

SUPPORTING SUSTAINABLE STARTUP IDEATION

PARTICIPATORY DEVELOPMENT OF A TOOL FOR
STUDENT ENTREPRENEURS

ANNE UILDRIKS

MSc. INDUSTRIAL ECOLOGY THESIS

SEPTEMBER 2019



Universiteit
Leiden



Climate-KIC

Thesis report

September 12, 2019

MSc. Industrial Ecology

Author:

Anne J. Uildriks

1st supervisor:

Jaco Quist

Delft University of Technology

Faculty of Technology, Policy and Management

Energy & Industry

2nd supervisor:

Stefano Cucurachi

Leiden University

Faculty of Science

Institute of Environmental Sciences (CML)

Company supervisor:

Sjoerd Louwaars

PLNT Leiden

Director of Innovation

Image front page: "BE GREEN" creative workspace of Google Ireland. Retrieved on September 9, 2019, from <https://officesnapshots.com/2013/06/10/google-dublin-office-design-headquarters/>

SUMMARY

The aim of this thesis research is to find ways to support student entrepreneurs in the development of sustainable startups. Specifically, to help them to oversee the sustainability impacts during the ideating phase. A design science approach is adopted for this. Seven experts on sustainable entrepreneurship related topics and eight student entrepreneurs working on sustainable startups are interviewed. In addition, twenty entrepreneurs provide information on their experiences in a survey. Ten design requirements are deduced from the content analysis of these research activities. The design requirements are then used to compare the tools/methods mentioned and to design a new tool. This tool is evaluated in a focus group with six student entrepreneurs working on sustainable startups.

It is concluded that a major challenge for the student entrepreneurs is to determine in an early phase whether the value proposition of their startup idea makes positive sustainability impacts. This problem can be broken down into smaller ones, such as there not being a clear definition of what a sustainable startup is, there (consequently) not being a proper way to assess the sustainability, and the lack of well-supporting tools and methods in the ideating phase. The results of this study suggest that sharpening the definition of a sustainable startup and taking a systems perspective on the impacts helps the student entrepreneurs. To address this, a set of three Sustainable Startup System Mapping (SSSM) worksheets are proposed. This tool can be seen as a first step towards taking a systems perspective in the development of sustainable startups.

Keywords: sustainable startup development (SSD), sustainable entrepreneurship (SE), system mapping, design science

PREFACE

“The direction in which education starts a man will determine his future in life” – Plato

Reflecting on the last couple of years, it strikes me that many aspects have led up to this Master’s thesis. In the Industrial Design bachelor program, I developed the vision that design should make a positive impact on the world we live in. Increasingly aware of the severity of the climate issues, I decided that I want to design and implement sustainable solutions. The Industrial Ecology master program promised to offer “concepts, methods and tools to help to identify, design and critically evaluate sustainability solutions and their implementation”, and therefore was a good fit.

For additional more action-oriented education, I took part in the Climate KIC master label program, on climate entrepreneurship. It was the start of the Sustain-A-Blade startup, offering a razor made of wood and ceramic that stays sharp for two year, to provide a sustainable alternative for the wasteful disposable razors on the market. Having developed an ever critical mind-set, a big question remained what exactly a sustainable startup is. How do we know that our Sustain-A-Blade razor is sustainable? How to define sustainability?

To find answers to such questions, I decided to write my thesis on sustainable entrepreneurship. Sustainability challenges are wicked problems, often with a lot of trade-offs. By adopting a systemic approach to the assessment of the potential impacts on the system I believe entrepreneurs can do a lot of good, stirring things up and taking the actions for changes necessary to conserve our planet.

“View the climate challenge as a shared challenge to which everyone can contribute in their own ways” – Sjoerd Louwaars

I believe entrepreneurs can play a major role in innovating current unsustainable practices. I think that education with an entrepreneurial twist is the way to move forward, because we need to teach and learn how to take action to tackle the biggest challenges we are facing today. Through this thesis I hope to have made a contribution to startup educational programs to support the entrepreneurs with their sustainability mission in estimating and improving their impacts. I think it is a step into the right direction, but we need to take bigger leaps. I hope that you will enjoy reading the report on this step, and that the worksheets presented will be useful and inspiring for you to take those leaps!

ACKNOWLEDGEMENTS

First of all, I want to thank my supervisors Jaco Quist and Stefano Cucurachi for their valuable feedback, advice and inspiration offered throughout the thesis period. Moreover, I am thankful for the opportunity to write my thesis in collaboration with PLNT Leiden. In particular the coaching of Sjoerd Louwaars, the Director of Innovation of PLNT Leiden, has been valued highly: he shared his network, gave advice and enthusiastically followed the research developments. Furthermore, I appreciate all the input of the interviewees, survey respondents and focus group participants very much. Their cooperation and enthusiasm were essential for the participatory research process and has given me useful insights on the topic of sustainable startup development. Lastly, I want to express my gratitude for all support of family, friends, and fellow Industrial Ecology students, who inspired me and who I could share experiences with.

TABLE OF CONTENTS

SUMMARY	3
PREFACE.....	4
ACKNOWLEDGEMENTS.....	5
TABLE OF CONTENTS	6
LIST OF FIGURES.....	8
LIST OF TABLES.....	9
1. INTRODUCTION.....	12
1.1 Background.....	12
1.2 Problem statement	13
1.3 Study’s objectives & research questions.....	14
1.3.1 Study’s objectives.....	15
1.3.2 Research questions.....	15
1.4 Relevance.....	17
1.4.1 Scientific relevance	17
1.4.2 Social relevance	18
1.5 Outline of the report	18
2. THEORY.....	20
2.1 Systematic literature review approach.....	20
2.1.1 Definition entrepreneurship	22
2.1.2 Definition sustainable entrepreneurship.....	23
2.1.3 Sustainable entrepreneurship challenges in literature.....	27
2.1.4 Sustainable entrepreneurship tools/methods in literature.....	28
2.1.5 Conclusion sustainable entrepreneurship theory.....	32
3. METHODOLOGY.....	34
3.1 A “Design Science” approach.....	34

3.1.1 Research setup	36
3.2 Data collection.....	37
3.2.1 Interviews method.....	37
3.2.2 Survey method.....	40
3.2.3 Focus group method	40
3.3 Data analysis	42
3.3.1 Content analysis method.....	42
3.3.2 Design and development tool/method	44
4. RESULTS: SUSTAINABLE STARTUP DEVELOPMENT CHALLENGES	46
4.1 Results interviews.....	46
4.1.1 Results interviews experts	46
4.1.2 Results interviews entrepreneurs.....	55
4.2 Results survey	67
4.2.1 Characteristics of the respondents	68
5. RESULTS: DESIGN REQUIREMENTS TOOL/METHOD & INTRODUCTION	
SSSM WORKSHEETS.....	78
5.1 Design requirements SE tool/method based on analyses.....	78
5.2 Comparison existing tools and methods for the ideating phase	80
Mentioned by experts/literature	80
Mentioned by entrepreneurs.....	81
5.3 System Mapping method introduction	82
5.4 Sustainable Startup System Mapping	87
5.4.1 Links between SSSM and other methods	88
5.5 Results focus group on Sustainable Startup System Mapping.....	93
6. DISCUSSION	102
6.1 Interpretations: theorisation & justification	102
6.2 Implications	105
6.3 Limitations.....	107
6.4 Recommendations	110
Managerial implications	112
7. CONCLUSION	115

7.1 Future research directions.....	117
REFERENCES	120
APPENDICES	128

LIST OF FIGURES

Figure 2.1	Systematic literature review process, according to example Munoz & Cohen (2018)
Figure 2.2	Startup development phases (Startup Commons, n.d.)
Figure 2.3	The sustainable entrepreneurship process by (Fischer et al., 2018) based on (Belz & Binder, 2017)
Figure 2.4	Startup development phases in which sustainability aspects are considered in the sustainable entrepreneurship process (based on Startup Commons, n.d.; Fischer et al., 2018; Belz & Binder, 2017)
Figure 2.5	Social vs Economic sustainability trade-off (4lenses, n.d.)
Figure 2.6	Literature review approach SE tools/methods
Figure 2.7	Overview SE tools/methods in literature
Figure 3.1	Iterative process design science (Romme, et al., 2017)
Figure 3.2	DSRP model (Peffer et al., 2006)
Figure 3.3	Research flow diagram
Figure 3.4	Coding scheme graph categories content analysis interviews experts
Figure 3.5	Coding scheme graph categories content analysis interviews entrepreneurs
Figure 3.6	Coding scheme graph categories content analysis focus group
Figure 4.1	Overview SE tools/methods mentioned in expert interviews
Figure 4.2	Overview SE tools/methods mentioned in interviews sustainable entrepreneurs
Figure 4.3	Roles respondents in startup
Figure 4.4	Focus of respondents' startups

- Figure 4.5 Overview tools/methods survey
- Figure 5.1 Suggestions SE tools for startup development phases
- Figure 5.2 Sustainable Startup System Mapping worksheet 1
- Figure 5.3 Sustainable Startup System Mapping worksheet 2
- Figure 5.4 Sustainable Startup System Mapping worksheet 3
- Figure 5.5 Photo of system mapping activity (confrontation phase) during focus group session
- Figure 5.6 Overview SE tools/methods mentioned during focus group session
- Figure 5.7 Completed (and post-processed using Kumu software) SSSM worksheet 3

LIST OF TABLES

- Table 4.1 Overview sample experts interviews
- Table 4.2 Strengths and weaknesses of tools/methods mentioned in interviews experts
- Table 4.3 Research opportunities presented by experts
- Table 4.4 Ideas experts on new SE tools/methods
- Table 4.5 Overview sample entrepreneurs interviews
- Table 4.6 Themes identified in SE definitions with example quotes entrepreneurs
- Table 4.7 Themes identified in SSD challenges with example quotes entrepreneurs
- Table 4.8 Strengths and weaknesses of tools/methods mentioned in interviews sustainable entrepreneurs
- Table 4.9 Overview entrepreneurs respondents survey
- Table 4.10 Themes identified in SE definitions survey with example quotes entrepreneurs
- Table 4.11 Themes identified in SSD challenges survey with example quotes entrepreneurs

- Table 4.12 Strengths and weaknesses of tools/methods mentioned in survey responses sustainable entrepreneurs
- Table 5.1 Overview design requirements and what research activities these have been deducted from
- Table 5.2 Benchmark tools/methods ideating phase mentioned by experts and in literature. See appendix Q for a one-sentence explanation and reference per tool.
- Table 5.3 Benchmark tools/methods ideating phase mentioned by entrepreneurs in interviews and survey. See appendix Q for a one-sentence explanation and reference per tool.
- Table 5.4 Sustainable Startup System Mapping (presented in way similar to ‘creative exercises’ of Van der Duin (2016))
- Table 5.5 Overview participants focus group
- Table 5.3 Excerpt focus group responses questionnaire

1

INTRODUCTION

1.1 Background	12
1.2 Problem statement	12
1.3 Study's objectives & research questions	14
1.3.1 Study's objectives	15
1.3.2 Research questions	15
1.4 Relevance	17
1.4.1 Scientific relevance	17
1.4.2 Social relevance	18
1.5 Outline of the report	18

1. INTRODUCTION

1.1 Background

The urgency of environmental challenges is increasing. Globally, the negative effects of climate change are observed in increasing frequency and intensity. In response, the 2030 Agenda for Sustainable Development (2015) and the Paris Agreement (2015) have been written to formulate a vision on how to tackle the challenges. In both documents, innovation is perceived to be key in working towards solutions.

Entrepreneurs can respond to the innovation opportunities for business and society identified in moving towards a circular economy (Climate KIC, n.d.; Belz et al., 2015). It is widely acknowledged in literature that entrepreneurs have the potential to contribute to mitigating and adapting to climate change, through sustainable entrepreneurship. The strengths of entrepreneurs relate to their flexibility: they can experiment to identify the best solutions, and then scale up or share the knowledge with others. The business case behind sustainable entrepreneurship is also triggering interest, since an increasing amount of money is becoming available for projects that have the potential to help saving the planet.

Sustainable entrepreneurship thus is a field of growing interest, but there is no consensus on the definition of the topic yet. A commonly used definition of sustainable entrepreneurship in literature is: “the discovery, creation, and exploitation of entrepreneurial opportunities that contribute to sustainability by generating social and environmental gains for others in society” (Hockerts and Wüstenhagen, 2010; Pacheco et al., 2010; Shepherd and Patzelt, 2011). A recurring element in the definitions is adhering to the sustainability triple bottom line: generating and balancing social, environmental and economic value (Epstein, 2018).

Sustainable entrepreneurship is a subsection of entrepreneurship, and both topics are receiving increased attention. Entrepreneurship has evolved into an established area of academic study, and educational institutes today are offering a wide range of entrepreneurship-related courses (Kuratko & Morris, 2018). The content of entrepreneurship education has been studied by Kuratko and Morris (2018), and there is a major focus on business aspects instead of on creating positive impacts, even

though the potential to “develop new products and innovations helping society to expand and grow” is recognized. Startup educational programs, intending to support student entrepreneurs, have expressed that they experience challenges in practice relating to sustainable entrepreneurship, for example related to the difficulty of determining the impacts and thus whether achieving the intended social and environmental gains.

PLNT Leiden, the Leiden centre for innovation and entrepreneurship, is an example of such an educational institute interested in sustainable entrepreneurship. Its Director of Innovation has expressed that they face challenges in supporting the sustainable entrepreneurs in their community. PLNT Leiden is a foundation initiated by the University of Leiden, Hogeschool Leiden and Leiden Municipality. Students, entrepreneurs, investors, teachers and companies are brought together in the hub to spark innovation. The activities hosted concern education and research, and supporting entrepreneurs with knowledge and financial resources. Nine programs (e.g. the Venture Academy for early stage development of startups) and many events (e.g. Masterclass on innovation and creative thinking) are organized. The aim of these programs and events is to support entrepreneurs in concurring urgent societal challenges. Some startups within the community have formulated missions related to sustainability: entrepreneurship for sustainability is a growing interest and focus. PLNT Leiden recognizes the potential impact of guiding entrepreneurs in sustainable startup development, the importance of collaborative approaches towards knowledge development on the topic, and therefore has expressed the intent to support the development of the thesis by sharing their experiences and networks. Through their networks, a pool of (sustainability) student entrepreneurs/entrepreneurship experts was available for repeated consultation during the participatory process of knowledge development on how to support sustainable entrepreneurship.

1.2 Problem statement

Startup educational programs, intending to support student entrepreneurs, have expressed that they experience challenges related to the sustainable entrepreneurship. For example, they find it difficult to determine the impacts and thus whether they will achieve the intended social and environmental gains. Despite all good intentions of the

entrepreneurs, their sustainability impacts might not always be what they envision. It is hard to determine what good sustainable entrepreneurship encompasses (Kraus et al., 2018). Sustainability issues are complex problems, for which there are no straightforward technical explanations and solutions (Roux et al., 2010; Chevalier et al., 2013). Therefore, educating entrepreneurs on how to develop a sustainable startup can be challenging.

A major challenge presented in literature is that in entrepreneurial practice there are trade-offs in balancing the competing triple bottom line (environmental, social and economic) objectives (Parrish, 2010; de Clercq & Voronov, 2011; Hockerts & Wüstenhagen, 2010; Schaltegger & Wagner, 2011; Bocken, 2015). Entrepreneurs would like to increase their positive impacts (Hockerts and Wüstenhagen, 2010), but, there may be unexpected downsides/negative impacts, which is argued to be a rich area for future research (Hall et al., 2010). There is a need for empirical studies in which primary data is retrieved (through observation or discussion) on how to successfully approach sustainable entrepreneurship (Larson, 2000; Parrish, 2010).

The aim of this thesis research is to gain a better understanding of what sustainable entrepreneurship, and in particular the development of sustainable startups, entails. Sustainable student entrepreneurs encounter challenges, which raises the question how they can be supported in their endeavours. The focus lies on providing support to entrepreneurs similar to those part of the PLNT Leiden community, which are typically young, highly educated and have strong ambitions related to making positive impacts. How can these student entrepreneurs be supported in making such impacts through the development of a sustainable startup? The hypothesis is that support can be provided by developing a tool or method (Spence et al., 2018) which guides them in developing startups with triple bottom line business models.

1.3 Study's objectives & research questions

Based on the scientific knowledge gap and research directions which were concluded from the literature review (see chapter 2), the study's objectives and the main research question and sub questions were formulated. The sub questions guided the research project and led to an answer to the main question.

1.3.1 Study's objectives

The research is mainly exploratory, with some distinguished objectives. The main objective of the research is to contribute to knowledge development on sustainable entrepreneurship through participatory research and tool/method design. It is deemed necessary for researchers to collaborate creatively with society/stakeholders to better understand the challenges before working towards solutions (Mauser et al., 2013). In the first part of the research, the topic of sustainable entrepreneurship and the challenges sustainable student entrepreneurs face are explored through literature review, interviews and a survey. Then, a way to support sustainable student entrepreneurs is suggested based on the insights, and evaluated in a focus group.

The intended outcomes of the study are insights in how student entrepreneurs currently approach sustainable startup development and an overview of the challenges they face (theory), a definition of good entrepreneurial sustainability practices (Kraus et al., 2018) (Linnanen, 2014) (theory), a tool or method which can support student entrepreneurs in sustainable startup development (practical). In addition, suggestions of areas for future research within the field of sustainable entrepreneurship, and more specifically to further develop startup educational programs, are provided.

1.3.2 Research questions

The study's objectives have been translated into research questions, which are the foundation of the report.

- **Research question: How can student entrepreneurs be better supported in the development of sustainable startups?**

The research direction and research questions have been developed in close collaboration with the Director of Innovation of PLNT Leiden. To formulate the research question, the Cambridge Dictionary and experts have been consulted, for proper understanding of the vocabulary in use. In the research question, support is meant as practical help. Entrepreneurs are the people performing the entrepreneurship (which is defined in chapter 2.1.1.1) processes. A student entrepreneur then is defined as a "person who is learning [about entrepreneurship] at a college or university". According to the PLNT Leiden Director of Innovation these student entrepreneurs are

typically young, highly educated and have strong ambitions related to making positive impacts. Sustainable is defined using the Brundtland (1987) definition of 'sustainable development': "meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition is specified more in relation to startup development, as suggested earlier, by the focus on triple bottom line value creation. Startup (also spelled as start-up) is defined as a small business that has just been started, with a business being a company buying or selling products or services. Development is "growing or changing into a more advanced form [in this case being the startup]".

Sub question 1: How do student entrepreneurs currently approach the development of sustainable startups?

To get a view on the current approach, drivers and barriers of entrepreneurs with a sustainability mission, interviews are conducted, and a survey is distributed among entrepreneurs who have noted sustainability in their mission statement. This is meant to provide insights in sustainable entrepreneurs' current practices, tools, drivers and barriers.

Sub question 2: What tools and methods to support student entrepreneurs in the development of sustainable startups are currently available and used?

To get a view on what tools and methods are currently available for and used by the student entrepreneurs, literature was reviewed, experts were consulted and entrepreneurs were interviewed. Overviews of the tools and methods and their strengths and weaknesses are provided. The analyses resulted in knowledge on the current practices.

Sub question 3: What new tool or method could better support student entrepreneurs in the development of sustainable startups in the ideating phase?

Based on the findings of the literature review, interviews and survey, design requirements for a way to support the student entrepreneurs were formulated, and a tool was created (according to the design science approach described in chapter 3). The format for a way to provide support remained open and was decided upon later based on the outcomes of the previous steps. It was concluded based on the previous research activities outcomes that especially in the ideation phase sustainability

tools/methods are lacking. A focus group with student entrepreneurs was organized to evaluate whether the method designed based on the design requirements was successful in supporting student entrepreneurs in the development of sustainable startups.

1.4 Relevance

The research topic is deemed to be scientifically and socially relevant, which is elaborated on in paragraphs 1.4.1 and 1.4.2. A participatory research approach is taken, in which both purposes of scientific knowledge production (scientific relevance) and societal problem handling (social relevance) have been combined (Pohl et al., 2017) by involving a multitude of stakeholders from different disciplines throughout the research for information and co-creation purposes.

1.4.1 Scientific relevance

As mentioned in 1.3.1, the first intended and main contribution is to the field of sustainable entrepreneurship: insights in how student entrepreneurs currently approach sustainable startup development, what challenges they face, an overview of tools and methods and their strengths and weaknesses, and a definition of good entrepreneurial sustainability practices (Kraus et al., 2018) (Linnanen, 2014). In addition, suggestions of areas for future research within the field of sustainable entrepreneurship, and more specifically with regards to startup educational programs, are provided. These are the main intended results of the literature review, interviews and survey.

A second contribution is to the field of industrial ecology, which is the scientific field focused on analysis, design and implementation of solutions to sustainability problems. In this field, the participatory research approach is common. Design Science is proposed in the thesis' methodology chapter as a suitable method towards participatory research knowledge creation through analysis (of the problems student entrepreneurs face in the development of sustainable startups), design (of a tool/method for support) and implementation (of that tool/method to create additional knowledge on the problems). The concept of knowledge creation through design is more common in for example the engineering fields, which could be used

more to increase the understanding of the wicked sustainability problems. By presenting an example of a design science method application (designing a sustainable entrepreneurship system mapping tool), the value of such a more practical method, a design science research approach, is explored (and evaluated in section 6.3).

1.4.2 Social relevance

The society faces challenges related to climate change, and entrepreneurs can step in to work towards solutions. Sustainable entrepreneurship is the name of the field which typically is concerned with solving societal challenges through entrepreneurship. Entrepreneurship education is offered increasingly commonly. In the educational programs there is a need for insights on how to support student entrepreneurs in the development of sustainable startups. The research therefore has a more practical relevance: aims to, in response to the challenges/requirements defined in the theoretical part, design a tool or method which can support student entrepreneurs in sustainable startup development. It is deemed important for this tool or method to be valuable (for which a participatory design approach is adopted) and not too abstract or academic (Ploum et al., 2018). This is the intended result of the design phase based on the theoretical findings, and the focus group.

1.5 Outline of the report

The thesis report is structured as follows. In chapter 2, the systematic literature review on sustainable entrepreneurship is presented. Chapter 3 presents the research design and methodology, including the approaches for the different phases of the researches, the expected deliverables and a research flow diagram. In chapter 4, the results of the research activities related to the needs of the entrepreneurs working on sustainable startup development are presented. Chapter 5 presents the directions on how to develop a support tool/method extracted from the results, and the Sustainable Startup System Mapping worksheets which resulted from that. In chapter 6, the results are discussed and in chapter 7 conclusions are drawn. References and appendices can be found in the back of the report.

2

THEORY

2.1	Systematic literature review approach	20
2.1.1	Definition entrepreneurship	22
2.1.2	Definition sustainable entrepreneurship	23
2.1.3	Sustainable entrepreneurship challenges	27
2.1.4	Sustainable entrepreneurship tools/methods	28
2.1.5	Conclusion sustainable entrepreneurship theory	32

2. THEORY

A systematic literature review is conducted to gain insights into the state of the art with respect to the sustainable entrepreneurship field. First the approach is described (2.1). The literature review's aim is to define the concept of sustainable entrepreneurship, which has resulted in paragraphs defining 'entrepreneurship' (2.1.1) and 'sustainable entrepreneurship' (2.1.2). The second aim was to identify challenges (2.1.3) and SE tools and methods (2.1.4) for which a second review with a new search inquiry was conducted. The theory studies resulted in a conclusion on the scientific knowledge gap and research directions, which can be found in chapter 1 (1.4.1).

2.1 Systematic literature review approach

As stated in the introduction, the thesis is written in collaboration with PLNT Leiden, the Leiden center for innovation and entrepreneurship. In a personal conversation with the PLNT Leiden Director of Innovation, it was noted that it is challenging to assess the sustainability performance of a startup. This was the starting point for the literature review.

Scopus, Elsevier's peer-reviewed literature database, was consulted to find relevant scientific papers.

Search terms used were:

**TITLE ((sustainable OR green OR sustainability OR environmental OR climate)
AND (entrepreneurship OR startup OR start-up))**

The first part of the inquiry limits the results to literature related to sustainability. After a first pass through grey literature, these terms seemed the most appropriate to limit the search to literature related to sustainability without omitting relevant literature. The same method was applied to the second search term to limit the search results to literature related to entrepreneurship.

The cover period was set to papers published since 2010, to give the state of the art with respect to the defined topical field. The abstract, executive summary, and conclusion were read of the fifteen most cited articles (out of 478 hits). An overview of

these fifteen articles is presented in the Literature list in chapter 5. A criterion for exclusion was set: the articles need to explicitly investigate sustainable entrepreneurship, for which the chosen definition (based on Munoz and Cohen (2018)) is: “individuals pursuing entrepreneurial opportunities to create social, environmental and economic value”. Based on this criterion, one publication was deemed not relevant enough, indicated in appendix A.

Based on the publications’ abstracts and conclusions, analytical categories, patterns and research challenges were identified. As an introduction into the field of sustainable entrepreneurship, and the challenges, this broad literature review through Scopus seems sufficient. Some references cited in the articles were also examined to refine the final argumentation. Additional libraries/research papers will be consulted with more specific search inquiries throughout the course of the thesis research.

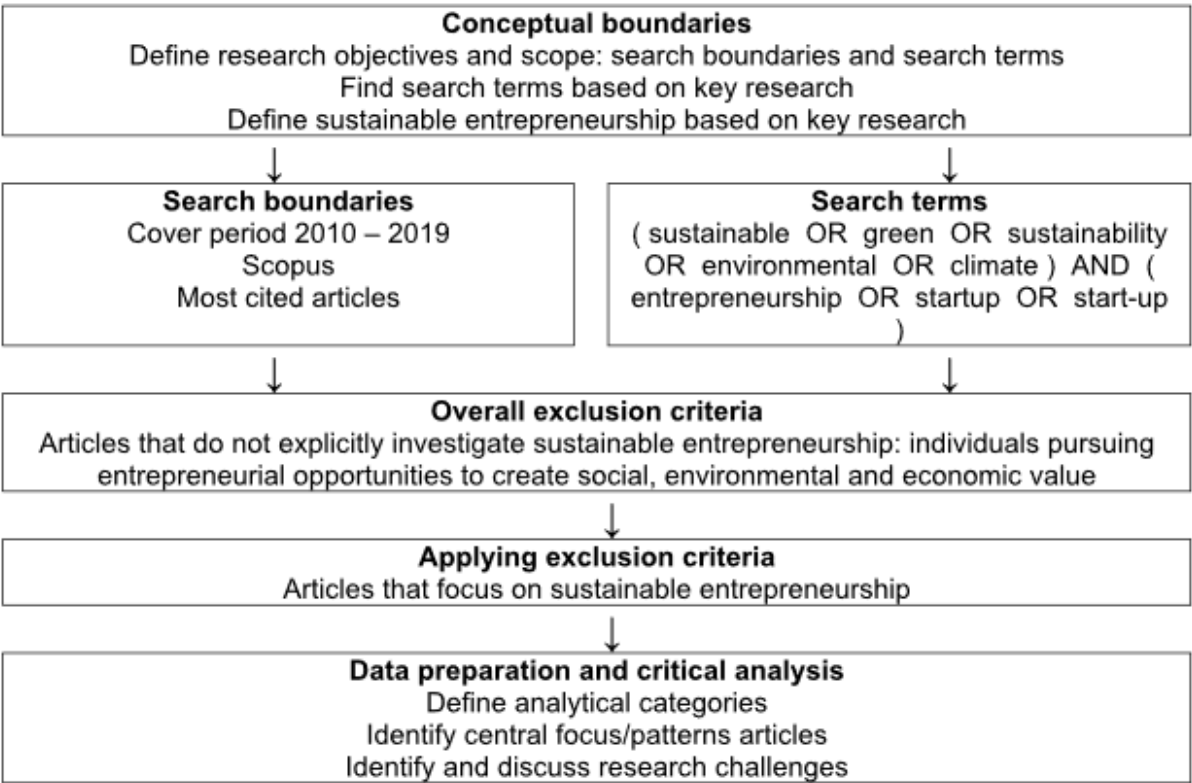


Figure 2.1 Systematic literature review process, according to example Munoz & Cohen (2018)

2.1.1 Definition entrepreneurship

In this paragraph, entrepreneurship is defined. In the literature studied, entrepreneurship is often viewed as the engine of sustainable development (Pacheco, Dean, & Payne, 2010) leading to fundamental societal changes through a “process of creative destruction” (Larson, 2000; Davis & Morris, 1991). Entrepreneurship has gotten increased attention in the scientific field, but is still a concept with many definitions. From the fifteen reviewed articles on sustainable entrepreneurship, the following recurring elements (in bold) in the definition of entrepreneurship have been extracted.

An entrepreneur carrying out activities according to a **vision** (Keogh & Polonsky, 2006). It concerns identification of the right **resources** (Davis & Morris, 1991) to **pursue (business) opportunities** (Hockerts & Wüstenhagen, 2010; Lans et al., 2014; Spence et al., 2018) maximizing **value creation** (Cohen, Smith & Mitchell, 2008) , in an **innovative, risk-taking** and **proactive** manner (Spence et al., 2018; Larson, 2000; Davis & Morris, 1991). They provide **technologies, products, markets, processes and organizational forms**, or **combinations** of these (Larson, 2000; Lordkipanidze, Brezet & Backman, 2005).

According to Dean and McMullen (2007), entrepreneurship can be the **formation of new organizations** as well as the actions of existing organization. This research will limit the scope to the formation of new organizations, because this is the type of entrepreneurship concerned at startup hubs such as PLNT Leiden. Also, it is an interesting focus because of the limited time, financial resources and expertise characteristics of startups (Brown, 2019).

The entrepreneurship process consists of different phases and is regularly visualized as in figure 2.2. The six phases in this model are Ideating, Concepting, Committing, Validating, Scaling and Establishing. These startup development phases as described in the figure, are adopted as a structure throughout the report.

