Social LCA

Impacts, Interests, Interactions

7th SocSem

Pre-proceedings

7th Social LCA Conference

June 15-17, 2020
Sweden

FRuiTROP Thema

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Social LCA

Impacts, Interests, Interactions

Pre-proceedings of the 7th Social Life Cycle Assessment Conference

S-LCA 2020 – June 15-17, 2020 – Sweden

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Preface

This book contains the collection of abstracts accepted for the 7th S-LCA conference, hosted from Gothenburg, Sweden on the 15-17th of June 2020. The theme we chose for the conference is 'Impacts, Interest and Interactions'. By that, we want to direct attention to not only the social impacts, the core of a social life cycle assessment, but also to the assessment process and its context, as well as to the social interactions in the product system as such. An assessment process is subject to influence from stakeholders with varying interests – the extent to which these stakeholders do, or do not, interact within the product system likely leads to differences in the way the assessments are conducted and to their outcomes. From this emerges a question about what recommendations are appropriate for different fields of application. When it comes to the product life cycle, a better understanding of its social organization can inform us about its particular sustainability challenges, the prospects of sustainability change and the role of assessments for this.

Things do not always go as expected. We committed proudly in Pescara on 10-12th of September 2018 to take the responsibility of hosting the upcoming S-LCA conference and to have the opportunity to welcome you all to Sweden and Gothenburg, in a time of the year when Sweden is at its best. Now, when that time is approaching, many things have been turned upside-down due to the pandemic of COVID-19. We have had to change the conference from a traditional to an online setting. This is sad since the very meeting of other researchers in your own field is so inspiring. Now we have to get inspired by each other in other ways.

This book can be such a source of inspiration. It has always been important to publish the 'state-of-the-art' of S-LCA research in conjunction to the conferences. But this time, with a virtual conference, a printed book is possibly even more important for sharing of our findings and insights from research. We extend our gratitude to Catherine Macombe and Catherine Sanchez for making the publication of this book through CIRAD possible.

Many interesting observations can be made about the contributions collected in this book. Most striking, perhaps, is the wide variety of methods and approaches presented in the contributions. We see a number of novel approaches to S-LCA, previously not attempted, such as the merging of S-LCA with other methods (see 3.5 in this book). There is also considerable innovation in methodologies for impact pathways and indicators (see 1.2). We noted the wide array of different types of applications for S-LCA. These range from company-level to economy-level assessments, from the study of existing production systems to explorations of novel designs, from procurement to waste management policy-making (see 2.1-2.5). But we also see another type of studies with less assessment and more description and social analysis (see 5.0). These could perhaps best be characterized as social life cycle studies.

Taken together, the contributions point to the method's potentially wide usage. Its usage in practice, however, is another matter. We are therefore pleased to see the first few studies focusing on the practice of S-LCA at the conference (see 4.0). Such studies could provide important feedback to method developers. Of particular importance for this conference are the contributions about the update of the 2009 S-LCA UNEP/SETAC guidelines and their road-testing (see 1.0 and 2.0). The work to revise guidelines has been underway for some time and the conference provides an important opportunity to share and discuss these with the wider research community.

To complement the submitted contributions, we have invited keynote speakers who can deepen our understanding of social sustainability and of the contexts for which S-LCA is aimed for. Such background knowledge is often taken for granted and therefore rarely discussed. These presentations bring even more multidisciplinary knowledge to our research. The S-LCA field is certainly varied and exhibits increasing methodological pluralism! Embracing this diversity could give us better tools to address the complex social problems associated with sustainability.

In this book, our ideas, if not our embodied selves, come together and form a body of knowledge. We hope this can serve as consolation in times when we want to be together but are kept apart by external circumstances. To turn this into, if not physical contact, so at least digital contact, we highly recommend all participants of the conference and others interested to read this book. Then, send an email to someone who has produced an abstract that you find especially important or influential for your own research, and start a conversation. Let us try to keep up the conversation, even though we right now need to do it in non-traditional ways.

