Sustainability assessments of research projects: exploring the case of Sustainability Readiness Level (SRL)

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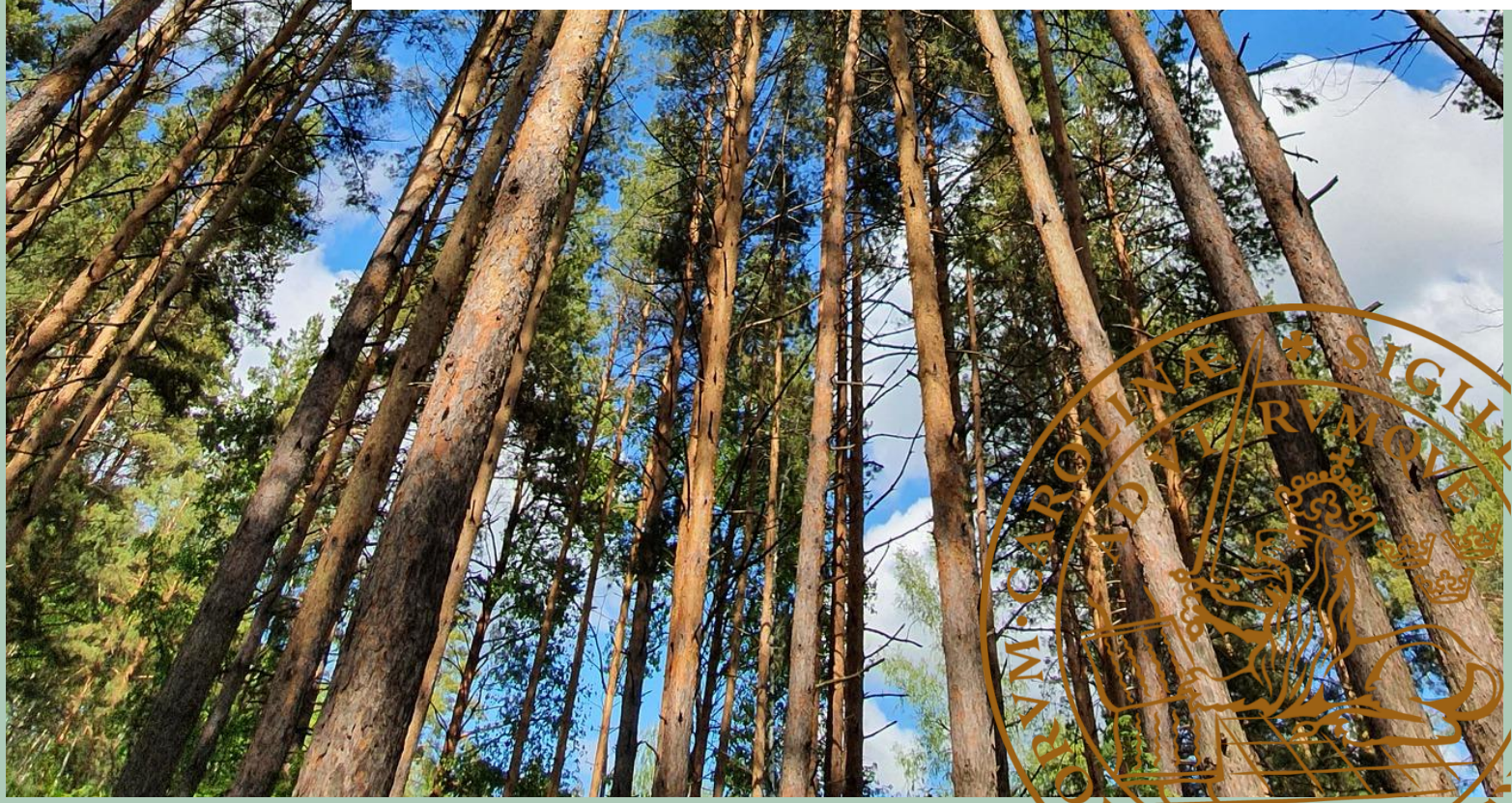

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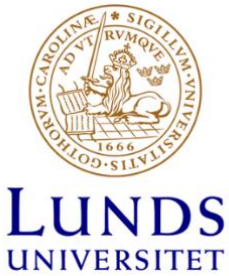

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Abstract

This study explores the cross-section between sustainability assessment and research reviewing- and evaluation at an early development stage of emerging technical solutions´ by conducting a case study on Sustainability Readiness Level, a tool used in the application and reviewing process of the Strategic Innovation Programme (SIP) BioInnovation. The aim of the thesis is to gain a deeper understanding of how sustainability assessments can be integrated into R&D projects and to get an understanding of the perception of SRL among its users (applicants and reviewers). This is done by conducting a qualitative interview study and a literature review. The results show a mixed perception on the effectiveness of SRL, however most of the interviewees perceive SRL as an important tool that to some degree forces the applicants to reflect around sustainability. However, all of the applicants considered SRL to be vague and difficult to understand and use. This can be related to the limited time of implementations, difficulties in interpreting and set boundaries of "sustainability", and to the, sometimes inherent, difficulties with ex ante assessments, such as uncertainties and lack of reliable data. The results indicate that SRL has led to discussions and reflections regarding sustainability issues within the projects and in the grant review process, but it does not seem to have had an effect on the integration of sustainability perspectives' in the project design. Instead, the potential market diffusion and market need (sometimes related to requirements and regulations on national or EU-level) along with a collaborative research form seems to be the main drivers for ensuring a sustainable design of the project's solution. SRL is a tool that answers to the many calls to incorporate sustainability perspectives into research projects applications and grant review, however, in order to fully study the effect and benefits of the tool a broader implementation in different contexts is needed, also in contexts where sustainability is not an explicit focus.

Abbreviations

A-LCA	Anticipatory LCA
EU	European Union
EC	European Commission
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LCSA	Life Cycle Sustainability Assessment
MRL	Market Readiness Level
RRI	Responsible Research and Innovation
R&D	Research and Development
SA	Sustainability Assessment
SDG	Sustainable Development Goals
SIP	Strategic Innovation Programme
SLCA	Social Life Cycle Assessment
SRL	Sustainability Readiness Level
STR	Sustainability Transition Research
STE	Sustainability Transition Experiment
TD	Transdisciplinary Research
TRL	Technology Readiness Level

Table of Contents

1 Introduction

In light of the intensified efforts to transform society towards a more sustainable path by mitigating the emissions of greenhouse gases and adapt society to a changing climate, the interest for effective and sustainability-oriented research has grown (Belcher et.al. 2016; Perez Vico, 2013). The importance of R&D in sustainability transitions is highly acknowledged, not only for its creation of new knowledge and solutions but also for creating "protected spaces" for the development of disruptive innovations, for the formation and strengthening of networks of actors and for its potential influence on policy and resource mobilization (Geels, 2006; Luederitz et al, 2017; Jacobsson & Bergek, 2011). Furthermore, there is a growing pressure to show accountability (Geuna & Martin, 2003; Benner & Sandström, 2000) and societal benefit in the public funding for R&D (Martin, 2011; Bornmann, 2013). However, R&D management by its very nature is characterized by uncertainty and brings several challenges to light, such as considerations on the balance between risk and return; of long- and short-term projects and of incremental vs disruptive projects (Doctor et al, 2001).

Emerging technologies and innovations are often promoted on the promise of bringing solutions to tackle the challenges of sustainability (Fichter & Clausen, 2016; Markard et al., 2012). The commercialization of emerging "green technologies" are for some seen as "essential to improve the sustainability of industrial processes" (Tan et al, 2019). However, as described by Tan et al (2019, p. 7) "decision-makers in industry and government invariably face the challenge of allocating limited financial resources to support competing (or complementary) projects intended to develop new innovations in renewable and sustainable energy technologies." There are ways of analyzing the potential impact of emerging technologies, products or processes in terms of its potential diffusion, environmental impact etc. However, this is often very time-consuming and complex. Furthermore, the guidelines and criterions used by funders for the project selection are often vague or "supposedly clear to everyone" (Hug & Aeschbach, 2020, p. 2). Technology Readiness Level (TRL) is a well-established scale for assessing the technological maturity of technologies, originally developed in the 1970s by NASA (Mankins, 2009). The method has undergone various mutations and is currently being used as a policy tool in the EU for certain EU-funded proposals. Within the EU, the scale has been interpreted as a metric for a product's readiness to be marketed (Héder, 2017). There have been several calls for

complementary methods focusing on aspects other than technological maturity for a deeper understanding of the potential of innovations, such as "System Readiness Level"[1] and readiness levels targeting market potential and sustainability (Sauser et al, 2006; Lettner, 2018).

In order to transition towards a sustainable paradigm, not dependent on fossil fuels, calls for a "bio-based economy" and "bio-economy" has been made. These terms refer to the economic shift towards "productive […] use of biomass and biomass conversions" (Staffas et al, 2013). As a way to accelerate the deployment of a sustainable economy, addressing the societal challenges of climate change and sustainable production and consumption, several stakeholders have worked for a mobilization of research and development (R&D) and innovations in the field of bio-based sectors (see e.g. the European Commission, 2018). One of the initiatives for the development of a bio-based economy through research and innovation is the Strategic Innovation Programme BioInnovation, funded by Vinnova, Formas and the Swedish Energy Agency. BioInnovation has integrated TRL in their application guide, along with the concepts "Market Readiness level" (MRL) and "Sustainability Readiness Level" (SRL). SRL seeks to integrate sustainability as a key aspect included in the project application and appraisal. Apart from being a concept for understanding the maturity with regards to sustainability, SRL also aims at fostering, and steering towards, the operationalization of a sustainable research results (Personal contact, 2020). The concept was created in order to balance the focus with that of TRL, acknowledging the importance of sustainability aspects for the diffusion of research results. The purpose of these aspects, MRL, SRL and TRL in the funding application process, is to foster and improve the diffusion of sustainable research results (BioInnovation, 2019a) and to get a further understanding of the expected result of the research projects (Personal contact, 2020). This is done by the communication of the current stage in the scale and the expected advancement between the levels. SRL is a newly developed concept, implemented in 2019, and little is known about the use and interpretation of the measure. In a context where the necessity for research and development to tackle the challenges facing society and the importance of sustainability assessments are widely acknowledged (Pope et al, 2017), SRL is an interesting case to study.

[1] The abbreviation "SRL" in this thesis refers to "Sustanability Readiness Level" and not "System Readiness Level".

1.1 Problem definition

The overall aim of this thesis is to contribute to the understanding of sustainability assessments of R&D projects and sustainability criteria by exploring by exploring the case of SRL, focusing on the perception of SRL among its users (applicants and reviewers). Understanding how grants applications are reviewed, as well as how applicants interpret the frameworks in which they operate, is important for several reasons, e.g. in order to improve transparency, quality, and legitimacy of grant allocation practices (van Arensbergen et al, 2014). There are several notions on the benefits of a structured grant application process. Examples of these are the recommendation of standardized criterions to make the application process more efficient, less burdensome and more reliable (Hug & Aeschbach, 2020; OECD, 2018; Abdoul et al., 2012). Furthermore, criterions also have the ability to show directionality of the funder for both applicants and reviewers. As explained by Hug & Aeschbach (2020, p. 2) criterions are often either vague and therefore difficult to articulate and understand or "supposedly clear to everyone". This accentuates a need to provide clear and direct requirements in the application and appraisal process. Furthermore, as the communication of sustainability aspects at an early stage might increase the chances of investing in sustainable solutions and products, there is a need for clear and understandable criterions/requirements for the integration of sustainability perspectives in the appraisal process.

As SRL is a newly developed concept introduced in 2019, an assessment of the effects of SRL is not possible. Aspects such as the potential effect on the project portfolio are therefore not considered within the frames of this thesis. Instead, focus will be on the perception of SRL by its users; grant reviewers and applicants. This might lead to valuable information on sustainability in the review process and for the potential development of the concept. In order to contextualize SRL, a literature review on sustainability assessments in the early stages of development will be included.

Research question (RQ)1:

> What is the current level of scholarly knowledge on sustainability assessment in the early stages of research?

Research question (RQ)2:

> How has SRL affected the application and evaluation process?

Sub question 1: How is SRL interpreted and used by researchers/project managers in the funding application and in the formative stage of the research project?

Sub question 2: How has SRL been interpreted and used as a criterion for appraisal by the reviewers in the decision-making process?

1.2 Scope and limitations

As already mentioned, it is not possible to perform an evaluation of the effect of SRL, due to a limited time since implementation. Thus, the available data is limited, and some insights in SRL might not appear at this stage. Therefore, this thesis takes a qualitative approach in order to answer the research questions, which can affect the generalizability of the results. The aim of the study is not to generalize, but to understand user's (both applicants and reviewers) experiences working with SRL. Furthermore, the thesis will focus on literature of R&D on a project level and in a European context. As the BioInnovation mainly focuses on technical solutions and research, this will be the primary focus. Thus, research on evaluation of transdisciplinary research and similar will not be included.

1.3 Ethical considerations

The interviews have been carried out with a mutual agreement of how the data will be used. A verbal affirmation on the consent to record the interviews were obtained from each participant. They were also informed that they at any moment could cancel their participation in the study. Furthermore, the participants were briefed on the purpose of the study. The topic of confidentiality was also discussed. As the study treats public funding and project selection tools, it was decided beforehand that the names of the participants were going to be anonymized. This was also due to the fact that there are dynamics of dependency, especially in the case of applicants, who are dependent on the funding of BioInnovation. This is however partly eased by the fact that the funding decisions are not taken within the programme, but by Vinnova and their external reviewers. Due to the above-mentioned dependency and the desire to get as honest and candid answers as possible, as well as for the comfort of the participants, it was decided that the interviewees associations would not be named. Instead, a brief description of their positions and association/employers are formulated in general terms.

2. Case context

2.1 The Swedish research- and innovation landscape & the Strategic Innovation Programs

Sweden has a long tradition of being an innovation country and invests over three per cent of its GDP in R&D, one percent being public investments (Ministry of Education and research, 2019). This places Sweden at the top of the rankings for investment in R&D internationally (Vetenskapsrådet, 2018).There has been a shift in innovation policy the past 50 years, from a linear model prioritizing technological discovery and developments towards a paradigm of technological, scientific and innovative mobilization for meeting societal needs and challenges (Schot & Steinmueller, 2018). This can be articulated by the Swedish innovation landscape, which currently places strong emphasis on system-wide transformation.