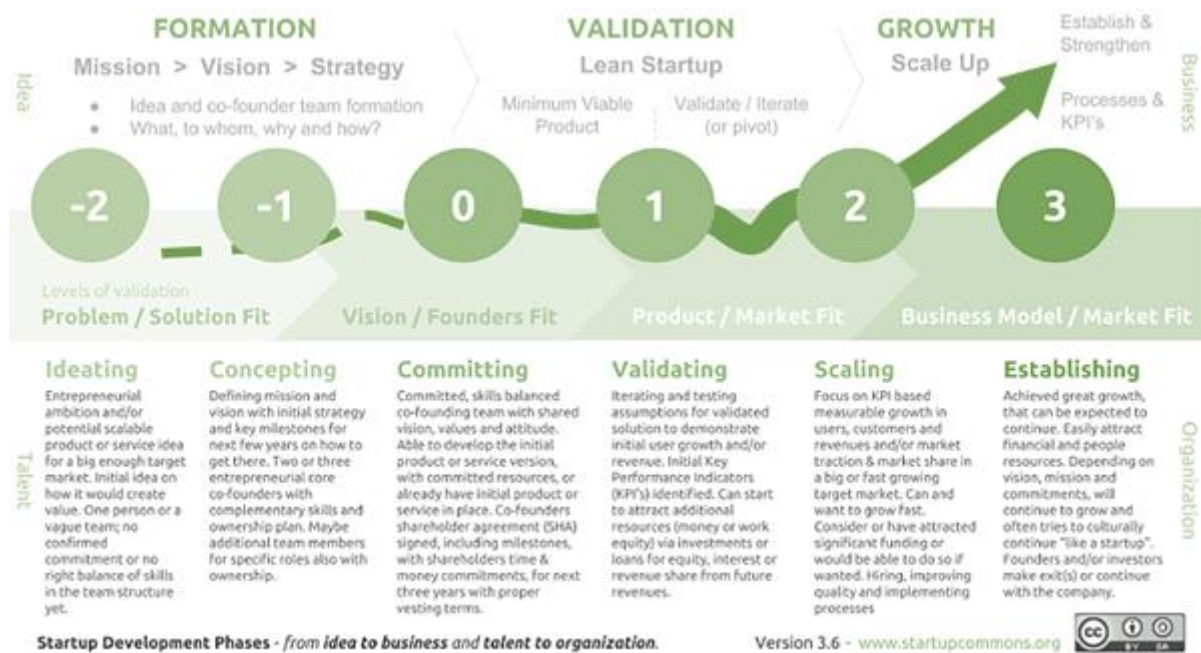


Figure 2.2 Startup development phases (Startup Commons, n.d.)

2.1.2 Definition sustainable entrepreneurship

Sustainable entrepreneurship is a subset within the field of entrepreneurship, which receives increasing scientific attention. It relates to Brundtland’s famous definition of sustainable development, which is development “that 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). Sustainable entrepreneurship is entrepreneurship contributing to **sustainable development** (Lans et al., 2014; Schaltegger & Wagner, 2011). Business opportunities with a **triple bottom line** are pursued, which stands for a broader, more holistic concept of value creation, namely social, economic, and environmental (Cohen et al., 2008; Shepherd & Patzelt, 2011; Bocken, 2015). Social value concerns creating beneficial relationships, economic value is about increasing wealth, and environmental value about balancing systems to sustain the natural environment (Jensen & Meckling, 1994).

Sustainability challenges are perceived as wicked problems because of the complexity and unclear solutions (Rittel & Webber, 1973; Lans et al., 2014). It is suggested by (Cohen et al., 2008) that entrepreneurs are likely to lead the movement towards sustainable business models, because they are in a better position to handle this complexity and take risks of underperformance than e.g. managers in corporations.

Entrepreneurship is recognized for being a major way of bringing sustainable products, services and processes to the market (Bocken, 2015; Fischer et al., 2018), and also inspires action of established companies in an industry (Hockerts & Wüstenhagen, 2010). It is recognized that sustainable entrepreneurs have a more favourable position in the market because of their environmental/social responsibility value proposition (de Clercq & Voronov, 2011).

Dentoni et al. (2012) have developed a framework presenting seven **competencies required** for those who are actively involved in dealing with sustainability in their work environment, which are: systems-thinking competence, foresight-thinking competence, normative competence, embracing diversity and interdisciplinarity, interpersonal competence, action competence and strategic management (Lans et al., 2014). They can support sustainable entrepreneurs (Ploum et al., 2018).

The **sustainable entrepreneurship process** looks as follows, according to (Fischer et al., 2018) and (Belz & Binder, 2017). The process, however, is presented in a linear way, even though it is recognized that the entrepreneurial process generally is an iterative one. To support the entrepreneurs, it might be helpful if the sustainable entrepreneurship process was described better in the literature.

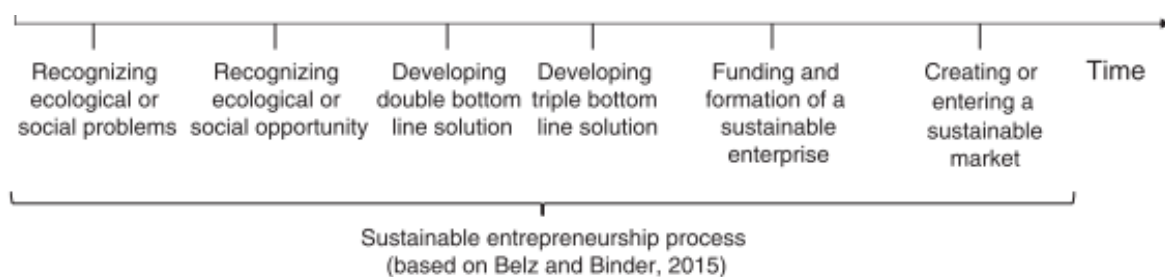


Figure 2.3 The sustainable entrepreneurship process by (Fischer et al., 2018) based on (Belz & Binder, 2017)

When comparing this process by Fischer et al. (2018) to the general startup development phases presented in figure 2.2, it suggests that the sustainable entrepreneurship process steps fit within four of the general startup development phases. The first four steps fall within Ideating, Concepting and Validating, and the latter two steps in Establishing. These four general startup development phases are perceived to be the ones in which sustainability aspects are considered in a sustainable entrepreneurship process (see figure 2.4).



Figure 2.4 Startup development phases in which sustainability aspects are considered in the sustainable entrepreneurship process (based on Startup Commons, n.d.; Fischer et al., 2018; Belz & Binder, 2017)

The definitions for these four sustainable startup development phases, as phrased by the Startup Commons (n.d.), and referred to throughout the report, are:

Ideating: [developing] “Entrepreneurial **ambition** and/or potential **scalable product or service** idea for a big enough **target market**. Initial idea on how it would create **value**.”

Concepting: “Defining **mission** and **vision** with initial **strategy** and key **milestones** for next few years on how to get there.”

Validating: “Iterating and **testing assumptions** for validated solution to demonstrate initial **user growth** and/or **revenue**. Initial Key Performance Indicators (KPI’s) identified.”

Establishing: “**Achieved great growth** that can be **expected to continue**. Easily attract **financial and people resources**. Depending on vision, mission and commitments, will continue to **grow**”

Definition social entrepreneurship

Social entrepreneurship is a concept coming forward in the literature as closely related to sustainable entrepreneurship. The difference is that social entrepreneurs do not aim to create substantial economic profits: profit is secondary to exploiting opportunities for addressing basic needs of societies (Muralidharan & Pathak, 2018). Sustainable entrepreneurs can therefore be social entrepreneurs, but can also be more for-profit/commercial entrepreneurs (Calic & Mosakowski, 2016). Social entrepreneurs

struggle in resource mobilization: they are less attractive to traditional capital providers, wherefore a focus on sustainable entrepreneurship, in which the economic part of the bottom line does not receive less attention, may be beneficial. Social sustainability and economic sustainability are often depicted as a trade-off (as shown in figure 2.3), for which an equilibrium point needs to be determined.

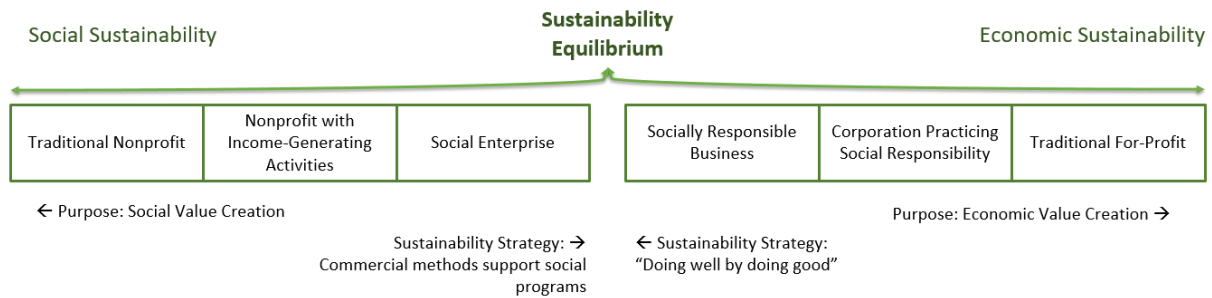


Figure 2.5 Social vs Economic sustainability trade-off (4lenses, n.d.)

Definition environmental entrepreneurship

Environmental entrepreneurship is a subset of sustainable entrepreneurship, with a double instead of a triple bottom line. A stronger focus lies on reducing environmental degradation, and increasing economic profitability (Dean & McMullen, 2007; Rodgers, 2010) by decreasing resource use, reducing risks and hazards, minimizing waste and safeguarding the environment from pollution and waste (Lordkipanidze et al., 2005; Kraus et al., 2018). The following terms are also used in the literature and have approximately the same meaning: green entrepreneurship, ecopreneurship, enviropreneurship.

According to Linnanen (2014), environmental businesses can be further classified into four segments: nature-oriented enterprises, producers of environmental technology, providers of environmental management services, and producers of environmentally friendly products.

It has been considered to focus on environmental entrepreneurship to reduce the scope of the research. However, to maintain the system's perspective, the social pillar also needs attention – sustainable entrepreneurship with a triple bottom line. The insights gained from the environmental entrepreneurship literature, however, are deemed useful and will be incorporated.

2.1.3 Sustainable entrepreneurship challenges in literature

Some important areas for future research within the field of sustainable entrepreneurship have been highlighted in the articles studied. They are clustered and described in this section.

Lack of clarity on how to integrate the triple bottom line in the entrepreneurial process

Entrepreneurs would like to increase their positive impacts (Hockerts and Wüstenhagen, 2010). However, there may be unexpected possible downsides/negative impacts of entrepreneurship, which is argued to be a rich area for future research (Hall et al., 2010). It is hard to pin down the definition of good entrepreneurial sustainability practices (Kraus et al., 2018) because the sustainability criteria are lacking clarity (Linnanen, 2014). Also because trade-offs in balancing competing objectives will occur (Parrish, 2010), combining environmental and social performance and profitability is considered a challenge in entrepreneurial practice (De Clercq & Voronov, 2011; Hockerts & Wüstenhagen, 2010; Schaltegger & Wagner, 2011).

Sustainable entrepreneurship research is mainly qualitative (Gast et al., 2017), prescriptive and anecdotal (Hall et al., 2010). Sustainable entrepreneurship competencies designed to help entrepreneurs with a sustainability mission are abstract and academic (Ploum et al., 2018). Research is needed for the development of new triple bottom line business model formats (Bocken, 2015). De Clercq and Voronov (2011) argue that a standard to which practices can be compared is missing. Hall et al. (2010) argue that entrepreneurship and sustainable development literature need to be connected, which could result in tangible measures for evaluating sustainability performance criteria (Cohen et al., 2008), while also focusing on the customer and satisfying their needs and wishes to improve the financial performance (Davis and Morris, 1991).

Entrepreneurs act in risky competitive business environments for which they need to gain information quickly (Keogh et al., 2006). Support programs for sustainable entrepreneurs need to fit the sustainable entrepreneurship process, and could provide sustainability training and a strong effective framework to guide them (Spence et al., 2018).

Lack of incentives

Entrepreneurs, even though they believe in their vision, need to be encouraged and sustained (Spence et al., 2018). The green prison is a term for the system in which sustainable practices are not encouraged by incentives (Pacheco et al., 2010).

Government institutions should encourage environmentally responsible and dissuade degrading entrepreneurship (Dean & McMullen, 2007; Meek et al., 2010; Bocken, 2015). Green venture capital is estimated to be only 0.1% of all invested venture capital (Linnanen, 2014). Also customers are not encouraged to pay for the sustainable entrepreneurs' proposed value because they do not have information to compare the sustainability performance (environmental, social and economic aspects) of alternatives and therefore cannot choose accordingly (Dean & McMullen, 2007).

2.1.4 Sustainable entrepreneurship tools/methods in literature

Scopus was consulted again to find the tools and methods which are presented in scientific literature. The selection of literature reviewed on sustainable entrepreneurship tools and methods was setup following the same approach as for the literature review performed to explore the field of sustainable entrepreneurship (see chapter 2.1). The list of literature is presented in appendix A. The tools and methods described in the papers have been collected in an Excel sheet, shown in appendix B. The main findings derived from the quotes selected are presented below.

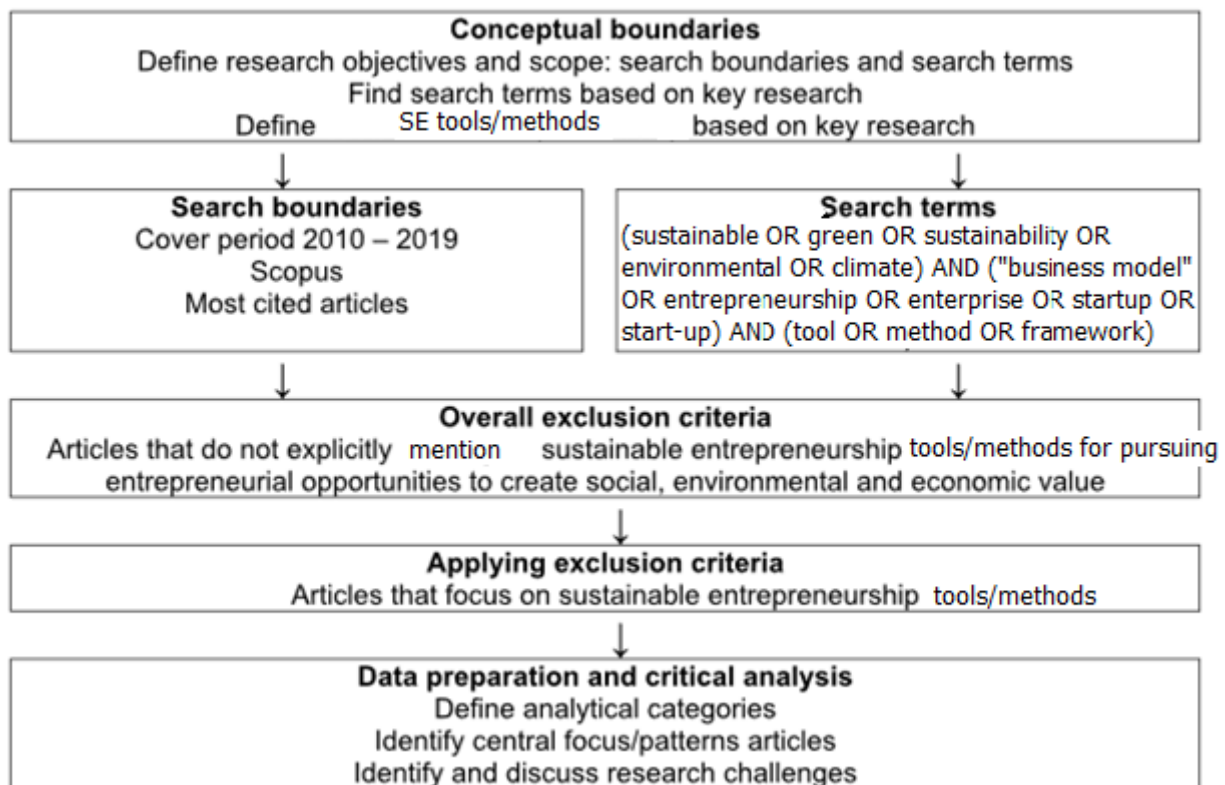


Figure 2.6 Literature review approach SE tools/methods

Corporate Social Responsibility (CSR)

In the literature, sustainability reporting (e.g. CSR) comes forward as the earliest form of a companies' response to environmental concerns (Othman & Ameer, 2009). In the earliest forms, the reporting was mostly like narratives, but more strict models were developed. Nowadays, there are guidelines but no strict formats for reporting. It is noted that CSR practices are often part of a marketing strategy and have a "positive effect on shareholder value creation (Gallego-Alvarez et al., 2010).

Analysing sustainability performance

Tahir & Darton also bring forward that it is difficult to turn the commonly referred to Brundtland definition of sustainable development into operational measures. Long-term definitions of sustainability are hard to translate into day-to-day company decisions (Gaziulusoy et al., 2013). With indicators, the often abstract terminology does not help. For startups, it is important to have sustainability-oriented decision support through effective analysis (Golinska et al., 2015), and to which they have access (Bonnani et al., 2014). A tool or methods, according to Golinska et al. (2015)

needs to handle data of qualitative and quantitative nature. Siew (2015) notes that the emphasis on qualitative data, however, can result in doubt over the accuracy of the analysis.

Issues of dominant life cycle perspective

According to Golinska et al.'s extensive literature review, the life cycle perspective using LCA and LCC is dominant. A problem with this life cycle perspective that comes forward in the work of Tahir & Darton (2010), is that frameworks based on it “suffer from various flaws such as inability to produce clear pictures of socio-economic conditions and the state of the environment, omission of essential aspects of sustainability, overlapping components and consequent double-counting, confusion about what is being measured and why, unmeasurable indicators, and distortion of assessments through an emphasis on documenting procedures rather than achieving results”, as expressed in previous work of Dalal-Clayton and Bass (2002). The analysis may not cover all relevant issues and may not follow an acceptable definition of sustainability (Tahir & Darton, 2010). Siew (2015) notes the observation that the economic, environmental and social criteria are compartmentalised. This division into the three pillars, however, is the most common way of approaching the sustainability analysis.

Increasing interest in system perspective

Some works suggest exposing “cause and effect” relationships, and taking a more systemic perspective. Gaziulusoy et al. (2013) note that existing tools and methods are not guiding enough to system level innovation. According to the same studies, these tools and methods also expose a trade-off between the time it takes and the depth of the output.

“Innovation at the system level requires companies to align their products/services, strategies and business models with long-term sustainability visions in a systemic way.” (Gaziulusoy et al., 2013)

Overview SE tools/methods in literature

An overview (figure 2.5) of the SE tools and methods mentioned in the literature reviewed has been made. The Excel file in appendix B provides an overview of in which articles the tools and methods were mentioned. In the visual below, the tools and methods have been arranged according to the sustainable entrepreneurship phase in which they are used, and whether they are mostly focused on sustainability or not. A one-line description of the tools/methods is provided in the footnote.

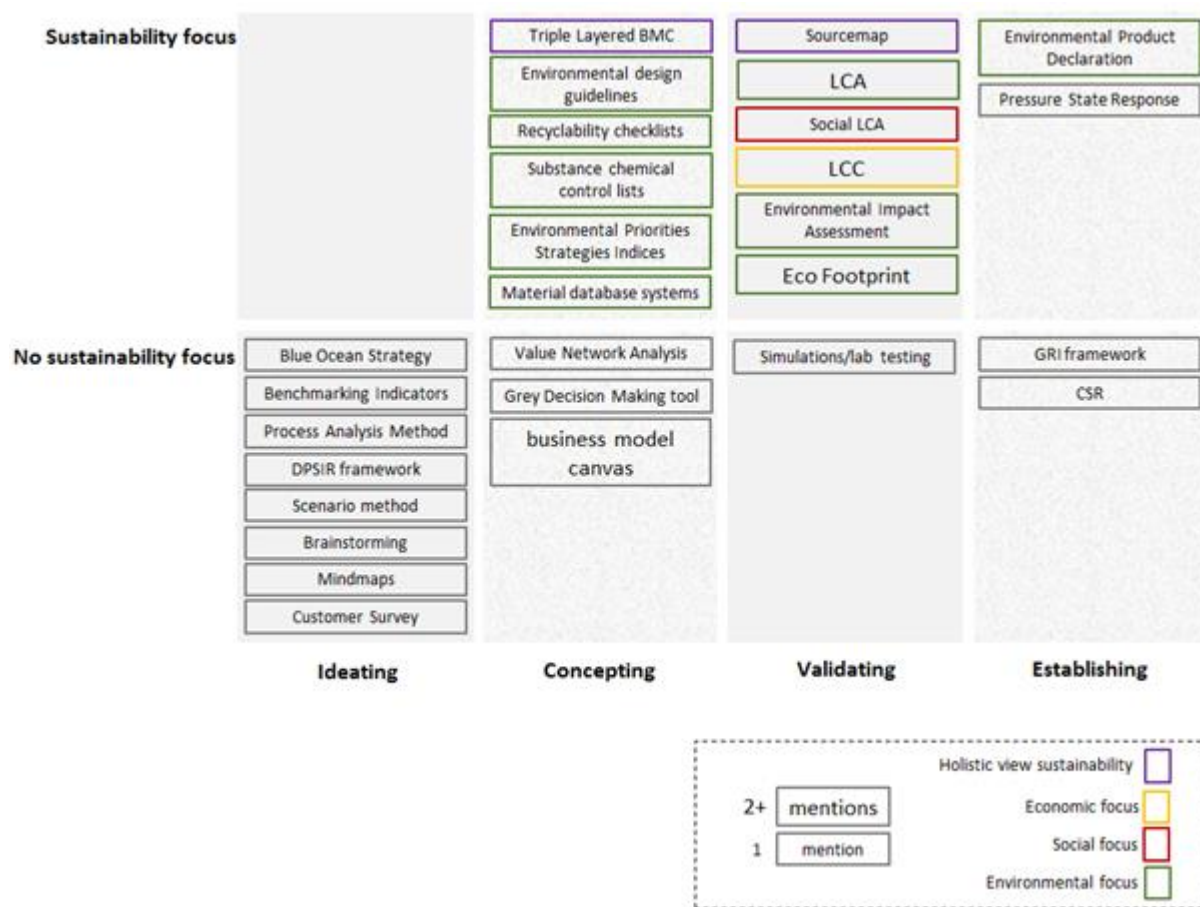


Figure 2.7 Overview SE tools/methods in literature¹

¹ Blue Ocean Strategy: marketing framework to create and capture “blue oceans”: unexplored markets (https://en.wikipedia.org/wiki/Blue_Ocean_Strategy)

Process Analysis Method: method to gain understanding of and improve business processes (<https://managementmania.com/en/process-analysis>)

DPSIR framework: causal framework to describe interactions between society and environment. Driving forces, pressures, states, impacts, responses (<https://en.wikipedia.org/wiki/DPSIR>)

Triple layered BMC: tool for sustainability business model innovation. BMC extended to cover the triple bottom line (Joyce & Paquin, 2016)

Environmental priority strategies (EPS): environmental impact assessment which can be applied in any LCA (<https://www.lifecyclecenter.se/projects/environmental-priority-strategies-in-product-design-eps/>)

2.1.5 Conclusion sustainable entrepreneurship theory

Sustainable entrepreneurship is a scientific field receiving increased attention, but there is ambiguity over how to define and approach the process. The main challenge, formulated based on the literature, is “Lack of clarity on how to integrate the triple bottom line in the entrepreneurial process”. However, when digging more into the development of tools and methods in a second literature review, it came forward that the triple bottom line is criticized, for it not covering all relevant issues and not following an acceptable definition of sustainability. Researchers have an increasing interest in taking a systems perspective towards finding solutions to the sustainability challenges through sustainable entrepreneurship. This conclusion formed the basis for the problem statement section (1.2).

Value network analysis (VNA): method to visualize and optimize value networks in economic ecosystems (https://en.wikipedia.org/wiki/Value_network_analysis)

Grey decision making: tool for identifying and prioritizing improvement actions for company operations (Golinska et al., 2015)

Sourcemap: software to map products supply chains (<https://www.sourcemap.com/>)

Environmental product declaration (EPD): certification that quantifies the life cycle of products (https://en.wikipedia.org/wiki/Environmental_product_declaration)

Pressure-State-Response (PSR): framework used for environmental performance monitoring used by big organisations (<http://www.fao.org/3/W4745E/w4745e08.htm>)

GRI: Global Reporting Initiative, which is a sustainability reporting framework used by big companies (https://en.wikipedia.org/wiki/Global_Reporting_Initiative)

CSR: Corporate Social Responsibility, model for companies to perform self-assessment to perform beyond compliance (https://en.wikipedia.org/wiki/Corporate_social_responsibility)

3

METHODOLOGY

3.1 A “Design Science” approach	34
3.1.1 Research setup	36
3.2 Data collection	37
3.2.1 Interviews method	37
3.2.2 Survey method	40
3.2.3 Focus group method	40
3.3 Data analysis	42
3.3.1 Content analysis method	42
3.3.2 Design and development tool/method	44

3. METHODOLOGY

In this chapter, the research activities are motivated, in line with the previously formulated research sub questions. To find ways to support student entrepreneurs in the development of sustainable startups, it is deemed important to gain user input for designing and testing solutions. Sustainable design expert Brown (personal communication, 2019) pointed out Design Science as described by Romme et al. (2017) as a model/scientific approach to creating designs in the pursuit of knowledge. It is recognized that creating a design to generate knowledge is a more common practice, for example in engineering. Design Science models provide a structure to the practice. First, two major publications on design science (research process) models have been analysed and combined into a Design Science (DS) model. The research setup (3.1.1) is inspired by this DS model, and the research activities link the research questions (1.3.2) with the DS phases (figure 3.4). In the second part of the chapter, the approaches for data collection per research activity are described.

3.1 A “Design Science” approach

Romme et al. (2017) describe Design Science as taking creative design and scientific validation as research approaches of which the research outputs complement each other. An iterative process, as depicted in figure 3.2, can be implemented. All four research activities, of creating, evaluating, theorizing and justifying, can produce research outputs, which can consequently serve as research inputs into a next phase. It is not solely about learning to understand contexts, but also to affect desired changes (design) to generate knowledge (Huang, 2010). This design aspect is deemed valuable for the scientific and social/practical relevance of the work. Theories from different fields are combined to increase the understanding of the wicked sustainability problems the entrepreneurs try to tackle. By presenting an example of a design science method application (designing a sustainable entrepreneurship system mapping tool), the value of such a more practical method for doing research is explored (and evaluated in section 6.3). The Design Science approach also suits the need for more empirical studies (gathering new primary data) which was identified in the sustainable entrepreneurship literature.

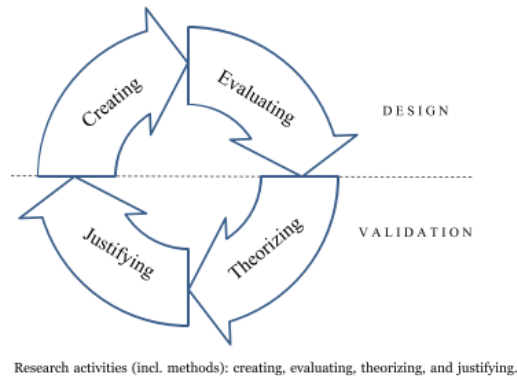


Figure 3.1 Iterative process design science

(Romme, et al., 2017)

Design Science originates from the field of information systems, and the most renowned model is developed by Peffers et al. (2006): the Design Science Research Process (DSRP) model, see figure 5. The DSRP model is a methodology for conducting Design Science research in information systems, for theory building at the intersections of information technology and organizations (Peffers et al., 2006). It suggests six steps, which are described in more detail in their paper, and includes the Design Science features: iterative design/validation research activities to create input for running through the design/validation research activities again.

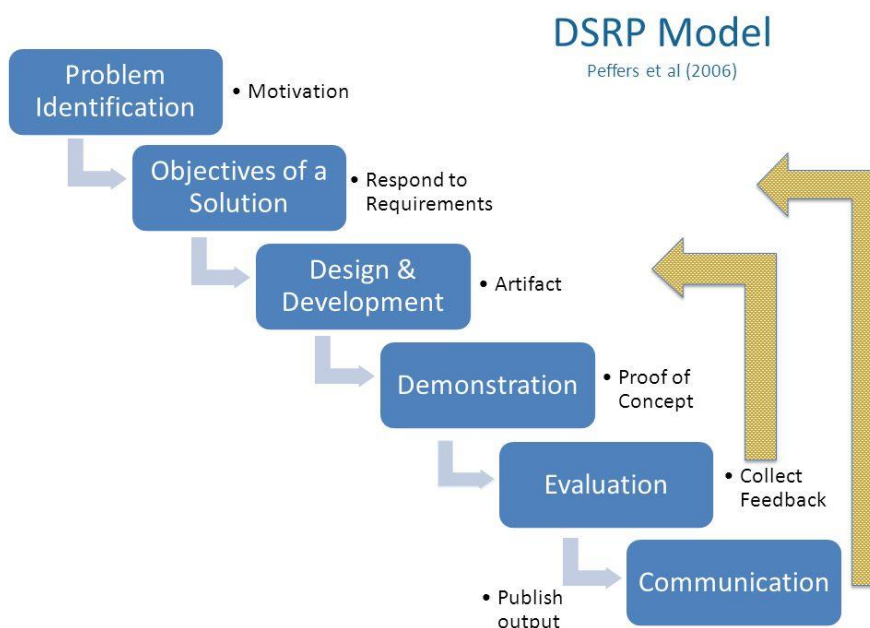


Figure 3.2 DSRP model (Peffer et al., 2006)

The arrows indicate the iterative Design Research approach, where output of one phase functions as input for the other phases. The DSRP model, however, does not indicate clearly where the golden arrows point to. The “Publish output” caption’s position seems to be slightly off in the visualization, and some outputs captions needed some clarification. Lastly, the validation activities of theorisation and justification, as introduced by Romme et al. (2017) have been added to the research flow diagram.

3.1.1 Research setup

In this section, the research setup is presented. The research flow diagram (figure 3.4) is largely based on the DSRP model (figure 3.3), with some minor adjustments based on the remarks above. It also includes the specification of the research activities, which are further elaborated on from section 3.2 onwards.

Sub questions 1 and 2, “How do student entrepreneurs currently approach the development of sustainable startups?” and “What tools and methods to support student entrepreneurs in the development of sustainable startups are currently available and used?” are answered as part of the Problem Identification step. The results are presented in chapter 4.

To answer sub question 3, “What new tool or method could better support student entrepreneurs in the development of sustainable startups in the ideating phase?” 10 design requirements were formulated in the Objectives of a Solution step. Based on those design requirements a tool (the SSSM worksheets) was designed and evaluated in the three consequent steps. The results are presented in chapter 5.

In the Theorisation and Communication steps the main research question “How can student entrepreneurs be better supported in the development of sustainable startups?” is answered and the main deliverables are the thesis report and presentation.

