Declaration of authorship

By signing this, I, Sofie Graunbøl, declare that the thesis with the title 'Setting boundaries for future development of social sustainability assessment tools, in (furniture) product development, through a design specification', and the work presented is my own.

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Preface

This is my thesis on social sustainability assessment tools and how I suggest we can develop future tools that are based on the needs of the people who are going to use them.

The thesis is divided in four parts: 1) reflections on the design process, 2) a scientific article for the journal *Sustainability*, 3) supplementary text and 4) Appendices (in a separate document)

The work throughout the project is planned and executed by myself alone and it can therefore appear one-sited, even though I have tried my best to avoid it. I have used my competences, as a Sustainable Design Engineer, to create the design process that made sense to execute within the timeframe of four months. If I had two more people and a month longer, I would have developed and tested a framework based on the criteria for development presented in the article. My biggest wish has been to take the first step in making (social) sustainability understandable, so we, in the future, can solve problems related to social sustainability <u>because</u> we understand the impacts. I have, together with experts created a new definition for social sustainability, that should work as a guidance for future development:

"Social sustainability are <u>communities</u>, <u>people</u>, and <u>human needs</u>. Both for the current and future generations. It exists to create culture of <u>resilience</u>, equality and equity, health care, work conditions and financial security."

The article is written to the journal *Sustainability* because it is based on several articles published by the journal, and it seeks to offer knowledge, understanding, and insight on assessing social sustainability and how/if it should be assessed.

I acknowledge that the article does not completely fit the journals format, as it usually does not include appendices. Appendix will be presented as [x, chap. X]. In the final version, it will fit the journals format correctly.

Setting boundaries for future development of social sustainability assessment tools, in (furniture) product development, through a design specification

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Abstract: This article focuses on identifying challenges on social life cycle assessment tools, based on a case study on the Danish design furniture company, SAYSHWO. The S-LCA methodology is based on LCA and was first presented in 2009 by the United Nations Programme *Guidelines for social life cycle assessment of products and organizations* [1]. These guidelines were supposed to act as the framework for doing assessments on potential impacts of a product but instead created barriers for the companies trying to use it. Several important aspects of the S-LCA have been overlooked and the interpretations become too unrealistic and based on assumptions. The research contributes to the social sustainability field by 1) identifying social assessment tools to use in a design process, which can enlighten decisionmakers and researcher looking for a tool to use, looking from a life cycle view, 2) create a common definition of social sustainability in design, and 3) sets the boundaries for creating new assessment tools by introducing a design solution that can guide the development process of such tools.

1. Introduction

Social sustainability can be defined as a measure of human welfare, where it is not about living a simple existence, but having the best possible lifestyle [2]. Social sustainability **"**(…) is focused on the development of programs and processes that promote social interaction and cultural enrichment." [3, p. 1]. United Nations Programme (UNEP) [1] argues that it is important to be able to make the best possible assessment of the *potential* positive and negative social impacts of products, processes, and systems [4]. One way of assessing the social sustainability of products, companies can use a Social Life Cycle Assessment (S-LCA) tool. S-LCA is based on Life Cycle Assessment (LCA) methodology, that asses *potential* environmental impacts associated with the life cycle of products, processes, or services. The

reviewing of environmental impact leads back to the 1960s, when Harold Smith created the calculations of cumulative energy requirements for chemical products, during the World Energy Conference in 1963 [5]. Later the LCA methodology was created. The LCA study is based on ISO-standard 14044[1] [6]. One of the barriers of a traditional LCA are that the framework in the bigger picture only focuses on the ecological aspects of sustainability and fails to consider economic or social aspects [7]; [8, Ch. 1]. According to Klöpffer and Grahl [9] the economic and social aspects avoided to not overload the method, even though the argument is that these aspects should not be overlooked [9]. Another barrier for LCA is implementation [10]. According to UNEP [1], [4], there the common limitations to the S-LCA, are related to 1) Novelty of technique (lack of tools e.g., software), 2) Difficulty in accessing data, 3) skill of practitioner etc [1], [4]. Where Klöpffer and Grahl [9] argues that the definition of social sustainability and implementation of the S-LCA methodology, are the biggest limitations [9], [11]. But what happens when there are different understandings of a word and complex frameworks and software, that makes it even harder to make the correct assessment?

This research is conducted in the context of SAYSWHO, a Danish design company, that is hired to design furniture on behalf of furniture manufacturers. "We're a dedicated team of design, engineering, and business professionals. We team up with furniture retailers, brands, and manufacturers as an external design and development partner." [12]. During the design process, SAYSWHO supervises their customers in making the most sustainable decisions in terms of material choice before it is being manufactured. The article will address how to assess social sustainability in the product development phase (Figure 1), where SAYSWHO are located. SAYSWHO have developed an LCA nudging tool[2] for the decision-making as other tools did not fulfil their needs. The decisions made in the design phase of the life cycle are highly important and SAYWSHO should keep nudging their customers in the right direction, with both their Sustainable Design Screening tool and strengthen their supervision with the future social sustainability tool.

Figure 1. SAYSWHOs part of the life cycle (green arrow)

The purpose of the article will be to 1) identifying social assessment tools to use in a design process, which can enlighten decisionmakers and researcher looking for a tool to use, looking from a life cycle view, 2) create a common definition of social sustainability in design, and 3)

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[1] International Organization for Standardization (ISO) 14001 sets out the criteria for an environmental management system and can be certified to. (ISO.org)
[2] Sustainable Design Screening tool

set the boundaries for creating new assessment tools, that companies like SAYWSHO can use.