Every four years the Government´s policy for research and innovation is set out, which states the direction of development, the latest being, "Knowledge in collaboration – for society´s challenges and strengthened competitiveness" (2017-2020). The bill outlines the current priorities in the Swedish R&D landscape, as well as the 10-year goals. The main objective is for Sweden to be "*one of the world's foremost research and innovation countries and a leading knowledge nation, where high-quality research, higher education and innovation promote the development and wellbeing of society, enhance the competitiveness of the business sector, and respond to the challenges facing society in Sweden and globally"* (Ibid, p. 3). Prioritized challenges are climate change and environment, health, digitalization, a sustainable society and improved results in the school and educational system. A recurring theme in the Swedish research bill as well as the Innovation Strategy is that of collaboration between actors and sectors in facing societal challenges. The Innovation Strategy states that: "*societal challenges faced by Sweden, together with the rest of the world, are big and complex in nature. Therefore, no single actor or area of society has sufficient knowledge or resources to meet these challenges on their own. It is important to further develop coordination between different actors in order to create the best conditions possible for innovation."* (Swedish Ministry of Enterprise, Energy and Communications, 2012). This can be related to the approach sometimes referred to as the "Triple Helix model of Innovation." The Triple Helix is a concept of innovation systems

that suggests that a set of interactions between academia, industry and the public sector is required for the achievement of socio-economic development (Galvao et al, 2019). The innovation model serves as a "universal model for the development of a knowledge-based society, through innovation and entrepreneurship" (Etzkowitz & Zhou, 2017, p. preface). Some even describe co-production of knowledge between the scientific community and other societal actors as a pre-requisite for "research aiming at more sustainable development paths", for a balance between "scientific and other forms of knowledge" (Pohl et al, 2010, p. 267).

The initiative of strategic research and innovation agendas (SIAs) that ran between 2012 to 2016 laid the foundation of the Strategic Innovation Programmes (Sweco, n.d). The agendas were created by stakeholders (such as the academia, research industries, the public sector, SMEs, research institutes, trade associations and large companies) within different societal relevant areas/fields (Vinnova, 2018). The initiative resulted in 136 agendas (Sweco, n.d.), covering a broad spectrum of innovation areas (Vinnova, 2020a). A number of agendas resulted in the Strategic Innovation Programs, SIPs (Sweco, n.d). There are currently 17 SIPs, financed by Vinnova, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) and the Swedish Energy Agency (Vinnova, 2018). The SIPs target system-wide transformations and seeks to build a foundation for sustainable solutions to global challenges and increase international competitiveness through collaboration (Formas, 2019). The programs can be seen as umbrellas for companies, higher education institutions and organizations for the development the sustainable products and services (Vinnova, 2020a).

2.2 BioInnovation

The use of biological resources is increasingly being suggested to play a central role in meeting the global challenges such as the depletion of fossil resources, a growing population, environmental protection and climate change (Efken et al, 2016). There are several definitions of bio-based economies, or bio-economies depending on context, sector and geography. However, a key feature is "the sustainable use of biological resources building on a wide range of modern technologies" (Viaggi, 2020, p. 3). Sweden has developed a strategy for innovation and research for a bio-based economy, which has been published by Formas and Vinnova. In the strategy a definition is provided, that can be separated into two main parts:

- "A sustainable production of biomass to enable increased use within a number of different sectors of society. The objective is to reduce climate effects and the use of fossil- based raw materials.
- An increased added value for biomass materials, concomitant with a reduction in energy consumption and recovery of nutrients and energy as additional end products. The objective is to optimize the value and contribution of ecosystem services to the economy." (Formas, 2012)

The aim of BioInnovation is to support a transition to a bio-based economy by 2050 and is based on the strategic innovation agenda "A bio-based economy" (Vinnova, 2020b). Emphasis is on "collaboration across industry boundaries, primarily within the forestry, chemistry and textile industries" (Ibid). The work of BioInnovation targets three main sectors; Chemicals and energy, materials and construction and design (BioInnovation, 2019a). According to BioInnovation, an increased resource effective utilization of renewable material and a decreased utilization of fossil resources is necessary for a sustainable societal development (BioInnovation, 2019b). BioInnovation is operationalized by a consortium with organizations from industry, academia and public sector. Stakeholders are given the opportunity to take part of the work of the organization on different levels, such as contributing in a project as well as form part of the General Assembly, which is the highest decision-making organ. Furthermore, the organization consists of a strategic board for the decision making on the strategic projects, calls for project applications, project accounting etc. (BioInnovation, 2020a). The programme office handles the daily work of the organization, such as planning and preparation of proposal calls, projects, information and strategic operations.

There have been some research done on BioInnovation, for example a study by Grillisch et al (2019), which studies BioInnovation and the SIP Re:Source from a systems-transformation perspective. The study suggests some challenges related to the requirement of the Triple Helix composition in the SIPs, as "the variety of stakeholders included in the programme and project applications substantially decreases in the implementation process" (Grillitsch et al, 2019, p. 1055). Furthermore, problems related to conflicts of interest, due to the lack of governance capabilities, are articulated. The study for example analyses the demand articulation of the SIPs and highlights the fact that BioInnovation has launched a call for projects specifically on bio-based innovation and public procurement as a response to the challenges related to developing innovation procurement capabilities in public bodies. This shows an adaptiveness with regards to the calls for projects, in relation to the challenges faced. The study highlights the uncertainties related to market relevance as a key challenge for BioInnovation, which can be related to users lack of knowledge of bio-based products (Grillitsch, 2019). This has made user-producer interactions a priority for the programme, making it unlikely for

projects that do not involve users to receive funding. A consequence of this, according to the study, is that more radical projects without a stable user base are also unlikely to receive funding.

The SIPs are evaluated very third year. The latest evaluation, from 2017, states that the BioInnovation has demonstrated an ability to contribute to the collaboration between different stakeholders, and that they are making sure that the agenda is updated. One of the weaknesses stated in the evaluation is thus that the ambition of the programme is broad, which can make the initiatives seem fragmented. Furthermore, it is stated that BioInnovation has not clearly identified the obstacles related to the transition towards a bio-based economy (Gröning et al, 2017).

2.3 BioInnovations application guide, Sustainability Readiness Level (SRL) and Vinnovas assessment criterions

In the application guide for project funding, BioInnovation describes the main aim of their programme; to strengthen the Swedish competitiveness and to contribute to the transition towards a circular bio-based economy. The application guide is directed towards applicants and external reviewers and serves to define central concepts and propose "tools for describing applications' ambition regarding technology, market and sustainability." The projects financed by BioInnovation are directed towards the development of bio-based products, materials and chemicals and three key aspects are laid out that the applicant needs to communicate and pay attention to. These are: technology, market and sustainability. These aspects are manifested and ranked by the scales TRL, MRL and SRL, the two latter being BioInnovations own scales of sustainability and market. TRL is a well-known method of ranking the technological maturity of an innovation, and the definition used is developed by the European Commission (See TRL and MRL in Appendix). BioInnovations aim of TRL is to state "what specific technology and associated technical maturity level are the project's starting point, and to state what TRL gap that the project will bridge" (BioInnovation, 2019a). The aim of MRL is to state "what market hypotheses with economical perspectives are the project's starting point, and to state what MRL gap that the project will bridge." Finally, SRL is used for the understanding of how the project results can contribute to a more sustainable society, from a "Sustainability Value Proposition". The aim of using SRL is state "how the project's market hypotheses relate to environmental and social perspectives, and to state what SRL gap that the project will bridge." See table 1 for an illustration of SRL.

Table 1 SRL (BioInnovation, 2019a)

SRL	Understanding of market and customers from a Sustainability Value Perspective
SRL1	• There is a hypothesis on how the solution/product contributes to increased sustainability in relation to existing solutions/products exist • A general analysis has been carried out from a sustainability perspective

SRL2	• Critical functions for a solution/product have been delivered and tested on potential customers, which provides a concrete basis for the quantification of how these contribute to increased sustainability. • A more detailed analysis has been carried out from a sustainability perspective.
SRL3	• Key partnerships and customers that confirm unique properties and functions have been established • Product testing or test sales are ongoing • A comprehensive systems analysis has been carried out from a sustainability perspective.

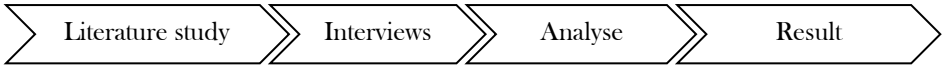
Projects funded by BioInnovation should be stating their current TRL, MRL and SRL. However, some requirements and reviewing process can vary between different calls. Therefore, it is stated in the application guide that the call text has to be thoroughly read. BioInnovation has two main categories of calls: hypothesis testing, which are "*smaller research and innovation projects covering radical and innovative issues*" (Vinnova, 2019a) and thematic projects (BioInnovation, 2020b). In the last calls, it has been stated that the applications need to describe the **current** TRL, MRL and SRL and a movement within at **least one** of the scales (Vinnova 2019b; Vinnova 2019c; Vinnova 2019d).

The projects are primarily reviewed on the following three criteria of Vinnova, in which TRL, MRL and SRL are integrated into: *potential*, "what effects and what value we can expect from the project, and what significance it will have for society if the project achieves its goals", *actors*, which is defined as "the participants' ability to run the project, and achieve desired results and effects" as well as *feasibility*, "how realistic and credible the project plan is, both to implement the project and to achieve desired results" (Vinnova, 2019e). The application of these criterions also varies between different calls. For example, in the case of "Hypothesis testing 1" the assessment criteria *potential* is valued higher than the other assessment criterions (Vinnova, 2019a). Vinnova typically use external reviewers that are knowledgeable within the specific field for the assessment of the applications. The reviewers go through and review the applications separately, before having a review meeting with the other reviewers and the programme managers at Vinnova, where the applications are discussed and the reviewers can leave their recommendations (Vinnova, 2019e). In the call category "hypothesis testing step 1" review **meetings** are not part of the review process (Personal contact, 2020).

3. Methodology and research design

This chapter will describe the methodological approaches and techniques used for data collection and for the analyzing the results. Furthermore, a theoretical framework will be presented, that will guide the questions in the interviews and discussed in relation to the results. The data collection can be divided into two main steps. The initial part will be conducted by doing a **literature review** of the theoretical and methodological aspects on research assessment, early-stage sustainability assessments and grant peer reviewing. This will be done to get an overview of current advancements and confirmed problems with different assessment methods, and answers to RQ1. For answering RQ2 a qualitative **case study** approach was selected, and 8 interviews were conducted with the users of SRL. Qualitative interviews as a research method is recognized as a technique suitable in order to get in-depth information in a specific case and for capturing the perspectives and experiences of the participants of the study in regard to a specific phenomenon (Yin, 2016). Furthermore, it is suitable for answering a "how"-question (Kvale & Brinkmann, 2009). As one of the main questions for this thesis is "how" SRL is the perceived by its users, the qualitative interview was regarded the most appropriate method for the case study. In some cases, quantitative methods are used for studying participants perceptions and understandings of specific questions through different forms of questionnaires. This method however requires a larger number of participants in order to create valid and generalizable results and was therefore not considered for this thesis. Furthermore, qualitative methods are deemed more suitable in studies where the aim is to get a deeper understanding of persons subjective experiences and understandings (Yin, 2016). It has also been proven that qualitative methods often can catch information "between" the questions compared to questionnaires with rating scales (Ibid).

Figur 1 Research process design



3.1 Literature review

The literature review was conducted in order to get a scientific overview of the different research streams connected to the research questions. The included literature consists of peer-reviewed articles and books. The literature has been found using the search bases Webofscience and LUBsearch. The result of the literature review is structured in thematical clusters. This is done in order to simplify for the reader; however, these subtopics are sometimes interconnected.

As the field of sustainability assessments and research review/evaluation encompass a large amount of literature, stemming from a vast amount of research fields, and due to limited time, a systematic literature was not conducted. Instead, a traditional narrative approach was used. Bryman (2012) describes the narrative review as a comprehensive assessment conducted by critical reading. The literature review can be divided into several steps. Firstly, the key concepts and difficulties with ex ante research evaluation was explored, as well as the difficulty's with early stage LCAs. Thereafter, research on TRL and similar approaches are explored, as well as methods of sustainability assessment linked with different TRL stages. Search terms included e.g. Early-stage sustainability assessment, Readiness Level, peer review process.

3.2. Guiding discussions for the selection of the case study

Two informing dialogues were conducted in the formulation of the study, with representatives from two of the main research funding agencies in Sweden, Vinnova and Formas. The aim of the conversations was to get perspectives on possible ways for narrowing the thesis, which at that time only had a general aim and interest (ex-ante sustainability-oriented assessment of research projects). The informants both recommended to try to find a case study for the concretization of the thesis and the representative from Vinnova suggested to look at BioInnovation and their use of SRL. Furthermore, a dialogue was established with the programme officer of Vinnova and with key actors at BioInnovation. This was done in order to get more information on SRL (such as the motives behind the development of SRL, implementation time etc.) and to discuss the possibilities in regard to the available data.

3.3 Methodology for the interview study

The following sections explains the methodological approach of the interview study.

3.3.1 Data collection, interviews

A set of pre-determined questions were used in the interviews in order to create a common frame for facilitating a comparison of the results. The questions were inspired by a typology of "effectiveness" found in literature (see section 4.2). However, the interviews can be considered semi-structured in the sense that the format was open for follow-up questions. The interviewees also had the opportunity to share ideas and reflections, leaving the interview more "dialogue"-like. Semi-structured interviews are considered suitable in studies where there is a need for flexibility and a value in understanding how the issues are addressed by the interviewee (Dunn, 2005).

3.3.2 Interviewees

Interviews were carried out with researchers using SRL in their project application and with reviewers/referees judging the applications. For the purpose of this study, the persons interviewed in this thesis will be interchangeable referred to as participants, informants or interviewees. Furthermore, the participants working with reviewing the grant applications are referred to as reviewers (R), and the participants that have used SRL as part of an application are referred to as applicants (A), not taking into account whether or not they have received funding. The applicants were identified by a desktop search on BioInnovations website (BioInnovation, 2020c), whereas the reviewers were mediated by BioInnovations programme manager at Vinnova.