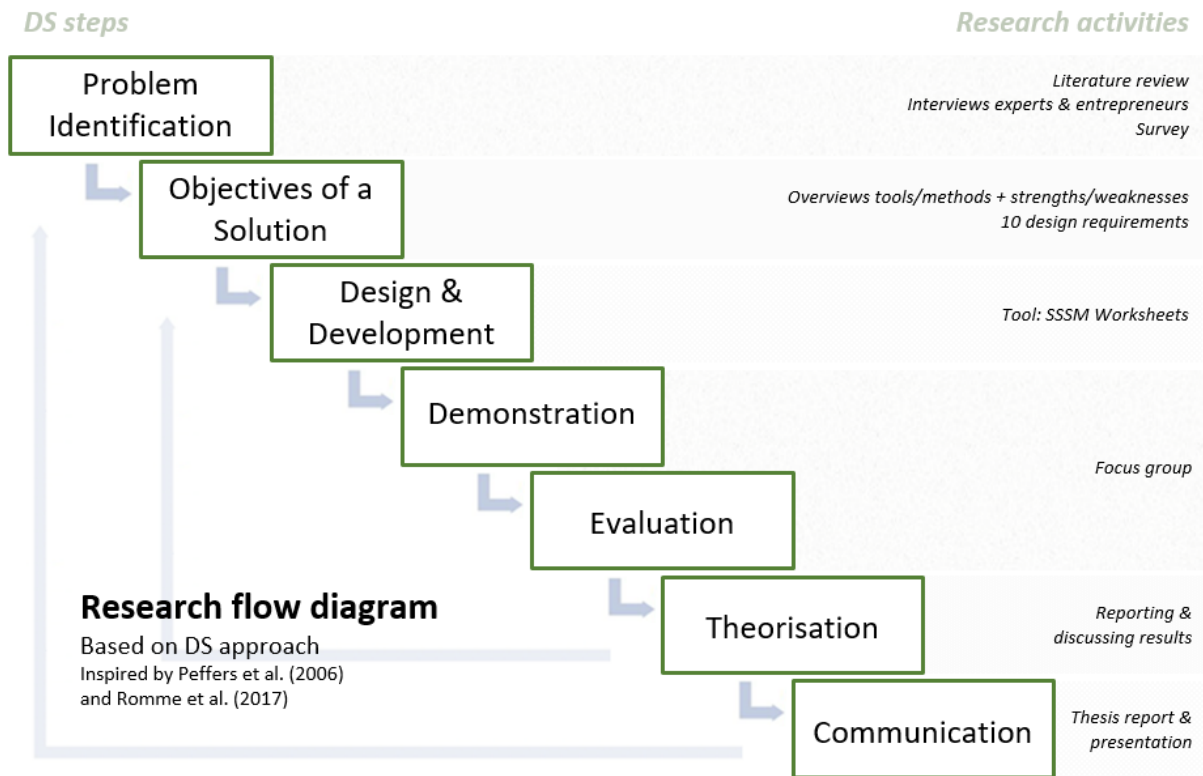


Figure 3.3 Research flow diagram

3.2 Data collection

3.2.1 Interviews method

Interviews experts

Seven experts have been interviewed. The experts were selected over time based on their expertise covering the main fields/themes coming forward in the literature and interviews. The face-to-face semi-structured interviews with open questions were conducted between February and May 2019 and lasted between 30 and 66 minutes. The approach of the interviews was chosen because it allows the interviewer to have a flow in the conversation, but to steer the direction. An interview protocol was set up, to the example of (Fischer et al., 2018) - see appendix C. 16 questions, with some sub questions, are covered. Interview questions 2-4 explore the interviewee's background,

questions 5-10 how the interviewee considers the sustainability aspects, and questions 11-13 the entrepreneurship aspects, of sustainable entrepreneurship. Question 1 asks for consent and questions 15 and 16 are round up questions. This interview protocol was given feedback on by an expert, tested and improved throughout the process.

The interviews were audio-recorded and transcribed. The transcripts are provided in a separate appendix D, according to the human research ethics guidelines. These anonymized transcripts can be requested. All experts have given consent (see appendix E for the informed consent form) to record the interviews and use the data in the report. The interview was conducted in the interviewee's preferred language, either Dutch or English. The quotes from the transcript used in the report have been translated literally to English. In the Excel file (see appendix F) the original quotes can be retrieved. The transcripts are shared with the experts and minor adjustments were made to them (indicated in the transcripts) based on their feedback.

Sample experts

The experts are selected based on theoretical sampling (Edwards & Holland, 2013): the selection is based on the relevance for the theory, in order to develop theoretical ideas that emerge in an iterative process between the theory and the data. The interviews then help to test these emerging ideas. The sample therefore emerges, based on convenience (accessibility) and snowballing (being introduced to new participants by previous participants). The experts were selected for their expertise on (1) LCA, (2) Ecodesign, (3) Positive impact product design, (4) Sustainable innovation, (5) Social enterprises, (6) Technology entrepreneurship, and (7) Social LCA. Table X shows an overview of the characteristics of the experts/interviews.

Interviews entrepreneurs

Eight entrepreneurs have been interviewed. The entrepreneurs were selected over time based on their startup subject, focus (environmental or social within sustainability), and stage (ideating, concepting, validating or establishing). The interviews were conducted between April and May and lasted between 23 and 59 minutes.

A similar interview approach to the one under "Interviews experts" was used. An interview protocol was set up, to the example of (Fischer et al., 2018) - see appendix G. 12 questions, with some sub questions, are covered. Interview questions 1-2 explore

the interviewee's background, questions 3 and 4 are on the perception of sustainable entrepreneurship, and questions 5 until 9 are about sustainable entrepreneurship tools and methods. Questions 10-12 are round up questions. This interview protocol was tested and improved throughout the process.

The interviews were audio-recorded and transcribed. The transcripts are provided in a separate appendix H, according to the human research ethics guidelines. These anonymized transcripts can be requested. All entrepreneurs have given consent (see appendix E for the informed consent form) to record the interviews and use the data in the report. The interview was conducted in the interviewee's preferred language, either Dutch or English. The quotes from the transcript used in the report have been translated literally to English. In the Excel file (see appendix I) the original quotes can be retrieved. The transcripts are shared with the entrepreneurs and minor adjustments were made to them (indicated in the transcripts) based on their feedback.

Sample entrepreneurs

For the selection of the sustainable entrepreneurs, the following criteria were used (approach similar to the one described by Belz et al., 2015):

- startup states that it offers a sustainable product or service
- startups from different industries to increase generalizability
- startup is launched after 2008, so interviewees can comment on the early startup phases
- interviewee is the (co-)founder to ensure they are familiar with the product/service and startup development process

Most (six out of eight) sustainable entrepreneurs have an environmental focus. Two startups with a social focus were included, during the process, to get a broadened perspective on sustainable entrepreneurship. The sample includes two startups from PLNT Leiden, but since the number of startups complying with the selection criteria was small, the scope was not limited to their community and other startups from the networks of PLNT Leiden and the researcher were included as well.

3.2.2 Survey method

The interview output served as input for the survey. The survey (see appendix J) had the same structure as the interviews with the entrepreneurs. 25 questions, with some sub questions, are covered. Questions 1-10 explore the respondent and startup backgrounds, questions 11-18 are about the sustainability aspects of the startup and what challenges are faced. Questions 19-22 are about the sustainable entrepreneurship tools and methods used. Questions 23-24 provide general information on the respondent, and question 25 asked for feedback on the survey so minor improvements could be made to it. Before distributing the survey, it was reviewed by experts, and then tested through two personal interviews with students, to see whether it was understandable. The survey responses (see appendix K) were analysed using the content analysis method, described in paragraph 3.3.1. See appendix L for the content analysis file.

To reach student entrepreneurs working on a sustainable startup, the survey was distributed through the PLNT Leiden, Climate KIC and YES!Delft networks, and was also shared via social media channels. A descriptive table showing the key characteristics of the respondents/startups was made, see the results chapter 4.2.

3.2.3 Focus group method

To get feedback on the first tool/method prototype, a focus group session was organized. A focus group is a planned discussion with a group of people. The tool/method is intended eventually be used in a startup team, and the focus group approach allows for testing it in a similar context. The setup of the focus group follows Kitzinger (1995), which is a commonly referred to paper on focus groups as a qualitative research method.

A theoretical sampling model was used, which is most common in focus groups, whereby the selection is made to reflect a study population or to test hypotheses. A homogeneous group was recommended because the participants have had similar experiences about which they can share. Therefore, student entrepreneurs developing a sustainable startup were selected. The ideal group size is between four and eight participants, for which a sample of six seemed an appropriate group size. The ideal length of the session is between one and two hours, for which a duration of sixty to

ninety minutes seemed appropriate. The three main criteria used for selection were: currently working on a sustainable startup or intending to, educational background, and differing operating contexts. For the first criterion, half of the six participants selected is currently working on a sustainable startup, and half has experience with sustainable startup ideation. Half of the participants has received sustainability education, and half has not. Two had a primary focus on environmental sustainability, two on social sustainability and two indicated to not have a preference.

Group exercises can be used to spark the discussions. The outcome of the exercises then is of lesser importance than the discussion generated. Similar to group exercises, co-reflection can be employed as a structure for the session. Co-reflection (Frow et al., 2015) is a process in which designers collaborate with stakeholders to increase mutual understanding, sharing thoughts and knowledge and defining opportunities for reflection on an artefact in context. The setup of the co-reflection session was based on the approach developed by Tomico et al. (2009), who teaches co-reflection at the Eindhoven University of Technology. The co-reflection session setup consists of three phases, which are described below. The script and PowerPoint used during the focus group session are presented in appendix M. The focus group transcript (appendix N) and content analysis results (appendix O) are also attached.

1. Exploration: *Discuss example cases*

In the first phase, a part of the sustainable entrepreneurship process is re-enacted (a case is presented to the participants) and a general conversation is hosted about the process and related situations (previous experiences of the participants). The practitioner observes and has an open conversation with the stakeholders on the way the sustainable entrepreneurship process is approached.

Goal: to find out how the stakeholders currently approach the early/ideation phase of the sustainable entrepreneurship process in this case, and related situations.

2. Ideation: *How could sustainable entrepreneurs be supported in developing a sustainable startup idea (value proposition)?*

In this phase, values are related to behaviours. The participants are asked to discuss what sustainable entrepreneurship entails and how the sustainable entrepreneurship process could be improved. They are asked to point out parts of the process which are striking them, either positively or negatively, and what contributes to that.

Goal: to find out what parts of the current approaches to the early/ideation phases of the sustainable entrepreneurship process are good or can be improved, and how this could be supported.

3. Confrontation: *Relate findings previous phases to the method, and discuss the usability of the method*

In this phase, the method is employed. The experiences are related to the topics raised in the exploration and ideation phases. The potential usability of the method is discussed.

Goal: to get new and fresh insights on whether the method is valuable and how it could be improved to support the sustainable entrepreneurship process more.

The session was audio-recorded to preserve a record of the proceedings. The audio-recording was transcribed, and subsequently analysed using the content analysis method. At the end of the session, a brief survey (see appendix P) was presented to the research participants so additional private comments could be recorded.

3.3 Data analysis

3.3.1 Content analysis method

Quantity of data does not determine the quality, but quantity can give an idea of the depth of the analysis. Approximately 12 hours of semi-structured interviews recorded, 100 pages of transcripts, and 20 survey responses were used as primary data input. Of

the interviews, 13 out of 15 were conducted face-to-face, and the other 2 over the phone. Because the study was exploratory, the interviews were transcribed so they could be analysed for themes, using the content analysis method. The themes were preselected, and the same for the interviews, survey and focus group.

Based on the findings from these activities, a tool/method was designed. The development and testing of a design or artefact as a way to address a research question is called Design Science, which was described previously in section 3.1. The format of the tool/method remained open and was decided upon based on the outcomes of the previous research activities. These outcomes were based on content analysis of the research activities, using the content analysis method, as described below.

The qualitative content analysis method uses language/text data for analysis, “to provide knowledge and understanding of the phenomenon under study” (Downe-Wambolds, 1992). The data may be verbal, printed or electronic text, and is derived from for example open-ended survey questions, interviews, focus groups and articles (Hsieh & Shannon, 2005).

The specific type of qualitative content analysis that will be used in this study is ‘directed content analysis’, which is the type which is used to support and extend existing theory on a phenomenon. The approach in this study is based on the work of Hsiu-Fang Hsieh and Sarah E. Shannon (2005). As a first step, the data is read thoroughly and important words capturing key thoughts or concepts are highlighted. Notes on thoughts/impressions are made on the side. The structures of the interview setups and survey were similar, based on important topics/aspects identified in existing research. Their questions categories were used as the categories for the analysis (see ‘tree diagram’ coding schemes in figure 3.6 and 3.7). The focus group was analysed using a similar coding scheme (see figure 3.8). If data could not be coded using the predetermined codes, this was noted in the comment section of the transcript documents.

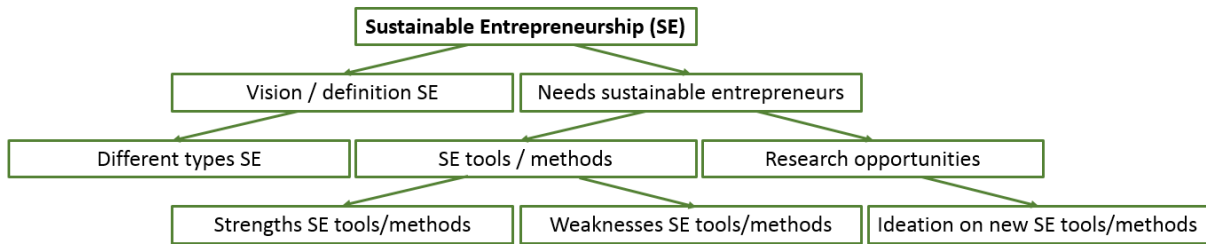


Figure 3.4 Coding scheme graph categories content analysis interviews experts

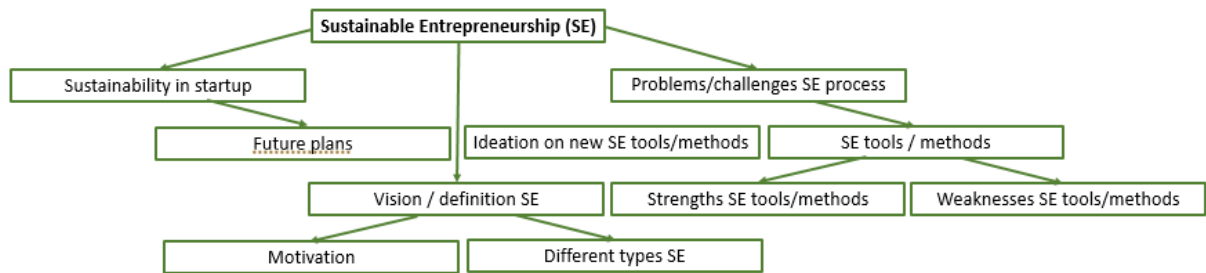


Figure 3.5 Coding scheme graph categories content analysis interviews entrepreneurs

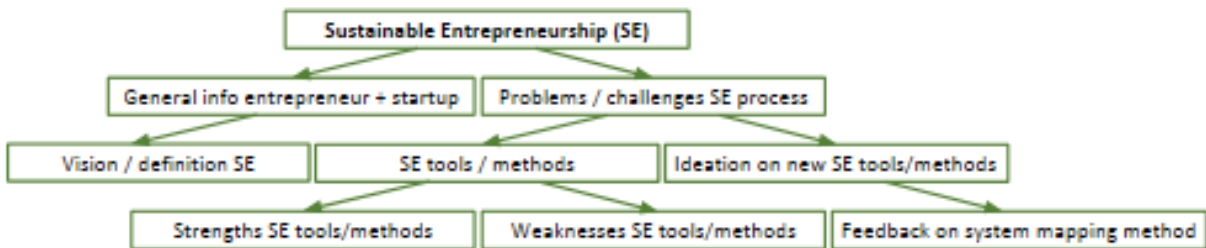


Figure 3.6 Coding scheme graph categories content analysis focus group

3.3.2 Design and development tool/method

A list of design requirements is made by extracting the findings (see results chapter section 5.1) of the content analysis step described above. These design requirements were numbered and translated into a tool/method prototype, through an iterative process, as described in section 5.2. The prototype is presented in section 5.3 and was evaluated in a focus group, as described in section 5.4, to create additional knowledge on how to develop a tool/method to support student entrepreneurs in the development of sustainable startups.

4

RESULTS: SUSTAINABLE STARTUP DEVELOPMENT CHALLENGES

4.1 Results interviews	46
4.1.1 Results interviews experts	46
4.1.2 Results interviews entrepreneurs	55
4.2 Results survey	67
4.2.1 Characteristics of the respondents	68

4. RESULTS: SUSTAINABLE STARTUP DEVELOPMENT CHALLENGES

The results relevant the topic of sustainable startup development and identifying the main challenges are presented in this chapter. Analysis of the data was performed per method, and the results are presented in a similar order. The conclusions are translated into design requirements for supportive tools/methods. In chapter 5 these requirements are used for benchmarking of the tools/methods mentioned throughout the research, and a suggestion for a better supporting tool based on the requirements is presented.

4.1 Results interviews

The aim of the interviews was to explore the topic of sustainable startup development and identify the main challenges. Sustainable entrepreneurship experts (academics) and entrepreneurs working on a sustainability-related startup were consulted. The main drivers and barriers in sustainable startup development, which came forward, are presented in this chapter.

4.1.1 Results interviews experts

According to sustainable entrepreneurship experts, the main challenge for sustainable entrepreneurs, is to know the sustainability impact of the startup. This challenge can be broken down to smaller interrelated challenges, such as there not being a clear definition of what sustainable entrepreneurship entails, there (consequently) not being a proper way to assess the sustainability, and the lack of well-supporting tools and methods. The chapter is concluded with suggested research directions and ideas for tools/methods as presented by the experts (see overview table 4.1).

Table 4.1 Overview sample experts interviews

Code Excel	Function	Expertise	Date interview	Duration interview
Expert1	Managing director	LCA software	28-02-2019	66 min
Expert2	Researcher and teacher	Ecodesign	15-03-2019	36 min
Expert3	Designer	Positive impact product design	27-03-2019	33 min
Expert4	Associate professor	Sustainability oriented innovation	09.-04-2019	30 min
Expert5	Teacher	Social enterprise management	11.-04-2019	58 min
Expert6	Director	Technology based entrepreneurship	15.-05-2019	45 min
Expert7	Researcher	Social life cycle assessment	17.-05-2019	47 min

No strict definition SE

There is no strict definition coming forward on what sustainable entrepreneurship is from the interviews with the experts. The experts also do not seem to agree on one clear cut definition of sustainability. Expert4, an Associate professor on Sustainability oriented innovation (personal communication, April 9, 2019), defines entrepreneurship as "the creation of a new business model, a new product or service, rather than a revision or extinction even, or incremental change of an existing institution or a product/service/business model", and with that is closest to the scientific literature. Also, the vocabulary from this expert throughout the interview is in line with that of the scientific literature. The other experts explained the terms more from a practical and personal point of view. Expert3, the positive impact product design researcher, argues that one cannot focus on all aspects of sustainability because it is too broad, and urges that "You need to make a choice: which sustainability", which opposes what the social enterprise management teacher says: "the emphasis is on being holistic, looking at everything" (expert5). Another difference coming forward is the extent to which the business part is considered in the definition. The assistant

professor on technology based entrepreneurship, strongly focuses on the business aspect: "you need to make money. And if you cannot then it won't work. Sustainability because it is good for the people then is not sufficient." (expert6). Apart from the business feasibility being required for sustainability, sustainability also is required for business feasibility: "Do you want to exist for a longer time as a company, then you need to include these [sustainability] subjects in your business model" (expert6). Expert7, the researcher on social life cycle assessment, argues that as a sustainable entrepreneur adopting a life cycle approach is crucial "consider the life cycle approach as a systemic approach. For me, the life cycle approach does not mean simply from the cradle to the grave, but it means analysing the relation between the system you have with the system around it". Because of a lacking definition/common understanding on what sustainable entrepreneurship is, it is noticed that it can be hard for entrepreneurs to come with a sustainable value proposition.

"Sometimes entrepreneurs think they are sustainable, but it is not true."

(Managing director LCA software company, personal communication, February 29, 2019)

Needs sustainable entrepreneurs

Two main distinct points on what sustainable entrepreneurs need come forward. The first point is that the entrepreneurs need a proper way to assess the sustainability of their proposition: "They want to quantify, measure or simply understand sustainability"... "to demonstrate that they are doing something good" (Expert7). The quantitative sustainability assessment method LCA is mentioned by all experts. Expert4, the Associate professor on Sustainability oriented innovation (personal communication, April 9, 2019) lists major shortcomings of LCA, since it would not address the root cause, oversee the system, cover the impacts and suit the phase in which changes can still be made.

The second point is more focused on the need for user-friendly tools that suit the specific characteristics of sustainable entrepreneurs. Expert1 has a strong focus on the needs of sustainable entrepreneurs relating more to their user experience while using the LCA software. The concerns of the complexity and time consumption of LCAs, often brought forward by the entrepreneurs (see section 4.1.2), are recognized: "They

actually want it very simple.”...”They don’t want to look at the lowest level. Just, this is the impact.” Expert3, the Positive impact product designer, who has developed several tools for sustainable entrepreneurs, acknowledges that the money and knowledge needed for assessment of whether the entrepreneur’s idea is good, often is lacking in early phases. Expert5 stresses that user-friendliness of a tool is of uttermost importance.

Lack of well-supporting SE tools/methods

See Figure 4.1 for an overview of all the tools and methods mentioned in the expert interviews. It is striking that LCA is mentioned by all the experts, but also has received most criticism. Not all tools mentioned are specifically for sustainable entrepreneurship – the ones in grey are more general entrepreneurship tools. The yellow border indicates the tool is focused on the economic pillar, red on the social pillar, and green on the environmental pillar. The tools in the smaller font were only mentioned by one expert. The tools have been arranged horizontally on the phase of the startup development they are meant to be used in. Vertically, it is indicated whether the focus of the tool/method lies on sustainability. A one-line description of the tools/methods is provided in the footnote.

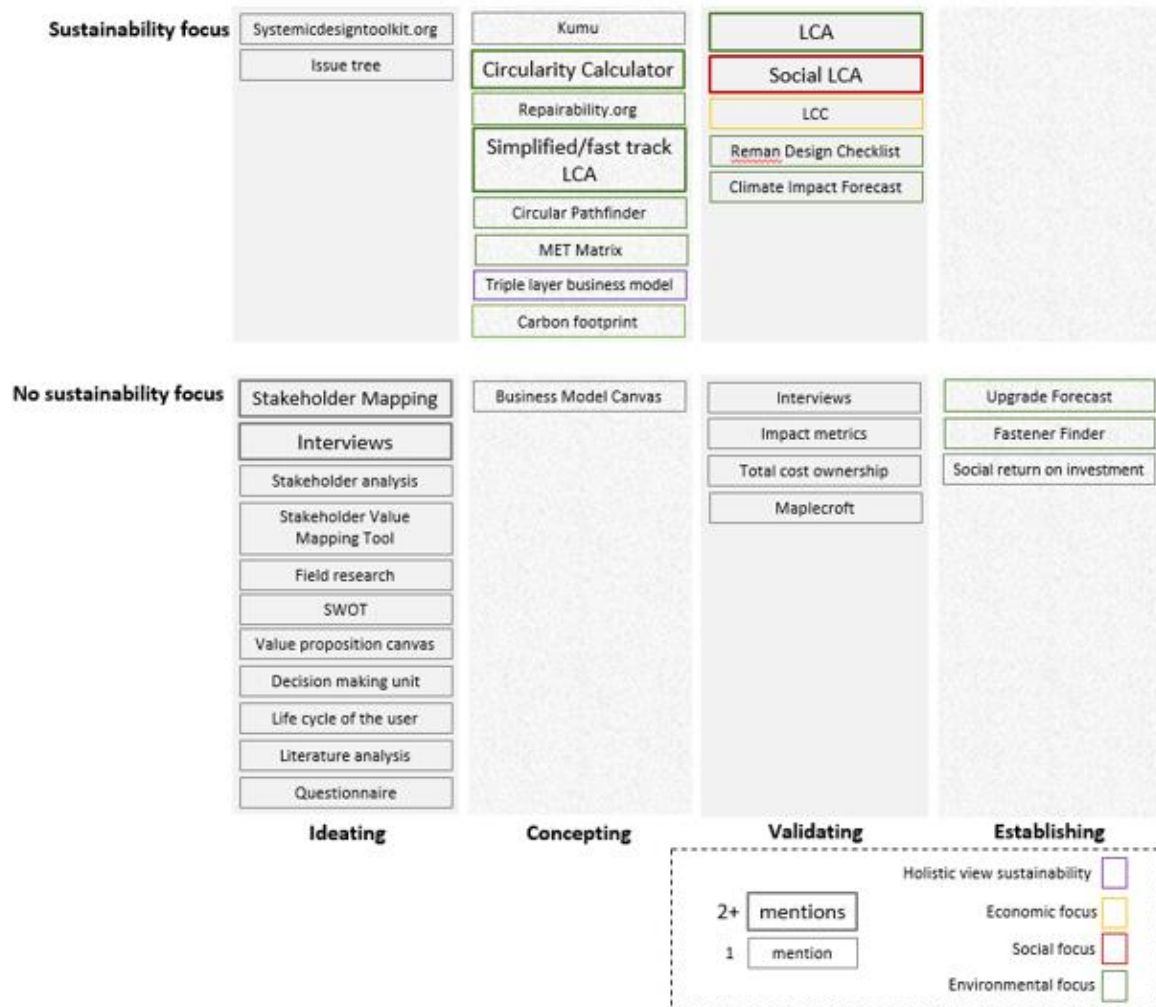


Figure 4.1 Overview SE tools/methods mentioned in expert interviews²

² Systemicdesigntoolkit.org: toolkit which helps co-creation towards tackling complex problems (<https://www.systemicdesigntoolkit.org/>)

Issue tree: graphical breakdown of a question to foster understanding (https://en.wikipedia.org/wiki/Issue_tree)

SWOT: strategic analysis technique to identify strengths, weaknesses, opportunities and threats as part of business planning (https://en.wikipedia.org/wiki/SWOT_analysis)

Decision making unit (DMU): group of people helping to make business decisions (<https://www.b2bmarketeers.nl/dmu/>)

Life cycle of the user: method to understand the customers and their needs and wishes (<https://tcagley.wordpress.com/2018/01/04/life-cycle-of-a-user-story-process/>)

Kumu: software to map complex data within a system (<https://www.kumu.io/>)

Circularity calculator: tool to understand and increase the circularity of business processes (<http://circularitycalculator.com/>)

Repairability.org: tool developed by iFixit which helps customer to repair electronics (<https://nl.ifixit.com/>)

Circular pathfinder: tool for selecting circular design strategies (<http://rescomd58.eurostep.com/idealco/pathfinder/>)

MET matrix: analysis tool to evaluate environmental impacts of a product. Materials, Energy and Toxicity. (https://en.wikipedia.org/wiki/MET_Matrix)

Triple layered BMC: tool for sustainability business model innovation. BMC extended to cover the triple bottom line (Joyce & Paquin, 2016)

Reman design checklist: checklist to assess the remanufacturability of a design (<https://www.rescoms.eu/assets/images/Reman-Design-Checklist.pdf>)

Climate impact forecast: tool to calculate and improve the carbon footprint of a business model (<https://climate.impactforecast.org/about/>)

Strengths and weaknesses of the tools/methods were mentioned by the experts, which are shown in table 4.2. Criteria deducted for helpful tools are whether insightful, trustworthy, user-friendly and addressing sustainability holistically.

Table 4.2 Strengths and weaknesses of tools/methods mentioned in interviews experts

Tool/method	Strengths	Weaknesses
Blended value creation	<i>Sustainability well addressed:</i> Holistic understanding (expert5)	
BMC		<i>Not trustworthy:</i> Too simplified (expert6); Too static (expert6) Not holistic enough (expert5)
Carbon footprint	<i>User-friendly:</i> No big investments needed (experts5,6)	
Financial tools (general)	<i>Trustworthy:</i> Standardized (experts4,6,7)	
Ideation tools (general)	<i>Insightful:</i> Generic (experts5,6) <i>User-friendly:</i> Simple (expert5); Easy to use (expert5); No big investments needed (experts5,6)	
Issue tree	<i>Sustainability well addressed:</i> Holistic understanding (expert5)	
LCA	<i>Insightful:</i> Lot of features/ functionalities (experts1,5); Transparent (expert1) <i>Trustworthy:</i> Scientific (expert1); Robust (experts1,6); Standardized (experts4,6,7); Complete (expert7)	<i>Too complex:</i> Too much in depth (expert1); Too specific (expert1); Difficult (experts1,5); Too complex (expert6) <i>Not trustworthy:</i> Hard to be objective/not be biased (expert2); Lot of assumptions (experts2,3);

Total cost of ownership: concept to estimate the financial aspects of a product
(https://en.wikipedia.org/wiki/Total_cost_of_ownership)

Maplecroft: data-driven identification and management of risks for companies' operations, investments and supply chains (<https://www.maplecroft.com/>)

Upgrade forecast: tool to forecast technological trends to develop future plans company
(<https://www.rescoms.eu/assets/images/Upgrade-Forecast.pdf>)

Fastener finder: tool which assists finding the correct fasteners for metal sheeting and cladding
(<https://www.fixfast.com/fastener-finder>)

Social return on investment: method for measuring value other than financial
(https://en.wikipedia.org/wiki/Social_return_on_investment)

	<p><i>Sustainability well addressed:</i> Multiple impact indicators (expert2); Covering whole value chain (expert7)</p>	<p>Results can be counterintuitive (expert2); Not detailed enough (expert4); Doubts accuracy (expert6) <i>Not user-friendly:</i> Too time consuming (experts3,5,6,7); Need to know what to do with it, lacking expertise (experts1,7); Data not available for free (experts3,7); Needs to be useable for different audiences (experts1,3,5) <i>Sustainability not holistically addressed:</i> Lacks ecosystem perspective (experts1,2,4); Not addressing root causes (expert4); Unintended consequences (expert4); Not holistic enough (expert5)</p>
Literature and document analysis	<i>Insightful:</i> Helps define problem (experts6,7)	
Social LCA		<i>Too complex:</i> Unclear how to quantify (experts2,3)
Social return on investment	<i>Insightful:</i> Specific (expert5)	
Stakeholder analyses	<i>Insightful:</i> Gives direction (expert6)	
Stakeholder engagement	<i>User-friendly:</i> Helps early-on visibility (expert7)	<i>Not user-friendly:</i> Too time consuming (experts3,5,6,7)
SWOT	<i>Insightful:</i> Helps define problem (experts6,7)	
System mapping/perspective	<p><i>Insightful:</i> Insights in early stages (expert4) <i>Sustainability well addressed:</i> Uncover unintended/unforeseen consequences (expert4); Address root causes instead of symptoms (expert4)</p>	<i>Not trustworthy:</i> Too abstract (expert6)
Triple layer business model	<i>Sustainability well addressed:</i> All aspects sustainability incorporated (experts3,6)	<i>Sustainability not holistically addressed:</i> Conflicting pillars triple bottom line (experts3,5,6)

Research opportunities + Ideation on new SE tools/methods

The experts bring forward plenty of research opportunities and ideas for new tools/methods, related to their expertise. A recurring element in the research directions presented in table 4.3, is the question of how to properly determine sustainability impact (experts2,3,4,5,6,7), and consequently how to support entrepreneurs with that (experts1,6,7). That impacts on different aspects of sustainability need to be overseen is a major challenge coming forward (experts2,3,4,5,6,7). The ideas on new SE tools/methods are mostly related to improving/adapting a current tool/method to suit the sustainable entrepreneurs. The tools/methods suggested for this are LCA (expert1), triple bottom line (expert3), planetary boundaries framework (expert4), system mapping (expert4), blended value creation (expert5), BMC (expert6) and stakeholder engagement methods (expert7).