This article investigates how social sustainability of products within the furniture industry, can be assessed through social life cycle assessments and what the barriers of the existing assessment tool are. The article is guided by the following research question:

How to set boundaries for future development of social sustainability tools, in furniture product development, through a design specification that facilitates a new understanding of social sustainability?

To answer the research question, a case study of SAYSWHO and a systematic literature review (SLR) of existing S-LCA tools was conducted, related to product development (in furniture design) was performed. To complement the systematic literature review, three expert consultations (interviews) with different stakeholders were performed, to gather knowledge on how experts assess sustainability throughout the life cycle of a product. To complement the case study, a focus group with experts was conducted to create a common definition of social sustainability. Criteria of development, based on the SLR, case study, expert consultations, and a focus group, sets the boundaries for future idea generation and evaluation of a future sustainability assessment tools.

The article is structured as follows: section 2 provides the background for the research. Section 3 introduces the research methodology including the systematic literature review on social sustainability assessment tools. Section 4 presents the result of data collection through the systematic literature review, stakeholder interviews and a focus group. Section 5 presents a set of criteria for development for a future design solution. The results and criteria for development will be discussed and concluded in section 6.

Throughout the article the word *tool* will be used for describing frameworks, methods and regular tools used for assessing the positive and negative social impacts of a product throughout its life cycle.

2. Background

2.1 Social impact

Social impact can be defined as a function of strength (power, influence, or intensity), immediacy (context) and number of people (people acting on the target) [13]. When assessing social impacts, we look at the *potential* social impacts where the potential is understood as the likely presence of a social impact, because of behaviours/activities of organisations linked to the life cycle of a product or service [4]. We asses *potential* impacts because we want to convey relativism [4]. *Actual* social impacts are the changes that affect different stakeholders because of activities during a life cycle [4] [8, Ch. 2]. Impacts can be evaluated at different levels, (i) micro (products/services/technologies), (ii) meso, "which includes "groups of related products and technologies, baskets of commodities (e.g., the product folio of a company), a municipality, a household" [14, p. 93] ; and (iii) macro, i.e., geographical/political entities [14], where S-LCA aims to cover all levels.

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2.2 Social Life Cycle Assessment

Social Life Cycle Assessment is defined as *"a technique available to account for stories and inform systematically on impacts that otherwise would be lost in the vast and fast moving sea of our modern world."* [1, p. 5]

The Social Life Cycle Assessment methodology helps to identify and assess potential positive and negative social impacts on various stakeholders during the life cycle of the product or service [1], [15], [16]. The current S-LCA tools are framed in the *Guidelines for social life cycle assessment of products* [1] [8, Ch. 3], which were updated in 2020 [4], and are based on assessing social and socio-economic impacts, by taking a **participatory** approach [1]. S-LCA aims to assess product and production related social impacts looking from a life cycle perspective [4]. S-LCA is based on the Environmental Life Cycle Assessment (E-LCA) and LCA framework [1] that focus on assessing the environmental impacts of a product. How come a methodology that does not consider the social aspect, lays the ground for a social assessment methodology?

Like all other assessments, there are several tools that can assess social sustainability (Benoît et. Al, 2020). Even though most of the tools look alike, they are complex in different ways and "(...) each S-LCA method is focused on a special field, using an independent database. It means that the research results cannot be directly reused or accumulated because of the disunity of the S-LCA process as well as the dynamic changing indicators and databases" [17, p. 3] This also means that the tool used to assess the production phase cannot always be translated to the product development phase. According to the Life Cycle Initiative, the S-LCA does not question whether a product should be produced or not, but the results should offer "food for thought" and can be helpful in decision-making throughout the life cycle [18].

2.3 Stakeholders

While E-LCA encourages expert involvement as part of the peer review of the study, to improve business, the S-LCA encourages involvement of "external" (life cycle) stakeholders to contribute with knowledge on impacts during the product life cycle [1]. Stakeholders are an individual or a group of people, that can be affected by a products life cycle [19]. According to Benoît et al [4], the stakeholders of the life cycle must be identified as one of the first things of the assessment and "all *relevant* stakeholders" [4, p. 51] must be included in the assessment process. The stakeholders are associated with geographic location and context (mines, factories, roads, harbours, offices, etc.). At each location the researcher can identify social and socio-economic impacts within six stakeholder groups:

- Workers/employees
- Local community
- Society (national and global)
- Consumer (end-consumers and consumers throughout the life cycle)
- Value chain actors

- Children[3]

A stakeholder category is a cluster of stakeholders that are expected to have shared interest due to their similar relationship to the investigated product system [1], [20]. The S-LCA framework is split into stakeholder categories, impact categories, subcategories, inventory indicators and data [8, Ch. 3]. Stakeholder subcategories are according to Traverso et al [20] the basis of an S-LCA because they are the items of which justification of inclusion or exclusion needs to be provided [20]

3. Methodology

To answer the research question research methodologies based on a case study, a systematic literature review and expert consultations were employed.