All of the applicants have applied at least one time, and some several. The reviewers have experience with reviewing projects for Vinnova for a couple years each. Due to difficulties in finding reviewers to interview, a programme manager at Vinnova was also interviewed. As the programme managers often are participating at the reviewers´ meetings and are part of integrating the requests of their programme (in this case BioInnovation) into the review process, it has been assumed that the program manager has a deep knowledge in how SRL is used in the review process and perceived by the reviewers. Therefore, the programme manager constitutes a part of the reviewers and is also referred to under the group (R) in the result.

The interviewees are presented in the chart below. In order to protect the confidentiality of the users, the participants names are anonymized, as well as the names of their respective organization/association.

Table 2 List of the interviewees

Interviewees					
Reviewer (R) Applicant (A)[2]	**Relevance to thesis**	**Short description of job/position and main field of expertise**	**Has applied for funding, or reviewed calls, within call for proposal…**	**Date of interview, mode**	**M /F**
R	Reviewer	Reviewer for Vinnova and Formas. Long experience working in industry and with industrial research and development.	Hypothesis testing projects	16th June 2020, via Teams	F
	Reviewer	Reviewer for Vinnova. Long experience working in industry and with industrial research and development.	Hypothesis testing projects and thematic projects	18th of June 2020, per telephone	M
	Programme manager	Programme manager at Vinnova working with BioInnovation.	Has been participating in review meetings for many different calls of proposals.	30th of June 2020, via Teams	F

[2] Names are excluded to protect the participants confidentiality.

A	Scientist and project manager	Currently employed at a university with a focus on wood quality and protection.	Hypothesis testing and thematic project	18th of June 2020, via Teams	M
	Scientist	Currently working at a research institute, mainly with wood durability and protection.	Hypothesis testing	23rd of June 2020, via Teams	M
	Scientists	Currently working at a research institute, with the main focus being wood-based materials and products.	Hypothesis testing (step 2)	2nd of July 2020, via Teams	F
	Project manager	Working at a research and development-oriented private firm.	Hypothesis testing	2nd of July 2020, via Teams	M
	Scientist and project manager	Currently working at a technically driven research-organization with strong connections to a university. Main research focus is biopolymers.	Thematic project and hypothesis testing	4th of August 2020, via Teams	F

3.3.3 Coding, transcription and thematization of the results

The interview data was then transcribed, coded and analyzed in accordance with a three-step model proposed by Hjerm et al (2014) for the analyze of qualitative data. The first step includes the reduction of data through coding. Coding allows the researcher to organize the material through words, phrases or paragraphs and are developed throughout the study. The second step includes a presentation of the material through a thematization. The thematization includes the organization of codes in order to structure the analyze form a set of key themes. The thematization can be seen as "coding" the codes and themes are to be re-occurring in the material as well as central to the study. The third step includes a summarization of the occurring themes relevant for the aims and purposes of the study, which forms a compilation of the research results. This compilation presents the main results of the study, which are not necessarily the same as the codes.

4. Analytical Framework

The questions in the interview guide were based on a set of common issues discussed in the literature on the effectiveness of sustainability assessments (SA) presented by Bond et al, 2012. Furthermore, the themes presented in this section are also discussed in section 5.2 of the discussion of the results. Before presenting the categories of SA effectiveness, the concept of sustainability assessment is presented briefly (section 4.1). Thereafter, a typology of "effectiveness" of sustainability assessments are presented, along with an explanation of how this is used and interpreted in this thesis (section 4.2). The use of the conceptualization of effectiveness in SA practices serves to capture different aspects and dimensions of the perceived effectiveness of SRL among its users. The reasoning of the thesis should however be considered abductive, i.e. not inductive nor deductive. This is much due to the fact that SRL is a new concept, and existing theoretical frameworks is not easily applied. By integrating different perspectives and angles to the effectiveness of SRL, the aim is to get an overview of the users' general approach to SRL and the perceived effect of using SRL. The aim is thus not to answer to whether or not SRL is "effective", as this would require more data. Furthermore, an important note is that SRL not should be seen as a sustainability assessment *per se*, but a practice of incorporating sustainability assessments into the projects and the appraisal- and application process.

4.1 Conceptualizing sustainability and sustainability assessments (SA)

The need for individuals, organizations and societies to find tools for articulating the extent to which, and the ways in which, activities are sustainable is widely recognized (Bebbington et al, 2007). "Sustainability assessments" (SA) can be conceptualized as a tool that can help decision-makers and policy-makers "decide what actions they should and should not take in an attempt to make society more sustainable" (Devuyst, 2001, p. 9) and have been recognized to be the new generation of environmental assessments and the "third generation of impact assessment" (Sadler, 1999). It is a concept explaining *"any process that directs decision-making towards sustainability"* (Bond et al, 2011) and can essentially be explained as a tool for decision-making to identify what actions can contribute to a more sustainable society by evaluating the impact of a proposed solution, technology, product etc. This includes both short- and long-term perspectives. (Lettner et al, 2018; Singh et al, 2012).

The concept of sustainability is the foundation upon which the sustainability assessment is built upon. This contributes to the difficulties of sustainability

assessments in general, as there are several theoretical formulations have been proposed of the what sustainability is, and should be (Pope et al, 2004). Sustainable development was first conceptualized by the Brundtland Commission in 1987 as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED, 1987). This is the most widely accepted and adopted definition of sustainable development. Since then, several definitions have been proposed, such as the Triple-Bottom-Line (TBL). This definition bases sustainability upon three main pillars: social, environmental and economic, and typically regard these as equally important. One of the most common notions on the TBL-concept is the need for integration between the pillars, as "the combined impacts, positive and negative, of the sets of measures as a whole, are likely to be more than the simple sum of the impacts of their constituent measures because of synergistic effects" (Lee & Kirkpatrick, 2001). If the pillars are not integrated, the sustainability assessment is reduced to separate assessments, which raises one of the main critiques against TBL: the possible trade-offs between the categories (Pope et al, 2004).

As stated by Pope et al (2004) there is a strong belief in literature that environmental assessments are important for the development towards sustainability. Gibson (2001) for example states that "environmental assessment processes…are among the most promising venues for application of sustainability-based criteria". Furthermore, it is argued that sustainability assessments should draw attention to otherwise neglected considerations, such as social aspects (Pope et al, 2004). Thus, it is highly suggested within literature that in order to assess sustainability, the three pillars of sustainability should be included. Hacking & Guthrie conceptualizes sustainability assessments with three characteristics; i) TBL-approach, ii) integratedness between the pillars and methods used, and iii) a strategic focus on the support of decision-making.

4.2 Effectiveness and Sustainability assessments (SA)

Sustainability assessments can be interpreted and used in a variety of ways depending on context, actors and aim of the assessment (Morrison-Saunders & Pope, 2013). Therefore, there is no clear definition of what an "ideal" SA entails. Bond et al. (2013) conceptualizes the effectiveness of sustainability assessment practices and defines four levels of SA effectiveness. These are: procedural effectiveness, substantive effectiveness, transactive effectiveness and normative effectiveness. The categories reflect the diversity of functions a sustainability assessment can have. As seen in the background (section 2.3) SRL seeks to integrate sustainability assessments into the projects. Thus, the applicants need to include sustainability perspectives into the application and the projects. Due to the meta-level of SRL, the tool should not be considered to be a sustainability

assessment method, but a tool to integrate SA into the projects. However, the typology of effectiveness by Bond et al (2013) is still considered to be useful in order to understand the practices of SRL and the perceived effect of the tool in the appraisal process and in the applications and projects.

Table 3 SA effectiveness, adopted from Bond et al, 2013

Effectiveness category	Key question
Procedural effectiveness	Have appropriate processes been followed that reflect institutional and professional standards and procedures?
Substantive effectiveness	In what ways, and to what extent, does the sustainability assessment lead to changes in process, actions or outcomes?
Transactive effectiveness	To what extent is the practice considered to be worth the time and cost by those involved?
Normative effectiveness[3]	In what ways, and to what extent, do the involved actors modify their perspectives on sustainability and adjust their policy choices during the sustainability assessment process?

For the purpose of this thesis, **procedural effectiveness** is interpreted as whether the level of describing SRL has been appropriate (thus, directed towards the reviewers). **Substantive effectiveness** is directed towards understanding whether or not the users perceived that SRL has affected actions and outcomes. **Transactive effectiveness** seeks to understand if the users found the use of SRL worth the time and efforts and the **normative effectiveness** is in this thesis directed at understanding the interpretation of sustainability in SRL; what perspectives does the users integrate? The integration of these guiding understandings of "effectiveness" should not confuse the aim of this thesis, which it to get a deeper understanding of the perception of SRL among its users, and not to determine whether SRL has been effective or not. See Appendix1&2 for the interview questions.

[3] This interpretation of normative effectiveness is inspired by Hugé, 2015.

5. Results

5.1 Synthesis of Literature review

The review is structured into 6 clusters, each outlined in Subchapters 4.1.1-4.1.6. The literature on research evaluation is manifold and rather intangible (specifically addressed in 4.1.2), with a wide range of "best practices" and tensions among different fields.

5.1.1 An introduction to research evaluation and research impact

The scope of research evaluations has broadened since the 1990s (Martin, 2011; Bornmann, 2012). From mainly focusing on scientific impacts within academia, e.g. by bibliometric analyses (citation rates etc.), more attention has been directed towards also including "societal products (outputs), societal use (societal references), and societal benefits (changes in society)" (Bornmann, 2012) while assessing research. Funders also increasingly expect the research they finance to have a societal impact, thus often including it in evaluation procedures (de Jong & Muhonen, 2020). The definitions and praxis of the word's "impact", "output" and "outcome" vary, however, as Bornmann (2012) establishes, most studies on research impact are concerned with "the assessment of social, cultural, environmental, and economic returns (impact and effects) from results (research output) or products (research outcome) of publicly funded research" (Bornmann, 2012, p. 217). "Impact" is therefore understood as returns of the research results, which can be described as effects or changes in the social, cultural, environmental and economic domains.

The concept of responsible research and innovation (RRI) capsules the European Union's anticipation of R&D to be aligned with societal priorities and foster sustainable research and innovation (Genus & Stirling, 2018) and is used by e.g. the framework programs (such as Horizon 2020) to describe the fact that they take potential impacts of their research into account (European Commission, nd). In funding Horizon2020, the European Commission includes "impact" as one of the

three criteria by which research proposals are evaluated and scored by the reviewers; Excellence, Impact and Quality and efficiency of the implementation. All of the proposals for financial requests are evaluated under these criteria, however there are often variations in what aspects are included. E.g. all innovation activities are given extra weight under "Impact" (European Commission, 2015).

Several scholars have tried to conceptualize "useful" knowledge development. For example, there are calls for e g "knowledge co-production", transdisciplinary & experimental research. Some even describe co-production of knowledge between the scientific community and other societal actors as a pre-requisite for "research aiming at more sustainable development paths", for a balance between "scientific and other forms of knowledge" (Pohl et al, 2010, p. 267).

5.1.2 The complexity of research evaluation

There are several methodological and conceptual challenges related to the evaluation of research. This section serves to give a short overview of the main problems of research evaluation found while conducting the literature review. Methods of demonstrating the benefits of R&D includes ex post evaluations, where benefits are demonstrated for R&D that has already been carried out, or ex ante, which involves an assessment of the future benefits of R&D (Mas & Liket, 2011). Furthermore, quantitative research is more likely to bring measurable result and forecastings, although it might be a difficult task to quantify at an early development stage (see section 4.1.3)

As mentioned earlier, the implication of the eagerness to evaluate the penetration of research results in society is a pressure to translate research results into something measurable. As the results of research projects vary immensely, there is a need to capture a large amount of, not necessarily measurable results. Furthermore, there is not always a need nor aim for commercialization of results. To find standardized (quantifiable or qualitative) indicators as to the success of a research project is therefore very hard, if not impossible. This can be particularly challenging in combination with the ambition to encourage innovation (Belcher et al, 2016).

Time lag. One of the main problems recurring in the literature is the aspect of time lag (see eg Penfield et al, 2014; Bell et al, 2011. As Perez Vico (2013) establishes the penetration of research results often changes and develops over long periods of time. Furthermore, secondary effects can appear due to societal and economical changes (Penfield et al, 2014). This is a broadly discussed subject without consensus nor norm. It is also one of the most crucial parts of evaluation, as the

time period of evaluation highly influences its found `impacts´. The question of time-lag is further complicated due to the fact that the research impacts might be *non-linear* and therefore difficult to evaluate within a set time period. As informed by the sustainability transition literature, innovation is a *non-linear* process and it can take decades for it to have an impact on the environment (Geels, 2010). Furthermore, impact can be short-lived and long-lasting (Penfield et al, 2014).

Attribution. The question of allocation of the research results are further challenges that creates uncertainties (Grant et al, 2010). To establish the cause-effect relationship and links between the research results and a societal change is extremely challenging. Secondly, if ever becoming a product or system solution, is it possible to allocate where or when the scientific discoveries where made? In project evaluation this question is pivotal as the impact of research projects leading to knowledge development, and not necessarily a measurable solution/product, risks to be underrated though leading to crucial knowledge.

Data collection and data uncertainty. Many scientists have pointed out the problem of the vast amount of time and research different kinds of evaluation takes. This is related to the gathering of evidence or data, which can be a problem in both ex-ante and ex-post evaluations, as data might not exist or it might no longer be available (Penfield et al, 2014). Furthermore, research results are often not quantifiable.

5.1.3 LCA and SA of emerging technologies

Numerous analytical approaches to assessing sustainability have emerged in recent decades, such as energy/exergy analysis and carbon/ecological footprinting (Matthews et al, 2019). They typically focus on environmental sustainability, the most widely applied and comprehensive methodology being life-cycle assessment (LCA) (Patterson et al., 2017). The difficulties with performing an LCA of emerging technologies (thus relevant for in a research context) can be highly related to the difficulties mentioned in previous section. Several studies highlight the issues of applying an LCA-methodology at an early stage of the technology (see e.g. Moni et al, 2020; Cucurachi et al., 2018; Hung et al 2020.)
The main issues found in the literature review are:

Comparability. The concept of functional unit is the basis of comparison between technologies in LCA. The function of emerging technology may not be comprehensively defined at low TRLs and may change with increased maturity. For a typical LCA, industrial data from established processes is used. However, for emerging technologies, data from lab scale processes must often be used. LCA results using lab scale data do not necessarily represent environmental impacts after scaling up to a typical

commercial scale although direct and accurate process data is used in LCA (Takata et al., 2007). For example, an LCA study on carbon nanotube manufacturing indicates 84% to 94% reduction in cradle-to-gate environmental impacts when manufacturing process moved from small scale to large scale (Gavankar et al., 2015). This is due to various efficiency measures such as reuse and recycle of materials in carbon nanotube synthesis process becoming only feasible beyond a certain production volume.