Gothenburg and Stockholm, April 2020

Henrikke Baumann and Elisabeth Ekener

Conference chairs of SLCA2020

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with a guest appearance by Marzia Traverso on The roadtesting of the revised guidelines

Track 1

SLCA Methodology

Updated guidelines for social life cycle assessment: the nuts and bolts

Catherine Benoit Norris[1] (catherine@socialhotspot.org), **Marzia Traverso**[2], **Elisabeth Ekener**[3], **Thomas Schaubroeck**[4], **Markus Berger**[5], **Sabrina Neugebauer**[2], **Sara Russo Garrido**[6], **Gabriella Arcese**[7], **Sonia Valdivia**[8], **Matthias Finkbeiner**[5]

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Introduction

Social Life Cycle Assessment (S-LCA) is a methodology developed to assess the positive and negative social impacts of products, services and organizations, along their life cycle. The first S-LCA Guidelines were published in 2009 as a project of the UNEP/SETAC Life Cycle Initiative (today UN Environment Life Cycle Initiative) (Benoit and Mazijn, eds. 2009, Benoît et al., 2011). These Guidelines were one of the Life Cycle Initiative most downloaded publication for several years. In the past 10 years, further developments and a myriad of implementations have been carried out, defining in more details the methodology, its indicators and impact assessment methods. This warranted a revision of the Guidelines undertaken under the umbrella of the United Nations Environment Life Cycle Initiative. This project is coordinated by the Social LC Alliance (https://www.social-lca.org) and it is also supported by the Consumer Information Program (CIP) of the 10 Year Framework of Programmes on Sustainable Consumption and Production (10YFP). The UN Environment Life Cycle Initiative provided support to the development, consultation, review and piloting process of these Guidelines. The project group includes about 70 experts and stakeholders as well as an advisory committee representing the sectors of business, government, non-governmental organization (NGO), intergovernmental organization (IGO) and academia.

Providing detailed guidance, the updated S-LCA Guidelines enable new practitioners and more experienced alike, to make informed decisions when planning, conducting or interpreting the results of a S-LCA. This paper will present the development process and the nuts and bolts of the content of the revised Guidelines.

Method

Building on the 2009 UNEP/SETAC Guidelines for S-LCA of products, new methodological and practical developments such as social organizational LCA (SOLCA) (Martínez-Blanco et al., 2015) as well as the refinements and additions of social impact subcategories have emerged in the literature and have been integrated in the new guidance (e.g. related to children) (Sureau et al., 2019; Sureau et al., 2018) Two S-LCA databases with national and sectoral information now exists and are widely used: the Social Hotspots Database (Benoit-Norris et al. 2012) and the Product Social Impact Life Cycle Assessment – PSILCA (Ciroth, Eisfeldt, 2016). Description of these databases as well as guidance on their use was needed. Hundreds of studies have been identified applying the Guidelines framework in the food (Petti et al. 2018), information and technology (IT) and mining sectors, as well as in other consumer product groups. We have distilled and added the learnings from these studies and addressed the gaps as much as possible in this new version of the Guidelines.

We have accomplished the revision process by bringing together a large group of practitioners, academics and members of the private sector. Working groups developed first version of chapters which were then revised and compiled by the steering committee. We organized two expert meetings (in August 2018 in Pescara, Italy, and in April 2019 in Paris) where drafts were discussed and amended. Experts also provided line by line comments which were considered and integrated in the draft whenever possible. An international public consultation process is underway early 2020, followed by the piloting of the revised S-LCA Guidelines. This will further ensure the relevance and practicality of the guidance.

From the onset, we had several objectives which guided the development process and the content of the revised Guidelines: Expansion of the audience, Focus on capability development, Covering methodological developments, Recognizing a plurality of established approaches, Positioning S-LCA in the current context, Developing areas where minimum guidance prevailed and Integrating SO-LCA to extend the focus from products to organization. The new format of the S-LCA publication aims to support broadening the practice, making the Guidelines a cornerstone reference for anyone wanting to conduct a S-LCA, Social Organizational Life Cycle Assessment, Social Footprint Assessment, Social Hotspots Assessment or a Human Rights Due Diligence Assessment.