This section introduces the research methodology steps of the overall research process. The article follows the first three phases of the design framework, *Double Diamond*, within the design phases; *Discover, Define and Develop* [21] (Figure 2). The framework conveys a design process with an exploring (divergent) thinking and focused action (convergent thinking) [21]. Whereas the *Deliver* phase will be explained in section 6. Even though, the figure shows a linear process, this is not the case [21].
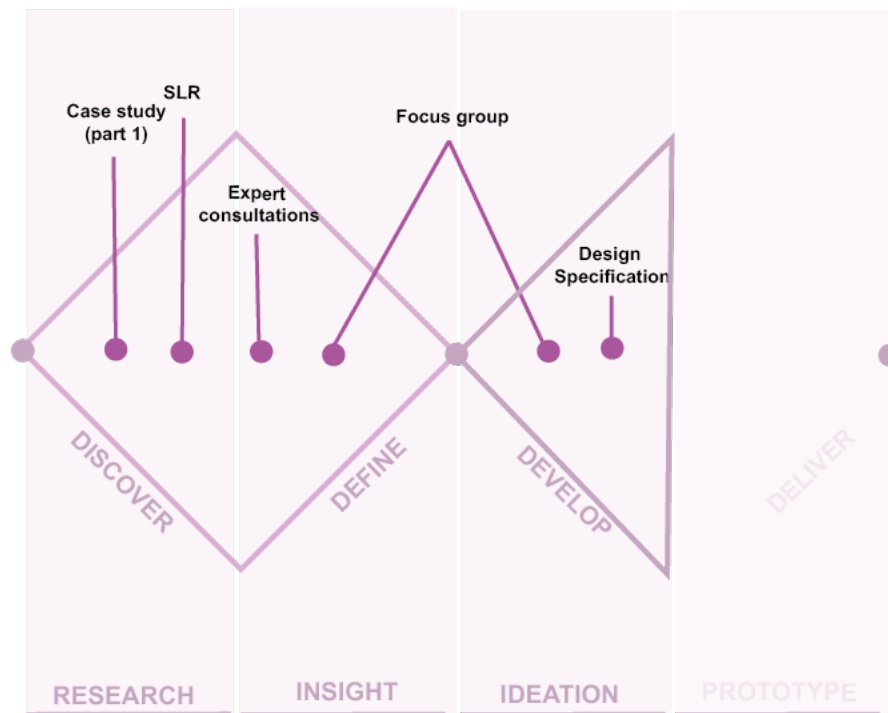

Figure 2. Double diamond, inspired by Design Council (2019)

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[3] Acknowledged in 2021 by UNEP as part of the newest version of the *Guidelines for social life cycle assessment of products* [44]

3.1 Discover

This section addresses the *Discover* phase of the Double Diamond methodology. Discover is about understanding the problem, not by making assumptions but by speaking to the people affected [21]

3.1.1 Case study

The case study was about understanding the practices of SAYSWHO and what their needs for a future tool was. The results from the preliminary interviews, would create the empirical base for the systematic literature review, regarding criteria set for the search, and the base for the further research and interview guides. The case study was done over a period, with several interviews creating a feedback loop through the whole process of the double diamond.

3.1.2 Systematic literature review

The systematic literature review (SLR) followed the approach presented by Biolchini et al. [22] consisting of three phases: Planning, Execution and Analysis. Biolchini argues that the methodological tool scientifically improves the assertions, in a field, and the degree of liability of methods used when developing. The literature review was planned as seen on figure 3 and follows five criteria (see table 1). As the review focussed on the furniture industry in the product development phase, the search string [8, Ch. 4] needed to be specific to identify relevant literature.

Table 1. Overview of tool selection criteria used while reviewing publications.

No.	Criteria	Explanation/Description	1st Initial Screening	2nd Detailed Screening
1	The publication must be relevant to S-LCA	The initial screening focuses on the conceptual frameworks, tools and methods used within Social Life Cycle Assessments. Whereas second screening filters out those not developed for the purpose or those that are not used within the assessments of products (e.g., furniture)	X	X
2	The publication is about a tool, process, or method (broad sense)	'Tool' is in this case, defined as steps taken to reach an end goal. Tools can appear as frameworks, processes, typologies, and design games.	X	X
3	Build on literature and practice	The tool must be developed carefully building on literature and practice.	X	X
4	Tool validated in practice and documented?	The tool must be validated in practice. Meaning the tool has been tested empirically and then documented in the publication.		X
5	The use of the tool is clear	There must be a clear procedure on how to use the tool (independently).		X

3.1.2.1 Shortlisting of Social sustainability assessment tools through two phases of filtering
The identification of literature was done through two major academic databases e.g., Web of Science and Scopus/Elsevier. As both databases are open access, the bibliographic databases are somewhat similar, which resulted in repetitive literature.
After removing any duplicates, the next step was to screen and shortlist the identified 92 publications in two review rounds to identify tools that fit the scope of research as presented in table 1. The shortlisting process showed that most tools comply with the first two criteria but a smaller number, fit criteria no. 3, 4 and 5. After the initial screening, and application of criteria, 56 publications containing tools remained. The second, and more detailed screening, identified 31 publications with tools that was suitable for analysis. In some studies, there was no clear distinction between frameworks and case studies, as the trend shows that researchers combine frameworks with case studies to apply and test/validate the (new) method. There has been no targeted selection on case studies, as the researcher wanted to map the different types of frameworks and later apply a selection on the chosen case.
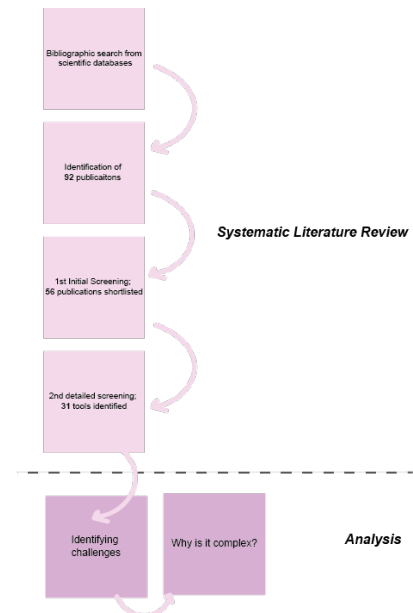

Figure 3. Review protocol.