Insufficient data There is often a lack of access to sufficient data at low TRLs, a problem which is accentuated by the fact there often is a lack of historic data. Primary data might not be available. If secondary data exists though, it can provide a basis for decision-making (Hetherington et al., 2014).

Difficulties with scaling This is related to the comparability, LCA-results does not always correspond with the environmental impacts at commercial scale (Takata et al., 2007).

Due to the difficulties mentioned above, uncertainties are often high. It is often stated that in order to handle the uncertainties, sensitivity analyses can be conducted (Ravikumar et al, 2018). These are however often time-consuming and complex. Furthermore, many studies try to simplify the results, which can be misleading in the decision-making process (Stirling et al, 2008). Furthermore, a big challenge is limitations in resources, knowledge and time. This could lead to incomplete assessments (Peace et al., 2017; Matthews et al, 2019).

There have been several proposals to use LCA at an early R&D stage, such as anticipatory LCA (A-LCA), which is a newly developed LCA-tool "for responsible research and innovation". The tool integrates stakeholder perspectives, sensitivity analyses and simulations (e.g. Monte Carlo simulations) (Wender et al, 2014). The landscape of LCA is constantly evolving, with developments such as e.g. Life Cycle sustainability Assessments (LCSA). LCSA is based on three pillars, traditional LCA, Life cycle costing (LCC) and social life cycle assessment (SLCA) (Finkbeiner et al, 2010). This method has currently not been standardized nor is widely used, due to immaturities in the method (Matthews et al, 2019).

Due to the difficulties and aspects mentioned above, it might not always be possible to include a full LCA in the development of emerging technologies. In a study conducted by Chebaeva et al (2018) SA methodologies were aligned with TRL levels, focusing on TRL2-TRL7. 39 methods were identified through a literature

review and assigned the TRL levels based on their earliest possible application. The list of the methods aligned with corresponding TRL can be seen in the Appendix.

5.1.5 R&D management and grant peer review

Increased attention is given process of selecting research and innovation projects (Arratia et al., 2016; Lui et al, 2019). R&D project evaluation and selection is a complicated process and can be handled through different qualitative or quantitative approaches (Lui et al, 2019; Lui et al, 2017). To make the decision-making process transparent and consistent the project selection usually follows a structured process (Silva et al, 2014; Lui et al, 2019). As problematized in the previous section, there are inherent problems concerned with measuring and understanding benefits in ex ante evaluations due to the uncertainties involved. As described by Doctor et al. (2018): *"Uncertainty exists if an action can lead to several possible outcomes and an essential, but, challenging aspect of R and D management is to identify the likelihood or probability that these outcomes or events will occur"* (p. 80).

Peer review is the most commonly used method for evaluating scientific research and is based on the principle that experts or competent scholars in different fields, are the most suitable for assessing the value of proposals within their fields of knowledge. It relies on "the expertise of fellow researchers and their ability to evaluate scientific quality, such as validity and relevance, and recognize innovation potential" (Fogelholm et al, 2012). As stated by the British Academy: "*the essential principle of peer review is simple to state: it is that judgements about the worth or value of a piece of research should be made by those with demonstrated competence to make such a judgement"* (Academy, 2007). Grant applications are usually evaluated by internal and/or external reviewers, who rate the application. The applications are then discussed by a review committee, that usually consists of reviewers and members of the funding agency. The decisions are then typically based on the ratings of the reviewers and the discussion (Abdoul et al, 2012). The reviewers are experts in specific research fields and are mostly selected based on their research competence. In some cases, aspects such as the fair representation of genders and regions, as well as measures to avoid bias, are taken into consideration for the selection of grant reviewers (Langfeldt, 2001).

Some studies focus on reliability of the review method of grant reviewers and suggest that the process of decision-making by using reviewers can be subject to a lack of reliability. One of the weaknesses of peer review for grant applications that has been discussed in literature is for example variations of ratings of the same proposal between different reviewers (Pier et al, 2018). High levels of inter-reviewer reliability, defined as the degree of agreement and consensus among

reviewers, is often seen as the proof of an efficient system of reviewing (Derrick & Samuel, 2017). However, this is also a contested notion, as "too much agreement is in fact a sign that the review process is not working well, that reviewers are not properly selected for diversity, and that some are redundant" (Bailar, 2011 via Derrick & Samuel, 2017). Furthermore Langfeldt (2011) argues that low inter-reviewer reliability is not an indication of low validity or low legitimacy, but it shows competence among reviewers and a rich discussion, with different interpretations on research quality. The discussion among reviewers and panel debates are therefore seen as one of the main strengths of peer-reviewing (Derrick & Samuel, 2017). Furthermore, some levels of low inter-reviewer reliability can be expected, especially in cases with new and uncertain criteria (Derrick & Samuel, 2016). Thus, peer reviewing should be considered a highly social process, as social factors and assessment culture affects the assessment criteria (Derrick & Samuel, 2016). However, in cases of a limited time frame of the evaluation, criterions that show direction are required in order "…to bring diverse opinions, perspectives and values onto the same page" (Derrick & Samuel, 2017).

Criteria is an essential component in the assessment of proposals. According to Davidson (2005, p. 91) criteria "*distinguish a more meritorious or valuable evaluand from one that is less meritorious or valuable*'. According to Hug and Aeschbach (2020) it can be used to generate questions such as "Is the project (evaluated entity) innovative (evaluation criterion)?' or 'How innovative is the project? Is project X more innovative than project Y?" (p. 2).

In a study of the French Academic Hospital Research Grant Agencies Abdoul et al (2012) investigates the practices and perceptions of grant reviewers. For example, the usefulness of the checklists or assessment criterions sometimes provided by the funding agencies are discussed, as well as the usefulness of the scoring methods used. The study found that most of the reviewers, both internal and external, found the assessment criterions helpful for their work in assessing the grant proposals. They were for example seen as helpful in order to understand the funders point of view on which parameters that are of importance. Furthermore, the checklists were seen as helpful to understand the overall project. However, some raised concerns about the broad nature of the assessment criterions, leaving it to the reviewer to determine to which degree a criterion should be evaluated, and what should be included within it. Some also found the scoring/ranking difficult due to the heterogeneity among reviewers, which makes the final scores difficult to interpret. The use and interpretation of the criterions was therefore varying and subjective between reviewers, where the given weight of each criterion varied. However, overall the reviewers found the "checklists" and criterions handed out by the funding organization to serve its purpose of assessing and ranking the proposals (Abdoul et al, 2012).

UK is one of first the countries to have applied a structured evaluation process for evaluating "impact" of higher education through the "Research Excellence Framework", introduced in 2014 (RCUK, 2016). REF has been broadly discussed in literature on evaluation systems. In a study conducted by Derrick and Samuel (2017) the reviewers' perception on a tool in the structured evaluation process and how it influenced the consensus among peers in the review panel is investigated. The study included the study of the perception of reviewers of the impact criteria and the training provided on how to use and interpret the criteria, both pre- and post-evaluation. The study finds that there has not been a development in terms of culture of how to interpret and use the "impact" criteria, and therefore the training of peers' pre-evaluation was necessary in order for the assessment to be fruitful (Derrick & Samuel, 2017).

In a study on the grant review process of The Research Council of Norway, Langfeltd (2001) analyzes the variations in what grant reviewers emphasize and how the review process affects the project selection. Langfeldt finds that guidelines of provided by the funding organization tends to have a limited effect on the review panels and that the method of ranking and ranking scales highly influenced the review outcome. For example, in cases where reviewers used an elimination method rather than proposing preferred funding candidates there was a tendency of funding uncontroversial and safe projects.

5.1.6 Earlier research on TRL and complementary approaches

As mentioned in the introduction, TRL is a tool often applied in grant funding. Mankins (2009a) describes the technological maturity as strongly linked to the risk of project failure, thus TRL can be used as a method for risk assessment. Some studies have been carried out on the TRL, although few have included its user community and their perception on the method for assessing the technological maturity of a technology. One shortcoming of TRL that has been identified in literature is the problem related to the lack of integration of an overall systems maturity approach. Several scholars highlight the fact that TRL do not into address a systems perspective, and that it does not indicate whether the implementation of the technology will contribute to a successful development of a system (Gove, 2013; Sauser et al, 2007). Furthermore, is has been stated that TRL are "judged subjectively based on expert estimates using these criteria" (Tan et al, 2017). A study on the user's opinion on the method similarly shows that there are difficulties related to the lack of integration of an overall system maturity approach (Tomaschek et al, 2016). TRL assesses the component-readiness of each technology, but the components are really integrated to work as a complete system. The connected components can be dependent on the development of each other.

Sometimes, the interface of connected components is more suitable for assessment. Some other shortcomings include: subjectivity related to the interpretation of the levels and the likelihood of progress (Tomaschek et al, 2016; Cronford & Sarsfield, 2004), a lack of integration of cost (Mankins, 2009b) and a lack of guidance on the TRL assessment and further maturation (Mankins, 2009b; Cronford & Sarsfield, 2004). Due to these limitations, some methodological developments have been suggested. For example, Sauser et al (2006) has suggested the incorporation of elements of the entire system through their method of System Readiness Level.

In line with TRL Chebaeva et al (via Lettner, 2018) proposes a "structural concept of sustainability assessment as an element of a research project" (Lettner, 2018). This is done against the background of an increasing interest for sustainability assessments of research projects, as well as lack of knowledge about the integration and implementation of sustainability assessment methods into public-private research projects. The concept of sustainability assessment levels (SAL) is therefore introduced. SAL consists of four levels with a focus on the research stages TRL2-TRL7.

Table 4 (Chebaeva 2018, from Lettner 2018)

TRL	TRL 2-3	TRL 4-5	TRL 6	TRL 7
Sustainability Assessment levels (SAL)	SAL 1	SAL 2	SAL 3	SAL 4
Description of SAL	Streamlined assessment of potential environmental hotspots	Preliminary sustainability assessment: life cycle thinking implemented	Full sustainability assessment	Full sustainability assessment and social-economic perspectives
Environmental dimensions	Gate to gate perspective, qualitative and semi-quantitative assessment	Quantitative assessment: additional life cycle stages: proxy indicators	Additional environmental impact categories	Additional use of consequential approaches

Economic dimensions	Potential fields of application; potential life cycle considered	Medium-detailed structure of life cycle	Customer requirements, material costs	Supply-chain well known and well understood
Uncertainty management	High level of uncertainties	Medium level of uncertainties	Decreasing level of uncertainties	Low level of uncertainties
Possible methods (exerpt)[4]	Screening methods; Matrix LCA, ABC-analysis, checklists, mixed MCA methods	Streamlined LCA, agent-based modelling, product material intensity, fuzzy eco-design	LCA and LCC, environmental risk assessment methods, MCA (qualitative and quantitative)	Full LCA, vulnerability analysis, life cycle index, MFA and SFA

The levels are based on the TRL levels and methods of sustainability assessments. SAL sees the data collection of as a continuous process and advocates for a structured process of data collection between and within the levels "so the data requested from researchers accumulates as the project progresses and gradually becomes more complex and detailed" (p. 10). Thus, SAL can be seen as a way to structure the information on sustainability aspects of the project, as well as requesting data on sustainability along with the TRL levels. SAL is based on three pillars: *substitute and applications definition*, *life cycle (LC) perspective* and *uncertainty management*.

The "substitute and applications definition" is the core of the assessment "*as it connects a focus technology (product) to the external environment by providing base levels and benchmarks, facilitating market analysis and enabling comparative performances."* The aim is to understand the potential application of the project result. For example, in SAL1 "the assessment can be carried out by identifying barriers and incentives for the potential market diffusion of the developed

[4] See Appendix for a more exhaustive list of SA methods aligned with TRL.

products." The LCA perspective (although highly related to the "uncertainty management") contributes to the understanding of the technology/product in order to assess "environmental, economic and social impacts." In order to assess the environmental and social impacts, metrics such as Global Warming Potential (GWP), non-renewable energy demand (NREU), environmental hot-spots analysis (at low SAL), as well as "categories considering eco and human toxicity can be integrated with increased SAL and a broader LC perspective." Furthermore, the aim of the uncertainty management is to understand possible pitfalls and misjudgments, as well as to allow "an optimally reasonable and accurate assessment to be made, while staying aware of the possible pitfalls and misjudgments."

5.2 Results from the case study

This chapter presents the findings of the case study. The themes are based on the codes found in the re-reading of the transcribed interviews. 8 themes were found in the coding of the results. All of the interviews except from one was conducted in Swedish. Therefore, most of the presented quotes are translated from Swedish to English. See Appendix for original quotes in Swedish. Furthermore, some of the applicants mentioned possible improvements of SRL. These can also be seen in the Appendix.

5.2.1 How SRL was used and supported in the applications - from the applicants' perspectives

The application guide states that it is of importance to strengthen the statements made on the current SRL-level and the intended movement to higher levels (the latter not being mandatory). A few tools are listed as possible ways to analyze and understand the projects SRL-level, such as LCA and Global reporting Initiative. It is also stated that other tools can be used. Naturally, due to the distinctive projects (with varying aim, scope, research area, resources, context etc.) falling under the SRL-criteria, the applicants referred to SRL and supported their statements in various manners. When asked about the justification or support for the stated self-assessed SRL-level two of the participants said that their approach to identify and support their sustainability readiness level was to consult within their project team in order to find a "reasonable" level.

> "*Well, it is a discussion with the others who are part of the group. You look at the chart and try to see where you are* [on the scale] *and what you find reasonable to be once you´ve finished the project. So, then we estimate where we might move it* [the SRL-level]. *But it has to be*

reasonable from what we want to do." (Quote 1, translated by author[5])

"*I talked to the person who helped with the application and he´s is quite experienced. We had a discussion about the degree to which these* [SRL] *levels are, how should I put it, reasonable*." (Quote 2, translated by author)

Thus, no standardized method or tool was used in these applications to support their SRL. Another of the applicants answered similarly that the SRL valuation (in one of two conducted applications) mainly were done by relying on the expertise and knowledge of the project group and external colleagues.