Results and Discussion

As stated above, the new Guidelines focus on accessibility and capacity building. The target audience is broader than in the previous version: we want to guide also non-practitioners of LCA throughout an implementation of S-LCA. This is particularly important for companies, in which the social topics and data are mainly handled by the ethical compliance and human resources departments. Each step of a S-LCA has been described in details and figures and boxes present examples and further information. Several approaches are defined throughout the document.

One example is this figure, which presents a decision tree summarizing the main early choices to be made.

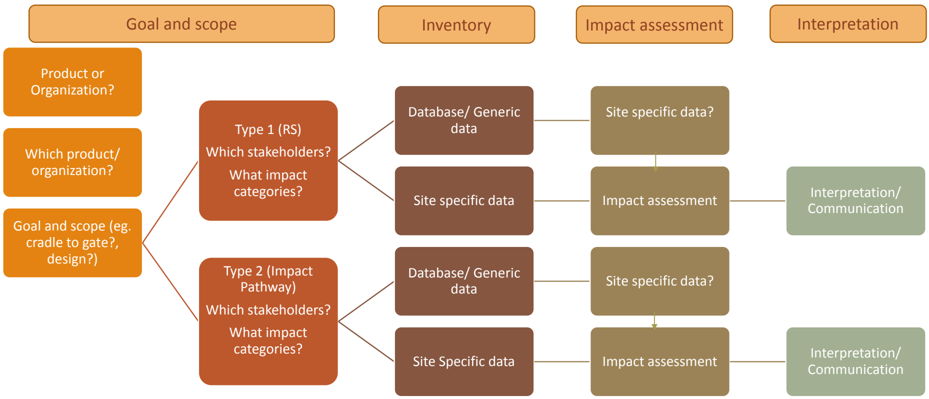

Figure 1: S-LCA decision tree

A new stakeholder category – Children – and some impact subcategories have been added to the framework in line with stakeholder's input. We have also added guidance on Social Organizational LCA (SO-LCA) and about the assessment of positive impacts. The Impact assessment phase section now provides actionable guidance. For instance, a detailed description of Type I (RS: reference scale) and Type II (IP: impact pathways) impact assessment approaches is given to better lead to a practical implementation.

Those and other innovative aspects will be presented and discussed.

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Scoping social LCA with participatory workshop for research and development project

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Abstract

One of the challenges in Social LCA is the broad scope of impacts to consider. A screening S-LCA was conducted with PSILCA in parallel to Environmental-LCA in a R&D-project with the aim to raise awareness on Social issues and to identify important impacts in the product value chain. A workshop was conducted inspired by the *Open Space* method where project participants prioritized the social impact categories. This approach raised awareness on social issues of resource use, but the selection of impact categories clearly did not represent workers or consumers as stakeholders and overlapped the E-LCA. After a review, few categories were added to counter this. An improvement of the approach is to pre-screen all impact categories and focus on those that show very high risk, high risk or no data in the workshop. That promotes active engagement of project participants as well as improving the expert assessment in the scoping.

Social life cycle assessment of mobility services: state of the Art

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Introduction

The automotive industry will have to navigate through a number of difficult challenges in the upcoming years. With advancing climate change, the pressure to reduce CO2 emissions is rising. The transportation sector is among the top three polluter with 14.3% of worldwide CO2 emissions (Herzog 2009). Due to urbanization and growing population, cities around the world are fighting with rising traffic, declining air quality and limited space availability (Gross 2019). Considering that more than 50% of the world's population live in cities (UN 2012), the automotive industry is seeking alternative business models to address the challenges that result from urbanization. Mobility services based on collective use, like car sharing or ride hailing, have been identified as one possible option (Gould et al. 2015). As different mobility services are growing in cities around the word, the question that automatically rises is whether mobility services can lead to more sustainable transportation options, thereby improving quality of life in cities. In order to answer this question, it is important to analyze sustainability impacts of these services in a systematic way, considering all three dimensions of sustainability. Life cycle-based methodologies have been developed over time for this purpose (e.g. Benoît et al. 2009, Fontes et al. 2014, Traverso et al. 2018). Although a lot of research has been done concerning economic and environmental assessment, a standardized approach for Social Life Cycle Assessment has yet to be agreed on (e.g. Dubois-Iorgulescu et al. 2018). Different S-LCA indicators and impact assessment methods have been applied and tested in a number of case studies (Di Cesare et al. 2018). Whereas the use phase plays an important role for the assessment of mobility services, its evaluation has been underrepresented in previous S- LCA case studies (Petti et al. 2018). Therefore, it is important to focus on use-phase social impacts, not only to have a consistent assessment along all three dimensions of sustainability and to avoid burden shifting, but also to be able to measure positive impacts. Especially for the assessment of mobility services, this is essential. For that reason, a systematic literature review was carried out to identify social indicators that allow to assess use phase impacts in general and more in detail of mobility services. The main purpose of this study was to define a core set of indicators to lead the way towards a comprehensive and inclusive set of indicators for the assessment of mobility services.