Table 4.3 Research opportunities presented by experts

Code Excel	Function	Research opportunities coming forward
Expert1	Managing director LCA software company	- how to make LCA easier and more accessible? - how to make LCA software for sustainable entrepreneurs?
Expert2	Researcher, teacher Ecodesign	- how to incorporate the concept of rebound effects in a sustainability assessment?
Expert3	Designer, researcher Positive impact product design	- how to combine economic and humanitarian methods?
Expert4	Associate professor Sustainability oriented innovation	- how to make a tool which is not a TBL assessment but a system's analysis? - how to determine whether doing the right things?
Expert5	Teacher Social enterprise management	- how to combine the environmental, social and financial impacts measurements?
Expert6	Assistant professor, director, Technology based entrepreneurship	- how to organize sustainability over the whole chain? - how to create a sustainable business model?
Expert7	Researcher Social life cycle assessment	- how to determine what social aspects/issues to include? - how to make it easy to engage stakeholders?

Table 4.4 Ideas experts on new SE tools/methods

Code Excel	Function	Ideas on new SE tools/methods
Expert1	Managing director LCA software company	- early in the process, look at the hotspots and improvement opportunities based on existing/general data and models
Expert2	Researcher, teacher Ecodesign	- required that it does not take too much time
Expert3	Designer, researcher Positive impact product design	- show the three parameters separately and the users can assign weights - user friendliness most important aspect
Expert4	Associate professor Sustainability oriented innovation	- start with the planetary boundaries framework - tool has to be contextually dependent on threshold limits - map out the current system and the variables to understand the dynamics - need strategic tools for the initiation phase, front end
Expert5	Teacher Social enterprise management	- base on blended value creation
Expert6	Assistant professor, director, Technology based entrepreneurship	- consider sustainability from the start of developing value proposition - make the business model canvas more dynamic
Expert7	Researcher Social life cycle assessment	- stakeholder engagement to support selection of social relevant issues

Conclusion: Design requirements

The following design requirements for tool/method development have been deduced from the expert interviews:

Design requirements:

- **Systems perspective on sustainability**
 - recognizing dynamics situation (experts4,6)
 - recognizing potential rebound effects (expert2)
 - enabling a system's analysis (experts4,5)
 - considering context (expert4)
 - considers business feasibility, the economic pillar (experts5,6)
- **Provides indication potential impacts**

- enables determining sustainability impacts (experts2,3,4,5,6,7)
- working with data available early in process (expert1)
- indicating whether doing the right things (expert4)
- **Easy to understand**
 - easy to perform (expert1)
 - user friendly (expert3)
 - enables to understand sustainability (expert7)
- **Enables stakeholders engagement**
 - structures approach to involving stakeholders (expert7)
 - talking with beneficiaries (expert5)
- **Addition to existing tools/methods**
 - a strategic tool for the early phase (experts4,6)
- **Accessible**
 - accessible to the entrepreneurs (expert1)
- **Time efficient**
 - not taking too much time (experts2,5)





4.1.2 Results interviews entrepreneurs





The interviews with seven entrepreneurs (see table 4.5 for the overview) have been transcribed, the content is analysed, and the main results are deducted from the categories in the analysis and presented in this chapter. The main challenge in sustainable startup development coming forward from the interviews with the sustainable entrepreneurs is, similar to what the experts say, related to knowing the sustainability impact of the startup. This is phrased as the desire to know whether making a positive impact. Important barriers identified are lack of sustainability expertise, business vs sustainability trade-offs, and lack of understanding the system in which they operate. Their mission is what motivates the entrepreneurs, but they would like to be supported in overcoming the hurdles in achieving that mission. This results section consists of four paragraphs. In paragraph 4.1.2.1 the definition of sustainable entrepreneurship is presented. 4.1.2.2 sheds a light on the three main challenges the entrepreneurs face. The section is concluded with a presentation of the tools and methods

discussed (4.1.2.3), their strengths and weaknesses, and some ideas of the entrepreneurs for tool/method development (4.1.2.4).

Table 4.5 Overview sample entrepreneurs interviews

Code Excel	Startup subject	Focus env/soc	B2B/B2C	Phase	Year start	Date interview	Duration interview
Entrepr1	Tents	Env	B2B	Concepting	2018	17-04-2019	34 min
Entrepr2	Tents	Env	B2B	Establishing	2015	18-04-2019	35 min
Entrepr3	Fish feed	Env	B2B	Validating	2018	25-04-2019	49 min
Entrepr4	Isolation material	Env	Undef	Scaling	2016	26-04-2019	58 min
Entrepr5	Sensors	Env	B2B	Scaling	2017	29-04-2019	59 min
Entrepr6	Trespa shields	Env	Undef	Concepting	2018	07-05-2019	27 min
Entrepr7	Restaurant	Soc	B2C	Establishing	2017	16-05-2019	23 min
Entrepr8	Platform	Soc	B2C	Validating	2017	17-05-2019	24 min

	<p>Entrepreneur 1 Age: 26 Working on startup since: 2018 Phase: Concepting Startup: a tent renting service for festivals offering a long lasting alternative for single use tents, to reduce tent waste Startup educational program: Climate KIC Motivated by: making the world/society a little bit better, the quicker effect, working on something innovative Main challenges: lack expertise on bio based materials, sub optimal choices under time pressure, validation concept with envisioned users, knowing in early phase whether on right track Tools/methods used: BMC, survey, Climate KIC LCA Excel sheet</p>
	<p>Entrepreneur 2 Age: 23 Working on startup since: 2015 Phase: Establishing Startup: recyclable cardboard tents to reduce festival tent waste Startup educational program: Clean Tech Challenge TU Delft Motivated by: counter movement, providing additional benefits apart from being more sustainable Main challenges: perceived sustainability vs business trade-off when making choices, development of product which is all new Tools/methods used: pilots at festivals, LCA, BMC</p>
	<p>Entrepreneur 3 Age: 28 Working on startup since: 2018 Phase: Validating Startup: convert carbon dioxide captured at large companies into protein for animal feed Startup educational program: Biocity (UK) Motivated by: valorising a big waste stream, creating no really negative environmental or societal impact Main challenges: meeting the requirements with the technology, limited time, ensuring feedstock quality and scalability Tools/methods used: BMC, LCA (commissioned), crude LCA, survey</p>
	<p>Entrepreneur 4 Age: 28 Working on startup since: 2016 Phase: Scaling Startup: uses fungi to grow isolation material Startup educational program: Climate KIC Motivated by: changing relation humans with planet, C2C, circular economy, revolutionizing industries Main challenges: business vs sustainability trade-off in choices made in setting up the company (e.g. electric vehicle for transportation or not), understanding what is sustainable and how to achieve that Tools/methods used: interviews, crude LCA, BMC</p>

	<p>Entrepreneur 5 Age: 28 Working on startup since: 2017 Phase: Scaling Startup: provides sensors to monitor energy use in a building Startup educational program: PLNT Leiden Motivated by: balancing nature and economy, business opportunities: the economic side Main challenges: finding the best hardware for the sensors, identifying target customer and shifting throughout process, determining what sustainability aspects to prioritize Tools/methods used: BMC</p>
	<p>Entrepreneur 6 Age: 23 Working on startup since: 2018 Phase: Concepting Startup: valorising Trespas waste stream by reusing it as building material Startup educational program: Circular Challenge BlueCity Motivated by: learning experience, reusing waste materials, contributing to bigger sustainability transition Main challenges: whether business really is sustainable, business vs sustainability trade-offs related to being a startup, difficult to be efficient at small scale SE tools/methods used: BMC</p>
	<p>Entrepreneur 7 Age: 23 Working on startup since: 2017 Phase: Establishing Startup: restaurant where refugees and locals connect by running it together, under guidance of volunteers Startup educational program: none Motivated by: helping refugees Main challenges: guaranteeing quality and effort of volunteers, people lacking expertise in what they are doing, receiving financing in early phase Tools/methods used: business plan document format, SWOT analysis, BMC</p>
	<p>Entrepreneur 8 Age: 29 Working on startup since: 2018 Phase: Validating Startup: app to connect people with distance to labour market and employers Startup educational program: none, but planning to because perceived as potentially useful Motivated by: helping people with distance to labour market, the intention most important Main challenges: financing: getting trust and investment, scaling up, expertise on juridical issues Tools/methods used: discussed a lot with people in network</p>

Definition SE

The sustainable entrepreneurs have in common that they are motivated by their mission to make an impact. The motivations are primarily expressed as big dreams of making a positive change (entreprs1,2,3,7): making “the world a little bit better” (entrepr1). Also the hands-on (entreprs1,4), active (entreprs1,8) learning experience (entreprs6,7) are what the entrepreneurs are attracted to. The entrepreneurs are viewing their sustainability contribution as part of a bigger transition/societal change. Entrepr1 highlights that entrepreneurship provides an “opportunity to have a quicker effect. In the end we can all talk about system change and what not, but we need solutions now”. Entrepr5 and Entrepr6 also refer to this system transition. Entrepr6 is more critical about what a truly sustainable enterprise would be, but concludes that it is more about the goal than the bottom line per se. When the interviewees refer to sustainability, they commonly link to well-known theories such as the Triple Bottom Line, Cradle to Cradle, Circular Economy, and Blue Economy. Entrepr5 recognizes this when going to startup events, and calls it the “hippebegrippenfabriek”, meaning that terms have become buzzwords. For entrepr6, however, the Blue Economy theory helps to understand sustainability, and talk about it with others, and for entrepr4 mentioning and applying the circular economy theorem is also a way of positioning and differentiating the startup in the market. What comes forward is that the entrepreneurs are generally motivated by contributing to sustainability, but what this entails remains unclear in their definitions.

Table 4.6 Themes identified in SE definitions with example quotes entrepreneurs

Definition SE themes	Example quotes entrepreneurs
Sustainability transition/ societal change	“opportunity to have a quicker effect. In the end we can all talk about system change and what not, but we need solutions now” (entrepr1)
	“about creating something that is sustainable. Not only in practice but also in the system” (entrepr5)
	“it all contributes to a transition to more sustainable practices or more sustainable company management. So I think that the goal then makes whether something is a sustainable enterprise” (entrepr6)
Link to well-known theories	Triple Bottom Line: “balancing environmental, economic and social perspectives” (entrepr1)

	Cradle to Cradle, Circular Economy: "I saw concepts as cradle to cradle and circular economy" (entrepr4)
	Blue Economy, Circular Economy: "blue economy or the circular economy are something people can be very enthusiastic about" (entrepr6)

Challenges sustainable startup development

Table 4.7 Themes identified in SSD challenges with example quotes entrepreneurs

Challenges SSD themes	Example quotes entrepreneurs
Lack of sustainability expertise	"really wanted to use bio based materials, but there is not a lot of skill there yet" (entrepr1)
	"Everything was new, which was nice, then you can think of it yourself, but it also slows down." (entrepr2)
	"make sustainable options insightful. You don't want to threaten your whole product or service because you're becoming more sustainable." (entrepr4)
	"What do I have to live up to, and more importantly what do I not have to live up to. Because there is so much in it [sustainability], that you cannot do it all as a company." (entrepr5)
	"[question of] What high-quality reuse is" (entrepr6)
	"that there is a lack of experience. And you see that in all parts of the organisation. That the people are not educated for what they do" (entrepr7)
Business vs Sustainability trade-off	"a business that finds the optimal balance between stimulant prosperity and net zero environmental impact, or strives to as much as possible" (entrepr1)
	"For example for an electric van."..."As a startup you do want that, but it just is not possible." (entrepr2)
	"There is a consideration between endless sustainable and endless business. Two aspects that need to meet somewhere in the middle." (entrepr4)
	"The bigger goal is of course sustainability, but before that are all companies that need to make money." (entrepr5)
	"Also because it's a startup we chose a lot for the less sustainable options." (entrepr6)
Understanding the system	"for new startups, which need estimates of impacts in a new scenario" (entrepr1)

	"a problem that many sustainable entrepreneurs have, which is that it doesn't have conventional value chains, supply chains" (entrepr3)
	"So complex. You should actually have been part of different parts of it for some years before you understand and see the problem." (entrepr4)
	"I also think the system changes a lot. I don't know if we will ever grasp how the system works." (entrepr5)
	"But I have the feeling that we then did not look at everything critically enough. Because you're in a challenge you just want it to work." (entrepr6)

Lack of sustainability expertise

"That is very difficult, is something sustainable or not." (entrepr4)

Entrepreneurs note that they have a hard time to determine whether they are on track sustainability-wise. It is recognized by the interviewees that unsustainability can be unintended because of the complexity of sustainability. Entrepr5 had critical remark that a business can also say that it is sustainable just to say it. There is overall agreement that it is hard to determine whether something is sustainable or not.

Entrepr1 mentions that new startups would need estimates of impact in a new context. Entrepr5 notes on this context that it is continuously changing: "Every half a year there are new trends and challenges, the landscape changes all the time. Entrepreneurs don't have the time to work that all out, because they are keeping their company running". Estimating the impact is considered to be very hard. LCA is mentioned as a tool for that, but it is too complex, especially in an early phase:

"you still want some kind of idea whether you're on the right track. Because that's the difficult thing"..."that is something you would want to uncover in a very early phase" (entrepr1)

All entrepreneurs note that a lack of expertise, for example on materials and processes, slows them down. Entrepr4 notes that they need more insight in sustainable options, and entrepr5 thinks getting more expertise ("talents") on board, for which resources are needed, would help.

Business versus Sustainability trade-off

"I think there are sustainable startups that have as a primary goal to have a functional startup, to grow bigger and to earn money. So there the success of a company is more important." ... "And then there are more ideological startups that find the goal more important." "And a lot in between, it's not the one or the other." (entrepr6)

It is mentioned that there is a gradient of whether businesses are truly sustainable. What comes forward in the interviews is the need of finding a balance between economic/business and sustainability/ideological targets. This is articulated by entrepreneurs 2, 4, 5 and 6.

"There is a trade-off between endless sustainable and endless business. Two aspects that need to meet somewhere in the middle." (entrepr4)

Some entrepreneurs tend to be more focused on the business/economic side, such as entrepr5: "That is just money, which always is the start of a sustainable business case." and entrepr4: "the more successful your business is, the more impact you have, so we will focus on the business" "So business stands above sustainability in a way." Entrepr2 also states to not "believe that sustainability sells" and that a startup needs something in addition that convinces people. "The catalyser is only there when it is cheaper, better, more beautiful or nicer."

Other entrepreneurs feel that the focus on the sustainability is most important. Entrepr6 struggles with the trade-off and recognizes the split between what she stands for ideologically, and what one can do as a startup with limited resources. "In my personal vision on sustainability the human society doesn't interest me very much, is it more about the nature that we still have, and the ecosystems that we still have. It is not feasible, to make a lot of people enthusiastic about that." Entrepr2 has a related view of looking up to "The people that let go of anything to reach some kind of sustainability, even though it's more expensive and more difficult in the chain."

Concluding, a common problem for the entrepreneurs is that they need to choose suboptimal solutions; make sustainability concessions for the plan to be feasible (Entrepr5). They argue that sustainable options are often not feasible, moneywise. All entrepreneurs note that they have made concessions. "Time pressure, and at some

point you need to make a decision" (entrepr1) "Also because it's a startup we chose a lot for the less sustainable options." (entrepr6). "We did not like using the plastic that much, but it was just the most optimal for now." (entrepr1) "As a startup you do want that [e.g. an electric van], but it just is not possible."

Understanding the system

"I also think the system changes a lot. I don't know if we will ever grasp how the system works." (entrepr5)

To understand whether a plan is indeed feasible, the entrepreneurs note that they need to understand the system, but that it is challenging. They notice a difference between entrepreneurs focusing on improving some product or service (entrepr6: "making little adjustments") in the existing system or introducing something innovative (entrepr2: "kicking against what there is now", entrepr6: "change a whole way of working, a whole part of the society. That is where big changes in sustainability can be made"). It is noted that the second is more difficult to accomplish because of the complexity.

"So complex. You should actually have been part of different parts of it for some years before you understand and see the problem." (entrepr4)

SE tools / methods

The entrepreneurs mention tools but are sceptical about how useful and supporting a tool can be. "The big question would be, how easy and reliable a tool can be" (entrepr1) "I understand that people call it a tool, but for me it devaluates the word tool." (entrepr4) "Tools, difficult. I don't really use them. It doesn't have significant value for what we are doing." (entrepr4), "I'm not really a tool man" (entrepr5). Most entrepreneurs state they ultimately base their decisions on "common sense".

The tools mentioned most frequently are LCA, the Business Model Canvas and surveys. The latter two do not focus on sustainability specifically, but can provide valuable insights and overview. LCA is a tool to assess the environmental sustainability, but is criticized, however, for the high data requirement (limiting particularly in early phases of sustainable startup development) and uncertainty, and it is mentioned that

"If you as an entrepreneur are working on a startup, and you perform an LCA and it shows, you are not more sustainable, the first thing you will look at is how to improve the LCA. Instead of your startup."

(entrepr2)

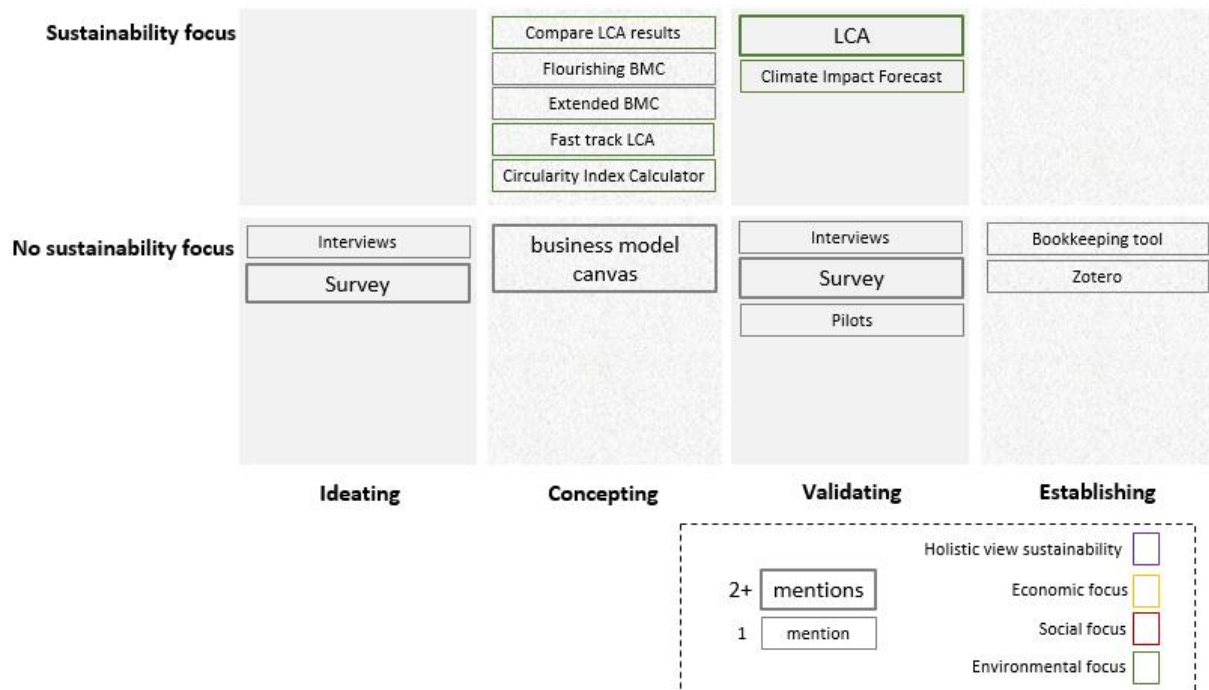


Figure 4.2 Overview SE tools/methods mentioned in interviews sustainable entrepreneurs³

Table 4.8 Strengths and weaknesses of tools/methods mentioned in interviews sustainable entrepreneurs

Tool/method	Strengths	Weaknesses
BMC	<i>Insightful:</i> Good overview (entrepr5); Puts finger on salient spot (entrepr6); Sound financial perspective (entrepr1); Helps defining strategy (entrepr8) <i>Trustworthy:</i> Well known (entrepr5)	<i>Not trustworthy:</i> Too simplified (entrepr1) <i>Not user-friendly:</i> Not very useful (entreprs2,3,4,6) <i>Sustainability not holistically addressed:</i> Could be more in depth

³ Flourishing BMC: tool to develop business model focused on financial, social and environmental performance

(<http://www.flourishingbusiness.org/the-toolkit-flourishing-business-canvas/>)

Extended BMC: BMC tool extended to aid searching for new areas of growth by identifying the key technologies and customer needs (<https://wiki.comalatech.com/display/CEX/Extended+Business+Model+Canvas>)

Circularity index calculator: tool to understand and increase the circularity of business processes (<http://circularitycalculator.com/>)

Climate impact forecast: tool to calculate and improve the carbon footprint of a business model

(<https://climate.impactforecast.org/about/>)

Zotero: tool to manage research (<https://www.zotero.org/>)

	<i>User-friendly</i> : Easy to understand (entrepr1); Concise (entreprs5,7); Simple (entrepr5)	(entreprs4,5), Sustainability part too minimal (entrepr1)
Bookkeeping tool	<i>User-friendly</i> : Faster (entrepr4); Helps with complicated activity (entrepr4)	
Circularity Index Calculator		<i>Not user-friendly</i> : Devaluates the word “tool” (entrepr4)
Climate KIC LCA Excel sheet		<i>Not trustworthy</i> : Uncertainty reliability outcome (entrepr1)
Commissioned LCA	<i>Trustworthy</i> : Performed by someone qualified in field (entrepr3)	<i>Not user-friendly</i> : Unaffordable (entreprs3,4)
Comparing LCA results		<i>Not trustworthy</i> : Uncertain whether comparison holds (entrepr1) <i>Sustainability not holistically addressed</i> : Maybe a lot of hidden impacts (entrepr6)
Flourishing BMC	<i>Insightful</i> : Extensive (entrepr1) <i>Sustainability well addressed</i> : Sustainability interwoven (entrepr1)	<i>Too complex</i> : Very complex (entrepr1,4)
Interviews	<i>Insightful</i> : Understand potential customer (entrepr3)	
LCA	<i>Insightful</i> : Considers a lot (entrepr6); Very thorough (entreprs3,4); Quantification (entrepr3)	<i>Too complex</i> : Lack the expertise (entrepr1) <i>Not trustworthy</i> : Lot of assumptions (entrepr2); Try to confirm assumptions (entrepr2); Outcome dependency (entrepr2); Data not yet available (entrepr4) <i>Not user-friendly</i> : Too time consuming (entreprs1,2,3,4,6)
Survey	<i>Insightful</i> : Understand potential customer (entrepr3)	<i>Not trustworthy</i> : Biased (entrepr1)
Talking	<i>Insightful</i> : Understand potential customer (entrepr3); Understand market (entreprs3,4)	
Zotero (reference manager)	<i>User-friendly</i> : Free (entrepr4); Easy sharing resources (entrepr4)	

Ideation on new SE tools/methods

Ideas for new SE tools/methods, based on the interviews, relate mostly to impact assessment: "look at the social and the environmental impact. And they should be as important as the financial part" (entrepr1). Entrepr1 suggests ex-ante LCA for that. Entrepr6 would also value simple quantification, and looking at an easy-to-perform variant on LCA.

Entrepr2 wants the eventual tool/method to be easy to comprehend and suggests to make the information visual instead of text to reduce the time it takes to process it. Entrepr4 also mentions this time-quality ratio in determining "whether it's sustainable what I'm doing". Entrepr5 suggests it would be useful to oversee the "trends, challenges and opportunities", and that it "can help to structure the chaos, what is out there".

"you would want to uncover in a very early phase, to see whether you're on the right track"... "that would need a tool or software that gives you an indication" (entrepr1)

Conclusion: Design requirements

The following design requirements for tool/method development have been deduced from the interviews with the entrepreneurs:

Design requirements:

- **Systems perspective on sustainability**
 - helps understanding how system works and changes (entrepr5)
 - helps understanding the challenge
 - helps contributing to sustainability transition
 - balances environmental, economic and social perspectives (entreprs1,4,5,7,8)
 - adopts system instead of linear perspective (entrepr3)
 - helps to understand the system's trends and challenges (entrepr5)
- **Works towards a feasible business model**
 - value proposed more than just sustainability (entrepr2)

- helps towards economic feasibility (entreprs3,5)
- focus on business to increase the impact (entrepr4)
- **Provides indication potential impacts**
 - helps making a positive impact (entreprs1,6)
 - indicates whether making a tangible difference (entrepr3)
 - proofs assumptions positive impacts (entreprs2,4)
- **Time efficient**
 - helps making decisions in limited time (entreprs1,6)
 - good time/quality ratio (entrepr4)
 - images and little text to save time (entrepr2)
- **Helps comparing sustainability of alternatives**
 - supports making choices, concessions (entreprs2,6)
 - supports handling trade-offs
- **Easy to understand**
 - uses understandable vocabulary
 - links to well-known theories
- **Enables stakeholder engagement**
 - helps to understand the customers drivers (entrepr4)
 - helps determining whether customers are interested (entrepr1)
- **Robust, scientific, common**
 - reliable (entreprs1,4)
- **Accessible**
 - affordable (entreprs3,4)

4.2 Results survey

The survey was filled in by twenty entrepreneurs. The content of is analysed, and the main results are deducted from the categories in the analysis and presented in this chapter. The aim of the survey was to substantiate the challenges suggested in the interviews by gathering more input from entrepreneurs working on a sustainability-related startup. The survey was also used to get a more complete overview of the tools/methods used currently by the sustainable entrepreneurs, and the strengths and weaknesses. It comes forward that a common definition of sustainable entrepreneurship

is lacking. The main challenges mentioned by the respondents are related to knowledge (e.g. how to develop product and how to find market fit), a well-functioning team, and funding. Determining the impact of the proposed solution is mentioned to be a specifically sustainability-related challenge. The Business Model Canvas and LCA are the most commonly used tools. In the section, first the general characteristics (4.2.1) of the respondents are presented, followed by their definition of SE, the main challenges faced, opinions on SE tools and methods and related ideation.

4.2.1 Characteristics of the respondents

The survey was filled in by 20 sustainable entrepreneurs, of which 11 men and 9 women. Three quarters of them were between 18-34 years old.

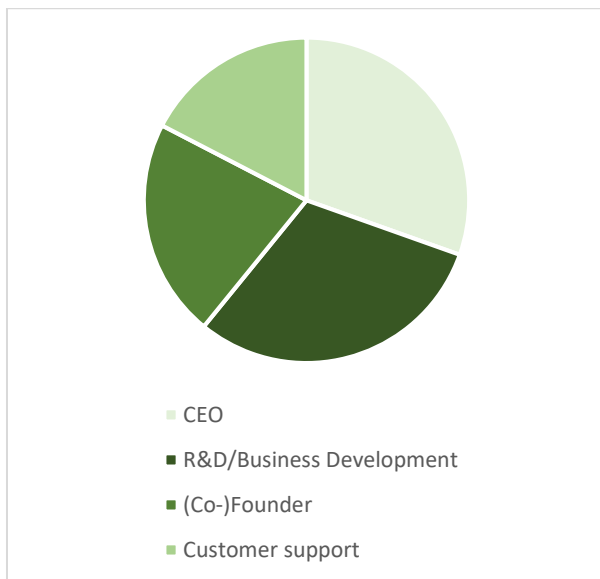


Figure 4.3 Roles respondents in startup

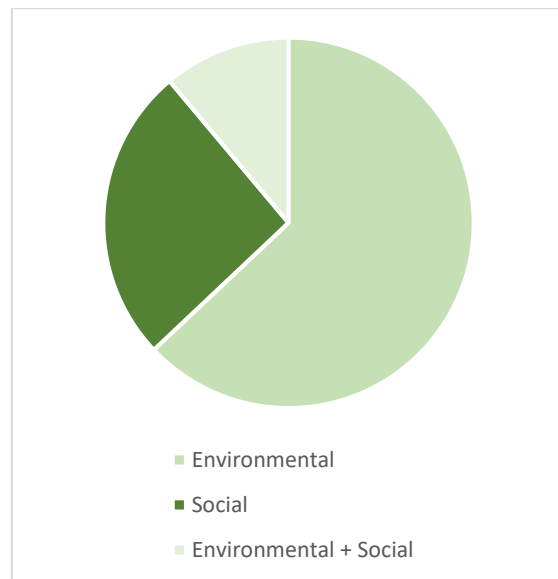


Figure 4.4 Focus of respondents' startups

A quarter provides a service, the rest products. Half of the startups mention sustainability aspects in their value proposition, the other half focuses in the value proposition on what the value for the customers is. 3 out of 20 were not sure on how to answer the question of what their value proposition is.

Table 4.9 Overview entrepreneurs respondents survey

Code Excel	Role	Startup subject	Phase	Startup program	Investment	Year start	Year start sales	Date survey
Entr epr9	Product development	Plastics	Conce.	Climate-KIC	Yes, price money	2018	-	6/6/2019
Entr epr10	Business development	Computer cooling systems	Valid.	Taiwan Startup Program	Yes, investor	2018	-	6/7/2019
Entr epr11	Founder, CEO	Sustainability consultancy	Estab.	-	-	2016	2017	6/13/2019
Entr epr12	Founder, CEO	Coconut boards	Estab.	Climate-KIC	Yes, funds programs	2019	-	6/14/2019
Entr epr13	Business Development	Smart energy devices	Estab.	-	-	2019	Earlier	6/17/2019
Entr epr14	Business Development	Water pumps	Estab.	YES!Delft	Yes, funds organization	Earlier	2015	6/17/2019
Entr epr15	CMO	Electronic waste	Conce.	YES!Delft	Yes, price money	2018	-	6/25/2019
Entr epr16	Everything	Building materials	Valid.	Circular Challenge	Yes, price money	2018	-	6/6/2019
Entr epr17	Founder	Energy	Estab.	-	Yes, crowd funding	Earlier	Earlier	6/6/2019
Entr epr18	Founder	Plastics	Valid.	-	Yes, funds organization	2018	-	6/13/2019
Entr epr19	Communication	Razors	Conce.	PLNT	Yes, price money	2018	-	6/14/2019
Entr epr20	CEO	Power chips	Estab.	YES!Delft	Yes, subsidies	2016	2018	6/14/2019

Entr epr2 1	Business Development	Coconut pallets	Conce.	Impact Hub	-	2016	-	6/14/2019
Entr epr2 2	Impact Researcher	Job guidance	Estab.	-	Yes, funds	Earlier	Earlie r	6/17/2019
Entr epr2 3	CEO	Batteries	Valid.	Climate- KIC	Yes, funds	Earlier	-	6/17/2019
Entr epr2 4	Customer support	EV charging	Estab.	-	Yes, investor	2017	2018	6/17/2019
Entr epr2 5	Service provider	EV	Estab.	-	Yes, investor	2016	2018	6/18/2019
Entr epr2 6	Researcher	Housing flood areas	Conce.	-	Yes, crowd funding	2016	-	6/18/2019
Entr epr2 7	Founder	African snacks	Estab.	Starters4 Communiti es	-	Earlier	Earlier	6/19/2019
Entr epr2 8	Leader	Cafe	Estab.	-	-	2018	2018	6/26/2019

In describing their startup and its value proposition, 17 out of 20 entrepreneurs mention environmental objectives in one of their answers. 7 out of 20 focus on both the environmental and social pillar of sustainability. 3 out of 20 mention only social aspects.

Most of the startups are in the establishing phase (11 out of 20). 4 are in the concepting and 5 in the validating phase of the startup development phases identified earlier (see paragraph 2.1.2). 9 out of 20 have taken part in a program to develop their startup. 15 out of 20 have received financial support, either through investment/subsidies (9), winning a competition (4), or crowdfunding (2). Half of the startups have not had their first customer yet, of which 2 started in 2016 or earlier.