One of the applicants' described the SRL-level of the proposed solution by providing rough estimations based on a simplified life cycle inventory and carbon footprint analysis, along with qualitative descriptions on aspects such as energy consumption, logistics etc. Thus, the focus of this participant was to give a general description of the solution/product/material by a chosen focus (climate impact, carbon footprint). This applicant stated that the aim during the project was to fulfill SRL1.

Two of the applicants worked in projects that that have continued to be financed and moved from hypothesis testing step 1 to step 2 or thematic project and during the initial part of the project fulfilled SRL1. The applicants therefore explained that it was to some degree easier to refer to the sustainability aspects, as they already had conducted some sort of sustainability assessment in the first part of the project. In order to reach SRL2 and SRL3 they stated that they would conduct further analyses. One stated that they would reach SRL2 by using an they would work with an internal sustainability tool, which they call "sustainability declaration" in which the project is related to the SDGs. The other applicant stated that they would conduct an LCA of one part of the solution, as the sufficient knowledge was already established surrounding the other components of the solution.

5.2.2 The perceived effect of SRL – from the applicants' perspective

As most of the projects financed by BioInnovation has an explicit sustainability focus, most of the applicants stated that they did not think that the introduction of

[5] See translations in Appendix.

SRL affected the focus of the projects. Four of the applicants stated that they did not think that SRL affected how they worked with sustainability or integrated sustainability perspectives in the project, but that it did have some (limited) effect on how the applications were written as they refer to a chart instead of describing it more descriptively/freely. Instead, the applicants referred to the fact that the sustainability aspects were an integral part of the idea behind the project, due to a **market need** for the development of the solution, and that this was the main motive behind the sustainability focus;

> *"No, but that is because our entire existence builds very strongly on sustainability. One of our competitive advantages is that our product is far more sustainable than what is currently on the market. So (...) that is a given for us, so to say. Those who invented the product have had it* [sustainability] *in their mind the whole time, so I cannot say that it* [SRL] *has helped us in that way. But that is because we are very far ahead in that concern."* (Quote 3, translated by author)

> *"If I am to be harsh, it* [SRL] *does not change how I write an application or what ideas that are elaborated. One should not be too self-righteous, but it* [sustainability] *comes a bit with what you do. You have to work where companies have a need, and you have a need to work for a more sustainable organization. It is what drives most of the companies that I work with, or one of the things."* (Quote 4, translated by author)

Another interviewee answered similarly that due to the fact that the idea behind the project was a clear demand on the market due to the environmental harm caused by the existing products, it did not affect the sustainability focus or work in the project;

> "*No, I don´t think so because it* [sustainability] *is the basis of the whole project. So, in this case, no, I don't think that we do it differently because of the scale. I can imagine that in other projects that goes further back in time, we might´ve had a little different behavior and work*

> *procedure if we would have had the scale to relate to, but not in this project."* (Quote 5, translated by author)

Two applicants furthermore added that they experienced that the market need was created due to regulations and laws by authorities on national and/or EU level. Thus, the market demand of sustainable product seems to incentivize the sustainability work of the projects, while SRL had less effect. However, one applicant explained that SRL was the drive to provide information on sustainability aspects in the **application**, and that it forced the project team to look for rough numbers and estimations.

Furthermore, one applicant stated that, while conducting the SA, it was identified that the project had a positive impact on several target goals of the SDGs, and a risk for a negative impact on one or two target goals. However, these aspects were already identified; *"... Luckily, we already work with the* [possible negative] *aspects that we identified, so it wasn´t like we discovered that we needed to change the whole project"* (Quote 6, translated by author). Thus, the discoveries from the assessment did not lead to knowledge that affected the project design/focus.

One of the main aims of BioInnovation is to create spaces for collaboration and to connect "ideas, actors and capital to create competitive and bio-based materials, products and services" (BioInnovation, 2020). While four applicants experienced that the **collaboration with companies** and the market need increased the sustainability focus, one experienced that companies focus tended to be towards finding a technical solution, rather than on the sustainability aspects. The applicant added that even though companies nowadays are required to work with/for sustainability, they are mostly interested in finding a new technological solution to introduce to market;

> *"...in these projects especially from Vinnova, you always need to work with companies. And companies are mostly interested in technological solutions. So, if I can give you one example, they want to find a new bio-based resin, and this is a technical question. So, all the focus of the teams is to find a good chemical, so sustainability of course is a general term that everyone wants, but they take it for granted that if we have a bio-based resin for example, that it will be more sustainable. While in reality, that might not be the case."*

Furthermore, it was explained that only if the *"…solution is good from the technological point of view they start digging into these sustainability issues."* The applicant thus experienced that the sustainability work is secondary to the viability of the technology/solution for the companies. This can probably be related to the need of profitability. In the quote above the applicant also touch upon another recurring theme in the interviews, namely the perception that **bio-based** solutions inherently are more sustainable.

5.2.2.1 Research on bio-based solutions and materials

Four of the applicants said that they found it easy to communicate the sustainability aspects of their solution due to the fact that they work with research and development on bio-based solutions or partly bio-based. Some referred to it as a bit like "cheating" and some stated that they could become better at explaining the actual environmental impact of the solution. One added that it can be difficult to explain the benefits of the solution if you exchange wood with wood, but that it is very simple when you change something fossil-based with something bio-based. "*It is very simple, it might be difficult when you change wood for wood, but if you change it from something else it is very simple. It is a bit like cheating in that way."* (Quote 7, translated by author)

According to one of the reviewers and the programme manager there is a tendency among applicants to rely on the presumption that bio-based = sustainable, but that there can be a lack of facts and explanation to *why* it is more sustainable. The programme manager explained that this seems to be because of lack of actual evidence on the sustainability of the product.

> "*There are many applicants from the forest industry and other bio-based materials that apply for funding within BioInnovation, that presume that it is a more sustainable process than a fossil-based process, just because they use a biobased raw material. This is often the case, but they* [the applicants] *might not have actual evidence that their product is more sustainable. It is always easy to say that something is green and sustainable, but it is seldom you see an actual estimation on for example emission reductions."* (Quote 8, translated by author)

Thus, while the applicants explained that they found it easier to explain the sustainability aspects in the project application due to working with bio-based products/solutions/materials, the reviewers lack actual support backing them up.

5.2.3 Difficulties and benefits of the use of SRL – from the applicants' perspective

The five interviewed applicants shared a view on SRL as difficult to use and understand and experienced the tool as fuzzy and vague. Some felt that this was related to the newness of the concept, to individual knowledge/experience in sustainability or to difficulties in defining sustainability. The applicants however agreed that the function that SRL fills is important, as it sends an important signal to the applicants. Most of the applicants did not think that SRL contributed to more additional time on the application, some said that in might have taken a bit more time to understand the concept of SRL, but not excessive. One applicant however stated that it did take time from other work.

A summary of the difficulties with SRL mentioned by the applicants can be seen in the chart below, along with the perceived value of the tool.

Table 5 Mentioned difficulties and value of SRL. The points in bold are mentioned by several applicants.

Difficulties	Benefits/value
• **To understand what the levels mean in practice. What does it mean to fulfill SRL1? What is a "more detailed" sustainability assessment? Some users mentioned that this is a question of interpretation, which makes the efforts put into SRL arbitrary.** • **It is fuzzy and vague** • **It is difficult due to personal**	• **It contributes to discussions and reflections around sustainability** • It can contribute to a more direct and structured application than it would be without any scale, as some find it easier to use numbers than descriptive text; *"I think it is good because as I said you can give some numbers and argue about it. So, in that sense it is good because otherwise it is empty words which don't mean anything."*

inexperience/lack of knowledge; *"It is difficult with sustainability since we are not experts, it is not easy to know the borders and what the work is about."* • **Sustainability includes many aspects to consider. Which indicators should be included and how?** • To some extent difficult to understand the difference between MRL and SRL. *"They* [the levels] *are not very clear. I think that SRL1 is pretty good, and to some extent also SRL2, but in SRL2 you start to talk about potential customers, and that to me is more MRL."* (Quote 10, translated by author) • *"On a theoretical level it is grandiose, but it is difficult to use."* (Quote 11, translated by author) • It takes time from the technological development of the solution	• It is a good first step to include sustainability in the appraisal and application process: *"It is better to start somewhere, no matter how vague it is."* (Quote 9, translated by author) • **It has the potential to be very effective and to spread to other contexts (if it gets more direct, explicit).** • *"It is good that you can communicate how mature the technology is from a sustainability perspective."* (Quote 12, translated by author) • **It sends a strong signal that sustainability is important and has to be investigated.** • Might lead to time effectiveness: *"I think that it was stated in the application within what span you´re expected to move, which is relevant. So, if you realize that you're outside of that span you don't have to waste your, or the reviewers, time."* (Quote 13, translated by author) • It is good to try to structure the sustainability questions in a systematic away from different dimensions.

As seen in the chart above, many thought it was difficult to understand what the levels mean in practice, and several reflected around that it is up to the applicant to interpret and think what the suitable measure to identify the SRL-level and how to fulfill the levels is.

5.2.4 Use and effect of using SRL in the appraisal process – from the reviewers' perspective

The review process can vary a bit depending on the call, and different aspects (such as specific sustainability aspects) are more relevant for some calls (see section 2.3). The reviewers highlighted throughout the interviews that their reviews are based on several criterions, where SRL is important but one of many sub-criterions. Their judgement is thus based on the whole picture, considering different values and criterions.

The reviewers expressed that the function and use of SRL in the grant review process consisted of providing a **common language** for sustainability the reviews, and that it facilitated the communication in the review meetings. Thus, SRL facilitated the communication both in the writing of the report, and also among the reviewers in the review meetings. According to one of the reviewers, SRL have also functioned as a checklist.

> *"I think that it has contributed to a pretty good discussion regarding the applications, it has been a very important perspective."* (Quote 14, translated by author)

> *"SRL becomes more like… You can use the vocabulary a bit in order to facilitate the communication when you write the review and it also functions a bit like some sort of checklist. But it is not like SRL controls the judgement, the judgement is based on the entirety* [of the application]*. You can also use the SRL-vocabulary like a common language with other reviewers in order to facilitate the discussion. But I don't think that the review of the projects is affected by the use of SRL."* (Quote 15, translated by author)

As seen in the quotes above, the reviewers expressed that the scale facilitated the communication among the reviewers. In the last quote however, it was stated that SRL did not change the review of the projects. This was also stated by another reviewer, who added that this was due to the fact that sustainability has been one of the main focus areas before SRL as well and as the goal is to look "behind" the scale. One of the reviewers however argued that SRL did change the review

process, as it provides a more structured way to integrate sustainability into the criterions and therefore puts sustainability more on the agenda. Furthermore, the reviewer also expressed that SRL had minimized the risk of investing in "unsustainable" projects.

The reviewers also mentioned that they found it easier to use MRL & TRL as these scales are more established, thus there are more examples to lean back to in the reviews. They also expressed that it can take time to learn how to calibrate between the levels, as it is not really established yet what constitutes a SRL1 or SRL2.The reviewers furthermore highlighted the importance of **credibility** in the statements on sustainability and indicated that it is more important to show understanding of the central sustainability aspects than to correctly refer to SRL. One of the reviewers added:

> *"We can overlook if an applicant has not understood the SRL-model and its precise definitions, but if the applicant does not understand the underlying reality concerning sustainability it* [the application] *is doomed anyway*." (Quote 16, translated by author)

Furthermore, it highlighted that the reviewers try to see whether or not the claims in the applications are achievable within the time frame and if the applicants have been able to communicate trustworthy information in a transparent way.

> "*The most important part is that the applicants do not ignore the risks, but that they give the reviewers the opportunity to understand the situation and how they handle them."* (Quote 17, translated by author)

Thus, a low SRL does not mean a decreased change to receive funding. Instead, the reviewers stressed that in cases of uncertainties and risks there should be open communication from the applicants on how these are going to be mitigated.

5.2.5 Difficulties and benefits of SRL from the reviewers´ perspective

It is difficult to draw any conclusions on the main difficulties and benefits perceived by the reviewers due to limited number of interviewees. However, some of the difficulties and benefits overlaps with the difficulties mentioned by the applicants, such as experienced difficulties related to the newness of the concept and the

contribution of the concept as a language for discussion. See the chart below for a list of the mentioned difficulties/benefits with SRL.

An important note is that the reviewers did not share the perception on the difficulties and benefits. Two of the reviewers did not think that SRL facilitated the understanding of sustainability of the proposed projects, nor that it contributed to an increased sustainability focus, but that it helped to facilitate communication a bit. Thus, the difficulties and benefits mentioned in the chart are not necessarily shared.