3.1.2.2 Analysing barriers
In the literature review, knowledge on different social initiatives, labels, databases, software, frameworks, and methodologies was gathered. By the preliminary mapping, an overview on the existing social life cycle and social sustainability assessment tools was obtained and the barriers in these tools were identified. After identifying several tools and tools with different names, methodologies, and outcomes, the research field was narrowed down to Social Life Cycle Assessment tools and their use. As the empirical part of this study was based on the practices of SAYSWHO, who will not move further than the product development phase, the researcher sought S-LCA to be hard to fit into their practices when assessing the products they design, based on data related barriers. The barriers then created the base for a set of criteria for development (design specification).

3.2 Define
Based on the insight from the discovery phase, the article will address and define the barriers identified [21]. One of the tasks for this phase, was to create a common definition of social sustainability. This was done through expert consultations and a focus group.

3.2.1 Expert consultations

When collecting data, it is important to have diversity of perspectives. By working from triangulation [23], the researcher guaranteed this. The data was collected by discussing the current S-LCA tools and the needs versus the ability of use. The triangular evaluation of the S-LCA tools provides data from three perspectives: 1) Industrial expert, 2) Sustainability experts and 3) Sustainability consultancies. By also working from a participatory approach [24], [25] through involving relevant actors through semi-structured interviews and design games [24], [26] the actors/participants [27], [28] was engaged and could elaborate on their knowledge on and experience within assessing sustainability.
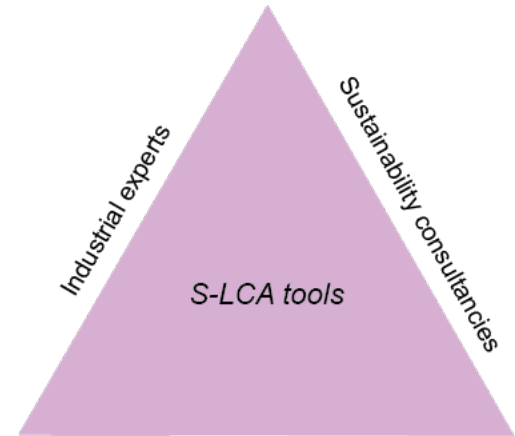

Figure 4. Evaluation triangle

Figure 4 provides an overview of the data collection according to the three types of participants on three different aspects of using sustainability assessment tools.

3.2.1.1 Semi-structured interviews

To engage the relevant stakeholders in the data collection, a guide for semi-structured interviews [29] was created based on the field of expertise of the stakeholder [8, Ch. 5] [8, Ch. 6] to obtain new knowledge, feedback, and thoughts on assessing social sustainability. Experts from each side in the evaluation triangle were interviewed. The interviews were categorized in the following topics: 1) defining social sustainability, 2) choosing an S-LCA tool, 3) using the S-LCA tool and, 4) identifying barriers when using the tool.

3.3 Develop

Develop is about seeking inspiration in creating design solutions for the problem identified in the first diamond [21].

3.3.1 Focus group

A focus group [30] was conducted with four industrial and academic sustainability experts. The experts were selected based on their knowledge on sustainability, LCA tools and knowledge on the furniture industry. The participants in the focus group were presented with the case of SAYSWHO, based on their needs and vision for a tool. The participants were presented with different objects, e.g., a design game based on the SAYSWHO case [8, Ch. 7], where they were to 1) create sentences of what social sustainability is, thereby **defining** social sustainability and, 2) discuss whether social

Figure 5. Defining social sustainability, by creating sentences.

sustainability can be assessed and how it should be done if so. The focus group enabled knowledges on social sustainability, the approaches within assessing sustainability and what barriers there could be.
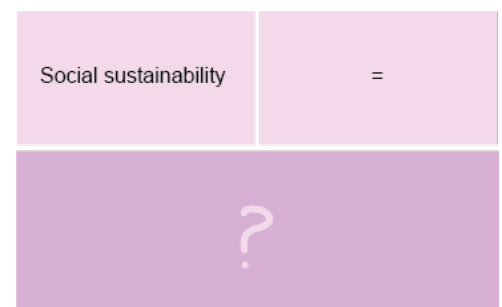
4. Results

This section reports the results from the systematic literature review (4.1 – 4.2), four semi-structured interviews with LCA, industry and sustainability experts (4.3) and the focus group with industrial and academic experts in the field of sustainability (4.4).

4.1 Which social life cycle assessment tools for products exist?

This section presents the results and data from the systematic literature review. The review created the basis of the knowledge of social sustainability and social life cycle assessment tools.