Definition sustainable entrepreneurship

It comes forward that there is no common definition of sustainable entrepreneurship among the entrepreneurs who filled in the survey. Only one entrepreneur mentions the triple bottom line (“environmental, economic and social”, entrepr14), so commonly presented in scientific literature, explicitly in the answer. Repeatedly the importance of a feasible business model is touched upon, in combination with an “eye for wellbeing of the planet and humans” (entrepr23).

The definitions include rather vague statements such as making the “world a better place” (entrepr10), “best-in-class solutions” (entrepr13) and “sustainability first” (entrepr21). Also in describing their motivations, the sustainable entrepreneurs make particularly bold statements on the big impact they want to make. The word positive is used repeatedly, e.g. in “positive impact compared to the status quo” (entrepr16) and “positive value creation with a positive effect for the future” (entrepr22), but it is not touched up what positive then means. All definitions stay rather superficial and do not provide directions and are not very strict or exclusive.

In describing the environmental and social aspects of their startups’ value propositions, the sustainable entrepreneurs all name different aspects, which is likely to be related to the overall ambiguity of what sustainability entails.

Table 4.10 Themes identified in SE definitions survey with example quotes entrepreneurs

Definition SE themes	Example quotes entrepreneurs
Importance feasible business model	“it is a way to earn money by providing environmentally friendly solutions for the customer's problem” (entrepr12)
	“Entrepreneurship that commercializes sustainable technologies in a sustainable business model” (entrepr14)
	“To make economic growth while reducing material insensitivity” (entrepr15)
	“in combination with a healthy business model” (entrepr21)
	“Entrepreneurship that is not only about making profit” (entrepr27)
Positive impact statements	“Entrepreneurship that commercializes sustainable technologies in a sustainable business model to create sustainable environmental, economic and social impact.” (entrepr14)
	“Entrepreneurship with positive impact as a goal (different ways to measure, e.g. less kg CO ₂) compared the the status quo” (entrepr16)

	"Positive value creation with a positive effect for the future" (entrepr22)
	"Entrepreneurship that is not only about making profit but also improving the world" (entrepr27)
	"An enterprise that social and consciously focuses on adding value for people and planet" (entrepr28)

Challenges sustainable startup development

Table 4.11 Themes identified in SSD challenges survey with example quotes entrepreneurs

Challenges SSD themes	Example quotes entrepreneurs
Lack of knowledge (12x)	"Expertise about product development" (entrepr9)
	"Lack of commercial understanding" (entrepr11)
	"Iteration of Product Development, Reaching to Product- Market fit" (entrepr14)
	"Product development, there is not a working prototype yet" (entrepr19)
	"Solve technical problems - how to make a transport pallet from coconut fibres." (entrepr21)
	"because I'm not from the field" (entrepr27)
	"We get a rest stream from a pretty valuable material. How do we keep this value?" (entrepr16)
Lack of well-functioning team (7x)	"Finding appropriate team members" (entrepr10)
	"a good like-minded team" (entrepr12)
	"Need a strong technical team and for that money is required. Without a team it is difficult to get money so we need a breakthrough somewhere." (entrepr20)
	"involve people that can do some things better than you. In the end it is about being able to enthuse and involve the right people at the right moment" (entrepr21)
	"there isn't someone full-time available in the Philippines" (entrepr26)
Lack of funding (10x)	"bringing down the cost because typically sustainability comes with a high price tag" (entrepr12)
	"Fundraising, Costs of IP protection" (entrepr14)
Sustainability: determining impact idea	"It's been hard identifying the exact environment impact of the solution" (entrepr10)
	"A lot of time and money is invested in the project, without the guarantee that it will have a good result" (entrepr18)

“A lot of time and money is invested in the project, without the guarantee that it will have a good result” (Entrepr18)

The main challenges mentioned by the respondents are related to knowledge (e.g. how to develop product and how to find market fit) (mentioned 12x), a well-functioning team (mentioned 7x), and financing (mentioned 10x). It shows that sustainable startups run into problems not specifically related to the sustainability focus – more general startup problems.

When asked specifically about sustainability-related challenges, determining the impact of the proposed solution is mentioned to be difficult, which relates to the lack of sustainability expertise challenge identified in the interviews. Also, determining the financial feasibility of sustainable plans is brought forward as a challenge, which relates to the business vs sustainability trade-off mentioned in the interviews. It is mentioned multiple times that pivoting, being flexible in changing the plans, is crucial to overcome the challenges. Many entrepreneurs indicate they have not solved the challenges they mention yet.

Sustainable entrepreneurship tools/methods

The tools/methods mentioned are again very diverse. The Business Model Canvas is used by a majority (12 out of 20) of the sustainable entrepreneurs. LCA is only mentioned by three. All other tools are only mentioned once. It is striking that only LCA and the system map developed by Noorderwind (on which no information is available publicly) focus specifically on sustainable/holistic entrepreneurship.

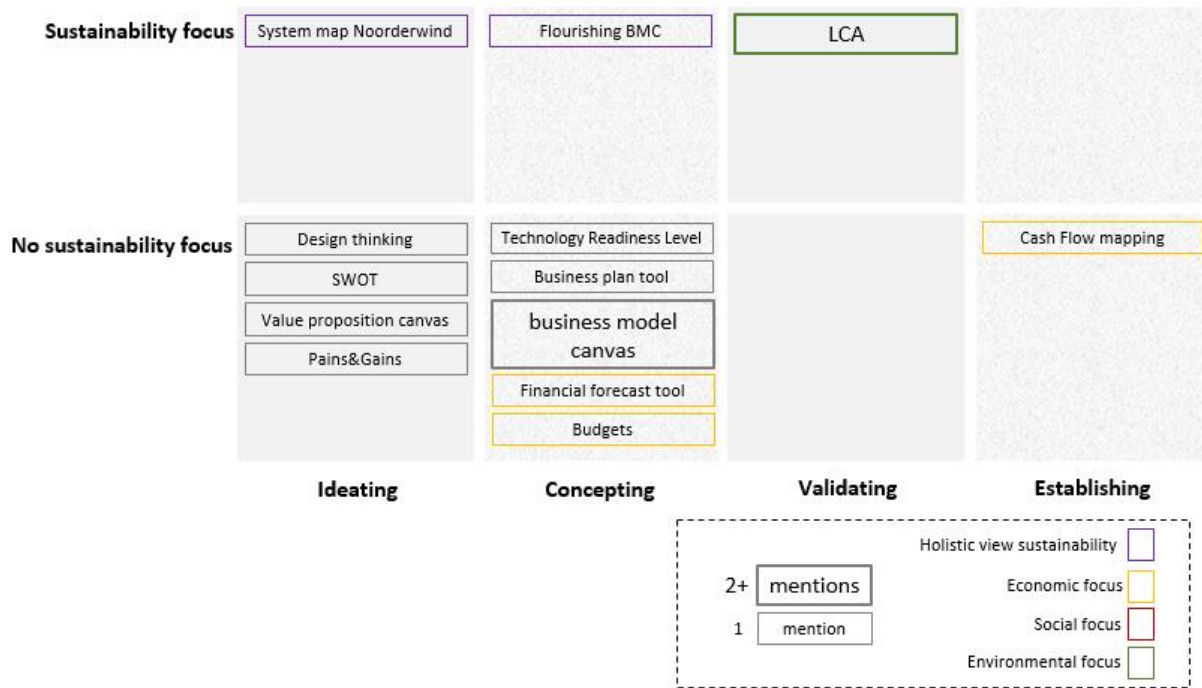


Figure 4.5 Overview tools/methods survey⁴

Table 4.12 Strengths and weaknesses of tools/methods mentioned in survey responses sustainable entrepreneurs

Tool/method	Strengths	Weaknesses
BMC	<p><i>Insightful:</i> Birds-eye-view (entrepr20); Helps narrow down (entrepr12); Overview business model (entrepr21); Different values for stakeholders (entrepr16) <i>User-friendly:</i> Helps to communicate (entrepr14)</p>	<p><i>Sustainability not holistically addressed:</i> Not good enough overview system (entrepr16)</p>

⁴ System map Noorderwind: tool to map the system, not publicly available

SWOT: strategic analysis technique to identify strengths, weaknesses, opportunities and threats as part of business planning (https://en.wikipedia.org/wiki/SWOT_analysis)

Pains&Gains: value proposition canvas: tool to understand customer needs (<https://www.strategyzer.com/canvas/value-proposition-canvas>)

Flourishing BMC: Flourishing BMC: tool to develop business model focused on financial, social and environmental performance (<http://www.flourishingbusiness.org/the-toolkit-flourishing-business-canvas/>)

Technology readiness level: method to estimate maturity of technologies (https://en.wikipedia.org/wiki/Technology_readiness_level)

Cash flow mapping: tool to understand the money flows around a business (<https://www.cashflowmapping.com/>)

Business Plan Template	<i>Insightful:</i> Guidelines for business growth (entrepr14) <i>User-friendly:</i> Easier to write plan (entrepr27)	
LCA		<i>Not trust-worthy:</i> Used to justify claims/competitive advantage (entrepr12); Outcome unreliable (entrepr12)
Pains & Gains		<i>Too complex:</i> Too complicated (entrepr19)
SWOT	<i>Insightful:</i> Identified strengths, weaknesses, opportunities and threats (entreprs10,24)	
Talking	<i>Insightful:</i> Learn a lot (entrepr26) <i>Sustainability well addressed:</i> Knowledge on many aspects (entrepr26)	
Value Proposition Canvas		<i>Too complex:</i> Easier to do with BMC (entrepr16)

Ideation SE tools/methods

The respondents have ideas for new SE tools/methods, which are similar to the ones mentioned in the interviews results chapter. They relate mostly to (environmental and social) impact assessment, e.g. using simplified LCA (entrepreneurs 10, 16, 19, 23). Other ideas are about stakeholder mapping (entrepreneurs 15, 20, 27), financial support (entrepreneurs 12, 22) marketing (entrepr14), and a monitoring tool for developments/threats/opportunities (entrepr24).

Conclusion: Design requirements

The following design requirements for tool/method development have been deduced from the survey responses:

Design requirements:

- **Works towards a feasible business model**
 - functions as input for the BMC
 - financial feasibility ideas (entreprs15,27)

- helps financing (entreprs17,18,20,21,22,23,25)
- keeping product affordable (entrepr12)
- **Provides indication potential impacts**
 - enables determining the impact of an idea (entreprs10,17)
 - enables determining how to make positive impact
 - enables determining environmental and social impacts (entrepr10)
- **Systems perspective on sustainability**
 - increases knowledge on how to approach sustainability
 - provides overview system
 - helps making concessions, handling trade-offs (entrepr23)
- **Helps understanding the challenge**
 - finding a product-market fit (entrepr14)
 - helps narrow down the challenge (entrepr12)
 - allows for iterations when insights change (entrep14)
- **Helps comparing sustainability alternatives**
 - choosing most sustainable materials (entreprs17,18,19,23,26)
 - choosing most sustainable processes (entreprs19,21)
- **Enables stakeholder engagement**
 - validate whether there is a market for it (entrepr12)
 - helps communication (entrepr14)
- **Time efficient**
 - indicates whether worth the time investment (entrepr18)

5

RESULTS: DESIGN REQUIREMENTS TOOL/METHOD & INTRODUCTION SSSM WORKSHEETS

5.1 Design requirements SE tool/method	78
5.2 Comparison existing ideating tools and methods	78
5.3 System Mapping method introduction	82
5.4 Sustainable Startup System Mapping	87
5.5 Results focus group Sust. Startup System Mapping	93

5. RESULTS: DESIGN REQUIREMENTS TOOL/METHOD & INTRODUCTION SSSM WORKSHEETS

In this chapter, the results from the different research activities are translated into design requirements (section 5.1). Based on the design requirements, a comparison of existing tools and methods was performed through benchmarking (section 5.2). The analysis of the sustainable startup challenges (chapter 4) and the design requirements comparison led to the identification of system mapping being a valuable direction for the development of a new SE tool/method (section 5.3). The Sustainable Startup System Mapping (SSSM) worksheets were developed based on the design requirements, Meadows' (2008) systems thinking theorem and Omidyar Group's (n.d.) systems practice workbook (5.4). A focus group has been hosted to evaluate the proposed method (5.5).

5.1 Design requirements SE tool/method based on analyses

Design requirements is a term mostly used in engineering and product design, and reflect the wants and needs of the intended users/customers, often formulated in nontechnical and vague terms (Pfeifer, 2009). The intended users of the new tool are the student entrepreneurs. Table 5.1 provides an overview of the design requirements and what research activities these have been deducted from, presented in the previous chapter. The dark green color indicates that the design requirement is based on a major conclusion drawn from the research activity. Lighter green means that the design requirement was mentioned but with lesser emphasis. The design requirements have been listed according to a rough prioritization, with DR1 coming forward most frequently and DR10 having been mentioned with less emphasis. In the table in appendix Q the design requirements are presented as such that the substantiation per requirement deducted from the research activities is summarized.

Table 5.1 Overview design requirements and what research activities these have been deducted from

	Literature review	Interviews experts	Interviews entrepreneurs	Survey entrepreneurs	Focus group
DR1 Sustainability system perspective					
DR2 Provides indication potential impacts					
DR3 Works towards a feasible business model					
DR4 Enables stakeholder engagement					
DR5 Easy to understand					
DR6 Time efficient					
DR7 Helps understanding the challenge					
DR8 Helps comparing sustainability of alternatives					
DR9 Robust, scientific, common					
DR10 Accessible					

5.2 Comparison existing tools and methods for the ideating phase

Existing tools and methods for the ideating phase have been compared using the **10 design requirements for sustainable startup development tools/methods** deducted from the research activities performed, presented in section 5.1. The results are provided in tables benchmarking the tools and methods.

Mentioned by experts/literature

Comparison of 21 tools/methods for the ideating phase, mentioned by the experts and in the literature. A one-sentence explanation and reference per tool is provided in the previous chapters and in the overview in appendix Q.

Table 5.2 Benchmark tools/methods ideating phase mentioned by experts and in literature. See appendix Q for a one-sentence explanation and reference per tool.

Tools/Methods for ideating phase startup development mentioned by experts and in literature, related to developed design requirements. SSSM worksheets added to overview.	Mentioned in Interviews/Literature (I/L)	Also mentioned by entrepreneurs	Tool/Method (T/M)	Sustainability system perspective	Helps understanding the challenge	Provides indication potential	Helps comparing sustainability of alternatives	Enables stakeholder engagement	Works towards a feasible business model	Robust, scientific, common	Easy to understand	Time efficient	Accessible
Systemicdesigntoolkit.org	I		T										
Issue tree	I		M										
Benchmarking indicators	L		M										
Blue Ocean Strategy	L		M										
Brainstorming	L		M										
Customer survey	L		M										
Decision making unit	I		M										
DPSIR framework	L		T										
Field research	I		M										
Interviews	I		M										
Life cycle of the user	I		T										
Literature analysis	I		M										

Mindmaps	L		M										
Process analysis method	L		M										
Questionnaire	I		T										
Scenario method	L		M										
Stakeholder analysis	I		M										
Stakeholder mapping	I		M										
Stakeholder value mapping tool	I		T										
SWOT	I		M										
Value proposition canvas	I		T										
SSSM worksheets			T										

Mentioned by entrepreneurs

Comparison of 19 tools/methods for the ideating phase, mentioned by the entrepreneurs. A one-sentence explanation and reference per tool is provided in the previous chapters and in the overview in appendix Q.

Table 5.3 Benchmark tools/methods ideating phase mentioned by entrepreneurs in interviews and survey. See appendix Q for a one-sentence explanation and reference per tool.

Tools/Methods for ideating phase startup development mentioned by entrepreneurs in survey, focus group and interviews, related to developed design requirements. SSSM worksheets added to overview.	Mentioned in Survey/Focus Group/Interviews (S/FG/I)	Also mentioned by experts/literature	Tool/Method (T/M)	Sustainability system perspective	Helps understanding the challenge	Provides indication potential impacts	Helps comparing sustainability of alternatives	Enables stakeholder engagement	Works towards a feasible business model	Robust, scientific, common	Easy to understand	Time efficient	Accessible
System Map Noorderwind	S		T										
Align objectives	FG		M										
Context mapping	FG		M										

Design thinking	S		M											
Brainstorm	FG		M											
Expert consultation	FG		M											
Focus group	FG		M											
Interviews	FG,I		M											
Mindmap	FG		M											
Pains&Gains	S		T											
Research	FG		M											
Stakeholder mapping	FG		M											
Survey	I		M											
SWOT	S		M											
User journey mapping	FG		M											
Value mapping	FG		M											
Value proposition canvas	S		T											
Visualize problem	FG		M											
Visualize system	FG		M											
SSSM worksheets			T											

The benchmarks (tables 5.1 and 5.2), based largely on the comments from the research activities and grey literature studies by the researcher, are of explorative nature to give an impression of the tools and methods and whether they match the design requirements (dark green color meaning they do, lighter green meaning they do partly). Especially for the design requirements of “sustainability system perspective”, “indication potential impacts”, “helps comparing sustainability of alternatives” and “works towards a feasible business model”, there is room for further development of tools and methods.

5.3 System Mapping method introduction

Based on the analyses of the literature, interviews and questionnaire, design requirements for a tool/method supporting sustainable startup development were formulated and presented in the previous section. What the labels for the design requirements (DR1 to DR10) refer to can be consulted there. Based on these design requirements, System Mapping was selected as a method which could potentially support entrepreneurs in sustainable startup development, which is elaborated on in this section.

The ideating phase

In the first stage, also called seed-stage, of startup development, entrepreneurs start from an idea or ambition and aim to concretize this into potential scalable startup concepts. For sustainable entrepreneurs, the aim is to work towards sustainable startup concepts. Student entrepreneurs have indicated that they find it hard to determine the sustainability of ideas in the ideating phase. From the analysis of what tools and methods are available for and used by entrepreneurs developing a sustainable startup, it comes forward that entrepreneurs could use more sustainability focused tools/methods in the ideating phase.

The ideating phase is the phase in which the problem is explored (1) and a solution is identified (2). The startup's value proposition is defined in this phase (3). The StartupCommons describe the Ideating phase as follows.

Ideating: [developing] “Entrepreneurial **ambition** and/or potential **scalable product or service** idea for a big enough **target market**. Initial idea on how it would create **value**.”: “What, to whom, why and how?”

The words in bold have been defined for better understanding, as follows, using the Cambridge Dictionary: Ambition: “a strong wish to achieve something”, Scalable product or service: business idea “able to grow or to be made larger”, Target market: “the group of people that a company wants to sell its products or services to”, Value: “the importance or worth of something for someone” or “the amount of money that can be received for something”.

Problem exploration

“A problem thoroughly understood is always fairly simple” (Kettering, 1971)

In startup educational programs, student entrepreneurs work on the development of a startup, starting from a challenge or a startup idea in response to a challenge: the ideating phase. The challenge is perceived as a business opportunity (Climate KIC, n.d.). Sustainability challenges are particularly wicked problems: complex and thus hard to comprehend. The better the problem is explored and understood, the better a solution identified is likely to be.

Based on the literature studies, interviews and questionnaire results, it is concluded that entrepreneurs would benefit from support in sustainable startup development, and more specifically in addressing sustainability holistically. Furthermore, a supporting SE tool/method needs to provide insights which are useful in practice. User-friendliness is suggested to be a main aspect determining whether a SE tool/method is useable in the sustainable startup development practice.

Sustainability holistically addressed

Sustainable entrepreneurs want to make a positive impact and contribute to sustainability, through sustainable entrepreneurship, but they need more knowledge on how to approach it. From the literature review it already came forward that an acceptable general definition of sustainability and sustainable entrepreneurship needs to be developed. To address sustainability holistically (DR1), means to oversee the complexity (DR2) and cover all relevant issues in the context. For that purpose, it is said that the system needs to be analysed to determine the potential sustainability impacts (DR3) of startup ideas, and how to improve these impacts. It is suggested that when overseeing the impacts, decision making for example in the case of trade-offs or rebound effects can be substantiated better (DR4). The system is recognized to be dynamic, and thus the SE tool/method must enable the entrepreneurs to make adjustments over time.

When browsing through the literature on a systems perspective on sustainability, the main author coming forward is Donella Meadows on systems modelling. This author and her system mapping theorem were also suggested by the Associate professor on Sustainable innovation.

Insightful and practical

It has been indicated that a strategic SE tool/method for the early phase of sustainable startup development would be valuable, to determine early on whether doing the right things towards a sustainable startup with a feasible business model (DR6). It is brought forward that in an early phase, one needs to work with the information that is available at that time. However, trustworthiness (DR7) of the assessment then is a main concern. To create sustainable startup ideas which have potential not only on paper, it is recognized that stakeholder engagement is highly valuable (DR5). The stakeholders

can provide insights on how the system works by giving feedback on the analysis of the system.

Donella Meadows' systems thinking theorem is meant to help overseeing the complexity of systems/challenges. It is suitable for the early phases, and enables entrepreneurs to map the causes and effects within a system. It is encouraged in the theorem to engage stakeholders to give input for and feedback on the system mapping, and the map can easily be adjusted. The outcome of the system mapping functions as input for the developing of a (sustainable) value proposition for the Business Model Canvas. When browsing in grey literature for practical guides on how to apply Meadows' theorem, the Omidyar Group guide was found, as described in more detail in section 5.4.

User-friendly

For the SE tool/method to suit the entrepreneurs, it is stated that it should be accessible (DR10), not take too much time (DR9) and should not be complicated to perform (DR8). Using visuals and easy vocabulary, linking to well-known theories is suggested to help with that.

The guide of the Omidyar Group was quite extensive (process of several months) and was cut down in length. Words were replaced with entrepreneurship terminology. The Sustainable Startup System Mapping (SSSM) worksheets were created as tangible sheets which can be used in the process. The system mapping method is described in more detail in the next section.

Input for consequent startup development phases

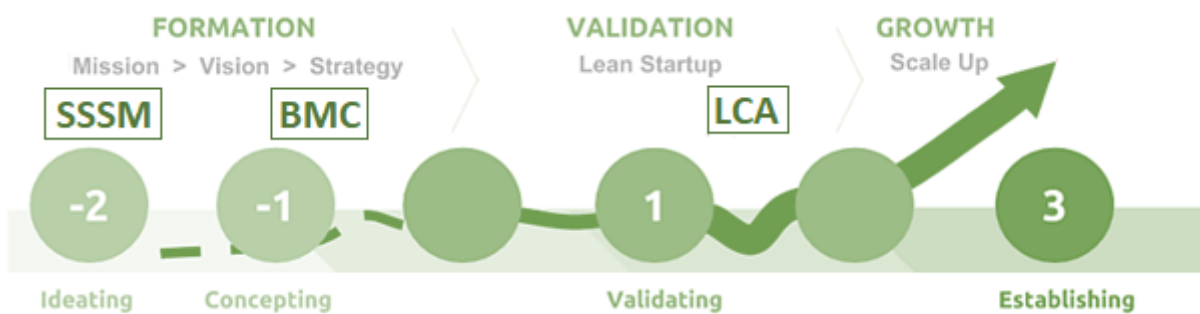


Figure 5.1 Suggestions SE tools for startup development phases

Using the SSSM worksheets, the system is mapped and potential opportunities for making a positive impact are identified. The result is a substantiated narrative for a value proposition, which is a core element of the Business Model Canvas (BMC) – the most commonly used SE tool. In the validation phase, performing or commissioning a Life Cycle Assessment (LCA), the second most commonly mentioned SE tool, is suggested, to get a quantitative substantiation of the environmental performance.

5.4 Sustainable Startup System Mapping

The increasing interest in the system's perspective in the field of sustainable entrepreneurship was already identified in the literature review. In the literature on this systems approach to sustainability it is perceived crucial to work towards an understanding of complex adaptive ecological and socio-economic systems (Clayton & Ratcliffe, 1996). System mapping is a common practice to get an overview of such systems: how elements connect towards a certain purpose. The method is proposed as a way to support creating a sustainable value proposition for a sustainable startup business model. It is based mainly on the work of Donella H. Meadows: Thinking in Systems, A Primer (2008), central in the academic literature, and the Omidyar Group (n.d.) Systems Practice workbook, retrieved from grey literature.

Donella H. Meadows (1941)

Was a scholar in Conservation and Environment, and a well-regarded, influential environmental researcher. She was part of the Club Of Rome, and principal author of "The Limits to Growth" (1972), which made her a globally leading climate thinker. She founded the Sustainability Institute in 1996. She was famous for analysing "the systems that produce the complex problems facing humanity" and has written a lot on system mapping.

When consulting the literature using "system perspective" and "sustainability" as keywords (in the Scopus literature database), Meadows theorem (also suggested by the Assistant sustainable innovation expert from Rotterdam School of Management) keeps reoccurring. Meadows suggests it is problematic to think about challenges in a linear way, because of the many interconnections that exist between the elements contributing to it. Challenges are system challenges, and systems can be redesigned. To visualize a system it can be mapped structurally, for which a lot of assumptions have to be made. These assumptions, however, can be overseen and discussed with stakeholders and experts because of them being visualized. Visualization makes ideas more vivid and engaging (Van der Duin, 2016). The system map is dynamic and can be redesigned all the time when gaining new insights in the working of the system.

It is recognized that similar ideas to system mapping are described as causal loop diagramming, as first coined by Jay Forrester in the 1950s.

It is striking that the system mapping/causal loop diagramming methodology is rather academic. Grey literature has been consulted to find a broader range of tools for system mapping used in practice. Within the tools, there are four categories identified by Kim (1994): brainstorming tools (identifying causes and effects), dynamic thinking tools (modelling behaviour over time), structural thinking tools (clarifying relationships between elements modelled) and computer-based tools (higher level technical proficiency required). Kumu is a system mapping software tool commonly referred to, which is deemed too complex for the ideating phase. The creators suggest using the workbook of Omidyar group for system mapping in an earlier stage.

Omidyar Group

Is a collection of companies, organizations, and initiatives that work collaboratively to increase social impact. It is based on the beliefs, of Pam and Pierre Omidyar, that everyone is part of a global community, and that people can support each other in making positive and far reaching impacts. The Omidyar Group recognized the values of Meadows' system theorem and has created a systems practice workbook. The workbook is licensed under the Creative Commons, a non-profit organization which aims to spread creative works, and it is indicated that it can be built upon when properly attributed.

The Omidyar group workbook is based on Meadow's theorem. It covers aspects of different categories of system mapping tools: is helpful for the early brainstorming, but does enable dynamic thinking. For the Sustainable Startup System Mapping workshop setup presented in table 5.1, the basic flow of the system mapping method as presented in the Omidyar group workbook has been followed. Sustainable Startup System Mapping worksheets were developed to be used in the workshop (see figures 5.1, 5.2 and 5.3, and appendix R).

5.4.1 Links between SSSM and other methods

The SSSM worksheets method links to other methods, such as context analysis, creative problem solving and cause and effect analysis. These methods did not come forward in the thesis research activities but were mentioned by an expert while reflecting on the SSSM worksheets. How the SSSM worksheets method links to these methods is described in this paragraph.

Context Analysis: looking at the internal and external business environment. There seems to be no common approach for Context Analysis. The analysis can be as in-depth as desired. The SSSM worksheets are proposed as a participatory way to perform Context Analysis.

Creative Problem Solving: identifying innovative solutions to a challenge. The methods designed for it all lead back to the model by Osborn and Parnes (1950s): the Osborn-Parnes Creative Problem Solving Process. This model consists of six phases to go from problem to solution, based on the thought that to get to ideas, the problem needs to be clarified by studying it carefully. The SSSM worksheets are perceived to help in the process of Creative Problem Solving.

Cause and Effect Analysis: is a common Creative Problem Solving method, which suggests studying all the causes of a problem before thinking about a solution. The Cause and Effect diagrams mostly have a linear structure. An effect is studied and possible causes are mapped. This does not recognize that elements in systems affect one another in a more circular fashion, and that there are more causal connections between elements to be drawn. Causal Loop Diagrams do aid in visualizing the causal relations and related balancing dynamics, and form the basis of systems thinking. The SSSM worksheets provide a participatory way to **Causal Loop Diagramming** for Cause and Effect Analysis from a systems perspective.

Table 5.4 Sustainable Startup System Mapping (presented in way similar to ‘creative exercises’ of Van der Duin (2016))

Sustainable Startup System Mapping (based on Meadows (2008) and Omidyar Group (n.d.))	
Purpose	Ideation for sustainable value proposition (input for Business Model Canvas) by mapping the system around the challenge that your (future) sustainable startup wants to tackle, to identify leverage points: points where you can make a change with a small effort and have a big positive impact.
When to use	In the early/exploration/ideation phase of sustainable startup development
What you need	A1 sheets of paper, post-its (in different colours), pens/markers.

<p>How does it work?</p>	<p>Select stakeholders related to the challenge and invite them to a workshop. Together</p> <ol style="list-style-type: none"> 1. Formulate a purpose (guiding star) which is Specific, Measurable, Attainable, Realistic, Timely (SMART) 2. Formulate a framing questions which sets the boundaries for the system mapping. (“Why is [the system] the way that it is?”) 3. Individually, list the causes (on post-its) that lead to negative and positive effects in the system. Indicate negative (minus sign -) or positive (plus sign +) per force. 4. Cluster the post-it’s in +-6 themes on a flip-over sheet <p>Split the group in smaller teams.</p> <ol style="list-style-type: none"> 5. Per team, select a theme to focus on. Take the post-it’s from the clusters sheet. Map for the theme how the forces interconnect: one force functions as causes and/or effects of other elements in the system. Add post-it’s to make the map more complete. 6. Identify leverage points: points where possible interventions take little effort but have a big positive impact 7. Present the system map (optional to use Kumu software) and the leverage points ideas to other stakeholders to get feedback on the assumptions. Improve the system map based on new insights.
<p>Advice</p>	<p>Postpone judgement in the brainstorm phase, read more about the system mapping method (Meadows, 2008), have a trained facilitator hosting the session</p>
<p>Options</p>	<p>The sustainable value proposition ideation method can have different durations. Decide how much time your team wants to spend on it and make a time planning for the session accordingly. Can turn the paper system map into a digital system map using the free Kumu software, which might be useful especially for communication purposes.</p>

These SUSTAINABLE STARTUP SYSTEM MAPPING worksheets have been developed based on Meadows' systems thinking theorem and the systems practice workbook developed by the Omidyar Group. The SSM worksheets are created to support entrepreneurs in sustainable startup development in the ideating phase. The aim is to provide a method to ideate on sustainable value propositions, by suggesting a way to map how the system works and identify how different value propositions may impact the system. For more information on the underlying theory and for more elaborate instructions, see the thesis report of Anne Uildriks, *Supporting sustainable startup ideation: Participatory development of a tool for student entrepreneurs (2019)*

SMART Purpose	Formulate a purpose for the team to work on which is specific, measurable, attainable, relevant, and timely				
Framing Question	Formulate a framing question relating to the SMART purpose which helps setting the boundaries around the system map <i>e.g. "Why is [the system] the way that it is?"</i>				
<p>Brainstorm on causes and effects Jot down causes and effects on post-its and stick the post-its in the figure below. Take a picture of the overview before going to the next step</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; height: 150px; vertical-align: top;">Causes leading to positive effects</td> <td style="width: 50%; height: 150px; vertical-align: top;">Positive effects</td> </tr> <tr> <td style="width: 50%; height: 150px; vertical-align: top;">Causes leading to negative effects</td> <td style="width: 50%; height: 150px; vertical-align: top;">Negative effects</td> </tr> </table>	Causes leading to positive effects	Positive effects	Causes leading to negative effects	Negative effects	<p>Cluster the post-its in themes Take the post-its from the brainstorm and cluster them in +6 themes. Discuss among the team. Take a picture of the overview before going to the next step</p>
Causes leading to positive effects	Positive effects				
Causes leading to negative effects	Negative effects				

Figure 5.2 Sustainable Startup System Mapping worksheet 1

<p>Theme map Divide the team into smaller groups and per group choose a theme. Take the post-its from the theme clustering and map how the causes and effects within that theme relate. Free to add post-its to make the map more complete. Draw arrows between the post-it's to indicate this. Take a picture of the overview before going to the next step</p> <div style="border: 1px solid black; height: 250px; width: 100%;"></div>	<p>Theme map Divide the team into smaller groups and per group choose a theme. Take the post-its from the theme clustering and map how the causes and effects within that theme relate. Free to add post-its to make the map more complete. Draw arrows between the post-it's to indicate this. Take a picture of the overview before going to the next step</p> <div style="border: 1px solid black; height: 250px; width: 100%;"></div>
--	--

Figure 5.3 Sustainable Startup System Mapping worksheet 2

System Map	Link the theme maps to one another to create a map showing how the elements in the system interconnect. Discuss the elements and connections among the team and with stakeholders identified to improve the map.
Sustainable Value Proposition (ideas)	Use the system map to identify potential leverage points: points where possible interventions take little effort but have a big positive impact. Write down all value propositions you can come up with in relation to the system map and use the system map to discuss them with stakeholders. Improve the system map and ideas based on the input you get. Use the sustainable value propositions as input for the Business Model Canvas.

