. CSR Assessment 2. Sustainability Reporting	Word	Mitchell
<b>User Requirements</b>		
<ul style="list-style-type: none"> <li>• Simple</li> <li>• Low cost</li> <li>• Low risk</li> <li>• Easily accessible</li> <li>• Make SMEs aware of successful case studies</li> <li>• Compensates for lack of resources and knowledge</li> </ul>		<ul style="list-style-type: none"> <li>• Respects confidentiality</li> <li>• Focus on cost savings and competitiveness</li> <li>• Practical</li> <li>• Specific to SME needs</li> <li>• Little time to implement</li> <li>• Quick impact with visible results</li> </ul>

Table 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	Organisation	Design	User	Product service	Governance
1.Reduce cost	A process to measure and monitor environmental-related costs	<ul style="list-style-type: none"> <li>Energy, Waste and Water Tracker</li> </ul>	<ul style="list-style-type: none"> <li>Highlight benefits of sustainability</li> <li>EMS Training Course</li> </ul>		•	•	•			
	LCC to assess the life-cycle costs of equipment and products purchased	<ul style="list-style-type: none"> <li>LCC Equipment calculator</li> <li>LCC Product calculator</li> </ul>	<ul style="list-style-type: none"> <li>LCC training course</li> </ul>	•		•	•	•		
2. Get informed: on legislation	A process to identify environmental trends and legislation issues	<ul style="list-style-type: none"> <li>Legislation tool</li> </ul>	<ul style="list-style-type: none"> <li>Legislation training</li> </ul>			•		•		
3.Gain a competitive advantage	A process to evaluate and improve the environmental and social performance of the product/company	<p><i>LCA tools:</i></p> <ul style="list-style-type: none"> <li>Eco-indicator 99 (Quantitative)</li> <li>Eco-compass (Qualitative)</li> <li><i>MET Matrix</i></li> <li>Carbon Footprint Calculator</li> </ul> <p><i>DfE tools:</i></p> <ul style="list-style-type: none"> <li>LiDS Wheel</li> <li>Eco-Design checklist</li> </ul> <p><i>CSR tools:</i></p> <ul style="list-style-type: none"> <li>Social Responsibility Assessment</li> <li>Sustainability Reporting Guide</li> </ul>	<ul style="list-style-type: none"> <li>LCA, DfE, carbon footprint calculator, social responsibility tool</li> <li>Training course for the tools/methodologies used to support this process (LCA, DfE, Environmental Management Systems)</li> <li>Case studies</li> </ul>	•	•	•	•			
4.Identify new business opportunities	A process to generate and evaluate new product/service/business from sustainable principles	<p><i>PSS tools:</i></p> <ul style="list-style-type: none"> <li>Transition along the Product Service System (TraPSS) Manual</li> </ul>	PSS; training course for PSS; case studies	•				•	•	