As seen on figure 6 [8, Ch. 8], the systematic literature resulted in a mapping. The mapping is divided in the categories *impact assessment frameworks, initiatives, labels, software, database, social impact, stakeholder/impact categories, indicators, framework, presentation, and other tools* [8, Ch. 8][8, Ch. 9]
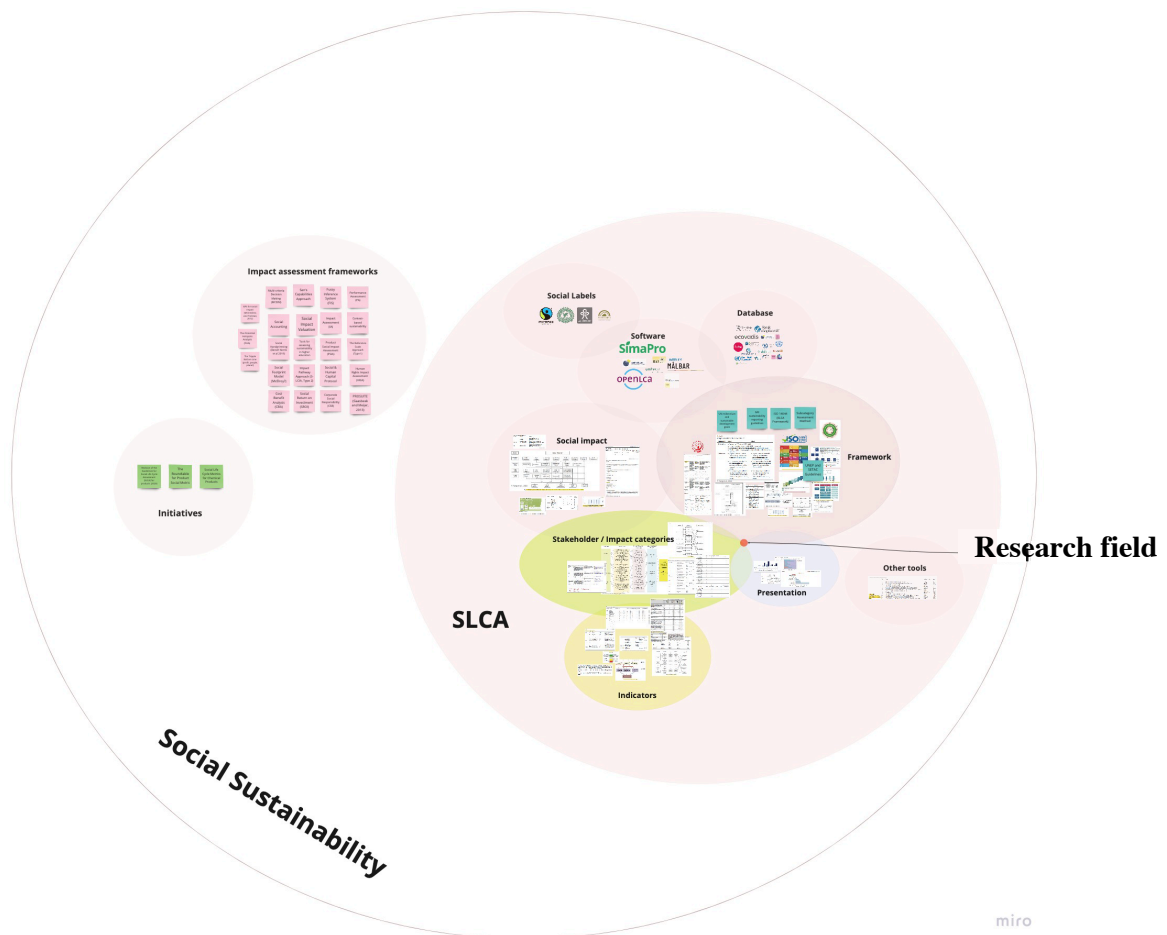

Figure 6. Finalized mapping of social impact labels, initiatives, frameworks/methodologies, databases, and software identified through literature review.

The most asked questions during the research were: 1) who should be involved? 2) which tool should be used? And 3) how can the results be used? The focus of this research was,

therefore, narrowed down to only focussing on the common denominator of the 1) Stakeholder/impact categories, 2) Framework, and 3) Presentation. Within the categories the most discussed tools, indicators and presentations methods are listed in table 2. The focus of the research is displayed as the red dot as it takes place within all three categories and will discuss how designers should move forward within the field of social sustainability.

Table 2. Excerpt of types of tools/indicators for social sustainability assessment.

Tools	Social Life Cycle Assessment [1], [4], [31]
	S-LCA in web development [17]
	Product Social Impact Assessment [32]
Indicators	Sustainable Development Goals [33]
	Social Sustainability Assessment Indicator [34]
Presentation	Reports [1], [4]
	Visualisation [17], [35]

So now, the tools are identified, how come the companies still have problems including them in their practices?

4.2 What barriers are there, for companies, when doing assessments of social sustainability of products?

This section presents barriers, when using the current S-LCA tools, identified through the literature.

When trying to identify and implement tools that can assess social sustainability there can be several barriers. Through the literature review, some of the common barriers are related to 1) lack of data availability, 2) no commonly accepted approach and 3) skills needed to use and communicate the results.

Table 3. Barriers identified through systematic literature review.

Barriers	Statement	Reference
Lack of data availability	"(…) databases are dynamically changing."	[17, p. 2]
	"(…) the weaknesses of the SLCA approach are mainly related to the selection of the appropriate data and social indicators, the inclusion of stakeholder groups and impact categories (…) (Benoît et al., 2010(…)"	[37, p. 1666]

	Use of qualitative data, methodologies, and indicators	[20]
	" The S-LCA methods focus on specific fields which means that the data cannot always be translated [36] to other fields."	[17, p. 3]
No commonly accepted approach	" No standard consensus across the worlds for a social life cycle assessment method"	[16, p. 17]
	" Is it possible to design a " one size fits all" social impact measurement?"	[38, p. 120]
	"Lack of generally accepted approach or method to evaluate social performance"	[39, p. 2]
Lack of expertise and skills	Ignoring casual relations in the supply chain Skills of the practitioners are not "good" enough Ignoring the use phase How to communicate the results? Difficulty in assessing data	[4]

Throughout the review, there is a need for a common definition of social sustainability is highlighted (e.g., [16]). While trying to identify the different tools, the saw that there were different approaches to the same tool, based on the UNEPs *Guidelines for social life cycle assessment of products,* and it therefore had different outcomes, such as different interpretations of the result [4]

4.3 Barriers identified through expert consultations

This section presents barriers identified through semi-structured interviews with experts on sustainability and the focus group with industrial and academic experts.