Methods

The literature review was carried out in four phases. In the first phase, the databases Web of Science, Science Direct and Springer Link were used with predefined search strings in order to identify publications that include suitable social indicators. As search strings multiple notations of 'Life Cycle Assessment', 'S-LCA', 'Sustainable urban mobility', 'Social sustainability' or 'Sustainable urban transportation' were used in combination with 'Mobility services', 'Sustainable city' or 'social indicator'. In the second phase, the social indicators were filtered and categorized according to associated stakeholder groups, as well as clustered in an analytical grid. The selection of the stakeholder groups was done in accordance with the UNEP/SETAC Guideline (2009) and the corresponding methodological sheet (2013): workers, local community, society, value chain actors and consumers. While identifying the stakeholder group, it was also analyzed whether the indicators are of quantitative (q), semi-quantitative (s) or qualitative/descriptive (d) nature. In the third phase, indicators that meet the needs for the assessment of mobility services were selected and examined according to their measurability. In the fourth phase, the final set of indicators was selected under consideration of expert consultations and data availability.

Results and discussion

After the systematic literature research in the stated databases and identification of all publications that include relevant social indicators (Phase 1), a total of 51 papers were selected. Based on the search strings and the focus on urban mobility, the selected publications focus on sustainability assessment of cities (47%), transportation systems (21%), neighborhoods (16%) or infrastructure/building projects (8%). Only few studies matched the search criteria with a different focus as for example social aspects in the mining sector or domestic water reuse (8 % others). The allocation of the indicators to associated stakeholder groups and the identification of the indicator type (Phase 2) demonstrate that out of the identified indicators, 36% assess social impacts that affect the stakeholder group 'Local Community'. 29% of the indicators are societal or institutional, whereas 28% target the stakeholder group 'Consumer'. 6% of the analyzed indicators assess social impacts related to the stakeholder group 'Worker' and only 1% 'Value Chain Actors'. This result differs from other S-LCA case study reviews where 32% considered workers (Petti et al. 2018). However, this outcome can be explained by the focus of this literature review on the assessment of use-phase impacts. Consequently, indicators assessing impacts regarding the local community, society or consumers become more prominent, whereas workers and value chain actors get less attention. In the next step, all indicators that are potentially suitable for the assessment of mobility services were filtered and grouped into categories. For each indicator, measurability and data availability was analyzed (Phase 3). As first conclusion, the analysis reveals a huge variety and diversity of indicators intending to measure the same aspect. Many indicators are not clearly defined, which makes them difficult to measure. The lack of concrete calculation methods in combination with a lack of data constitutes a major challenge. This results in the necessity for experts and decision-makers to not only specify in detail the respective indicators but also select a suitable calculation method on their own. To meet this challenge and to lead the way towards a comprehensive and inclusive set of indicators, a core set of indicators was defined based on this analysis. For this purpose, expert consultations were taken into account as well as data availability (Phase 4). The core set of indicators comprises 9 indicators for the stakeholder group Local Community, 6 indicators for the stakeholder group Consumers, 5 indicators for Workers, two indicators for Value Chain Actors and finally 6 indicators for the stakeholder group Society.