Table 6 Mentioned difficulties and added value of SRL by reviewers

Difficulties	Benefits/value
• It is new and therefore difficult to calibrate between the levels • It is a bit fuzzy and vague • Because of the conceptual fuzziness with "sustainability" and what should be included in a sustainability assessment it is important to be observant on different interests that might affect the assumptions' and statements being made. This makes the reviewers ability so "see behind" SRL and how it is supported of high importance. • It is not possible to strictly base the judgements on models such as SRL. Like many other descriptors/criterions used for reviewing, the	• Makes the work of the reviewers more efficient by making is easier to get an overview of the sustainability aspects. • Contributes to the discussions as a complement to TRL. • A support for the reviewers • It sends a signal that it is important to think about sustainability • It forces the applicant to think and reflect • **To some extent** it facilitates to get an overview of the sustainability aspects and therefore makes the work of the reviewers a little bit more efficient. • It facilitates the discussions slightly. • It promotes a kind of LCA-thinking form the beginning of the project that needs to be carried on throughout the whole project,

	detail level of the models is not sufficient for; *"No matter how you try it is not possible to get enough detailed information of a sufficient quality so that you can use these models strictly."* (Quote 18, translated by author)	

5.2.6 How the reviewers perceive the applicants´ description of SRL

When asked about their level of satisfaction regarding the quality of the description and information of SRL and sustainability in general in the applications, the reviewers answered that it varies a lot between different applications. While the applicants seem to be experienced and skillful in the statements on TRL (and therefore provide are more homogenous level of descriptions) the descriptions and level of standard of SRL differed more from application to application: *"To answer your question I think that they* [the applicants] *have experienced it* [the use of SRL] *a bit more difficult and it has shown in the applications, because the difference in using SRL has been a bit bigger than it has been with the other* [sub-criterions, TRL & MRL]" (Quote 19, translated by author). One of the reviewers experienced that the applicants try their best with their descriptions and that in some cases the descriptions have lacked, while still stressing that the development and use of SRL should be seen as a process. This reviewer also stated that the most important thing is that the applicants start to reflect about sustainability aspects. Another reviewer answered that the quality level of the applicants´ descriptions varies a lot and added that there unfortunately are applicants that tries to reach as many of the criterions as possible without really substantiating the statements made. Furthermore, there are those who focus too much on SRL and lose focus from the essence of the tool;

> *"It varies a lot. Some only tries to tick all the boxes in the applications and only tries to make sure that they reach as many criterions as possible. And sometimes it shines through that they don't know what they are doing,*

> *unfortunately. Some are very well-informed on this subject* [sustainability/SRL] *and some are taking it to the extreme and puts the definitions and intricacies of SRL above the content and substance in the applications. So, it varies a lot and it is often easy to see in the applications."* (Quote 20, translated by author)

One of the reviewers furthermore added that the level of supporting the SRL-valuations is uneven: "(…) *everything from something very arbitrarily conceived to an actual assessment of sustainability, maybe in a form of a simple LCA where the whole value chained has been considered. So, I would say that it is very uneven"* (Quote 21, translated by author). The programme manager furthermore added that the aim to "tick all the boxes" is a big question, and that Vinnova can see the same tendency when it comes to equality; where applicants state that they are more equal than they in fact are (e.g. when it comes to representation). However, it was added that although the statements might not always be supported, there is a value in making the applicants think about these issues; "*… they* [the sustainability statements/SRL level] *might not always be 100% genuine. But I do think that there is a value in getting these thoughts* [around sustainability] *spinning and to get them* [the applicants] *to think. I think this is the biggest gain with these sub-criterions"* (Quote 22, translated by author). Furthermore, it was added that for many of the applicants', this funding can be pivotal and that this can trigger that the applicants "*write what they think the reviewers want to hear"* (Quote 23, translated by author).

Furthermore, two of the reviewers mentioned that the applicants tend to refer to environmental sustainability more than for example social aspects in their applications, but that it might now always be possible or necessary to consider a large amount of indicators/perspectives. Two of the reviewers added that there are some cases where social sustainability is included, such as projects related to the textile industry, but that those statements also tend to lack support/evidence. To sum it up, a recurring theme among the reviewers is the **credibility** and **achievability** of the statements made on their SRL-level, and whether or not the applicants are convincing in their statements.

5.2.7 Defining "sustainability" and how to measure it – applicants and reviewers

During the interviews with the applicants, doubts and uncertainties related to the definition of sustainability were revealed, which can be much related to the general notion in literature, where the definition of "sustainability" is subject to constant

debate. When asked the question of how they interpret the concept of sustainability in relation to SRL, several were uncertain and referred back to the application guide.

Table 7 Some of the sustainability definitions provided by the users

Interpretation of what "sustainability" refers to in SRL	
R	*"I have interpreted the concept "Sustainability" to not just refer to the environmental aspects, but also to the social. It can, of course, be described in different ways but the essence of the concept is both how we interact with the environment but also how we humans interact amongst each other."* (Quote 24, translated by author)
R	*"Sustainability is a variety of things, everything from economic and social sustainability, to different forms of ecologic and more natural science-based sustainability. In this case you have you have to go back to the purpose of the call, and what is to be achieved with the money. And from that it is possible to identify what sustainability aspects are most relevant for the review."* (Quote 25, translated by author)
A	*"I have mostly thought about it in an environmental perspective. But of course, we also have the economic part and the social sustainability. But I have spontaneously thought about the environmental aspects."* (Quote 26, translated by author)
A	*"I think that that the sustainability focus is environmental sustainability."* (Quote 27, translated by author)
A	*"It was quite easy for me to say "Ok, let's see what numbers I can give". So that means sustainability for me - if I can compare with numbers. Because otherwise you can say nice words, that we don't use fossil-based resources and we use bio-based materials etc.… But I don't know if it's better or not for every solution, so then I must have a number."*

As seen in the chart above, three of the applicants stated that they mainly thought about the environmental aspects, while the reviewers had broader definitions. One of the applicants saw sustainability as comparability with numbers, thus seeing sustainability primarily as a method rather than an objective.

Furthermore, all the users except for one stated that TRL and MRL are easier to use than SRL. This was explained firstly by the experience among the users to refer to TRL and that TRL is well-established and used within their field of work. Secondly, some experienced TRL & MRL to be more direct and instinctive;

> *"It is much easier to support a TRL-status as it is easier to concretize and prove the statements; have you tested the solution in a lab-scale or in a fabric scale, have 10 tons of this product been produced or not? It is much more tangible. It is the same case with MRL, where it is possible to use economic metrics, and state whether or not there is contact with the customer, how much of the product has been sold, whether or not there any property rights. Sustainability is a much wider concept. There are some aspects that are measurable, like how much fossil CO2 you replace etc. But when it comes to aspects such as biodiversity and social sustainability… It is fuzzier because it has to do with ethics, politics and ideology."* (Quote 28, translated by author)

In the quote above one of the reviewers reflect upon the fuzziness in the sustainability concept by comparing the ability to support the statements on the stages between SRL, MRL and TRL, explaining that TRL and MRL are more tangible and direct. The user furthermore added that defining and measuring some of the "fuzzier" aspects, like biodiversity and social sustainability, intentionally or unintentionally, is a product of a subjectivity and an ideological/political or ethical interpretation. Several of the applicants reflected on the difficulties with finding suitable measures of sustainability, and also reflected on the fact the results of the analysis depend on the measure you choose, how you define it and establish the system boundaries;

> *"I think that it* [SRL] *is a vague concept and that is related to the many interpretations of sustainability in general. Everyone wants to do something good and sustainable and feel that the work that is carried out is within the sphere of sustainability. But the concepts are very vague and the methods for measuring them are also vague and disputed. So, I think that it is good to start by thinking about it and to do accordingly, then to wait for a better metric or indicator, because then nothing will happen at all."* (Quote 29, translated by author)

In the quote above, one applicant reflected on the vagueness of SRL and related it to the difficulties with defining sustainability in general. Furthermore, the applicant added that, due to the fact that it is vague, there is a risk that applicants state that they are on a higher level than what can be proved/supported. As seen in the previous section, this risk is also acknowledged by the reviewers. One of the applicants furthermore added that there are different perspectives on the sufficiency

of different methods of assessments as well, where some heavily relies on LCA as the main mode of analysis, while some argue that this is not sufficient in a sustainability assessment. Furthermore, one applicant stated that the broad definitions used in SRL gives the applicants the responsibility to find and argue for which sustainability aspect that is relevant and how to use it, and that MRL is easier to use, as "*you can get help to write it from different parts of the value chain. But SRL is more based on a gut-feeling and an assumption"* (Quote 30, translated by author)

One of the reviewers added that *"One can end up anywhere if it is only stated that the project should contribute to better sustainability."* (Quote 31 translated by author). The reviewer also stated that SRL however would be too difficult to work with if it is made bigger and bigger, as it is difficult to lump all the possible sustainability indicators together. As an example, the reviewer asked; "*How can you weight rising sea level with increased social sustainability for a farmer in Africa to be able to sell more crops? As long as you have SRL as a common term for a bunch of different things, it is per definition a blunt tool"* (Quote 32, translated by author). The reviewer then suggested that this can be handled either by having indicators and sub-indicators specialized for each call, or leaving it up to the reviewers to determine which indicators that are of importance within the different calls; "*So, either it is up to the reviewers to define the SRL-relevant aspects of each call, or you have to have indicators and sub-indicators on each call text that does not entail the broad sustainability aspects. I think it is better to be sharp and more direct on the relevant aspects from the beginning, in the call for proposal*" (Quote 33, translated by author). Thus, according to the reviewer the sustainability aspects included in the application and appraisal should be specific for each call. The programme manager also stated that it is difficult to have strict definitions or indicators of sustainability in SRL, as it often is necessary to be open to many types of projects operating in different contexts. It was also added that it would be easier if the target group for the calls for proposals were more limited, as it is difficult to narrow the definition of sustainability when it is cross-sectorial and a large variety of research areas. The programme manager also said, similarly to the reviewer, that the sustainability definition could be individually adjusted to every call but added that that would be difficult to achieve due to the workload required.

6. Discussion

In this chapter the results from the literature synthesis and the interviews are discussed. The discussion is structured in two sections, the first being a discussion on the limitations of the study and the second a discussion of the results in relation to the effectiveness typology presented in section 4.

6.1 Limitations and methodology discussion

Due to the limited data and chosen methodology, this study provides a limited basis for generalization. It is therefore important to highlight that the results from the case study should not be considered generalized facts, but understandings of the use and value of SRL in this particular context, seen from the perspective of its users. However, the results can be seen as indications on the perceptions of the use, difficulties and opportunities among the users and be useful for the development of SRL and in similar contexts, e.g. in the introduction and development of tools similar to SRL used in research and innovation contexts. Furthermore, this study is limited to focus on a specific program in a national context.

6.2 Discussion of the results

Many of the difficulties mentioned in the literature review are highlighted by the users, such as the difficulties related to measuring and weighting sustainability aspects, especially when there might be a lack of data. The discussion of the results is divided into the four parts following the four effectiveness categories identified by Bond et al (2013). The discussions within each section are however not strictly separated but interrelated. Furthermore, the discussion of related literature is connected to the results from the case study, although the former might not necessarily be related to the effectiveness categories. As mentioned in section 4.2 is not possible to say whether SRL has been an effective tool or not, however, a general notion or indication of the perceived influence that SRL has had on the

appraisal, application and project design are discussed from Bond et al (2013) effectiveness typology.

Procedural effectiveness. As explained in the analytical framework (XX), the procedural effectiveness is interpreted as whether the level of describing SRL has been appropriate. As only two reviewers and one programme manager were interviewed (and due to limited time of implementation), it is not possible to draw any conclusions on whether or not the level of describing SRL is "satisfactory" nor what that level constitutes and should entail. However, the results indicate that the differences between the applicants´ ability to support the SRL-scale were greater in comparison to the other scales (TRL & MRL), as expressed by all of the interviewed reviewers. This implies large differences between the level of efforts put into the use of SRL in the application *or* level of knowledge in SA. Furthermore, the results show that there are large uncertainties among the applicants regarding the required level of effort put into SRL in the application, where some conducted a simplified carbon footprint analysis, while other based it on "gut-feeling" or discussions. The results furthermore indicate that there is a tendency among applicants to presume that their research is sustainable due to the fact that they research on bio-based solutions/materials. The assumption of sustainability as an inherent characteristic of bio-based innovations/solutions been acknowledged and criticized by several scholars (Swinda et al, 2014; Lettner, 2018; Morone & D´amato, 2019). However, this can perhaps be related to the discrepancy in focus, where the applicants tend to focus on the benefits of their solution while the reviewers put more attention to the uncertainties and possible risks. Due to the dependency in the context of funding, this discrepancy might to some extent be inevitable. In order to mitigate a situation where the applicant mainly focus on areas and situations where they already perform well, a requirement to include main uncertainties and risks can be included. Furthermore, communication regarding the fact that a higher SRL not necessarily leads to higher possibility to receive funding.

***Substantive effectiveness*.** For the purposes of this thesis, substantive effectiveness has been directed towards understanding the perceived effect of SRL in the application-, appraisal- and project design-process. As already mentioned, the scale forces the applicants to include sustainability aspects into the application, and to, at least, **reflect around the different levels and the relevant sustainability aspects**. One of the applicants stated that they did search for and provide rough numbers on the carbon footprint of one part of their solution in their application. The other applicants did not experience that SRL had much effect on their sustainability work, as sustainability were an integral part of the solution/idea and that the market need along with collaboration with companies/stakeholders/users was the main driver of their sustainability focus. User-producer interaction is a prioritized topic by BioInnovation, due to a general lack of knowledge on bio-based products among users and often uncertain market relevance (Grillitsch et al, 2019).

Thus, it is easier to receive funding for a project with user-involvement (Ibid, 2019). Collaborative research, sometimes called co-production of knowledge, is often promoted as a prerequisite for sustainable development (Pohl et al, 2010) However, in the study by Grillitsch et al (2019) it was found that "the variety of stakeholders included in the programme and project applications substantially decreases in the implementation process." Thus, it can therefore be important to monitor so that the sustainability focus does not decrease with the potential decrease of stakeholder engagement. Two of the three reviewers stated that they did not think that SRL affected which project receive funding, whereas one experienced that SRL have minimized the risk of funding projects that is not sustainable. The reviewers furthermore agreed that SRL provide a **common language** of sustainability between reviewers.

Transactive effectiveness. The transactive effectiveness refers to whether or not the assessment has been seen as effective in relation to time and effort put into it. Most of the applicants found that it took a bit more time with the applications in order to understand SRL, however most of them considered it reasonable. One argued that it took time from the actual development of the solution, thus seeing it as somewhat hindering. Alike most of the applicants, the reviewers did not either find the time required to include SRL in the review excessive, instead some implicated that SRL made the decision making more time effective. Thus, the amount of time and effort the integration of SRL took in the application and appraisal process was the effectiveness dimension that the participants mostly agreed upon.