Table 4. Barriers identified through semi-structured interviews [4].

Barrier	Statement	Reference
Difficult to measure	" It has been necessary to opt out of it because we are sitting so far away from it"	[8, Ch. 10]
	Tools are simplifying reality – particularly in the social sustainability aspect, it can become dangerous to reduce aspects into numbers and make decisions based on these. There is a trade-off in every aspect!	[8, Ch. 11]
	I think with the with the social sustainability, the challenge is really with the quantification."	
	"That's just how it is. It's not intuitive at all."	[8, Ch. 12]
	"We cannot really measure it, but we do what we can." (Social sustainability)	
Difficult to translate into action	"I believe it is much better to do something imprecise instead of doing nothing"	[8, Ch. 10]
	The company can often not implement it itself - it requires a lot of work and a little more sacrifice. "	[8, Ch. 13]
No commonly accepted approach	"We are not even in agreement in what it should contain, so this will definitely become a challenge to try and "solve""	[8, Ch. 11]
	We want to make sustainable practical and tangible (...) down from the complex pedestal"	[8, Ch. 13]
	"I think we have maybe too much too many frameworks. (..) or at least we lack some agreement of	[8, Ch. 11]

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[4] Disclaimer: Some statements have been translated from Danish to English

The most common issue in this field of research is that even though tools are available, companies choose to look away from sustainability to avoid using them or develop yet another tool [8, Ch. 10]. SAYSWHO presented their LCA nudging tool and expressed that "We made our own because we did not find one on the market that could do what we want." [8, Ch. 10]) due to the lack of data available to them. UNEP argues, that when a designer wants to supervise on sustainability it is important to be able to identify the total life cycle of the product to get the most accurate *potential* impact interpretation [1], but lack of common accepted approaches creates a barrier for the design when trying to do so.

As in the literature, the LCA expert stated, "We are not even in agreement in what it should contain, so this will definitely become a challenge to try and "solve"" [8, Ch. 11] and "I think we have maybe too many frameworks. (..) or at least we lack some agreement of what social sustainability should be." [8, Ch. 11] . Both the industrial expert and the LCA expert argue that it is not possible to measure social sustainability the way it is currently done [8, Ch. 12] and "the challenge with social sustainability is the quantification" [8, Ch. 11] and simplification of social sustainability [8, Ch. 11]. Lastly, the sustainability consultant argues, "It's always a lot easier to make changes on paper - everyday life makes it harder." [8, Ch. 13] which can be related to the barrier *Difficult to translate into action* (table 4). The researcher then identified a common, yet unspoken, barrier as the designer usually do not know which stakeholders gets affected during the life cycle [8, Ch. 14]. This can be related to barriers; 1) lack of expertise and skill, 2) difficult to measure and 3) difficult to translate into action.

The most common barriers based on the SLR, and expert consultations are:

- No common accepted approach
- Lack of data availability
- Lack of expertise and skill
- Difficult to measure
- Difficult to translate into action

The barriers create the base for criteria and demands for a design solution, in the design specification used in the development phase, in the topics: 1) Facilitate a common understanding for social sustainability, 2) communicating results and 3) implementation.

4.4 A common definition of social sustainability
This section presents the focus group with experts. The primary reason for the focus group, was to get different kinds of field experts to create a common definition for social sustainability [8, Ch. 11], [16] and take the first steps in idea generation of a design concept. The focus group was the last step in confirming the barriers identified in the SLR and the expert consultations and the second diamond of the double diamond. By presenting the experts with a sentence, "*social sustainability is..*", they could start the dialogue on creating a

new common definition of social sustainability. This resulted in several words (e.g., people, value, and resilience) and expressions related to social sustainability (figure 7).
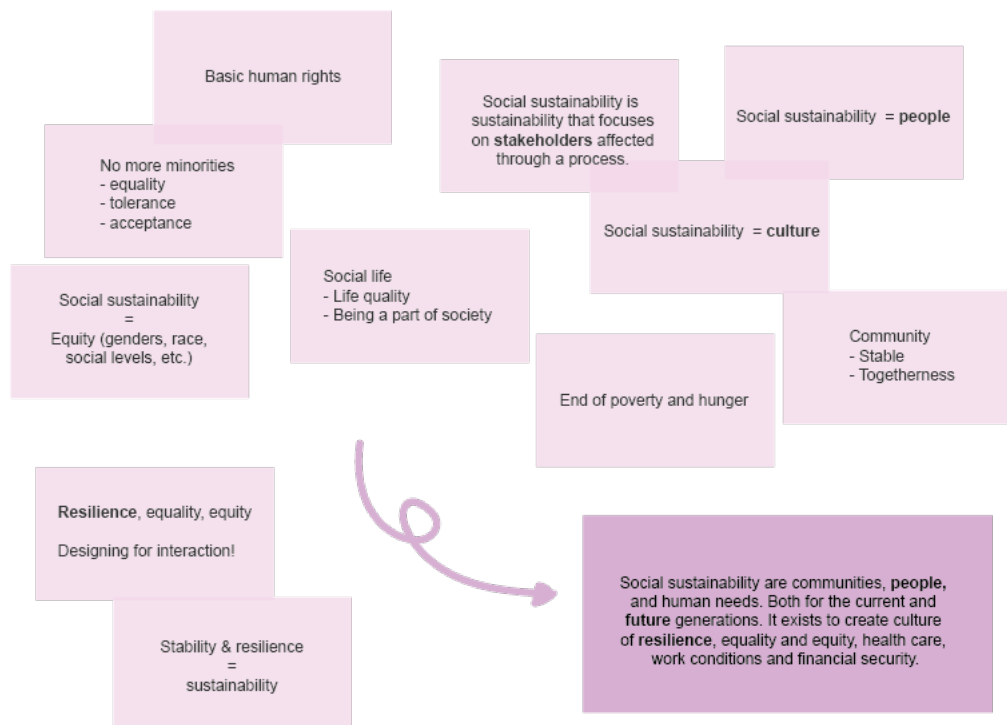