Figure 5.4 Sustainable Startup System Mapping worksheet 3

5.5 Results focus group on Sustainable Startup System Mapping

The aim of the focus group was to evaluate whether Sustainable Startup System Mapping (as presented in table 5.1) is a method which can support entrepreneurs in sustainable startup development.



Figure 5.5 Photo of system mapping activity (confrontation phase) during focus group session

Table 5.5 Overview participants focus group

Code Excel	Background	Role	Startup product	Startup program
Entrepr29	Industrial Ecology	Founder	Aquaponics system	PLNT startup accelerator, Climate-KIC
Entrepr30	Engineering, Industrial Ecology	Chair Sustainable Business Battle	-	Climate-KIC, Sustainable Business Challenge
Entrepr31	Industrial Ecology	Board Sustainable Business Battle	-	Sustainable Business Challenge
Entrepr32	Strategic Product Design	Founder	Repurpose waste material	Blue City Program
Entrepr33	Design for Interaction	Student	Ideas for mental wellbeing	-

Entrepr34	Industrial Design Engineering	Coach	Ideas for new phone	YES!Delft program, Sustainable Business Challenge
-----------	-------------------------------	-------	---------------------	---

Six sustainable entrepreneurs participated in the focus group, which took place on June 19, 2019. The sustainable entrepreneurs are currently working on a sustainable startup or planning to. Three of them have a sustainability-related background. Five of them have learned about entrepreneurship in startup programs, among which the Sustainable Business Challenge, the PLNT startup accelerator, Climate-KIC, Blue City, and YES!Delft.

Reporting on content analysis different phases focus group

The session was audio-recorded to preserve a record of the proceedings. The audio-recording was transcribed, and subsequently analysed using the content analysis method. At the end of the session, a brief survey was presented to the research participants so additional private comments could be recorded.

1. Exploration: *Discuss example cases*

In the first phase, a general open conversation was hosted about the sustainable startup development process and related previous experiences of the participants.

Goal: to find out how the stakeholders currently approach the early/ideation phase of the sustainable entrepreneurship process in this case, and related situations.

The participants were asked about how they got to their sustainable startup ideas, and a lot of ideation methods were written down. When analysing these methods, it shows that they do not have a sustainability focus (see figure 5.5).

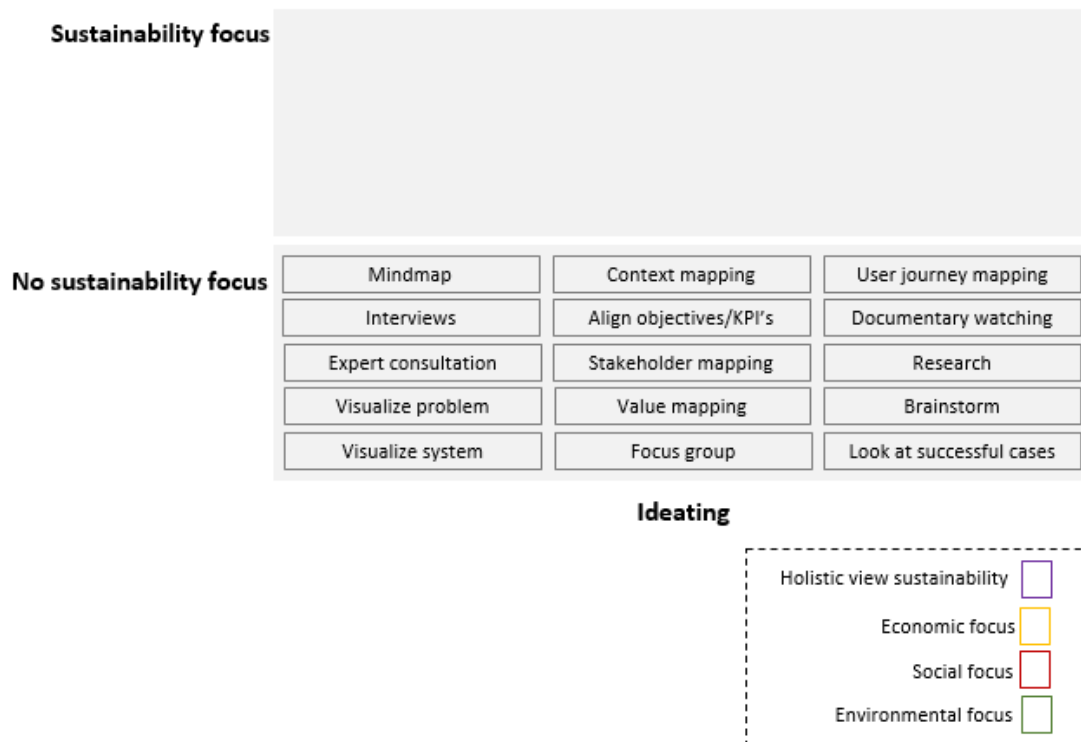


Figure 5.6 Overview SE tools/methods mentioned during focus group session

2. Ideation: How could sustainable entrepreneurs be supported in developing a sustainable startup idea (value proposition)?

In this phase, values were related to behaviours. The participants were asked to discuss what sustainable entrepreneurship entails and how the sustainable startup development process could be supported. They are asked to point out parts of the process were striking them, either positively or negatively, and what contributed to that.

Goal: to find out what parts of the current approaches to the early/ideation phases of the sustainable entrepreneurship process are good or can be improved, and how this could be supported.

The conversation was audio-recorded, transcribed and analysed using the content analysis method.

Definition sustainable entrepreneurship

“it’s really key to define what that means. Because a lot of people have different ideas regarding sustainability” (Entrepr34)

Similar to what showed in the interviews and survey results, the participants in the focus group have a broad range of definitions for what a sustainable startup is or should be. The participants with a sustainability background also all use different explanations, which is likely to be related to the ambiguity which also is present in the scientific literature on SE. One participant at some point mentioned the social pillar of the triple bottom line, but the participants seemed to “Mostly focus on the environmental part of course” (Entrepr29). The participants noticed that it was “pretty difficult” (Entrepr31) for them to get a clear-cut definition, and mentioned that “maybe it’s also about the [sustainability] intention”, or “objective” (Entrepr30), because “if you would really strictly define what a sustainable startup is, most sustainable startups could be crossed off the list” (Entrepr32).

At some point in the discussion, there was some agreement on a sustainable startup needing to provide an “improvement to the current status quo” (Entrepr31), and aim to make a positive impact.

Challenges sustainable entrepreneurship

“as a sustainable entrepreneur, the main challenge is to be sure that what you’re doing is the right thing” (Entrepr31)

It is perceived as the main challenge to determine whether the impact a startup makes is indeed positive. Impact assessment was brought forward as a method, e.g. in the form of LCA, with a side-note that it is very complex to perform, especially in an early phase of startup development, when the life cycle is far from well-defined and the uncertainty is high.

The importance of a feasible business model was also recognized. “if you don’t have money to make it happen, the goal ultimately fails” (Entrepr30).

SE tools/methods

The participants argued it is difficult to determine what a sustainable startup is, because "impact takes so much calculations, and even then you're not really sure whether that is the impact it has" (entrepr34). LCA is suggested as a method, but also criticized for use in an early stage of startup development because "you don't even know how the whole process looks like" (entrepr31). Some ideation tools and methods mentioned in the brainstorm do link to getting an overview of the system, such as "picture the system around it", "mindmap" (entrepr29), "stakeholder mapping" (entrepr31), "value mapping" (entrepr32) and "context mapping" (entrepr33).

3. Confrontation: Relate findings previous phases to the tool, and discuss the usability of the tool

In this phase, the tool was employed. The experiences were related to the topics raised in the exploration and ideation phases. The potential usability of the tool was discussed.

Goal: to evaluate the SSSM tool, and get new and fresh insights on whether the tool is valuable and how it could be improved to support the sustainable entrepreneurship process more.

Outcomes of SSSM workshop

The participants went through the SSSM steps, which resulted in a first version of a system map in response to the Household Waste challenge. This map was drawn by hand by the participants, and post-processed using the Kumu system mapping software to make it more legible. This map is presented in figure 5.7, and was used to communicate intervention points identified by the participants, as input for a sustainable value proposition. The map helped the participants to explain the effects of the propositions on the system, largely due to the visual nature. It is deemed to help discussing the assumptions leading up to the ideas with a multitude of stakeholders, and can be updated easily when gaining new insights in the system's workings. The suggested value propositions which resulted from this short session were mostly related to the perceived lack of knowledge on the benefits of decentralized

management of household waste. Three ideas were to host workshops for municipalities (to inform them better on the advantages), target primary school education (so kids learn about separating waste and bring the practice into their homes) or design a bin which turns waste separation into a game (where the game element incentivizes people to separate the household waste).

Feedback on system mapping method

“It’s a cool method, since you have a visual representation of (a part of the) complex problem, which makes it easier to see solutions and the impact of those solutions”

“Provides simplification, direction, context to approaching the entirety of the system”

The participants reflected on the system mapping method (elaborated on in chapter 3.4) which was presented in the confrontation phase, verbally and by filling the individual questionnaire (see appendix P for the results). All six would use the method in future sustainable entrepreneurship processes because they note it provides them of insights in how the system works, enabled them to identify “the root of the challenge”, and get an idea of how their value proposition might make an impact. Because of the system map being visual, it is perceived to help identifying the problems, ideating, communicating and discussing the concept and its impacts (“sustainability-related consequences”) with stakeholders.

“All-round understanding of sustainability-related consequences on choices and gives ideas/options”

The method helped the entrepreneurs to come up with more system’s ideas in response to the challenge. Participants noted in the questionnaire as points for improvement that one “can come to wrong conclusions, if assumptions are not tested/double-checked” because they “rely a lot on previous knowledge and preconceptions”, and some aspects can be missed unintentionally. Also, they think the method requires a facilitator.

SUSTAINABLE STARTUP SYSTEM MAPPING

worksheet 3

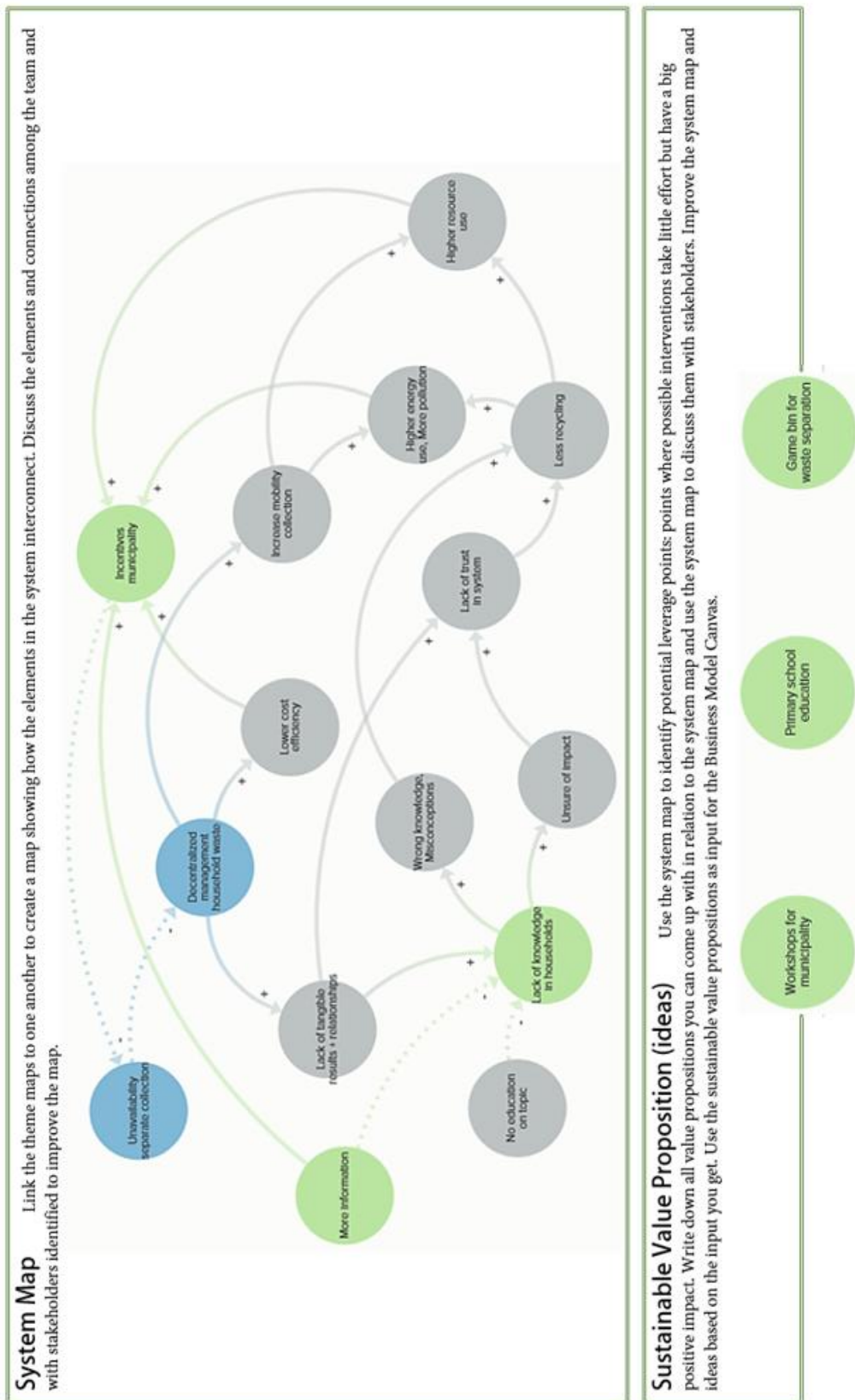


Figure 5.7 Completed (and post-processed using Kumu software) SSSM worksheet 3

Table 5.3 Excerpt focus group responses questionnaire

Would you use system mapping in future sustainable startup endeavours? Why (not)?
“Yes, not only for sustainability startups. I think it’s a great way to map out any (complex) problem.”
“Yes! I think it gives insight in stakeholders and values for them.”
“Yes, but my team members would also need an introduction to it so they don’t do it the way they always do it and use this tool”
“Yes, I believe so. The ‘fuzzy’ front end can be incredibly difficult and needs to be structured in order to increase success rates”
“Yes. Useful for explaining/engaging multiple stakeholders in a system and see how they are interconnected”
“Yes, big overview connecting many different types of factors (values, thoughts, infrastructure, etc)”

Ideas for further development system mapping method

The student entrepreneurs who evaluated the Sustainable Startup System Mapping (SSSM) worksheets argue it is a valuable new tool for the ideating phase of the development of sustainable startups. However, the tool needs to be developed further by going through some more design iterations including more user testing to ensure this value.

It also needs to be confirmed whether using it results in startup ideas/business models which are feasible. It could potentially be interesting to do a studies on the effects of using the worksheets on the (long-term) sustainability and success of startups.

6

DISCUSSION

6.1	Interpretations	102
6.2	Implications	105
6.3	Limitations	107
6.4	Recommendations	110

6. DISCUSSION

In this chapter, the results of the thesis work are discussed in relation to the literature review and research questions. First the interpretation of the results (6.1) is presented, followed by the implications (6.2) and limitations (6.3). In 6.4, the discussion is concluded with recommendations for further research.

6.1 Interpretations: theorisation & justification

The findings of the thesis research suggest that student entrepreneurs would benefit from support in the development of their sustainable startups. This is a finding from the interviews, survey and focus group, which confirms an issue which came forward in the literature review: “Lack of clarity on how to integrate the triple bottom line in the entrepreneurial process”. A main challenge for the entrepreneurs is to determine in an early phase whether the value proposition of their startup idea makes positive sustainability impacts.

Definition sustainable startup

The lack of a common approach to determining the sustainability impacts is in accordance with the lack of a common definition of sustainable entrepreneurship/startups. A commonly used definition of sustainable entrepreneurship is: “the discovery, creation, and exploitation of entrepreneurial opportunities that contribute to sustainability by generating social and environmental gains for others in society” (Hockerts and Wüstenhagen, 2010; Pacheco et al., 2010; Shepherd and Patzelt, 2011). A recurring element in the definitions is adhering to the sustainability triple bottom line: generating and balancing social, environmental and economic value (Epstein, 2018). This triple bottom line has been criticized by the expert on Sustainability Innovation because it compartmentalizes the values. Also, it is not clearly indicated per pillar what it entails, so entrepreneurs tend to loosely refer to aspects of the pillars when formulating their value proposition.

The results of this studies suggest that sharpening the definition of sustainable entrepreneurship and taking a holistic perspective on the impacts helps entrepreneurs

with the development of sustainable startups. This is in line with the increasing interest in the system perspective identified in the literature.

The resulting definition of what a sustainable startup is, which is mostly rephrasing and specifying the definition of sustainable entrepreneurship mentioned above, is as follows:

“exploitation of an economically viable new business opportunity which generates positive-sum social and environmental impacts”

Exploitation is defined as “to make productive use of”, and in this case of a startup that is of the new business opportunity. The economic aspects of sustainability are reflected in the startup needing to be “economically viable”, meaning profitable, so the efforts can be sustained. It is suggested that to oversee all social and environmental impacts and estimate whether positive-sum (total of gains and losses greater than zero, as phrased by Britannica encyclopaedia), a holistic/systems perspective needs to be adopted. Sustainable entrepreneurs differ from regular entrepreneurs because their startup business model has an additional strong focus on the environmental and social “gains”, reworded as positive impacts in the definition because that is the vocabulary used most commonly by the entrepreneurs.

Tools and methods available

A contribution to the scientific literature is the overviews of the sustainable entrepreneurship tools and methods mentioned by the experts and entrepreneurs. An unexpected finding is that the entrepreneurs currently generally use different tools and methods. The only common tools are the Business Model Canvas and LCA. The Business Model Canvas, however, is not focussed on sustainable business model development, and LCA is not helpful in an early phase of startup development when the high data requirements cannot be fulfilled yet. LCA also is focused on environmental performance, and therefore does not consider the economic and social aspects of sustainability. By mapping out for what startup development phases the tools mentioned are used, it showed that sustainability focused tools in the ideating phase are rare and therefore an area for further investigation.

By categorizing the strengths and weaknesses of the tools, four general requirements for valuable sustainable entrepreneurship tools/methods came forward: tools/methods

need to be insightful without being too complex, be trustworthy, be user-friendly and have to address sustainability holistically. Ten design requirements for a new tool/method were deduced from the research findings and used to compare the tools and methods available for the ideating phase. They were also the basis for the design of the worksheets for sustainable startup system mapping, which were developed and evaluated. They were found to be helpful to oversee the potential impacts when ideating on a sustainable value proposition as input for the Business Model Canvas.

System mapping, as described by Donella Meadows (2008), has been identified as a holistic method for taking a system perspective to oversee the impacts. This is a method which is, in different forms, used more commonly in business fields, for example in relation to creative problem solving, context analyses and cause and effect analysis. However, its introduction in the field of sustainable entrepreneurship is new. The system perspective taken through using the tool is seldom adopted in the other sustainable entrepreneurship tools/methods mentioned in the different parts of the research.

Quantitative/qualitative impact mapping

It was expected that the resulting sustainable startup tool or method would focus on quantification of the impacts on the triple bottom line. This is where the being insightful versus being too complex to perform trade-off comes into play. It has shown that especially in an early phase of the startup development there are a lot of unknowns about the life cycle aspects and therefore quantifications will be very rough and uncertain, if at all possible to indicate. Quantification, e.g. using LCA, therefore is recommended in a later stage when the startup concept is more thought through. With the system mapping method, qualitative data or estimations can be used to indicate how elements affect each other. The method allows for a dynamic approach to impact assessment, where new insights in how the system works can be implemented easily as the idea evolves over time.

6.2 Implications

A participatory research approach was adopted to serve the purposes of scientific knowledge production and societal problem handling simultaneously. For both literature and practice, the findings suggest some implications.

Scientific implications

Contribution to the SE literature

The first intended and main contribution is to the field of sustainable entrepreneurship. The research has provided insights in how entrepreneurs currently approach sustainable startup development, an overview of the challenges they face, and a definition of what sustainable entrepreneurship entails (Kraus et al., 2018) (Linnanen, 2014). In addition, suggestions of areas for future research within the field of sustainable entrepreneurship are provided.

Overviews of the tools and methods mentioned by experts and entrepreneurs in the different research activities have been made, to provide insights in what tools and methods are available, and for what phases of startup development. It showed that sustainability focused tools in the ideating phase are rare and therefore an area for further investigation.

By categorizing the strengths and weaknesses of the tools, four general requirements for valuable sustainable entrepreneurship tools/methods came forward: tools/methods need to be insightful without being too complex, be trustworthy, be user-friendly and have to address sustainability holistically.

More specific design requirements for a new tool/method were deducted from the research findings and used to compare the tools and methods available for the ideating phase. They were also the basis for the worksheets for sustainable startup system mapping, which were developed and evaluated. System mapping is a method which is, in different forms, used more commonly in business fields, for example in relation to creative problem solving, context analyses and cause and effect analysis. However, the introduction of system mapping in the field of (sustainable) entrepreneurship is new. The system perspective taken through using the tool is seldom adopted in the other sustainable entrepreneurship tools/methods mentioned in the different parts of the research, including the literature. The literature studies on sustainable

entrepreneurship already suggested an increasing interest in taking a systems perspective, and these worksheets are a suggested way for entrepreneurs to do that.

The major challenge which was deduced from the literature review is: “Lack of clarity on how to integrate the triple bottom line in the entrepreneurial process”. However, this studies has challenged the triple bottom line, and suggests that entrepreneurs should instead look at sustainability holistically from a systems perspective. It is suggested that there is a need for the development of SE tools/methods in the ideating phase of the development of sustainable startups.

Contribution to the IE field

A second contribution is to the field of industrial ecology, on the theoretical level. The official regulations of the Industrial Ecology Master program state that graduates must have learned to “analyse sustainability problems, to design solutions and to develop implementation plans for those solutions, all from an Industrial Ecology systems perspective” (Leiden University & TU Delft, 2018). The research has resulted in an easy way for entrepreneurs to adopt this systems perspective to do just this: to analyse sustainability problems, design solutions and develop implementation plans. Through the design science method, aspects/theories from different fields have been combined to increase the understanding of the wicked sustainability problems the entrepreneurs try to tackle. This is relevant for industrial ecology because it is a relatively young field which still leaves a lot of space for exploration of methodologies and finding synergies between different fields to concur sustainability challenges. By presenting an example of a design science method application (designing a sustainable entrepreneurship system mapping tool), the value of such a more practical method for doing research is explored (and evaluated in section 6.3).

Social implications

Sustainable startup system mapping worksheets for startup educational programs

Entrepreneurship has evolved into an established area of academic study and there is an increasing number of startup educational programs. The content of these programs is mainly focused on the business aspects of startup development. The difficulty of determining the impacts and thus whether achieving the intended social and environmental gains is recognized to be a challenge.

The system mapping method responds to this challenge, is new to sustainable student entrepreneurs and it is suggested to be a valuable addition to startup educational programs. The Sustainable Startup System Mapping worksheets could potentially be a format for it but would need further testing and development. The system mapping method acknowledges the complexity of issues by mapping out the system around an issue. Engaging stakeholders comes forward to be important in startup development, and the visual nature of the method allows for that and is valued a lot for getting an overview and communication. System mapping as a method is rarely used by entrepreneurs and discussed in the entrepreneurship literature. When evaluating the SSSM worksheets, it was indicated by all participants that adopting this perspective is useful for overseeing impacts in the early stage of sustainable startup development.

6.3 Limitations

In this section the research limitations that may have affected the quality of the findings and the ability to answer the research questions properly are discussed per research method. The methods and findings are presented in the appendices to provide transparency and increase the replicability of the research. Also the limitations of the SSSM worksheets are discussed.

Literature review

The literature review was important in defining the direction of the research. Fifteen research papers were systematically selected. However, the search inquiry and criteria for selection may have filtered out articles which could have provided more insight, for example because they were relatively new and not cited a lot yet. Through snowballing and suggestions of experts, the number of articles studied increased. The papers were analysed and notes were taken, upon which conclusions on research directions were drawn by the researcher. These were discussed with experts, but might not be fully comprehensive and this might have skewed the direction of the research.

Interviews

The sample size and sample profile are factors which are likely to have affected the generalisability of the interview findings. The seven experts and eight entrepreneurs interviewed were selected from the researcher's network and may not have touched upon all important subjects. An expert gave feedback on the sample and interview setup, upon which improvements were made, e.g. by including sustainable entrepreneurs with a social focus in the entrepreneurs sample. The criteria for selection of the sample could have been more restrictive, to ensure only student entrepreneurs were selected in the entrepreneurs sample. Also, more questions on startup educational programs could have been posed, which was not done since the research was narrowed down by focusing on student entrepreneurs interested in or working on a sustainable startup in these programs only in a later stage. Six out of eight entrepreneurs and four out of seven experts were involved in startup educational programs, which could have been a higher share so the focus on these programs would be more corroborated. General strengths of conducting interviews, as described by Yin (2014), are that it is an approach with which the interviewer can target the topic directly, and it provides many insights: explanations and personal views. General weaknesses are that the findings can be biased because of the formulation of the questions, response bias (inaccurate answers) and reflexivity (interviewee adjusts answers to what is expected to be told). These weaknesses were considered beforehand, and relating to the third point, it was aimed for to not pose leading questions to reduce the reflexivity. The interviewees have reviewed the interview transcripts afterwards, and have provided comments and clarifications where they felt it was necessary.

Survey

Similar to the interviews limitations, the main limitations of the survey are related to the sample size and profile. The survey was filled in twenty times, which is good for exploration of the topic but does not necessarily lead to quantitative well-substantiated generalizable conclusions. Again, the criteria for selection of the sample could have been more restrictive, to ensure only student entrepreneurs were selected in the entrepreneurs sample. Also, more questions on startup educational programs could have been posed, which was not done since the research was narrowed down by focusing on student entrepreneurs interested in or working on a sustainable startup in

these programs only in a later stage. The survey setup was largely based on the interview setup, and was repeatedly given feedback on by an expert. At the end of the survey a question was added to ask for feedback on the survey setup. Comments made were that the survey was relatively long and that the respondents were not always sure about what to fill in. This is a weakness of surveys as a method compared to interviews, that clarification cannot be given on the spot, and more in-depth questions based on responses cannot be posed.

Focus group

Again, sample size and profile are important factors limiting the reliability of the findings of the focus group. The participants in the focus group were from the network of the researcher and relatively young and inexperienced. Three out of six were currently working on a sustainable startup and three were intending to and in the process of ideation. Therefore they could all share their experiences on the early phase, but not per se on how the startup developed over time. Five out of six took part in a startup educational program, which in hindsight could have been discussed more in the exploration phase of the focus group. The focus group setup was shared with an expert for feedback, but the setup may still have affected the outcomes.

Content analysis

The content analysis method is considered to have affected the reliability of the outcomes the most. A limitation of the directed content analysis method is the informed but nonetheless strong bias towards the categories, because of the preconceptions based on the theory studied in advance. Also, an overemphasis on the categories can blind the researcher to some aspects of the phenomenon. Having multiple researchers develop the categories and clustering the content under the categories would likely increase the quality and reliability of the outcomes a lot.

Design Science approach

The relatively unknown Design Science research setup in which creative design and scientific validation are viewed as research approaches which complement each other (Romme, et al., 2017) was used. The creative design of a tool or method based on knowledge derived from previous research activities, to in turn create new knowledge

is perceived as valuable. However, the process of creating such a design left a lot of freedom in how to do this, so it did not provide a clear method, which in turn does not result in replicability. The Design Science approach would benefit from further development and clearer guidelines for the researcher on how to perform the research activities and how to build on the knowledge resulting from those activities.

SSSM worksheets

The student entrepreneurs who evaluated the Sustainable Startup System Mapping (SSSM) worksheets argue it is a valuable new tool for the ideating phase of the development of sustainable startups. However, as mentioned above, the Design Science method which was the research setup through which the worksheets were developed, does not provide clear guidelines for the researcher on how to perform which research activities and how to build on the resulting knowledge. Therefore, it is recognized that if other choices were made this might have resulted in different outcomes. For example, systems thinking tools could have been studied more systematically to learn from their approaches. The SSSM worksheets could be developed further by going through some more design iterations including more user testing to ensure the tool provides valuable support. It needs to be confirmed whether using it results in startup ideas/business models which are feasible. Related to that, it could potentially be interesting to do a studies on the effects of using the worksheets on the (long-term) sustainability and success of startups.

6.4 Recommendations

In this section, recommendations are provided based on the findings of the research, both for further research (theory) and for startup educational programs (practice). The managerial implications provide suggestions for incorporating systems thinking and the SSSM worksheets in startup educational programs.

Systems perspective on sustainability

A main challenge for the entrepreneurs is to determine in an early phase whether the value proposition of their startup idea makes positive sustainability impacts. Sharpening the definition of sustainable entrepreneurship and taking a holistic perspective on the impacts is suggested to help entrepreneurs with the development of

sustainable startups. The definition of a sustainable startup proposed is: “*exploitation of an economically viable new business opportunity which generates positive-sum social and environmental impacts*”. It is suggested that these positive-sum social and environmental impacts can be estimated and improved when adopting a systems perspective to design solutions (which address root causes) through analysing the sustainability problems properly, and consequently develop implementation plans with the Business Model Canvas.