Future developments

In order to verify and validate the established set of indicators, an application to mobility service use cases is essential. This should be part of further research. In that way, accuracy and reliability can be tested and if necessary, adjustments can be made. The results lead to a better understanding of social implications of mobility services and can help to achieve a higher quality of life in cities.

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Subcategory indicators choice when conducting SLCA: a participative approach for local community stakeholder dimension

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Introduction

Social Life Cycle Assessment (SLCA) approach aims to evaluate potential social impacts of a product in a life cycle perspective. It is a recent approach that evaluates product systems' performances in a holistic way, considering all life cycle phases, from raw material production until end of life (Chhipi-Shrestha et al. 2015). The results of this kind of assessment are useful for support decision-making processes in company context, helping managers to decide which social issues must prioritized. However, selecting social themes to be evaluated involves subjectivity, currently neglected by scientific researches (Sureau et. al., 2017).

Different SLCA methods were developed last years. However, they present high subjectivity associated to selection of subcategory indicators, evaluation scales used to measure product performances at subcategory indicators and the relative importance of subcategory indicators, as identified by Carmo et al. (2017). Thus, it is until necessary the development of a structured and transparent approach able to address these issues.

Considering evaluation scales, Sawaenqsak et al. (2019) identified a set of models used for this purpose. However, there is no consensus which one is the best approach. Carmo et al. (2017) proposed a model to represent the subjectivity associated to evaluation scales and the relative importance of subcategory indicators in SLCA studies.

Concerning the subjectivity related to subcategory indicators choice when conducting a SLCA study, Venkatesh (2018) observes there is no consensus about subcategory indicators choice, neither social impact definition or how to measure them. Our research consider that these criteria can differ a lot considering the type of product analyzed or the social context surrounding product's life cycle. As such, a participative approach including stakeholders' point of view is desired on this kind of choice.

Mathé (2014) developed a model to support the selection of subcategory indicators through a participative approach. However, it is a theoretical method and non-transparent concerning on how to proceed. Finally, the research conducted by Sureau et al. (2018) observed that the subcategory indicators' choice realized on SLCA studies are not justified, being empiric, subjective and non-transparent, reducing the credibility and the relevance of the results obtained by SLCA. As such, they conclude the necessity of frameworks able to address this issue.

Finally, scientific literature on SLCA presents important gaps to be fulfilled by future research concerning the subcategory selection when conducting SLCA studies. Our research aims to provide a method able to address this issue. For this purpose, this paper presents a framework able to structure the subcategory indicators selection process to be included into a SLCA study, providing a customized list based on the product analyzed. This approach was developed in a participative perspective, including stakeholders' point of view on this decision-making process.

Methods

This research presents a novel framework able to address the subjectivity associated to subcategory indicators selection. Considering a stakeholder inclusion perspective, we propose a participative approach to consider stakeholder value judgment. Figure 1 presents the general steps proposed on this framework. We propose two different approaches to establish the list of customized subcategory indicators.

For the first model (1st phase), stakeholders' representatives are invited to evaluate the subcategory indicators provided by UNEP (2009) considering a set of three criteria: social benefit, economic benefit and relevance. In order to complete this task, they use Likert scale. As second task, stakeholders are invited to provide the relative importance of each criteria. Those collected data are used together to establish the list of relevant subcategory indicators for the specific product system through PROMSORT method, a multi criteria decision tool able to address this classification problem.

For the second model (2nd phase), we conduct a voting approach considering a representative sample of stakeholders and ask them for vote if each potential subcategory indicator is relevant or not for the product system evaluated. The result of this model also establishes a set of relevant subcategory indicators considering the point of view of the stakeholders' sample.

Finally, the third phase compares the results of both methods in order to evaluate the agreement between them. At this point, are also presented the benefits and challenges associated to each method and we argue when each one indicated.

Our approach is being tested for a Brazilian fruit pulp case study, an organic product produced by local family farming based on environmentally and ecologically sustainable production. For this application, we included only local community stakeholder dimension. It is important to remark that scientific research addressing this stakeholder dimension is limited.

For the first model we considered 5 representatives of local community associated to product life cycle and a sample of 255 stakeholders was interviewed for the second model.