Figure 7. Defining social sustainability (focus group)

This resulted in the new definition:

> *"Social sustainability are <u>communities</u>, <u>people</u>, and <u>human needs</u>. Both for the current and future generations. It exists to create culture of <u>resilience</u>, equality and equity, health care, work conditions and financial security."* (Figure 7, [8, Ch. 15]).

This new definition created the base for facilitating the new conversations on social sustainability, what it entails and which stakeholders the companies should include, together with table 5.

Table 5. Overview of 1), 2), 3)s

Limitations of S-LCA according to UNEP [1], [4]	1) Novelty of technique 2) Difficulty in accessing data 3) Skill of practitioner
Limitations according to [40]	1) Defining social sustainability 2) Implementing S-LCA
Interviews – Interview guide	1) Defining social sustainability 2) Choosing a tool 3) Using the tool 4) Barriers of the tools
Focus group – format	1) Defining social sustainability 2) Discussing how we should assess social sustainability

5. Develop

Nigel Cross argues that designers must set boundaries to evaluate design solution based on empirical knowledge [41]. This section presents the work in moving from barriers into requirements for a future design solution (tool). The specification will be split into topics, based on the barriers, that each contain 'x' amount of demands (D, table 5) and criteria (C, table 6), where demands are *'need to haves'* and criteria are *'nice to haves'*. The requirements of the specification creates the framework for future social life cycle tool development; thus the design solution must live up to these requirements.

5.1 Presenting a design specification

Topic 1: Facilitate a common understanding of social sustainability

The analysis shows a lack of a common definition of social sustainability, or at least a common **understanding** of the meaning of these words. The solution therefore must make social sustainability easily understandable for the companies using it, in all the product life cycle phases (D1). By creating a new understanding on social sustainability, this should create a new core value (or mindset) for the company using it (C1), as it become more relatable. As the new definition rimes with 'people' the solution should create a common understanding of what stakeholders would be affected (C2) by the product the company wants to manufacture. Lastly, the solution should create food for thought (C3) [4] regarding what potential impacts there could be. This could be done during the decision-making of materials; would wood or metal affect the stakeholders most in terms of e.g., disposal?

Topic 2: Communicating results

Lack of data availability was a huge barrier identified in both the case study [8, Ch. 10], SLR (table 3) and expert consultations (table 4) which also relates to the barrier *difficult to measure*. A part of this barrier was not only about measuring, but also not having been able to translate the data into other phases of the life cycle [17] and understanding the results of the assessment. The solution must therefore have understandable results (D2) and should be able to be translated into other parts of the life cycle (C4). To keep the solution resilient, the data should be based on existing databases to keep up with the changes (C5) in the world. Lastly, the results must be easy to translate to other people or companies (D3) when being communicated.

Topic 3: Implementation

In the analysis, the sustainability consultant argued that a barrier with trying to implement something new, in organizations, is that practice is different from theory [8, Ch. 13]. The consultants and companies plan for change and when reality hits, the company deviate from the plan or stops acting according to plan (table 4). The adoption therefore must be easy for the company to do (D4). Lastly, the solution should be implementable in companies in all phases of the product life cycle (C6), because the everyone should be able to obtain knowledge in *their* part of the life cycle phase.

Table 6. Design Specification

Topic	Demand	Criteria	Note	Reference
Facilitate a common understanding of social sustainability	D1: Must create an understandable overview of social sustainability in different countries and **all phases** in the product life cycle		'Understandable' is based on the current knowledge of the designer and will depend on an understanding of the context.	SLR Expert consultations Focus group
		C1: Should create the base of a new core value (or mindset) for the company		LCA expert Focus group
		C2: Should create a common understanding of which stakeholders are being affected during the product life cycle		SLR
		C3: Should give food for thought, before making decisions	e.g., choice of material	SLR
Communicating results	D2: Results must be easily understood			SLR Expert consultations Focus group
		C4: Data should be able to be translated to other parts of the product life cycle		SLR Expert consultations LCA expert
		C5: Data should be based on existing databases to retain constant updates	Database: e.g., PSILCA, Social Hotspot Database	SLR Expert consultations Focus group
	D3: Must be able to be translated to other people/companies		The results must be translatable to keep an ongoing dialogue on	SLR Expert consultations Focus group

		social sustainability	
Implementation	D4: Must be easy to adopt in the company		Sustainability consultant
		C6: Should be implementable in companies in all phases of the product life cycle	Focus group

The requirement from the design specification, will create the boundaries for going into conceptualisation. Later the design specification can be used in evaluating ideas and contributing to the iterative process of detailing the design solution.