Recommendations for researchers are to further develop this definition of a sustainable startup, into one which helps the entrepreneurs, and to further explore the application of systems thinking (instead of focusing on the triple bottom line) in the realm of entrepreneurship. Additionally, by mapping out for what startup development phases the tools mentioned in the different research activities are used, it showed that sustainability focused tools in the ideating phase are rare, and therefore an area for further investigation. Lastly, further research is needed to develop the system mapping method into a thoroughly substantiated one, through several iterations. A participatory approach for this research would be recommended.

Explore other challenges sustainable entrepreneurs

The sustainable entrepreneurs have indicated to also run into other problems which are more general startup related. The main challenges mentioned by the respondents are related to knowledge (e.g. how to develop product and how to find market fit), a well-functioning team, and funding. These challenges were recognized but not studied in detail, because of the focus of the research lying on the sustainability aspects. For researchers these challenges would be recommended research directions.

Furthermore, it has shown that sustainable entrepreneurs do use very different tools – there is not one generic way of approaching the development of sustainable startups. It is recommended to study the tools and methods over all startup development stages, and develop a toolkit which is a collection of the most valuable tools and methods for sustainable startups, covering all these stages.

Empirical studies in SE field

In the field of sustainable entrepreneurship, it is recognized that a lot of research stays theoretical, and that there is an ask for empirical studies (Larson, 2000) (Parrish, 2010)

in which primary data is retrieved (through observation or discussion) on how to successfully approach sustainable entrepreneurship. The design science method is relatively new in the literature and it could possibly benefit from more detail on how to approach it, but it is a recommended approach, because the stakeholder engagement it involved has turned out to be highly valuable as a research approach because of the iterative nature and the repeated incorporating of stakeholders.

Managerial implications

Startup educational programs

Entrepreneurship has evolved into an established area of academic study and there is an increasing number of startup educational programs. The content of these programs is mainly focused on the business aspects of startup development. The difficulty of determining the impacts and thus whether achieving the intended social and environmental gains is recognized to be a challenge. The system mapping method is new to sustainable student entrepreneurs and it suggested to be helpful to include it in educational programs on entrepreneurship. The Sustainable Startup System Mapping (SSSM) worksheets can support student entrepreneurs in the ideating phase of the development of sustainable startups. The current setup can be developed further collaboratively and is perceived to have the potential to be valuable for entrepreneurs who want to contribute to solving complex sustainability challenges.

Recommendations for startup educational programs wanting to support entrepreneurs in the development of sustainable startups, are to critically think about what a sustainable startup is, and to teach how to adopt a systems perspective when working towards sustainable startups. A suggestion is to try out system mapping in the ideating phase to develop sustainable value propositions.

PLNT Leiden

PLNT Leiden, the startup educational program which the thesis has been written in collaboration with, intends to contribute to solving urgent societal challenges, and recognizes the potential impact of guiding startups in sustainable entrepreneurship, but states to seek way to do this effectively. This research suggests that the SSSM worksheets can be a valuable method for them to support the student entrepreneurs within their programs in ideating towards a sustainable value proposition. A

recommendation for PLNT Leiden is to test this method in their educational programs. Especially for workshops on formulating a value proposition (for example part of the Venture Academy programme), the SSSM worksheets seem a valuable addition. It is a suggestion that PLNT Leiden could differentiate their startup educational programs more by emphasizing their intention to solve urgent societal challenges. They could teach the student entrepreneurs how to ideate towards startup concepts with a positive impact, tackling complex sustainability challenges, by using a systems thinking tool.

7

CONCLUSION

7.1 Future research directions

117

7. CONCLUSION

In this chapter, the research question and sub questions are answered, the scientific and practical contributions are summarized, and future research directions are proposed (section 7.1).

This research aimed to identify how student entrepreneurs can be better supported in the development of sustainable startups. The design science approach was adopted as the research method, which consists of participatory research and tool/method design towards knowledge development. The first intended and main contribution of the research is to the field of sustainable entrepreneurship: insights in how specifically student entrepreneurs currently approach sustainable startup development, what challenges they face, an overview of tools and methods and their strengths and weaknesses, and a definition of good entrepreneurial sustainability practices. Based on analysis of the literature review, interviews, survey and focus group it was concluded that it is important for student entrepreneurs to know from the start whether their value proposition is sustainable. The results suggest that adopting a systems perspective on sustainability helps student entrepreneurs to do that by identifying the potential environmental and social impacts of their proposition already in the ideating phase of startup development. Therefore, there is a second more practical contribution of the research: a systems perspective tool is designed which can be offered as support to student entrepreneurs developing sustainable startups by startup educational programs.

The gaps in knowledge addressed, identified in the literature review, are related to how student entrepreneurs currently approach the development of sustainable startup, what tools and methods are used, and how a new tool or method could better support the development.

“as a sustainable entrepreneur, the main challenge is to be sure that what you’re doing is the right thing” (Entrepr31)

The results indicate that the main challenge for sustainable entrepreneurs is to determine in an early phase whether the value proposition of their startup idea makes positive sustainability impacts and to find ways to improve these impacts. This

challenge can be broken down to smaller interrelated challenges, such as there not being a clear definition of what sustainable entrepreneurship (or a sustainable startup) entails, there (consequently) not being a proper way to assess the sustainability, and the lack of well-supporting tools and methods. Sustainable entrepreneurs have identified important barriers, being lack of sustainability expertise, business versus sustainability trade-offs (in which financial feasibility is an important hurdle), and difficulties with understanding the system in which they operate. Common sense is mentioned as the major way of making decisions.

Sustainable entrepreneurship tools/methods meant to support the entrepreneurs are available and used. Two of them are very common: Business Model Canvas and Life Cycle Assessment. Both are criticized, the first for not incorporating sustainability enough, the second for requiring too much (unavailable) data especially in an early stage. There are many other (primarily entrepreneurship) tools which are not generally used, they are only mentioned once. Overviews of the tools and methods have been made, which show the startup development phase in which the tools and methods are used, and whether they have a specific focus on sustainability. The overviews suggest that there is a gap in sustainability tools for the ideating phase of the development of sustainable startups. Also overviews of the strengths and weaknesses of these tools have been made, which functioned as the main input for formulating the design requirements.

A need has been identified for insightful, trust-worthy, user-friendly tools/methods which address sustainability holistically. Sharpening the definition of sustainable entrepreneurship and taking a holistic perspective on the impacts is suggested to help entrepreneurs with the development of sustainable startups. Based on the findings per research activity, ten design requirements have been formulated (see section 5.1). In response to the design requirements, the SSSM worksheets (see section 5.4) were designed and consequently evaluated in a focus group. All six participants (student entrepreneurs) of the focus group would use the method in future sustainable entrepreneurship processes because they note it provides them of insights in how the system works, enabled them to identify “the root of the challenge”, and get an idea of how their value proposition might make an impact. Because of the system map being visual, it is perceived to help identifying the problems, ideating, communicating and

discussing the concept and its impacts (“sustainability-related consequences”) with stakeholders.

The research direction and questions were determined in consultation with the Director of Innovation of PLNT Leiden, the startup educational program the thesis was written in collaboration with. A main conclusion is that startup educational programs could potentially better support student entrepreneurs intending to develop a sustainable startup by teaching them how to take a systems perspective on the sustainability of their value proposition. The content of startup educational programs currently is mainly focused on the business aspects of startup development. The difficulty of determining a startup’s impacts and thus whether it achieves the intended social and environmental gains is recognized as a challenge. The system mapping method is new to sustainable student entrepreneurs and it may be considered for inclusion in educational programs on entrepreneurship. The current setup can be developed further collaboratively and is perceived to have the potential to be valuable for entrepreneurs who want to contribute to solving complex sustainability challenges.

PLNT Leiden intends to contribute to solving urgent societal challenges and recognizes the potential impact of guiding startups in sustainable entrepreneurship, but states to seek ways to do this effectively. A recommendation for PLNT Leiden is to test this method in their educational programs. It is a suggestion that PLNT Leiden could differentiate their startup educational programs more by emphasizing their intention to solve urgent societal challenges. They could teach the student entrepreneurs how to ideate towards startup concepts with a positive impact, tackling complex sustainability challenges, by using the SSSM worksheets.

7.1 Future research directions

In this section, directions for future research identified in this study are summarized, based on section 6.4.

An overarching suggestion is for researchers to respond to the ask for empirical studies in which primary data is retrieved (through observation or discussion) on how to successfully approach sustainable entrepreneurship. The design science method could be a valuable approach, especially when stakeholders are engaged extensively.

Secondly, the results challenge the current common triple bottom line approach and suggest that instead a systems perspective on sustainability should be adopted.

A third research direction is to study what tools or methods could best be used by student entrepreneurs in the different phases of development of sustainable startups, with a suggested emphasis on the ideating phase. It has shown that sustainable entrepreneurs do use very different tools – there is not one generic way of approaching the development of sustainable startups. It might be helpful to study the tools and methods over all startup development stages, and develop a toolkit which is a collection of the most valuable tools and methods for sustainable startups, covering all these stages.

A last research direction is finding ways to support student entrepreneurs with the other identified challenges that they run into. The sustainable entrepreneurs have indicated other problems, which are more general startup related: lack of knowledge (e.g. how to develop product and how to find market fit), a well-functioning team, and funding. These challenges were recognized but not studied in detail, because of the focus of the research lying on the sustainability aspects. These challenges would be recommended research directions.

REFERENCES

REFERENCES

- Belz, F. M., & Binder, J. K. (2015). Sustainable Entrepreneurship: A Convergent Process Model. *Business Strategy and the Environment*, 26(1), 1–17. doi: 10.1002/bse.1887
- Bocken, N. (2015). Sustainable venture capital – catalyst for sustainable start-up success? *Journal of Cleaner Production*, 108, 647–658. doi: 10.1016/j.jclepro.2015.05.079
- Bocken, N., Short, S., Rana, P., & Evans, S. (2013). A value mapping tool for sustainable business modelling. *Corporate Governance: The International Journal of Business in Society*, 13(5), 482–497. doi: 10.1108/cg-06-2013-0078
- Bonanni, L., Hockenberry, M., Zwarg, D., Csikszentmihalyi, C., & Ishii, H. (2010). Small business applications of sourcemap. *Proceedings of the 28th International Conference on Human Factors in Computing Systems - CHI 10*. doi: 10.1145/1753326.1753465
- Bonnet, H., Quist, J., Hoogwater, D., Spaans, J., & Wehrmann, C. (2006). Teaching sustainable entrepreneurship to engineering students: the case of Delft University of Technology. *European Journal of Engineering Education*, 31(2), 155–167. <https://doi.org/10.1080/03043790600566979>
- Bradbury-Huang, H. (2010). What is good action research? *Action Research*, 8(1), 93–109. <https://doi.org/10.1177/1476750310362435>
- Chevalier, A., Harmon, C., O’ Sullivan, V. and Walker, I. (2013). The impact of parental income and education on the schooling of their children. *IZA Journal of Labor Economics*, 2(1), p.8. CLICKNL, (2018), Knowledge & Innovation Agenda, retrieved March 12, 2019, from https://assets.ctfassets.net/h0msiyds6poj/4eenv39jLOac08SuCgSy20/2df9a0313b2f94fa085878bccca0277a/CLICKNL_KIA_2018-2021-2_EN__1_.pdf
- Clercq, D. D., & Voronov, M. (2011). Sustainability in entrepreneurship: A tale of two logics. *International Small Business Journal: Researching Entrepreneurship*, 29(4), 322–344. doi: 10.1177/0266242610372460

- Climate-KIC, (n.d.), What is Climate KIC?, Retrieved March 15, 2019, from <https://www.climate-kic.org/who-we-are/what-is-climate-kic/>
- Creative Council, (2018), Vanzelfsprekend Duurzaam, retrieved March 12, 2019, from <http://www.creative-council.nl/vanzelfsprekend-duurzaam>
- Davis, D., Morris, M. and Allen, J. (1991). Perceived Environmental Turbulence and Its Effect on Selected Entrepreneurship, Marketing, and Organizational Characteristics in Industrial Firms. *Journal of the Academy of Marketing Science*, 19(1), pp.43-51.
- Van der Duin, P. (2016) *Foresight in Organizations: Methods and Tools*, Routhledge, London
- Epstein, M. J. (2018). *Making Sustainability Work | Best Practices in Managing and Measuring Corporate Social, Environmental and Economic Impacts*. Retrieved March 15, 2019, from <https://www.taylorfrancis.com/books/9781351280112>
- Fischer, D., Mauer, R., & Brettel, M. (2018). Regulatory focus theory and sustainable entrepreneurship. *International Journal of Entrepreneurial Behavior & Research*, 24(2), 408–428. doi: 10.1108/ijebr-12-2015-0269
- Frow, P., Nenonen, S., Payne, A., & Storbacka, K. (2015). Managing Co-creation Design: A Strategic Approach to Innovation. *British Journal of Management*, 26(3), 463–483. <https://doi.org/10.1111/1467-8551.1208>
- Gallego-Álvarez, I., Prado-Lorenzo, J. M., Rodríguez-Domínguez, L., & García-Sánchez, I. M. (2010). Are social and environmental practices a marketing tool? *Management Decision*, 48(10), 1440–1455. doi: 10.1108/00251741011090261
- Gast, J., Gundolf, K., & Cesinger, B. (2017). Doing business in a green way: A systematic review of the ecological sustainability entrepreneurship literature and future research directions. *Journal of Cleaner Production*, 147, 44–56. <https://doi.org/10.1016/j.jclepro.2017.01.065>
- Gaziulusoy, A. I., Boyle, C., & Mcdowall, R. (2013). System innovation for sustainability: a systemic double-flow scenario method for companies. *Journal of Cleaner Production*, 45, 104–116. doi: 10.1016/j.jclepro.2012.05.013
- Golinska, P., Kosacka, M., Mierzwiak, R., & Werner-Lewandowska, K. (2015). Grey Decision Making as a tool for the classification of the sustainability level of

- remanufacturing companies. *Journal of Cleaner Production*, 105, 28–40. doi: 10.1016/j.jclepro.2014.11.040
- Griskevicius, V., Cantú, S. M., & Vugt, M. V. (2012). The Evolutionary Bases for Sustainable Behavior: Implications for Marketing, Policy, and Social Entrepreneurship. *Journal of Public Policy & Marketing*, 31(1), 115–128. doi: 10.1509/jppm.11.040
- Hall, J. K., Daneke, G. A., & Lenox, M. J. (2010). Sustainable development and entrepreneurship: Past contributions and future directions. *Journal of Business Venturing*, 25(5), 439–448. doi: 10.1016/j.jbusvent.2010.01.002
- Heijungs, R., Huppes, G., & Guinée, J. B. (2010). Life cycle assessment and sustainability analysis of products, materials and technologies. Toward a scientific framework for sustainability life cycle analysis. *Polymer Degradation and Stability*, 95(3), 422–428. <https://doi.org/10.1016/j.polymdegradstab.2009.11.010>
- Hockerts, K., & Wüstenhagen, R. (2010). Greening Goliaths versus emerging Davids — Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. *Journal of Business Venturing*, 25(5), 481–492. doi: 10.1016/j.jbusvent.2009.07.005
- Jawahir, I. S., Dillon, O. W., Rouch, K. E., Joshi, K. J., Venkatachalam, A., & Jaafar, I. H. (2006, September). Total life-cycle considerations in product design for sustainability: A framework for comprehensive evaluation. In *Proceedings of the 10th International Research/Expert Conference, Barcelona, Spain* (pp. 1-10).
- Joyce, A., & Paquin, R. L. (2016). The triple layered business model canvas: A tool to design more sustainable business models. *Journal of Cleaner Production*, 135, 1474–1486. doi: 10.1016/j.jclepro.2016.06.067
- Klöpffer, W. (2003). Life-Cycle based methods for sustainable product development. *The International Journal of Life Cycle Assessment*, 8(3), 157–159. <https://doi.org/10.1007/bf02978462>
- Kitzinger, J. (1995). Qualitative Research: Introducing focus groups. *Bmj*, 311(7000), 299–302. doi:10.1136/bmj.311.7000.299

- Kraus, S., Ribeiro-Soriano, D. and Schüssler, M. (2018). Fuzzy-set qualitative comparative analysis (fsQCA) in entrepreneurship and innovation research – the rise of a method. *International Entrepreneurship and Management Journal*, 14(1), pp.15-33.
- Kuratko, D. F., & Morris, M. H. (2017). Examining the Future Trajectory of Entrepreneurship. *Journal of Small Business Management*, 56(1), 11–23. doi: 10.1111/jsbm.12364
- Lans, T., Blok, V., & Wesselink, R. (2014). Learning apart and together: towards an integrated competence framework for sustainable entrepreneurship in higher education. *Journal of Cleaner Production*, 62, 37–47. doi: 10.1016/j.jclepro.2013.03.036
- Linnanen, Lassi. (2002). An Insider's Experiences with Environmental Entrepreneurship. *The Journal of Corporate Environmental Strategy and Practice*. 38. 10.9774/GLEAF.3062.2002.su.00008.
- Mauser, W., Klepper, G., Rice, M., Schmalzbauer, B., Hackmann, H., Leemans, R. and Moore, H. (2013). Transdisciplinary global change research: the co-creation of knowledge for sustainability. *Current Opinion in Environmental Sustainability*, 5(3-4), pp.420-431.
- Munoz, P., Cohen, B. (2018), Entrepreneurial Narratives in Sustainable Venturing: Beyond People, Profit, and Planet. *Journal of Small Business Management*, Vol. 56, pp. 154-176, 2018.
- Othman, R., & Ameer, R. (2009). Environmental disclosures of palm oil plantation companies in Malaysia: a tool for stakeholder engagement. *Corporate Social Responsibility and Environmental Management*. doi: 10.1002/csr.218
- Pacheco, D. F., Dean, T. J., & Payne, D. S. (2010). Escaping the green prison: Entrepreneurship and the creation of opportunities for sustainable development. *Journal of Business Venturing*, 25(5), 464–480. doi: 10.1016/j.jbusvent.2009.07.006
- Parrish, B. D. (2010). Sustainability-driven entrepreneurship: Principles of organization design. *Journal of Business Venturing*, 25(5), 510–523. doi: 10.1016/j.jbusvent.2009.05.005

- Ploum, L. J. L., Lans, T., Baggen, Y. (2018). Towards more synergy in entrepreneurial competence research in entrepreneurship education. In A. Fayolle (Ed.), *A research agenda for entrepreneurship education* (pp. 224-242). Edward Elgar Publishing.
- Pohl, C., Krütli, P., & Stauffacher, M. (2017). Ten Reflective Steps for Rendering Research Societally Relevant. *GAIA - Ecological Perspectives for Science and Society*, 26(1), 43–51. doi: 10.14512/gaia.26.1.10
- Poulikidou, S., Björklund, A., & Tyskeng, S. (2014). Empirical study on integration of environmental aspects into product development: processes, requirements and the use of tools in vehicle manufacturing companies in Sweden. *Journal of Cleaner Production*, 81, 34–45. doi: 10.1016/j.jclepro.2014.06.001
- Rodgers, C. (2010). Sustainable entrepreneurship in SMEs: a case study analysis. *Corporate Social Responsibility and Environmental Management*, 17(3), 125–132. doi: 10.1002/csr.223
- Romme, A.G.L., Reymen, I.M.M.J., (2017), *Entrepreneurship at the interface of design and science: Toward an inclusive framework*, PDF
- Roux, D., Guiot, D. (2010). A Second-hand Shoppers' Motivation Scale: Antecedents, Consequences, and Implications for Retailers, *Journal of Retailing*, Elsevier, vol. 86(4), pages 355-371.
- Schaltegger, S., & Wagner, M. (2011). Sustainable entrepreneurship and sustainability innovation: categories and interactions. *Business Strategy and the Environment*, 20(4), 222–237. doi: 10.1002/bse.682
- Schaltegger, S., Hansen, E. G., & Lüdeke-Freund, F. (2015). Business Models for Sustainability. *Organization & Environment*, 29(1), 3–10. <https://doi.org/10.1177/1086026615599806>
- Schaltegger, S., Lüdeke-Freund, F., & Hansen, E. G. (2016). Business Models for Sustainability. *Organization & Environment*, 29(3), 264–289. doi: 10.1177/1086026616633272
- Shepherd, D. A., & Patzelt, H. (n.d.). *The New Field of Sustainable Entrepreneurship: Studying Entrepreneurial Action Linking “What Is to Be Sustained” With “What Is to*

Be Developed.” A Psychological Approach to Entrepreneurship, 45–71. doi: 10.4337/9781783479801.00009

Siew, R. Y. (2015). A review of corporate sustainability reporting tools (SRTs). *Journal of Environmental Management*, 164, 180–195. doi: 10.1016/j.jenvman.2015.09.010

Spence, M., Gherib, J. B. B., & Biwolé, V. O. (2010). Sustainable Entrepreneurship: Is Entrepreneurial will Enough? A North–South Comparison. *Journal of Business Ethics*, 99(3), 335–367. doi: 10.1007/s10551-010-0656-1

Startup Commons. (2019). Startup Development Phases. [online] Available at: <https://www.startupcommons.org/startup-development-phases.html> [Accessed 15 Aug. 2019].

Tahir, A. C., & Darton, R. (2010). The Process Analysis Method of selecting indicators to quantify the sustainability performance of a business operation. *Journal of Cleaner Production*, 18(16-17), 1598–1607. doi: 10.1016/j.jclepro.2010.07.012

The Academy for Systems Change. (2019). About Donella “Dana” Meadows. [online] Available at: <http://donellameadows.org/donella-meadows-legacy/donella-dana-meadows/> [Accessed 15 Aug. 2019].

Tomico, O., Frens, J. W., & Overbeeke, C. J. (2009). Co-reflection. Proceedings of the 27th international conference extended abstracts on Human factors in computing systems - CHI EA '09, . <https://doi.org/10.1145/1520340.1520389>

UNESCO, (n.d.), What do we Mean by the Cultural and Creative Industries?, retrieved on March 12, 2019, from <https://en.unesco.org/creativity/sites/creativity/files/digital-library/What%20Do%20We%20Mean%20by%20CCI.PDF>

United Nations. (2015). Paris Agreement. Retrieved from https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en

United Nations. (2015). Transforming our World: The 2030 Agenda for Sustainable Development: Sustainable Development Knowledge Platform. Retrieved on September 1, 2019, from <https://sustainabledevelopment.un.org/post2015/transformingourworld/publication>

Waage, S. A. (2007). Re-considering product design: a practical “road-map” for integration of sustainability issues. *Journal of Cleaner Production*, 15(7), 638–649. <https://doi.org/10.1016/j.jclepro.2005.11.026>

World Commission on Environment and Development. (1987). *Our common future*. Oxford: Oxford University Press.

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). Los Angeles: Sage.

York, J. L., & Danes, J. E. (2014). Customer Development, Innovation, and Decision-Making Biases in the Lean Startup. *Journal of Small Business Strategy*, 24(2), 21-40.

4lenses.org. (2019). *Social Enterprise in Context | The Four Lenses Strategic Framework*. [online] Available at: http://www.4lenses.org/Setypology/se_in_context [Accessed 15 Aug. 2019].

APPENDICES

APPENDICES

A. Literature review references	129
B. SE tools/methods from literature review	*
C. Interviews experts protocol	132
D. Interviews experts transcripts	**
E. Informed consent form	133
F. Interviews experts content analysis	*
G. Interviews entrepreneurs protocol	135
H. Interviews entrepreneurs transcripts	**
I. Interviews entrepreneurs content analysis	*
J. Survey	136
K. Survey responses	*
L. Survey content analysis	*
M. Focus group script	142
N. Focus group transcript	**
O. Focus group content analysis	*
P. Focus group questionnaire	149
Q. Design requirements	151
R. SE tools/methods explanations and references	154
S. SSSM worksheets	156

* The appendices B, F, I, K, L and O are to be found in the Excel file separate from this report

** The appendices D, H and L (transcripts) are to be found in the additional PDF separate from this report because of high number of pages

Appendix A. Literature Review References

Systematic Literature Review 1: Sustainable Entrepreneurship

Document title	Authors	Year	Source
Sustainable entrepreneurship and sustainability innovation: Categories and interactions	Schaltegger, S., Wagner, M.	2011	Business Strategy and the Environment 20(4), pp. 222-237
Sustainable development and entrepreneurship: Past contributions and future directions	Hall, J.K., Daneke, G.A., Lenox, M.J.	2010	Journal of Business Venturing 25(5), pp. 439-448
Greening Goliaths versus emerging Davids - Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship	Hockerts, K., Wüstenhagen, R.	2010	Journal of Business Venturing 25(5), pp. 481-492
The New Field of Sustainable Entrepreneurship: Studying Entrepreneurial Action Linking "What Is to Be Sustained" With "What Is to Be Developed"	Shepherd, D.A., Patzelt, H.	2011	Entrepreneurship: Theory and Practice 35(1), pp. 137-163
Sustainability-driven entrepreneurship: Principles of organization design	Parrish, B.D.	2010	Journal of Business Venturing 25(5), pp. 510-523
The impact of social norms on entrepreneurial action: Evidence from the environmental entrepreneurship context	Meek, W.R., Pacheco, D.F., York, J.G.	2010	Journal of Business Venturing 25(5), pp. 493-509
Escaping the green prison: Entrepreneurship and the creation of opportunities for sustainable development	Pacheco, D.F., Dean, T.J., Payne, D.S.	2010	Journal of Business Venturing 25(5), pp. 464-480
Learning apart and together: Towards an integrated competence framework for sustainable entrepreneurship in higher education	Lans, T., Blok, V., Wesselink, R.	2014	Journal of Cleaner Production 62, pp. 37-47
The evolutionary bases for sustainable behavior: Implications for marketing, policy, and social entrepreneurship*	Griskevicius, V., Cantú, S.M., Van Vugt, M.	2012	Journal of Public Policy and Marketing 31(1), pp. 115-128
Business Models for Sustainability: A Co-Evolutionary Analysis of Sustainable	Schaltegger, S., Lüdeke-	2016	Organization and Environment 29(3), pp. 264-289

Entrepreneurship, Innovation, and Transformation	Freund, F., Hansen, E.G.		
Sustainable entrepreneurship in SMEs: A case study analysis	Rodgers, C.	2010	Corporate Social Responsibility and Environmental Management 17(3), pp. 125-132
Sustainable Entrepreneurship: Is Entrepreneurial will Enough? A North-South Comparison	Spence, M., Ben Boubaker Gherib, J., Biwolé, V.O.	2011	Journal of Business Ethics 99(3), pp. 335-367
Sustainable Entrepreneurship: A Convergent Process Model	Belz, F.M., Binder, J.K.	2017	Business Strategy and the Environment 26(1), pp. 1-17
Sustainability in entrepreneurship: A tale of two logics	de Clercq, D., Voronov, M.	2011	International Small Business Journal 29(4), pp. 322-344
Sustainable venture capital - Catalyst for sustainable start-up success?	Bocken, N.M.P.	2015	Journal of Cleaner Production 108, pp. 647-658

* (Griskevicius, Cantú, & van Vugt, 2012) excluded because the article does not explicitly investigate sustainable entrepreneurship

Systematic Literature Review 2: Sustainable Entrepreneurship Tools/Methods

Document title	Authors	Year	Source
Are social and environmental practices a marketing tool?	Gallego-Álvarez, I., Prado-Lorenzo, J., Rodriguez	2010	Management Decision
Empirical study on integration of environmental aspects into product development	Poulikidou, S., Bjorklund, A., Tyskang, S.	2014	Journal of Cleaner Production
Environmental disclosures of palm oil plantation companies in Malaysia	Othman, R., Ameer, R.	2009	Corporate Social Responsibility and Environmental Management
Grey decision making as a tool for the classification of the sustainability level of remanufacturing companies	Golinska, P., Kosacka, M.,	2015	Journal of Cleaner Production

	Mierzwiak, R., Werner-Levvando		
The process analysis method of selecting indicators to quantify the sustainability performance of a business operation	Tahir, C., Darton, R.C.	2010	Journal of Cleaner Production
A value mapping tool for sustainable business modeling	Bocken, N., Short, S., Rana, P., Evans, S.	2013	Corporate Governance (Bingley)
System innovation for sustainability: a systemic double-flow scenario method for companies	Gaziulusoy, A.I., Boyle, C., McDowall, R.	2013	Journal of Cleaner Production
A review of corporate sustainability reporting tools (SRTs)	Siew, R.Y.J.	2015	Journal of Environmental Management
Small business applications of Sourcemap: a web tool for sustainable design and supply chain transparency	Bonanni, L., Hockenberry, M., Zwarg, D.	2014	International Conference on Human Factors in Computing Systems
The triple layered business model canvas: a tool to design more sustainable business models	Joyce, A., Paquin, R.L.	2016	Journal of Cleaner Production

Appendix C. Interviews Experts Protocol

Setup 20-03-2019

Opening

Shortly introduce my thesis + experience startup + experience LCA

1. Record the interview, consent?

Interviewee background

2. Could you tell me about yourself and your expertise/role in the organization?
3. Could you introduce the organization you work for?
4. How would you describe your vision concerning sustainability and/or entrepreneurship?

Sustainability

5. How do you work towards sustainability?
6. What do the sustainability tools/methods you use/develop account for?
 - 6.1 Where is the data derived from?
7. What pillars of sustainability do you consider: people, planet, profit? How? Indicators?
8. Could you (show and) describe the tools/methods?
9. What are the major strengths/weaknesses of these tools/methods?
10. What would be research opportunities for further development?

Entrepreneurship

11. Are the tools/methods helpful for the development of triple bottom line business plans?
12. In what stage of the entrepreneurial process would the tools/methods be most useful?
13. To what extent are the tools/methods user-friendly?
 - 13.1 To what extent were the stakeholders involved in the development?

Round up

15. Could you recommend literature/experts for consultation?
16. Could I contact you for further details/information if necessary?
 - 16.1 Will provide an overview of the main takeaways later for feedback

Thank you

Appendix E. Informed Consent Form

Informed consent form for *Thesis Sustainable Entrepreneurship Tool*

Based on template for research with human participants, by Kormelink and Teperek (2018)

Please tick the appropriate boxes

Yes No

Taking part in the study

I have read and understood the study information dated 12/06/2019, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.

I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.

I understand that taking part in the study involves an audio-recording which will be transcribed as text, and the recording is destroyed afterwards.

Use of the information in the study

I understand that information (quotes) I provide will be used for the thesis report and thesis defence presentation.

I understand that personal information collected about me that can identify me, such as my name, or the name of my company, will not be shared beyond the study team.

I agree that my information can be quoted in research outputs

Future use and reuse of the information by others

I give permission for the anonymized quotes retrieved from the audio-recording to be archived in the TU Delft Repositories and Leiden Repository so it can be used for future research and learning. All deposited data will be anonymised by excluding names and participant specific details.