Normative effectiveness. As mentioned in section 4.2 the normative effectiveness is directed towards understanding the interpretation of sustainability. One of the main concerns in literature on SA is the possible trade-offs between different sustainability pillars/aspects, weighting and aggregation of them (Bond et al, 2012; Morrison-Saunders & Pope, 2013; Moldan & Lyon Dahl, 2007). As explained by one of the reviewers, it is difficult to use a tool that use the broad term "sustainability", due to the difficulties in weighting different sustainability aspects and lumping them together: "*How do you weight increased biodiversity for e.g. a bird against decreased CO2 emissions?"* (Quote 34, translated by author) However, a need to include openness and flexibility with regard to a variety of interpretations of sustainability was also revealed, due to the different contexts of the projects. To include a set of determined sustainability indicators for all projects could therefore affect the quality of the sustainability assessments and decrease the researchers own reflections of what constitutes important sustainability aspects/indicators and measures for their research project. Furthermore, as stated by Moldan & Lyon Dahl (2007) there is a risk that the interest for the sustainability assessment decreases if a large number of indicators are included in the

assessments. Social aspects as well as aspects related to biodiversity were mentioned by some of the users as difficult to assess, as it was seen as a question of interpretation and demanding in terms of knowledge and expertise. Earlier research on the current practices on sustainability evaluations on bio-based value chains suggests that there is a lack of mature methods and knowledge in including social indicators in LCA (Martin et al, 2018). Van Schoubrock et al (2018, p. 115) e.g. states that there is a "clear hierarchy within the concept of sustainability (…) where the environmental aspect dominates over economic and social indicators" in the sustainability assessments conducted of biobased chemicals. Furthermore, a central problem that has been found is how to relate social indicators to the functional unit and how to restrict the number of social indicators that have been proposed into a manageable number (Kloepffer, 2008). This was also something mentioned by the some of the participants; the fact that it is up to the applicant to define which indicators' and metrics to use contributes to uncertainties on how many, which aspects, and how to include them. Furthermore, some of the applicants also mentioned the difficulty in measuring some aspects in quantitative terms. Earlier research suggests a lack of social data regarding the use of biomass have been revealed, especially in contrast with the data available for the environmental aspects (Rafiaani et al, 2018). Furthermore, it might be easier to include a narrower sustainability focus in the call text, rather than in SRL.

To sum it up, the main observations that can be drawn are:

i) SRL is a newly developed tool, which highly affects the perception of SRL among its users, applicants' and reviewers.

ii) The concept of sustainability in itself can be difficult to define and narrow down to measurable metrics.

iii) There is a need to be open and inclusive related to the sustainability definitions and focus, due to the broad variety of projects funded through BioInnovation. This has contributed to the perceived vagueness of SRL, which has led to a variety of interpretations and usages of the tool. These are often implicit and based on discussions with others or "gut-feeling".

iv) According to the applicants SRL did not have much influence on the sustainability work in the projects (focus, efforts) due to the fact that i) there is a strong market need for sustainable solutions and ii) a presumption that bio-based materials/solutions inherently are sustainable.

7. Conclusions

There is currently no standardized or widely accepted method of ex ante sustainability assessments/valuations of research projects. As showed in the literature and in the case study, there are several difficulties with assessing the possible sustainability impact of research. Furthermore, the question of what constitutes impact, as well as sustainability, can be disputed and vary in relevance depending on context, geography, research field, scope etc. Many of the limitations that were found in the literature were highlighted by the applicants, such as identifying the relevant scope of the assessment, uncertainties and data scarcity. Furthermore, the results indicate that what constitutes "sustainability" and how it can be assessed were seen as somewhat arbitrary. The cross-section between the research fields sustainability assessment and research evaluation/appraisal is rather undiscovered in literature. However, there seems to be a growing interest for sustainability tools that can be used at an early stage in the research process before eventual lock-ins. Although several methods and frameworks have been proposed, many of them have not been used in practice.

The results of the interviews show a mixed perception of the contribution and usability of SRL. Most of the participants argued that SRL was difficult to use and vague, while also recognizing its conceptual value and importance as a tool (along with TRL and MRL) to emphasize the importance of sustainability perspectives in research & innovation projects. The perceived vagueness can be related to an ambiguity related to the definition and measurement of sustainability, where several expressed some uncertainty e.g. with how broad the assessment should be, relevant indicators and how it can be measured and/or communicated. The results from the study indicate that SRL provides a tool that forces the applicants to reflect and think about the sustainability of their project. However, improvements are needed, especially regarding clarifications of what degree of efforts and work is expected within the levels, as the applicant experienced the level of detail unclear. Furthermore, as economic aspects are included in MRL and SRL, there might be a risk that the economic aspects overshadow other sustainability aspects, especially as the social aspects are considered more difficult to analyze. One aspect to consider is the limited implementation time of SRL, which might be related to the fuzziness related to what the levels should entail. As explained by one of the reviewers, it can take time to learn what can be expected within each level. The development of SRL

should therefore also be seen as an iterative process. Furthermore, in order to fully understand the effect and benefits of tools such as SRL, a broader implementation in different contexts are needed. This however requires consensus and common frameworks on how they should be applied and used.

7.1 Recommended future development

- A problem with a need of flexibility and pluralism with regard to the sustainability interpretations along with a perception of SRL as a vague and fuzzy tool was revealed in the study. In order to mitigate this current discrepancy, guidelines should be developed on how to use SRL and the level of detail and information required within each level. The guidelines should include examples of earlier successful movements on the scale, and possible methods to use within each level. Furthermore, including a requirement to identify main uncertainties related to the possible sustainability impact as well as motivations for the excluded sustainability aspects could be fruitful.
- Learning platforms for the applicants to discuss their sustainability work and use of SRL could mitigate the perceived "closed" sustainability debate and contribute to transparency and learning. Including the researchers and their difficulties working with SRL would hopefully encourage further efforts with incorporating sustainability awareness and life cycle thinking into the projects, mitigating the risk of making SRL an imposed administrative task.

7.2 Recommended future research

- More research is needed on the effect of tools such as SRL after a longer period of time, using both quantitative and qualitative measures. What are the consequences of such tools in terms of the project portfolio, the contribution of R&D in sustainability transitions and the diffusion of research results? Furthermore, more research is needed that focus on the effect of tools that introduce mandatory sustainability assessments/valuations on the different phases of the project life cycle.
- The requirements on researchers to identify and assess possible impacts of their research has increased. As shown in the literature review, there are

several inherent methodological difficulties related to this, such as the fact that research impact might not be visible until after a long time after the project end and might not be quantifiable. More research should focus on the effects of this "impact agenda", and how it affects projects where the sustainability aspects/possible impacts are less predictable. Furthermore, how can impact- and sustainability assessments be developed and specified in a way that mitigates the risk of prioritizing certain types of impacts while still providing directionality and clear requirements?

- Furthermore, future research should be directed towards handling the need for openness and flexibility of SA practices along with the demand (as seen in this study) to be direct and explicit in the requirements and targets of the SA.

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Appendix

1. Interview guide applicants

Inledning

Kort presentation av exjobbet; syfte, metod & analys.

Kort presentation av projektledare/forskare: i) erfarenheter av att skriva ansökningar ii) Vilka utlysningar har du ansökt inom med SRL? iii) Eventuella erfarenhet av att arbeta med hållbarhetsanalyser.

Etiska riktlinjer:

- Frivilligt att delta i undersökningen och du har möjlighet att avbryta intervjun.
- Konfidentialitetskravet, namn & organisation anonymiseras. Hur ser du på beskrivningen av din bakgrund/organisation/erfarenhet/kön?
- Det som sägs kommer endast användas till den här studien.
- Inspelning. Endast jag kommer att ta del av rådata och transkriberingar.
- Analys av data: transkribering, kodning och kategorisering

”Procedural effectiveness”	Hur uppfattade du SRL som koncept och dess funktion i ansökningsprocessen? (Syfte och användning) Hur använde ni er av SRL i ansökan? (Vilka verktyg användes m.m.)

”Substantive effectiveness”	Påverkar användningen av SRL förståelsen för hållbarhetsaspekter som är centrala för projektet enligt dig? I så fall, hur? (*Om ansökan beviljats)* Påverkades ni av SRL i utformningen eller integreringen av hållbarhetsaspekter i projektet? Om ja, hur? Vilket värde ser du i användandet av SRL? Vilka eventuella svårigheter upplevde du i användningen av SRL? (Fanns det några svårigheter med användningen av SRL utifrån projektgruppens egna förutsättningar?) Hur ser du på de olika SRL-nivåerna? Är de tydligt beskrivna och lättförståeliga?
”Transactive effectivenesss”	Hur påverkade SRL arbetsbörda och tid i ansökningsprocessen? (Anser du att SRL är ett effektivt sätt att beskriva centrala hållbarhetsaspekter i förhållande till tid och arbetsbörda?)
”Normative effectiveness”	Hur uppfattar du att ”hållbarhet” definieras enligt SRL? Vad tycker du om den definitionen av hållbarhet? Anser du att SRL bidrar till integreringen av olika hållbarhetsaspekter i projektets hållbarhetsarbete/analyser?
Generella frågor	I jämförelse med de andra skalorna som används, TRL och MRL, hur upplever du användningen av SRL i ansökningsprocessen? (Dess effekt för er i ansökningen och dess svårighetsgrad i appliceringen?) Hur ser du på relationen TRL, MRL och SRL?

	Hur skulle SRL kunna utvecklas enligt dig?
	Övriga kommentarer, tillägg eller reflektioner?

2. Interview guide reviewers

Inledning

Kort presentation av exjobbet; syfte, metod & analys.

Kort presentation av bedömare: i) erfarenheter av forskningsbedömning. ii) Vilka utlysningar har du bedömt där SRL har förekommit? iii) Eventuell erfarenhet av hållbarhetsarbete/analyser.

Etiska riktlinjer:

- Frivilligt att delta i undersökningen och du har möjlighet att avbryta intervjun.
- Konfidentialitetskravet, namn & organisation anonymiseras. Hur ser du på beskrivningen av din bakgrund/organisation/erfarenhet?
- Det som sägs kommer bara att användas till den här studien.
- Inspelning. Endast jag kommer att ta del av rådata och transkriberingar.

”Procedural effectiveness”	Hur använder ni er av SRL i bedömningen av ansökningar? Vilken funktion har SRL haft? Hur skulle du beskriva kvalitén i hänvisningen till SRL-nivå och beskrivningen av SRL-förskjutning bland ansökningar som du har läst?

”Substantive effectiveness”	Hur påverkar användningen av SRL förståelsen för hållbarhetsaspekter som är centrala för projektet enligt dig?
	Har användningen av SRL påverkat vilka projekt som får finansiering?
	Vilket värde ser du i användandet av SRL?
	Vilka eventuella svårigheter ser du med användningen av SRL?
”Transactive effectivenesss”	Hur påverkar SRL arbetsbörda och tid i bedömningsprocessen? (Anser du att SRL är ett effektivt sätt att få en förståelse för centrala hållbarhetsaspekter i förhållande till tid och arbetsbörda?)
”Normative effectiveness”	Hur uppfattar du att ”hållbarhet” (sustainability) definieras enligt SRL?
	(Vad tycker du om den definitionen av hållbarhet?)
	Bidrar SRL till att minska risken att investera i ”ohållbara” projekt?
	Anser du att SRL bidrar till integreringen av olika hållbarhetsaspekter i bedömningen och projektansökan?
Generella frågor	Hur ser du på relationen mellan SRL, TRL och MRL? Vägs dessa lika och sker avvägningar mellan dessa aspekter?
	Risk/osäkerhet & potential. De huvudkriterier som Vinnova generellt bedömer utifrån är potential, aktörer och genomförbarhet – hur ser du på relationen mellan dessa kriterier och TRL, MRL och SRL? Tex ett projekt som ni anser har stor potential i förhållande till

hållbarhet men låg/ dåligt motiverad SRL, hur hanteras det?

Hur tycker du att SRL ska utvecklas?

Övriga kommentarer, tillägg eller reflektioner?

3. TRL & MRL

Table 8 TRL (as stated by EC and used in BioInnovations application guide)

TRL	Description
TRL1	Basic principles observed
TRL2	Technology concept formulated
TRL3	Experimental proof of concept
TRL4	Technology validated in lab
TRL5	Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL6	Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL7	System prototype demonstration in operational environment
TRL8	System complete and qualified
TRL9	Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

Table 11 MRL (BioInnovation, 2019)

MRL	Understanding of customer and market based on a Market Value Proposition
MRL1	• A hypothesis on customer and market needs is formulated • Existing solutions/products are described An overview of the right and opportunity for commercialization is described
MRL2	• Critical functions for a solution or product have been delivered to and tested on potential customers • A more detailed picture of right and opportunity for commercialization has been developed • A business concept has been described, e.g. according to the NABC model • Customer and market needs have been confirmed through interviews or practical tests
MRL3	• Key customer relations and partnerships that confirm unique properties or functions have been established • Ownership with documented right and opportunity for commercialization is investigated A business concept is confirmed against a number of potential customers and has an estimated commercial potential • Product testing or test sales are ongoing

4. Possible improvements of SRL mentioned by the applicants & reviewers

The users mentioned several possible improvements on how SRL can be developed. The main suggested improvements can be seen in the chart below. The reviewers did not leave as explicit suggestions on the improvement of SRL. As seen in the result, one of the reviewers suggested that the call texts could become more explicit in what sustainability aspects are of interest for the different calls, thus the suggested improvements were related to the general sustainability reviewing and the call text rather than on SRL. Another reviewer stressed that time is needed to learn how to calibrate between the levels. The programme manager added that it would be interesting to see SRL in other programs and on a larger scale in the future. Thus, the improvements listed in the chart below are mentioned by the applicants.