6. Discussion and conclusion

This article focuses on identifying challenges on social life cycle assessment tools, based on a case study on the Danish design furniture company, SAYSHWO. The S-LCA methodology is based on LCA and was first presented in 2009 by the United Nations Programme *guidelines for social life cycle assessment of products and organizations* [1]. These guidelines were supposed to act as the framework for doing assessments on potential impacts of a product but instead created barriers for the companies trying to use it. Several important aspects of the S-LCA have been overlooked and the interpretations become too unrealistic and based on assumptions. This study, to the researcher's knowledge, is one of the few that 1) identifies social assessment tools to use in a design process, 2) creates a common definition of social sustainability in design, and 3) sets the boundaries for creating new assessment tools.

The most common barrier for the researchers are to find a common understanding for social sustainability. Together with experts and based on the systematic literature review, a new definition has been created, through the article:

"Social sustainability are communities, people, and human needs. Both for the current and future generations. It exists to create culture of resilience, equality and equity, health care, work conditions and financial security." [8, Ch. 15].

This new definition will create the base for future dialogue on social sustainability as it will act as something more relatable to companies trying to address social sustainability in their product life cycle, than the current definitions. The definition is only the beginning for a new mindset on social sustainability.

The article presents a design specification, which is to act as boundaries for development of future assessment tools. The first part of the design specification therefore focusses on facilitating a common understanding of social sustainability. This can be done in several ways, but a future solution should overall create an understandable overview of social sustainability in all phases of the product life cycle. Secondly, it should act as a new mindset within the company and third, create an understanding of who will be affected by the product being designed. Lastly, it should give food for thought. The second part of the requirements

focusses on communicating results. Not only is the "correct data" hard to obtain, but what do the company do when the interpretation is done? Who should know what? First, the results must be easily understood, even though the company are not experts on social sustainability. Secondly, it must be easily translated to stakeholders within or outside the company. This can be done by sticking to facilitating a common understanding of social sustainability and the new core values/mindset of the company. The new definition tells you, that future tools are based on "culture of resilience". The data being used in the future tools, should therefore be based on data from existing databases, that change. This is by Shang et al [17] seen as a current challenge, but this is only a challenge if the company does not know it is happening. But as Francis Bacon says in Meditationes Sacrae [42] knowledge itself is power. The last part of the design specifications focusses on the implementation of the future tool. Both the research and sustainability consultants argue that implementation of new tools is the hardest part of the process, due to difficulties in translating plans into action. Therefore, the future solution must be easy to adopt into work processes in the company, in all phases of the products life cycle.

Some limitations and challenges exist in applying the design specification in the social life cycle assessment tool development. Finding a tool to assess social sustainability is easy but finding the right one to adopt into the decision making is bit more challenging. Especially when a common approach and even understanding of social sustainability is lacking. The design specification itself is not supposed to either assess sustainability or create the common understanding, but act as the boundaries for the future idea generation and evaluation of solutions. The limitations within the design specification, is to 1) staying within the topics, 2) sticking to the common definition and 3) get an overview of who the product affects. The literature addresses data availability and getting access to these databases could become a challenge. The overall design specification is not specific, which means that the user/designer needs to work on defining the context they are in. The design specification does not come with a user guide. It will only act as a cynosure for the development phase of the new tool. This means that designers can use it for evaluating potential solutions and later choosing and detailing the best solution, based on their needs. Another limitation for using the design specification is that the developer needs to have knowledge about social life cycle assessment tools to make the best possible solution.

A barrier for the design specification is that it both can act as the framework for developing ideas, but also as a block for ideas flowing. The ability to use the design specification, comes with experience of working within a design process. The design speciation will need facilitation from either a regular designer, innovator, or design engineer, as it needs to be a controlled yet still open negotiation space [28]. Another limitation to the design specification is trying to create a 'one size fits all' approach. For history not to repeat, the developers of the future social life cycle assessment tools must be aware of creating clear guidelines for who the tool is for, what it "solves" and how the results can be communicated.

A limitation to the research itself is that the researcher did not have resources (e.g., time and manpower) to complete the deliver phase of the double diamond methodology. Another limitation is competencies. The researcher acknowledge that the decisions made through the

design process could have had different outcomes by having other points of view to guide challenge.

Future works will need to stabilize [36] the new definition. The *deliver* phase must be done. This should include the first feedback loop with SAYWSHO, which contains testing and adjusting the design specification, and the conceptualisation of a new framework should be initiated. This should both be done with SAYWSHO and other relevant stakeholders e.g., experts (LCA and industry).

In practical terms, the design solutions, based on the requirements, should not only fulfil the demands and somewhat the criteria, but also needs to create the 'food for thought' the literature and the article addressees. Some challenges when working within medium or larger organization is making people understand the need for change [43] and address that for the change to happen. And for this to happen, the organizations need to do the work according to plan. Despite the challenges the design specification presents a new future in terms of social sustainability. This will help researchers develop a new tool, that designers can use when making decisions throughout the design/product development phase by understanding what is at stake. The research contributes to the social sustainability field by 1) identifying social assessment tools to use in a design process, which can enlighten decisionmakers and researcher looking for a tool to use, looking from a life cycle view, 2) create a common definition of social sustainability in design, and 3) sets the boundaries for creating new assessment tools by introducing a design solution that can guide the development process of such tools.

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Figures / tables

Acronyms

LCA – Life Cycle Assessment

S-LCA – Social Life Cycle Assessment

SLR – Systematic literature review

UNEP – United Nations Environment Programme

Supplementary material

Search	Results (Google Scholar / AUB)	Fits criteria (initial screening)
"social life cycle assessment framework"	143 / 121	12 / 15
(s-lca) framework, 2012 - 2022	134	8 (2 x thesis)
ISO/AWI 14075	None / none	-
Social footprint method	35 / 9	4 / 3

Only headlines or direct quotes from the text.

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S-LCA		
Social impact framework		
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