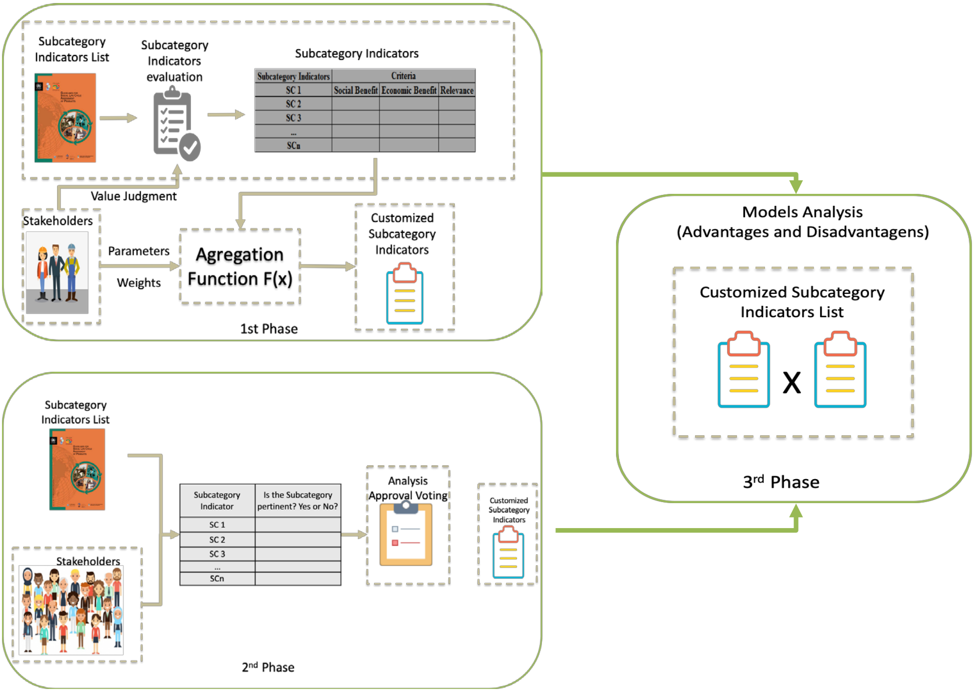

Figure 1: Participative approach for subcategory indicators selection.

Results and discussion

The developed approach is able to provide a set of customized subcategory indicators based on the value judgment of stakeholders and social context of product's life cycle. Both models present benefits and challenges. For the first one, it is necessary that the stakeholders' representatives have an in-depth knowledge about local community social issues in order to be able to be used as decision-makers on our approach. The second model is easier to implement and is able to consider a larger point of view of stakeholders' sample. However, it is necessary a high effort associated to data collection, especially with the local communities, implying high costs to be applied.

Finally, it is important to remark it is the first approach able to take into account stakeholders' points of view when selecting subcategory indicators to be included on SLCA studies.

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Testing the PSILCA database in a honey S-LCA case-study

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Introduction

This paper aims at assessing the social and socio-economic aspects of a jar of honey along its life cycle by using the Product Social Impact Life Cycle Assessment database (PSILCA). PSILCA is a database for Social Life Cycle Assessment (S-LCA), which allows for the calculation and evaluation of social risks of products along their entire life cycle, already used by several scholars (e.g., Di Noi and Ciroth, 2018; Hannouf and Assefa, 2018; Werker et al., 2019a; Werker et al., 2019b). The variety of ways of assessing social aspects (Parent et al., 2010; Russo Garrido et al., 2018) demonstrates that S-LCA is a methodology that still needs an ever- growing number of implementations in order to be standardised. Therefore, the main goal is to contribute to the methodology- and the implementation-related development with the help of PSILCA.