Signatures

Name of participant

Signature

Date

For participants unable to sign their name, mark the box instead of sign

I have accurately shared the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Anne Uildriks

12-06-2019

Researcher name

Signature

Date

Information study

Thesis Sustainable Entrepreneurship Tool

Industrial Ecology Master thesis on the development of a tool
for sustainable entrepreneurship
12-06-2019

Purpose of the research

The purpose of involving the participant is to gain insights on sustainable entrepreneurship, serving as input for the development of a tool to support sustainable entrepreneurs.

Benefits and risks of participating

The benefits of participating are a potentially interesting information exchange on sustainable entrepreneurship, and access to the thesis report/tool in September 2019. It is perceived that there are no risks involved.

Procedures for withdrawal from the study

If you want to withdraw from the study, please contact Anne Uildriks via the contact details provided below.

Handling of personal information

The participant's involvement will be audio-recorded, transcribed and analysed, and serves as input for the development of a sustainable entrepreneurship tool. The data will be presented in the reporting in an anonymized way. The transcript will be shared with the participant, and the participant has the right to request rectification or erasure of personal data. The anonymous data will be archived in the TU Delft Repositories. The audio-recording will be destroyed.

Contact details

The interview is conducted as part of Anne Uildriks' Industrial Ecology Master thesis. The Master program is part of Leiden University and Delft University of Technology. Anne Uildriks can be reached via email or phone for questions or remarks.

Anne Uildriks
a.j.uildriks@student.tudelft.nl
+316 XXXXXXXX

Appendix G. Interviews Entrepreneurs Protocol

Setup 09-05-2019

Opening

Shortly introduce my thesis + experience startup + experience LCA

Record the interview. Sign consent form.

Interviewee background

1. Could you tell me about your startup and your expertise/role in the startup?
 - 1.1 How long have you been working for this startup?
 - 1.2 When did/will you start selling?
2. How would you describe your vision concerning sustainability?
 - 2.1 What motivates you as a sustainable entrepreneur?
 - 2.2 How is sustainability incorporated in your startup?

Sustainable entrepreneurship

3. What is in your view sustainable entrepreneurship and why is it important (or not)?
 - 3.1 Would you distinguish different kinds of sustainable entrepreneurship?
4. What would you consider important for starting entrepreneurs who want to be sustainable entrepreneurs?
 - 4.1 What kind of problems did you run into in the development process?
 - 4.2 What helped you in the development process?
 - 4.3 How could the process have been made easier?

Sustainable entrepreneurship tools/methods

5. Do/did you use sustainability tools/methods? Could you (show and) describe them?
 - 5.1 What is/was the most relevant one for your startup?
6. What do the tools/methods account for?
 - 6.1 Indicators? Triple bottom line?
 - 6.2 Where did you gather the data?
7. What are the major strengths/weaknesses of these tools/methods?
 - 7.1 What kind of decisions did you make based on the insights you got using the tools/methods?
 - 7.2 Were the tools/methods user-friendly?
8. Could you describe a tool/method which has helped you in the development of your sustainable startup?
9. What are your plans for further development of the startup?
 - 9.1 Could a tool/method help you in that?

Round up

10. Is there anything else you would like to mention about sustainable entrepreneurship?
11. Could you recommend other sustainable startups to contact?
12. Could I contact you for further details/information if necessary?

Will share the interview transcript later for feedback

Thank you

Appendix J. Survey

In this appendix the survey questions on sustainable entrepreneurship are presented – first the Dutch and then the English version. The surveys were distributed and filled in online through Google Forms.

Duurzaam ondernemerschap

Deze vragenlijst gaat over de ontwikkeling van uw duurzame startup. De antwoorden helpen om inzicht te krijgen in hoe duurzame startups beter ondersteund kunnen worden. Uw input is waardevol voor de ontwikkeling van een duurzame ondernemerschaps tool, die gemaakt wordt als onderdeel van een Industrial Ecology Master scriptie onderzoek. De focus ligt op ondernemers die duurzaamheid noemen in hun missie/visie. U kunt de vragen anoniem beantwoorden, en de antwoorden zullen hoe dan ook anoniem verwerkt worden in het verslag. Er is een optie om contact informatie in te vullen aan het einde van de vragenlijst, indien u geïnteresseerd bent in de resultaten van het onderzoek. Of stuur een email naar a.j.uildriks@student.tudelft.nl. Bedankt voor uw inbreng!

(25 vragen, 5-10 minuten)

1. Waar gaat uw startup over?
2. Heeft uw startup een waarde propositie? Indien ja, hoe zou u deze formuleren?
3. Wat is de doelgroep van uw startup?
4. Wat is uw rol in de startup?
5. Waarom wilt u duurzaam ondernemen?
6. Wat wilt u met uw startup bereiken?
7. Heeft u deelgenomen in een startup programma? Zo ja, welke? En wat heeft u er aan gehad?
8. Heeft u financiering/investering gekregen? Zo ja, van wie of wat?
9. Welk jaar bent u begonnen aan de ontwikkeling van de startup?
 - 2019
 - 2018
 - 2017
 - 2016

- 2015
- eerder

10. Welk jaar had u de eerste klant?

- 2019
- 2018
- 2017
- 2016
- 2015
- eerder

11. Welke plannen heeft u voor verdere ontwikkeling van uw duurzame startup?

12. Wat is duurzaam ondernemerschap volgens u?

13. Hoe zijn milieu aspecten van duurzaamheid in uw startup meegenomen?

14. Hoe zijn sociale/maatschappelijke aspecten van duurzaamheid in uw startup meegenomen?

15. Wat waren moeilijkheden tijdens de ontwikkeling van de startup?

16. Hoe heeft u deze moeilijkheden opgelost?

17. Wat waren duurzaamheid gerelateerde moeilijkheden tijdens de ontwikkeling van de startup?

18. Hoe heeft u deze duurzaamheid gerelateerde moeilijkheden opgelost?

19. Welke tools/methodes heeft u gebruikt om beslissingen te maken tijdens de ontwikkeling van uw startup? bijv. business model canvas / LCA. Geef ze een nummer. (tool1: , tool2: , etc.)

Hoe waardevol waren deze tools/methodes?

	1 (Helemaal niet waardevol)	2	3	4	5 (Heel erg waardevol)
Tool 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

20. Wat was de meest waardevolle tool en waarom?

21. Wat was de minst waardevolle tool en waarom?

22. Wat voor soort tool zou nuttig zijn voor duurzame ondernemers? Wat voor tool heeft u gemist? Waar kan deze bij helpen?

23. Geslacht

- Man
- Vrouw
- Anders

24. Leeftijd

- 12-17 jaar oud
- 18-24 jaar oud
- 25-34 jaar oud
- 35-44 jaar oud
- 45-54 jaar oud
- 55-64 jaar oud
- 65+ jaar oud

25. Wat vond u van deze enquête? Wat had er beter gekund?

Laat uw email adres achter als u graag de resultaten van het onderzoek wilt ontvangen. Als u vragen of opmerking heeft, gelieve een email te sturen naar a.j.uildriks@student.tudelft.nl Bedankt voor het invullen van de vragenlijst!

Sustainable entrepreneurship

This questionnaire is about the development of your sustainability-related startup. The questions help to gain insights in how sustainable startups can be supported better. Your input is valuable for the development of a sustainable entrepreneurship tool, which is created as part of an Industrial Ecology Master thesis research. The focus lies on entrepreneurs who mention sustainability in their mission statement. You can respond to the questions anonymously, and your answers will anyways be anonymized in the report. There is an option to leave contact details at the end of the

questionnaire, if you are interested in hearing more about the project. Or send an email to a.j.uildriks@student.tudelft.nl. Thank you very much for your input!

(25 questions, 5-10 min)

1. What is your startup about?
2. Does your startup have a value proposition? If yes, how would you formulate it?
3. Who are the target customers of your startup?
4. What is your role in the startup?
5. What motivates you as a sustainable entrepreneur?
6. What is the goal you want to reach with your startup?
7. Did you take part in a startup program? If yes, which? And how was it useful?
8. Did you receive funding/investment? If yes, from who or what?
9. What year did you start working on your startup?
 - 2019
 - 2018
 - 2017
 - 2016
 - 2015
 - earlier
10. What year did you have your first customer?
 - 2019
 - 2018
 - 2017
 - 2016
 - 2015
 - earlier
11. What plans do you have for further development of your sustainable startup?
12. What is sustainable entrepreneurship in your words?
13. How are environmental aspects of sustainability incorporated in your startup?
14. How are social aspects of sustainability incorporated in your startup?

15. What difficulties did you face during the development of the startup?
16. How did you overcome these difficulties?
17. What sustainability related difficulties did you face during the development of the startup?
18. How did you overcome these sustainability related difficulties?
19. What tools do or did you use to make decisions in your startup development process? e.g. business model canvas, LCA. Give them a number. (tool1: , tool2: , etc.)

How valuable were the tools?

	1 (Not valuable at all)	2	3	4	5 (Very valuable)
Tool 1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tool 6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

20. What was the most valuable tool and why?
21. What was the least valuable tool and why?
22. What kind of tool would be useful for sustainable entrepreneurs? What kind of tool did you miss?
What could it help with?

23. Gender

- Male
- Female
- Other

24. Age

- 12-17 years old
- 18-24 years old
- 25-34 years old
- 35-44 years old

- 45-54 years old
- 55-64 years old
- 65+ years old

25. What did you think of this questionnaire? What could have been better?

Please leave your email address if you are interested in receiving the outcomes of this research. If you have any questions or remarks, please send an email to a.j.uildriks@student.tudelft.nl Thank you very much for filling in the questionnaire!

Appendix M. Focus Group Script

Focus group took place on : Wednesday June 19, 12.30-14.00, in Delft

To get feedback on the first tool prototype, a focus group session was organized. A focus group is a planned discussion with a group of people. The tool will eventually be used in a startup team, and the focus group approach allows for testing it in a similar context. The setup of the focus group follows Kitzinger (1995), which is a commonly referred to paper on focus groups as a qualitative research method.

A theoretical sampling model was used, which is most common in focus groups, whereby the selection is made to reflect a study population or to test hypotheses. A homogeneous group was recommended because the participants have had similar experiences about which they can share. Therefore, sustainable entrepreneurs and people interested in entrepreneurship and sustainability were selected. The ideal group size is between four and eight participants, for which a sample of six seemed an appropriate group size. The ideal length of the session is between one and two hours, for which a duration of sixty to ninety minutes seemed appropriate.

Group exercises can be used to spark the discussions. The outcome of the exercises then is of lesser importance than the discussion generated. Similar to group exercises, co-reflection can be employed as a structure for the session. Co-reflection (Frow et al., 2015) is a process in which designers collaborate with stakeholders to increase mutual understanding, sharing thoughts and knowledge and defining opportunities for reflection on an artefact in context. As described by Mauser et al. (2013), this is the co-dissemination step, as mentioned previously in ##. The setup of the co-reflection session was based on the approach developed by Tomico et al. (2009), who teaches co-reflection at the Eindhoven University of Technology. The co-reflection session setup consists of three phases:

1. Exploration: *Discuss example cases*

In the first phase, a part of the sustainable entrepreneurship process is reenacted (a case is presented to the participants) and a general conversation is hosted about the

process and related situations (previous experiences of the participants). The practitioner observes and has an open conversation with the stakeholders on the way the sustainable entrepreneurship process is approached.

Goal: to find out how the stakeholders currently approach the early/ideation phase of the sustainable entrepreneurship process in this case, and related situations.

Exploration:

- 3' for this challenge, how would you start ideating towards a sustainable startup value proposition?
Challenge: make households separate waste
- 10' to discuss the similarities and differences with your startup ideation experiences

2. Ideation: *How could sustainable entrepreneurs be supported in developing a sustainable startup idea (value proposition)?*

In this phase, values are related to behaviors. The participants are asked to discuss what sustainable entrepreneurship entails and how the sustainable entrepreneurship process could be improved. They are asked to point out parts of the process which are striking them, either positively or negatively, and what contributes to that.

Goal: to find out what parts of the current approaches to the early/ideation phases of the sustainable entrepreneurship process are good or can be improved, and how this could be supported.

Ideation

- 10' how to support the development of a sustainable startup idea (value proposition)?
 - what is a sustainable startup?
 - how to come up with a sustainable idea (value proposition)?

- what is difficult / easy about the process?
- how can it best be supported? tools/methods?

3. Confrontation: *Relate findings previous phases to the method, and discuss the usability of the method*

In this phase, the method is employed. The experiences are related to the topics raised in the exploration and ideation phases. The potential usability of the method is discussed.

Goal: to get new and fresh insights on whether the method is valuable and how it could be improved to support the sustainable entrepreneurship process more.

Confrontation

- 5' introduction system mapping
- 15' experience system mapping
- 10' reflection
- 5' individual questionnaire

The session was audio-recorded to preserve a record of the proceedings. The audio-recording was transcribed, and subsequently analyzed using the content analysis method. At the end of the session, a brief questionnaire was presented to the research participants so additional private comments could be recorded.

The Focus Group Powerpoint slides



Welcome

- Consent form
- Audio-recording, which will be deleted after being transcribed
- Use quotes (anonymous) in thesis report and presentation

Focus group

- "A focus group is a gathering of deliberately selected people who participate in a planned discussion"
- Sample: 6 people interested in sustainable startups, all having experience with ideation on sustainable startups

Introduction round

- Who are you?
- Experience with sustainability and startups?
- What is a sustainable startup according to you?

Co-reflection approach (Tonks et al., 2009)

- Exploration:
 - 3' to generate ideas in response to challenge
 - 12' to discuss the similarities and differences with your ideation experiences
- Ideation
 - 10' how to support the development of a sustainable startup?
- Confrontation
 - 5' introduction system mapping
 - 15' experience system mapping
 - 10' reflection
 - 5' individual questionnaire

Exploration

- 3' to generate ideas in response to challenge
- 12' to discuss the similarities and differences with your ideation experiences

Challenge: make households separate their waste

- 3 minutes
 - how to generate ideas for this challenge to get to sustainable startup concept?

Trash it right!

Waste sorting guide

♻️ Plastics, Metal cans and Drink cartons

- Plastic bottles
- Drink cartons
- Plastic foil
- Plastic bags
- Plastic cups
- Plastic packaging for food
- Metal containers such as drink cans

♻️ General Waste

- Food remains
- Non-food packaging
- Coffee cups
- Photo paper
- Paper towels
- Pizza boxes
- Hygiene pads
- Combined packaging such as straps and wrap packaging

For more information visit www.plasticrecycling.org.uk/wasteguide
 © National Environment Foundation, 2016

Your experiences idea generation?

1 minute

- What did you just write down?
- How do/did you generate ideas for your own sustainable startup?
- Did you use tools or methods?

Ideation

- 10' discuss how the development of a sustainable startup could be supported
 - what is a sustainable startup?
 - how to come up with a sustainable idea?
 - what is difficult / easy in the process of development?

Confrontation

- 5' introduction system mapping
- 15' experience system mapping
- 10' reflection
- 5' individual questionnaire

Sustainable entrepreneurship

- "is about creating **business models** for sustainable development, with a **holistic triple bottom line** of social, environmental and economic **value creation**"



The Business Model Canvas





Sustainable entrepreneurship

- "Is about creating **business models** for sustainable development, with a **holistic** triple bottom line of social, environmental and economic **value creation**"



Sustainable entrepreneurship

- "Is about creating **business models** for sustainable development, with a **holistic** triple bottom line of social, environmental and economic **value creation**"
- Critique: triple bottom line does not enable holistic estimation/overseeing impacts?
- Holistic: "characterized by the belief that the **parts** of something are intrinsically **interconnected** and explicable only by reference to the **whole**"



Holistic view on sustainability

- **System mapping!**
 - System: elements, connections, a purpose/function
 - Mapping: graphical representation of a structure
- **Donella Meadows:**
 - The Limits to Growth report (1972)
 - Thinking in Systems: A Primer (2008)
- **Omidyar Group**
- **Kumu**





Challenge: make households separate waste

- Formulate a purpose (guiding star): SMART?
- Framing question: "Why is (the system) the way that it is?"
- List the forces (on pos-its) that lead to negative and positive behaviors in the system
 - Cluster them in themes

Sticky notes on a whiteboard illustrating the challenge and methodology. A yellow note says "Purpose: →", another yellow note says "Question: ?". Below them are several smaller sticky notes in green, blue, and orange, representing the forces and themes identified in the system.

Divide over two teams. Choose a theme to focus on

- For the theme, map the causes and effects
 - Try to create loops: interconnectness
- Find a leverage point
 - A possible intervention which risks little effort, with a big potential impact
- Present the leverage idea and how it impacts the system according to your map

A sticky note map on a whiteboard showing a system with various nodes and connections. The nodes are represented by colorful sticky notes (pink, yellow, green, blue) and are connected by orange arrows, forming a network of relationships.

Reflection

- Fill in the individual questionnaire
- Discuss the potential usability of system mapping in the ideation phase of sustainable startup development
- Strengths / Weaknesses?
- How can it be improved?

Thank you for participating!

- Questions? Remarks? Tips/tricks?

development of a tool to support Sustainable Startups

Focus Group 19-06-2019

Logos of PLNT, TU Delft, Universiteit Leiden, and CRISS-FOC.

Appendix P. Focus Group Questionnaire

Individual questionnaire results Focus Group 19-06-2019

What are the strengths of system mapping as a method for developing a sustainable value proposition?	“It’s a cool method, since you have a visual representation of (a part of the) complex problem, which makes it easier to see solutions and the impact of those solutions”
	“You can see the links between different systems and combine values/problems together to come up with better propositions. To be more sustainable”
	“Allows you to find a solution that can really have an impact on the system – through finding the leverage points. Understand your business environment. Visualization”
	“It is a great method at finding the root of the challenge while also finding the most ‘leverageable’ one. Also, it would work great for communication purposes.”
	“Provides simplification, direction, context to approaching the entirety of the system”
	“Allround understanding of sustainability-related consequences on choices + gives ideas/options”
What are the weaknesses of system mapping as a method for developing a sustainable value proposition?	“We ignored the social side of the problem a bit”
	“You look at systems, thus you can miss out on primarily smaller systems which can have a big impact”
	“Can come to wrong conclusions, if assumptions are not tested/double-checked”
	“Without the involvement of a trained facilitator I think it would not be as effective as participants don’t know how it works”
	“We rely a lot on our previous knowledge and preconceptions, so we tend to want to self-satisfy these”
	“Different contributors can have different ideas of the final map because of complexity”
Do you know other methods for overseeing the complexity/interconnectedness of a (sustainability) challenge? Please name them	“Stakeholder mapping?”

	“Context of use, stakeholder mapping, vision in product design”
	“LCA further down the line, else, no”
	“Mindmapping”
	“No sorry”
	“Named in list during session”
Would you use system mapping in future sustainable startup endeavors? Why (not)?	“Yes, not only for sustainability startups. I think it’s a great way to map out any (complex) problem.”
	“Yes! I think it gives insight in stakeholders and values for them.”
	“Yes, but my team members would also need an introduction to it so they don’t do it the way they always do it and use this tool”
	“Yes, I believe so. The ‘fuzzy’ front end can be incredibly difficult and needs to be structures in order to increase success rates”
	“Yes. Useful for explaining/engaging multiple stakeholders in a system and see how they are interconnected”
	“Yes, big overview connecting many different types of factors (values, thoughts, infrastructure, etc)
Do you have any other questions/remarks/feedback?	“☺”
	“Will it be combined with other tools?”
	“Good exercise! Would maybe be valuable to have a sustainability sceptic to push us more. Good luck with the rest!”

Appendix Q. Design Requirements

In the following tables, the design requirements are presented as such that the substantiation per requirement deducted from the research activities is summarized.

DR1 Sustainability system perspective

Literature review:	<ul style="list-style-type: none"> - follows acceptable definition sustainability - covers all relevant issues, oversees the complexity
Interviews experts:	<ul style="list-style-type: none"> - recognizes dynamics situation - recognizes potential rebound effects - enables a system's analysis - considers context
Interviews entrepreneurs:	<ul style="list-style-type: none"> - helps understanding how system works and changes - helps understanding the challenge - helps contributing to sustainability transition - balances environmental, economic and social perspectives - adopts system instead of linear perspective - helps to understand the system's trends and challenges
Survey entrepreneurs:	<ul style="list-style-type: none"> - increases knowledge on how to approach sustainability - provides overview system - helps making concessions, handling trade-offs
Focus group:	<ul style="list-style-type: none"> - provides overview system

DR2 Provides indication potential impacts

Literature review:	<ul style="list-style-type: none"> - helps determining how to increase positive impacts
Interviews experts:	<ul style="list-style-type: none"> - enables determining sustainability impacts - works with data available early in process - indicates whether doing the right things
Interviews entrepreneurs:	<ul style="list-style-type: none"> - helps making a positive impact - indicates whether making a tangible difference - proofs assumptions positive impacts
Survey entrepreneurs:	<ul style="list-style-type: none"> - enables determining the impact of an idea - enables determining how to make positive impact - enables determining environmental and social impacts
Focus group:	<ul style="list-style-type: none"> - helps to determine impacts

DR3 Works towards a feasible business model

Interviews experts:	- a strategic tool for the early phase
Interviews entrepreneurs:	- value proposed more than just sustainability - helps towards economic feasibility - focus on business to increase the impact
Survey entrepreneurs:	- functions as input for the BMC - financial feasibility ideas - helps financing - keeping product affordable
Focus group:	- helps in early stage startup development

DR4 Enables stakeholder engagement

Interviews experts:	- structures approach to involving stakeholders
Interviews entrepreneurs:	- helps to understand the customers drivers - helps determining whether customers are interested
Survey entrepreneurs:	- validate whether there is a market for it - helps communication

DR5 Easy to understand

Interviews experts:	- easy to perform - user friendly
Interviews entrepreneurs:	- uses understandable vocabulary - links to well-known theories

DR6 Time efficient

Interviews experts:	- not taking too much time
Interviews entrepreneurs:	- helps making decisions in limited time - good time/quality ratio - images and little text to save time
Survey entrepreneurs:	- indicates whether worth the time investment

DR7 Helps understanding the challenge

Survey entrepreneurs:	<ul style="list-style-type: none">- helps finding a product-market fit- helps narrow down the challenge- allows for iterations when insights change
-----------------------	---

DR8 Helps comparing sustainability of alternatives

Interviews entrepreneurs:	<ul style="list-style-type: none">- supports making choices, concessions- supports handling trade-offs
Survey entrepreneurs:	<ul style="list-style-type: none">- helps choosing most sustainable materials- helps choosing most sustainable processes

DR9 Robust, scientific, common

Interviews experts:	<ul style="list-style-type: none">- generic, useable among many different startups
Interviews entrepreneurs:	<ul style="list-style-type: none">- reliable

DR10 Accessible

Interviews experts:	<ul style="list-style-type: none">- accessible to the entrepreneurs
Interviews entrepreneurs:	<ul style="list-style-type: none">- affordable

Appendix R. SE Tools/Methods Explanations, References

One-sentence explanations of tool/methods mentioned in research activities, with link to a reference which can be consulted for more information.

Tool/method	One-sentence explanation	Reference
Blue Ocean Strategy	marketing framework to create and capture “blue oceans”: unexplored markets	(https://en.wikipedia.org/wiki/Blue_Ocean_Strategy)
Cash flow mapping	tool to understand the money flows around a business	(https://www.cashflowmapping.com/)
Circularity calculator	tool to understand and increase the circularity of business processes	(http://circularitycalculator.com/)
Circularity index calculator	tool to understand and increase the circularity of business processes	(http://circularitycalculator.com/)
Climate impact forecast	tool to calculate and improve the carbon footprint of a business model	(https://climate.impactforecast.org/about/)
Climate impact forecast	tool to calculate and improve the carbon footprint of a business model	(https://climate.impactforecast.org/about/)
CSR	Corporate Social Responsibility, model for companies to perform self-assessment to perform beyond compliance	(https://en.wikipedia.org/wiki/Corporate_social_responsibility)
Decision making unit (DMU)	group of people helping to make business decisions	(https://www.b2bmarketeters.nl/dmu/)
DPSIR framework	causal framework to describe interactions between society and environment. Driving forces, pressures, states, impacts, responses	(https://en.wikipedia.org/wiki/DPSIR)
Environmental priority strategies (EPS)	environmental impact assessment which can be applied in any LCA	(https://www.lifecyclecenter.se/projects/environmental-priority-strategies-in-product-design-eps/)
Environmental product declaration (EPD)	certification that quantifies the life cycle of products	(https://en.wikipedia.org/wiki/Environmental_product_declaration)
Extended BMC	BMC tool extended to aid searching for new areas of growth by identifying the key technologies and customer needs	(https://wiki.comalatech.com/display/CEX/Extended+Business+Model+Canvas)
Fastener finder	tool which assists finding the correct fasteners for metal sheeting and cladding	(https://www.fixfast.com/fastener-finder)
Grey decision making	tool for identifying and prioritizing improvement actions for company operations	(Golinska et al., 2015)
GRI	Global Reporting Initiative, which is a sustainability reporting framework used by big companies	(https://en.wikipedia.org/wiki/Global_Reporting_Initiative)

Issue tree	graphical breakdown of a question to foster understanding	(https://en.wikipedia.org/wiki/Issue_tree)
Kumu	software to map complex data within a system	(https://www.kumu.io/)
Life cycle of the user	method to understand the customers and their needs and wishes	(https://tcagley.wordpress.com/2018/01/04/life-cycle-of-a-user-story-process/)
Maplecroft	data-driven identification and management of risks for companies' operations, investments and supply chains	(https://www.maplecroft.com/)
MET matrix	analysis tool to evaluate environmental impacts of a product. Materials, Energy and Toxicity	(https://en.wikipedia.org/wiki/MET_Matrix)
Pains&Gains	value proposition canvas: tool to understand customer needs	(https://www.strategyzer.com/canvas/value-proposition-canvas)
Pressure-State-Response (PSR)	framework used for environmental performance monitoring used by big organisations	(http://www.fao.org/3/W4745E/w4745e08.htm)
Process Analysis Method	method to gain understanding of and improve business processes	(https://managementmania.com/en/process-analysis)
Reman design checklist	checklist to assess the remanufacturability of a design	(https://www.rescoms.eu/assets/images/Reman-Design-Checklist.pdf)
Social return on investment	method for measuring value other than financial	(https://en.wikipedia.org/wiki/Social_return_on_investment)
Sourcemap	software to map products supply chains	(https://www.sourcemap.com/)
SWOT	strategic analysis technique to identify strengths, weaknesses, opportunities and threats as part of business planning	(https://en.wikipedia.org/wiki/SWOT_analysis)
System map Noorderwind	tool to map the system	not publicly available
Systemicdesigntoolkit.org	toolkit which helps co-creation towards tackling complex problems	(https://www.systemicdesigntoolkit.org/)
Technology readiness level	method to estimate maturity of technologies	(https://en.wikipedia.org/wiki/Technology_readiness_level)
Total cost of ownership	concept to estimate the financial aspects of a product ((https://en.wikipedia.org/wiki/Total_cost_of_ownership)
Triple layered BMC	tool for sustainability business model innovation. BMC extended to cover the triple bottom line	(Joyce & Paquin, 2016)
Upgrade forecast	tool to forecast technological trends to develop future plans company	(https://www.rescoms.eu/assets/images/Upgrade-Forecast.pdf)
Value network analysis (VNA)	method to visualize and optimize value networks in economic ecosystems	(https://en.wikipedia.org/wiki/Value_network_analysis)
Zotero	tool to manage research	(https://www.zotero.org/)

Appendix S. SSSM Worksheets

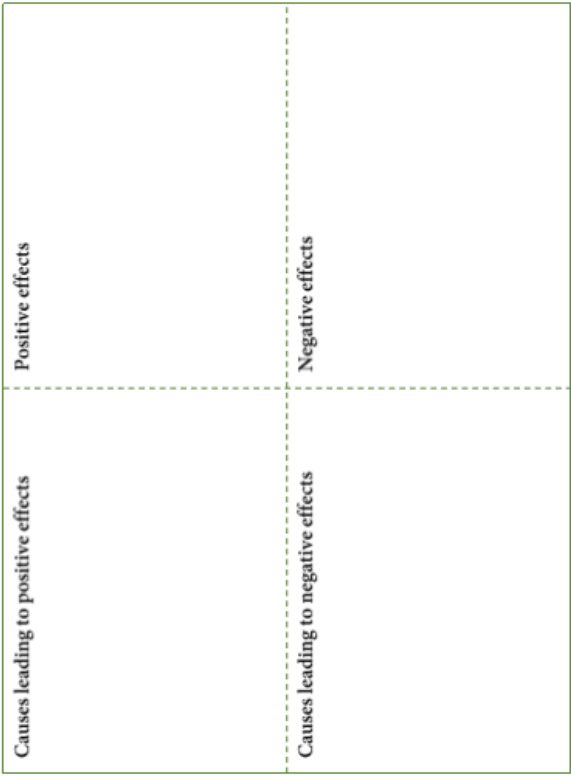
SUSTAINABLE STARTUP SYSTEM MAPPING worksheet 1

These SUSTAINABLE STARTUP SYSTEM MAPPING worksheets have been developed based on Meadows' systems thinking theorem and the systems practice workbook developed by the Omidyar Group. The SSSM worksheets are created to support entrepreneurs in sustainable startup development in the ideating phase. The aim is to provide a method to ideate on sustainable value propositions, by suggesting a way to map how the system works and identify how different value propositions may impact the system. For more information on the underlying theory and for more elaborate instructions, see the thesis report of Anne Uildriks, *Supporting sustainable startup ideation: Participatory development of a tool for student entrepreneurs (2019)*

SMART Purpose Formulate a purpose for the team to work on which is specific, measurable, attainable, relevant, and timely

Framing Question Formulate a framing question relating to the SMART purpose which helps setting the boundaries around the system map
e.g. "Why is [the system] the way that it is?"

Brainstorm on causes and effects Jot down causes and effects on post-its and stick the post-its in the figure below.
Take a picture of the overview before going to the next step



Cluster the post-its in themes Take the post-its from the brainstorm and cluster them in +-6 themes. Discuss among the team.
Take a picture of the overview before going to the next step

SUSTAINABLE STARTUP SYSTEM MAPPING

worksheet 2



Theme map

Divide the team into smaller groups and per group choose a theme. Take the post-its from the theme clustering and map how the causes and effects within that theme relate. Free to add post-its to make the map more complete. Draw arrows between the post-it's to indicate this. Take a picture of the overview before going to the next step

Theme map

Divide the team into smaller groups and per group choose a theme. Take the post-its from the theme clustering and map how the causes and effects within that theme relate. Free to add post-its to make the map more complete. Draw arrows between the post-it's to indicate this. Take a picture of the overview before going to the next step

SUSTAINABLE STARTUP SYSTEM MAPPING

worksheet 3

System Map Link the theme maps to one another to create a map showing how the elements in the system interconnect. Discuss the elements and connections among the team and with stakeholders identified to improve the map.

Sustainable Value Proposition (ideas) Use the system map to identify potential leverage points; points where possible interventions take little effort but have a big positive impact. Write down all value propositions you can come up with in relation to the system map and use the system map to discuss them with stakeholders. Improve the system map and ideas based on the input you get. Use the sustainable value propositions as input for the Business Model Canvas.