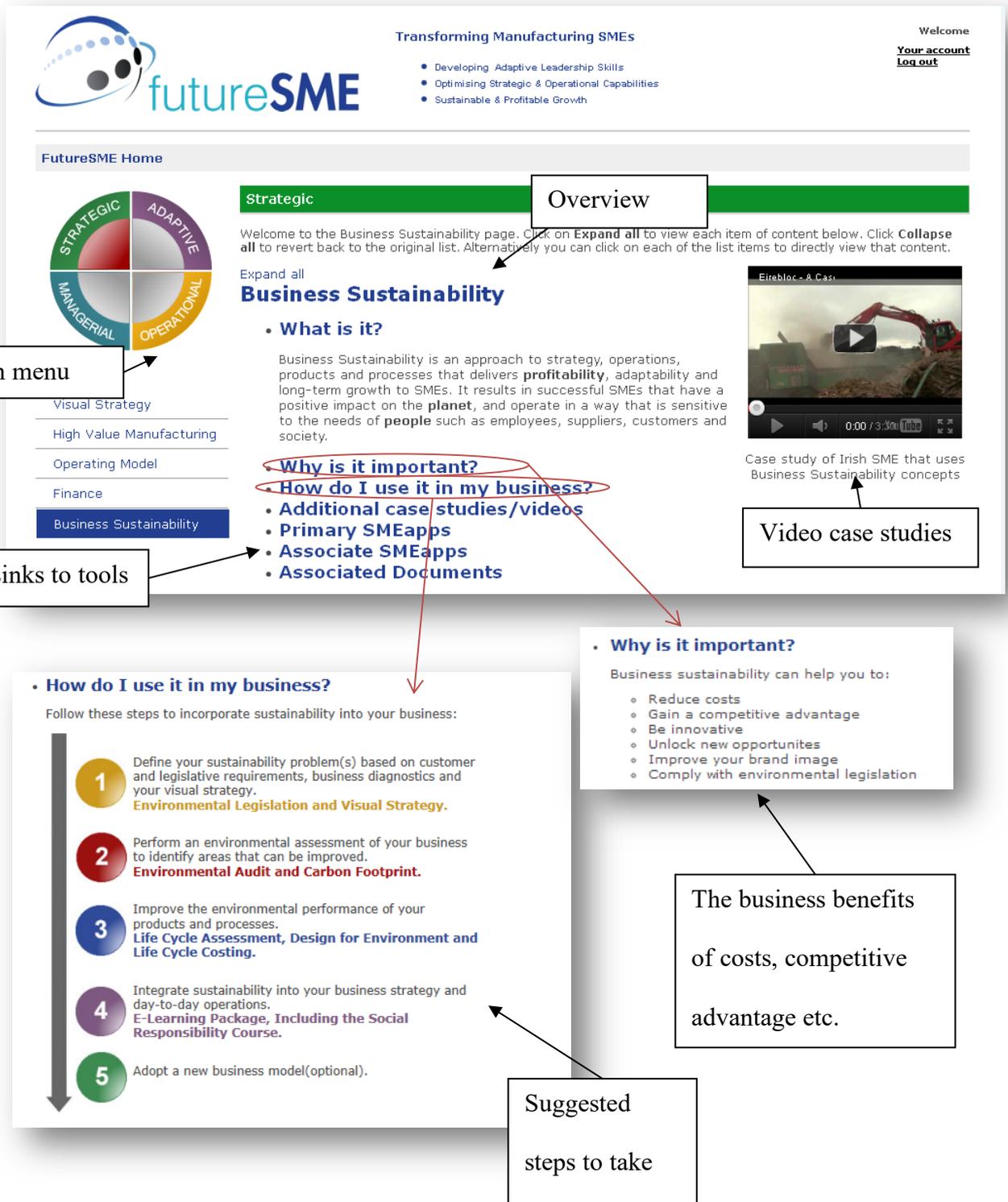


Figure 5: Main Business Sustainability Webpage presenting the Framework

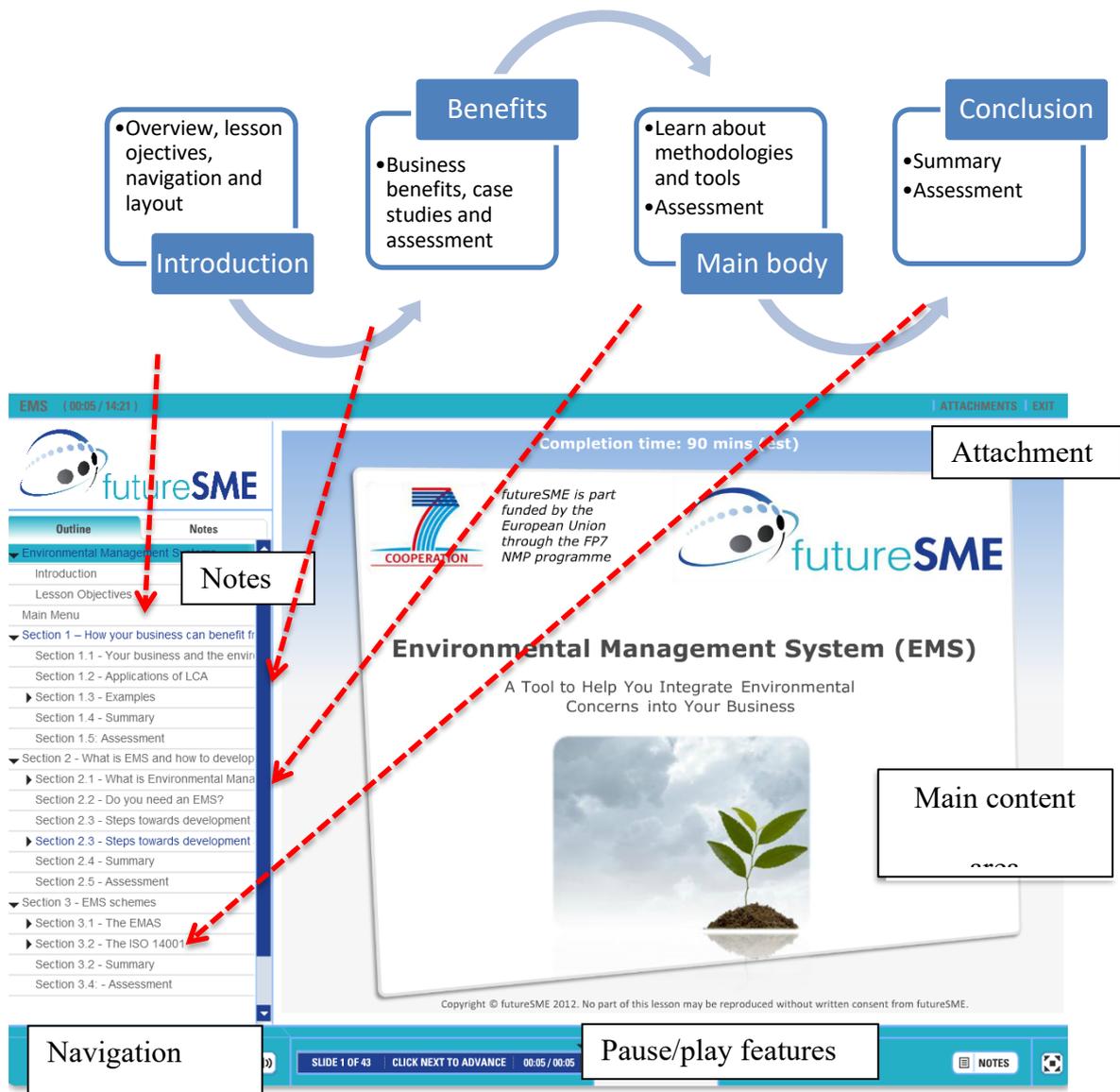


Figure 6: Common Structure of the environmental training lessons

#### 4.5 Testing the SEco pilot framework

A three-step testing framework was designed, outlined in Figure 7. Every eLearning module and tool within the Pilot Framework was tested by the SME end-user group. Overall, the tools were rated highly by the testers in relation to usability and appropriateness for SMEs, and the SEco Pilot Framework was approved by the end-user group. All SME end-users agreed that the SEco Pilot Framework was satisfactory at the time of testing.