Table 12 Possible improvements of SRL mentioned by the applicants. Reflections on these developments are also included

Possible improvements of SRL stated by the applicants	• More guidelines on what the levels entails. What is general sustainability assessment and what level of detail should it include? However, it was also stressed by some applicants that long texts and descriptions should be avoided. • Examples on the levels, including how applicants successfully have moved from one level to another. • Feedback, preferably on both the good and bad parts. • Some kind of educative workshop for interested scientists/parties. • Forum for discussion where parties in the projects can share thoughts, approaches and proceedings. • Include reflections around SRL in an end-report in order to contribute to the development of SRL as a tool and to promote a more open climate around sustainability issues.
Reflections on the development of SRL	"*I think that it would be nice if these issues could be downplayed a bit, so that people don't feel like they need to be "the best"* [in the explanations of SRL], *but that it would be more forgiving. (…) Because it is better to highlight the question marks than to ignore them and pretend to be better than you actually are. Maybe this could be a requirement in an end-report that we hand in, to reflect around SRL in a transparent and open way, so that BioInnovation can use this information for the development of SRL"* (Quote 35, translated by author)

	"Feedback is key for the applicant as it is an educational process. Often you're left in the dark because you don't get feedback more than a yes or a no, which is a pity." (Quote 36, translated by author) *"It occurred to me now that what usually happens when something is not clear enough is that a long cheat sheet is provided, with 10 pages for every part. SRL should not become an administrative thing. Because that probably ends with everything just becoming an administrative must. It has to be very clear what the aim is for it to have an impact. Now, it can develop so that SRL is used only because it is a requirement in the application, but it has a greater potential."* (Quote 37, translated by author) *"First and foremost, I think that BioInnovation should send out some cheat sheets of what they actually mean, without stacking empty words on each other."* (Quote 38, translated by author)

5. Original quotes

Table 9 Original quotes (in Swedish)

Quote nr#	Quote
1	"Ja det blir en diskussion med de andra som är i gruppen så tittar man i den här tabellen och försöker se vart man är och vad man tror är rimligt att man kan vara när man har gjort ett projekt eller… så då bedömer vi att vi kanske har flyttat den hit. Men det måste vara rimligt också utifrån det vi vill göra."
2	"Jag hade en diskussion med han som hjälpte till med ansökan och han har varit med rätt mycket och sen

	hade vi rimlighetsnivå eller rimlighetsbeskrivning, eller vad jag ska säga, av nivåerna.”
3	“Nej, men det beror på att hela vår existens bygger så stenhårt på hållbarhet. En av våra konkurrensfördelar är att vår produkt är betydligt hållbarare än det som finns på marknaden idag. Så vi upplever inte att… Den är given för oss så att säga. De som har uppfunnit produkten har haft det (hållbarhet) i åtanke hela tiden, så jag kan inte påstå att det har hjälpt oss på det sättet men det beror på att vi har varit väldigt långt fram i den delen.”
4	”Ska jag vara rent krass så förändrar det ju inte hur jag gör en ansökan eller vad det är för idéer man sjösätter. Det kommer ju med, ja man kanske inte ska vara alltför självgod heller men det kommer lite med det man håller på med, så att man måste ju jobba med, där företag har behov och man har ju ett behov av att verka för en mer hållbar verksamhet. Det är det som driver de företag som jag jobbar med, eller en av de sakerna.”
5	“Nej jag tror inte det för att det är ett spår som, nämen det är grundtanken i hela projektet. Så i det här fallet, nej, jag tror inte att vi gör annorlunda på grund av skalan. Jag kan tänka mig andra projekt som ligger längre tillbaka i tiden som vi kanske skulle ha haft ett litet annorlunda beteende eller arbetssätt om vi hade haft den här skalan att relatera oss till, men inte just detta projekt.”
6	”Och som tur är så jobbar vi redan med de aspekterna som vi kom fram till, så att det var inte som att vi kom fram till att nu måste vi svänga om hela projektet.”
7	”Ja det är superenkelt, det svåra kanske är när man byter trä mot trä men byter du det mot något annat så är det ju väldigt enkelt. Det är ju lite fusk på det sättet.”
8	“I BioInnovation är det många sökare inom skogsindustrin och andra biobaserade material, som antar att för att man använder en biobaserad råvara, så är det en mer hållbar process än en fossil råvara, vilket det ofta är men de kanske inte har några faktiska belägg för att deras produkt är mer, och på vilket sätt

	deras produkt är mer hållbar. Och det är ju alltid lätt att säga att någonting är grönt och hållbart men det är väldigt sällan som man ser en faktisk uppskattning på tex minskade klimatutsläpp.”
9	”Så det är ändå bättre att man börjar, så vagt det än är och liksom”
10	”Ja de är inte glasklara kan man inte säga. (…) Jag tror att SRL 1 och i viss mån SRL2 är rätt okej. Men i SRL2 där börjar man att prata om potentiella kunder och det tycker jag är lite mer MRL egentligen.”
11	”På en teoretisk nivå är det grandiost men det är svårt att tillämpa.”
12	”Det är väl bra om man kan kommunicera hur mogen teknologin är utifrån hållbarhetsperspektiv.”
13	“Jag tror att det också stod i utlysningstexten vilka delar man förväntas röra sig inom och det är ju relevant. Så att om man inser att man ligger utanför spannet så behöver man inte spendera våran och granskarnas tid utan då får man titta sig om efter annan finansiering.”
14	”Så att jag tycker att det har bidragit till en ganska bra diskussion kring ansökningarna, det har liksom varit, ja ett perspektiv till som har varit väldigt viktigt, speciellt för dem här utlysningarna.”
15	“Sen blir egentligen SRL mer som att man kan använda sig lite av de glosorna där, för att förenkla kommunikationen när du skriver bedömningen och kanske som något ”kom ihåg”-liknande, men det är ju inte som att SRL är det som styr bedömningen utan bedömningen gör man på helheten. Och sen kan man använda SRL-begreppen som ett gemensamt språk med andra bedömare för att förenkla diskussionen. Men jag tror inte att bedömningen av projekten påverkas speciellt mycket av användningen av SRL.”
16	“Man kan ha ett överseende med om man inte har fattat SRL modellen eller precisa definitioner men å andra sidan har man inte överseende med om man inte har fattat de grundläggande hållbarhetsaspekterna alls, då kan man vara hur inläst på modellen som helst men om man inte fattar den verklighet som man ska hantera är det kört ändå.”

17	“Det viktiga är ju att de som skriver ansökningarna inte nonchalerar riskerna, utan att man ger bedömarna chansen att förstå situationen och också bedöma hur man förhåller sig till det.”
18	”Du får inte med dig, hur du än vrider och vänder så får du inte med dig tillräckligt, så mycket detaljerad information av en sån kvalité så att du kan använda dig skarpt av de här modellerna.”
19	”Så jag tror, som svar på din fråga så tror jag att de har tyckt att det har varit lite svårare och det har också synts för det har varit lite större skillnader just inom SRL mellan ansökningar, än det har varit inom de andra, så upplever jag det.”
20	“Jätteolika. Det finns de som bara försöker ”checka boxarna” i ansökan, och som bara försöker se till att de når upp till så många kriterier som möjligt. Och detta lyser ibland igenom att egentligen vet man inte vad man håller på med, tyvärr. ibland är det de som har jättebra koll på detta och ibland är det de som går till överdrift, där definitionerna och finesserna att uttrycka sig på ett SRL-korrekt sätt blir viktigare än innehållet och substansen i ansökan. Så det är väldigt olika och man märker det tydligt i ansökan från vilket håll de sökande kommer.”
21	”Det kan vara allt möjligt. Allt ifrån att man bara har hittat på något, dragit något ur luften till att man kanske faktiskt har tittat på hållbarhet, kanske gjort någon form av enklare LCA-analys, tittat på hela värdekedjan. Så det är väldigt högt och lågt skulle jag säga. Det är ojämnt.”
22	“Sen om det är liksom, att det kanske i början inte alltid är 100% genuint eller vad man ska säga, så tror jag ändå att det finns ett värde i att få den här tanken att komma igång och få dem att börja fundera över det. Det tror jag är den största vinsten med dem här underkriterierna.”
23	”Nej men man ska ju vara medveten om att det är institut, företag, högskolor, universitet som söker och det handlar ju om pengar. Och för många är ju de här pengarna väldigt viktiga att få in så att ja, det är ju inte ovanligt att man skriver det som man tror att bedömarna vill höra. Så är det.”

24	“Jag har tänkt det så att ”sustainability” är ju hållbarhet, det är ju inte miljö, utan tanken är ju miljö och sociala aspekter. Sen kan man beskriva det på lite olika ätt men kontentan är ju att det är både och, både hur vi interagerar med miljön men också hur vi interagerar människor emellan.”
25	“Ja alltså hållbarhet är ju en mängd olika saker. Allt ifrån ekonomisk och social hållbarhet, till olika former av ekologisk och mer naturvetenskapligt baserad hållbarhet. Och där får man egentligen gå tillbaka till syftet med utlysningen, vad är det man vill åstadkomma med de här pengarna man har till sitt förfogande. Och utifrån det får man gaffla in sig på vilka hållbarhetsaspekter är det som är mest relevanta för den här bedömningen.
26	“Jag har nog tänkt väldigt mycket utifrån ett miljöperspektiv. Men visst, vi har ju den ekonomiska delen också och den… vad heter det, social sustainability. Men jag har nog tänkt spontant på miljöaspekterna.”
27	”Jag tycker nog att fokus är på miljömässiga aspekter.”
28	”Det är mycket lättare att belägga en TRL-status, och där kan man ju också föra fram konkreta, man kan understödja sina påståenden mer. Har man testat det i fältskala eller har man inte testat det i fältskala. Nej vi har kört i provrörsskala i på labb. Eller har ni kört det här i fabriksskala, har ni gjort 10 ton av den här grejen eller inte. Så det är ju mycket mer konkret, och lika så med MRL, kan man ju också ta fram ekonomiska mätvärden på, finns det kontrakt med kunden, hur mycket har ni sålt. Finns det IP-rättigheter osv. Hållbarhet är ett mycket mer spretigt instrument. Det finns vissa saker som man kan räkna på och ha lika bra koll på som med TRL eller MRL, hur mycket fossilt koldioxid ersätter du osv, vad har du för Co2 besparingsrätt, det finns ju legalt definierade beräkningsmodeller osv, men sen när man kommer in på biodiversitet, social hållbarhet osv, det är så fluffigt för då kommer man in på väldigt mycket runt etik och politik, och ideologiska inriktningar.”
29	”Jag tycker att det är ett vagt begrepp och det är ju lite så det är med hållbarhet överhuvudtaget att det finns väldigt mycket synpunkter, alla vill göra bra på något sätt, alla vill göra något som är hållbart och känna att man har gjort någonting som faller inom ramarna för hållbarhet. Men begreppen är väldigt vaga och sätten

	att beskriva eller mäta någonting är också väldigt vagt och man är inte överens. Så att jag tycker ju att det är bra att tänka och det är bättre att tänka och göra utifrån hur man tänker än att inte göra någonting alls och vänta på någon sorts bättre mätsticka eller mätetal, för då kommer ingenting att hända.”
30	”Då kan man ju få hjälp att beskriva MRL på ett ganska bra sätt. Men SRL är ju kanske många gånger lite mer magkänsla eller ett antagande eller hypotetiskt.”
31	”Man kan hamna lite varsomhelst om man bara säger att det ska bidra till hållbarhet.”
32	“Hur ska du vikta ökade havsnivåer mot en ökad social hållbarhet för att en bonde i Afrika ska kunna sälja mer av sina grödor? Så att så länge du har SRL som ett stort samlingsbegrepp för massa olika saker, så blir det per definition väldigt trubbigt.”
33	”Så att antingen får man lämna till bedömarna att plocka ut de aspekter som i den aktuella utlysningen är relevanta inom SRL och så hanterar man det, eller också så får man helt enkelt, ha underindikatorer eller andra indikatorer som inte är de här superbreda hållbarhetsaspekterna då. Jag tror att man ska bli mer specifik, skarp och spetsig och säga att det är de här och de här aspekterna som man i första hand ska ta hänsyn till här.”
34	”Så att du inte kan klumpa ihop tex hur väger du biodiversitet för någon sånglärka mot ökad/minskad Co2 effekt? Det är inte självklart. Hur ska du vikta de två?”
35	”Jag tycker att det hade varit skönt om det kunde avdramatiseras lite grann så att man känner att man inte behöver vara så duktig, utan att det hade varit lite mer förlåtande. Så att man mer hade kunnat säga att ”såhär långt har vi tagit oss när vi har tagit de här antagandena och det här är fortfarande kvar som frågetecken för oss”. Så att man inte försöker vara så himla duktig, att man inte känner att man behöver vara så himla duktig för att det är bättre att det blir gjort och att man belyser de frågetecken som finns kvar faktiskt än att låtsas vara bäst. Det skulle ju kunna vara nånting som man kanske skulle kunna ha

	som ett krav kanske i en slutrapport när man lämnar in. Att alltså, föra mer ett resonemang runt SRL på en transparent och öppen nivå som sen BioInnovation kan ta till sig för att vidareutveckla SRL som verktyg.”
36	” Återkoppling är för de som söker medlen väldigt viktigt. Tyvärr får man inte alltid återkoppling på det man skriver heller mer än att man får ett ja eller ett nej så man famlar i blindo på det sättet, vilket är synd.”
37	“Ja nej men det som slog mig är att det som ofta blir om man säger att okej det här är inte tillräckligt tydligt, det är att man då kanske måste skriva en lång lathund på 10 sidor för att förklara vad varje punkt betyder och att man ska gå igenom det. Det får inte bli en administrativ grej. För att det slutar i så fall med att det bara blir administration av allting, man måste vara tydlig på väldigt få punkter som är i en sån här tabell. Och det måste va väldigt klar med vad man menar och hur man tänkt för att det ska få genomslag. Nu kan det bli så att det används för att man måste använda det i en ansökan, men det finns en mycket större potential”
38	“Alltså först och främst så tror jag att i fallet BioInnovation så tror jag att man behöver skicka med mer lathundar och mer kunskaps, vad de avser utan att det blir massa ord som staplas på varandra.”

6. Possible SA-methods aligned with TRL

Table 10 TRL and possible SA methods (Chebaeva et al, 2018)

TRL	Possible methods

TRL 2-3	Outranking (qualitative), mixed MCA methods, MCA[6] (qualitative + screening), multi-objective decision methods (screening), multi-attribute utility methods (qualitative + screening) checklists, simplified checklists, Bournemouth University model, ABC-analysis, theme-based and accounting indicator frameworks, market assessment, conceptual modelling, matrix LCA, streamlining LCA, cost-benefit matrices, hedonic pricing method, fuzzy models for sustainability indicators assessment (screening-based), diffusion assessment and growth-curves, experience curves, sustainability/ environmental performance ratings and scorings, sLCA (qualitative), Philips Fast Five Awareness and LiDS Wheel
TRL 4-5	Screening, streamlining/matrix LCA, screening LCC, screening sLCA, screening CBA, MCA (qualitative+ screening+ accounting), multi-attribute utility methods (qualitative+ screening), environmental footprint (screening), MECO (screening), dynamic integrated driving force-state-impact-response model, system dynamics, agent-based modelling, energy/ exergy/ energy analysis, WAR-algorithm, product material intensity (partially screening), Eco-HoQ and Eco-QFD, fuzzy EcoDesign Index, customer immersion

[6] Multi Criteria analyses

TRL 6	LCA (partially screening), LCC (partially screening), CBA (partially screening), MCA (qualitative & quantitative), multi-attribute utility methods (qualitative & quantitative), MFA and SFA (partially screening), product material/energy intensity (accounted), environmental risk assessment, MECO, Driving Force-Pressure-State-Impact-Response Reporting, life cycle index (partially screening), fuzzy models for sustainability indicators assessment