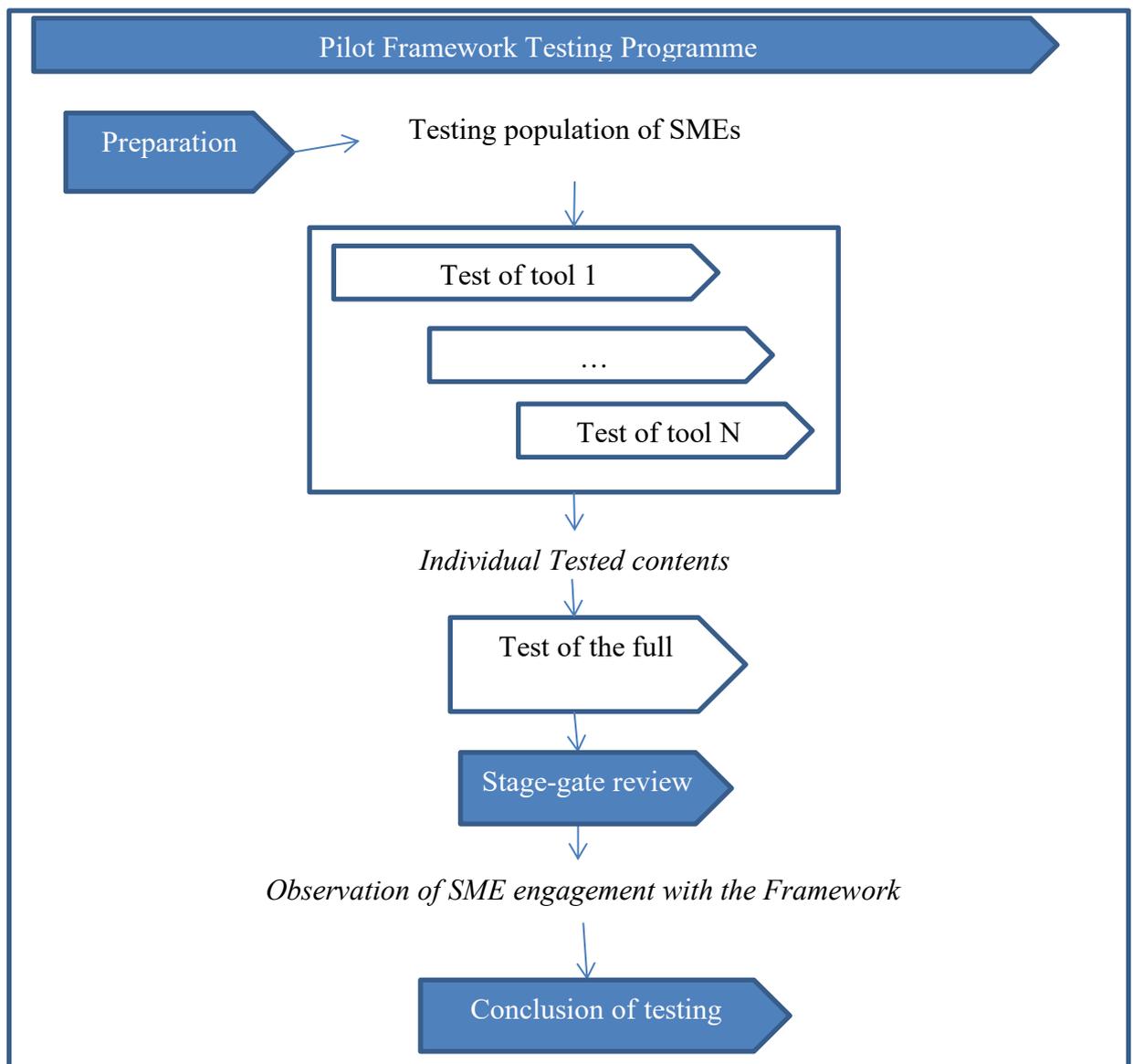


Figure 7: Pilot Framework Testing Framework

The back-end analytics output from the web portal was used to assess user activity. An evaluation of each of these downloads identified that the tools were not being downloaded by the target audience - SMEs. Downloads were mainly from universities, large organisations and environmental consultancy organisations. Only 2% of downloads were from SME companies. None 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.

## 5. Discussion and Conclusion

The aim of this research was to deepen the understanding of and to develop new insights into the practices of sustainability and eco-innovation in manufacturing SMEs. There is a strong and growing case for all business to embrace sustainability principles. While, SME owner-managers want to improve, there is little evidence that they are engaging. A Framework was developed and tested to overcome the barriers related to the slow uptake of good environmental practices. It is a *one-stop-shop* approach comprising of an online self-led environmental training programme and a set of environmental tools free of charge that could be accessed at any time. While there was engagement with the tool online from various organisations, there was very little activity by the target group - SMEs.

The lack of voluntary uptake compelled the researchers to identify the gaps in the SEco Pilot Framework. The ongoing engagement over the four-year project gave some insight. For example, during the testing process, some SME owner-managers requested that elements of the Framework be demonstrated to them (rather than do it themselves). They were more interested in something that could relate directly to their business immediately with personal business advantages. 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. They were not attracted by the self-led approach.

In conclusion, SME Owner-managers often simply do not know where to start with sustainability and eco-innovation. The online framework did not overcome the issues fully. Providing free learning and tools designed and approved by the end-user group at

each step was not sufficient. A formal intervention methodology is needed to support SMEs to engage with sustainability and identify eco-innovation opportunities. The findings indicate that without further guidance and support, an online toolkit is not an effective approach to reach or convince resource-poor SMEs, who are not already influenced by the business benefits and lack the basic skills to start.

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### **Declarations of interest**

None.

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## Supporting Materials

All the tools and training are available to download on [www.futuresme.eu](http://www.futuresme.eu)

eLearning Lessons can be accessed online using the links

- Life Cycle Assessment (LCA) for SMEs [here](#)
- Life Cycle Costing (LCC) for SMEs [here](#)
- Design for the Environment (DfE) [here](#)
- Product Service Systems (PSS) [here](#)
- Corporate Social Responsibility (CSR) for SMEs [here](#)
- Environmental Management Systems (EMS) for SMEs [here](#)
- Environmental Legislation for SMEs [here](#).