Methods

This paper is based on data collected for S-LCA and Life Cycle Assessment (LCA) case studies (D'Eusanio et al., 2018; Arzoumanidis et al., 2019). The primary data processing was deemed necessary since the PSILCA database did not contain the required processes of the product system under study. The product system was built starting from the aforementioned cited article (D'Eusanio et al. 2018) and by considering the same elements of the goal and scope definition phase. Indeed, the functional unit (FU) is a jar of honey, produced in Abruzzo, Italy. The system boundary is from cradle to gate and the evaluated stakeholders were workers, local community, society, consumers and value chain actors. As far as the selection of subcategories is concerned, the choice depended on the social indicators foreseen in PSILCA as well as in the S-LCA case study. In this perspective, only the indicators used in common for both methods have been taken into account : children in employment, evidence of violations of laws and employment regulations, frequency of forced labour, living wage per month, net migration rate, presence of anti-competitive behaviour or violation of anti-trust and monopoly legislation, rate of fatal accidents at workplace, rate of non-fatal accidents at workplace, right of association, right of collective bargaining, social security expenditures, unemployment rate in the country, weekly hours of work per employee. Data collection was performed for the evaluated indicators and subcategories following the PSILCA guidelines (Eisfeldt, 2017).

Finally, the Impact Assessment phase was performed directly via the method proposed by PSILCA (i.e., Social Impact Weighting Method), while for the S-LCA case study (D'Eusanio et al. 2018), the Subcategory Assessment Method (SAM) had been taken into account.

Results and discussion

The results of the Social Impact Weighting Method (incorporated in PSILCA) showed that most affected social impact indicator was "unemployment", followed by "weekly hours of work per employee", "public sector corruption", "social responsibility along the supply chain" and "non-fatal accidents". For these indicators, the identified hotspot was related to the consumption of electricity during the phase of hives placement, probably connected to the higher value of worker hours linked to it. Moreover, this revealed a series of methodological and applicative observations also in terms of highlighting the limits and difficulties of the method. The main difficulty, whilst implementing the PSILCA case study, was the absence of the needed processes in the database thus requiring additional effort in collecting the necessary data [i.e., working hours were taken from Arzoumanidis et al. (2019), prices of raw materials were provided by the firm under study]. This led to the need to define the risk level for each indicator based on the primary data and the methodological "rules" of PSILCA. Moreover, it appears that PSILCA identifies the social risk based on generic data for social indicators that can be found in international databases (Eisfeldt, 2017), but the user can provide primary data for worker hours and materials prices. All in all, the PSILCA-based case study allowed for the evaluation of the social risks of a jar of honey; such risks appear to depend on two intrinsic variables (e.g., worker hours, monetary flows).

Future developments may focus on providing the full results of this ongoing project as well as on highlighting the strengths and weaknesses of PSILCA (eventually also in parallel to the SAM method) by assessing different types of products of different sectors.

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A direct quantification of indicators in social LCA – Beyond worker hours

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Introduction

Social LCA is increasingly used for assessing social impacts along supply chains and in life cycles; especially the calculation of life cycle results was however often questioned by practitioners. It is common understanding that social indicators can be qualitative, or ordinal, and thus are not directly "accessible" in a life cycle calculation which requires quantitative indicators or flows linked to a process typically. Databases created for calculating social impacts along life cycles are therefore today using a concept called "activity variables" proposed initially by Greg Norris in 2006, where worker hours spent in each process are used to quantify the risk-assessed social indicators. This allows to calculate any social indicator over the life cycle, but evidently worker hours are not necessarily linked to indicators for the stakeholders local communities or society, and thus could "scale" the indicators in an inappropriate way.

Looking at the indicators compiled in social LCA databases now, there are also other possibilities for calculating the life cycle. Some of the options are:

a) Using a different activity variable such as value added

b) Encoding all indicators so that they represent a quantitative figure, with the same direction (higher = worse), calculating the impacts; this is done for ordinally scaled variables by providing class scores, from 1 to 5 representing no risk to very high risk

c) As b, but in addition, depending on defined performance reference points, and the value observed in each process of the life cycle, the effective amount considered in the calculation is obtained following an impact assessment, to be able to reflect non-linear effects.

Methods

The three options will be explained and presented using the PSICLA and also the Social Hot Spots database (SHDB); for PSICLA, the observed amounts will be used, for the SHDB, where observed amounts are not available, the risk-assessed values.

Figure 1 shows the "transformation" of the observed values for the PSILCA database, using "construction in the Bermudas" as example.

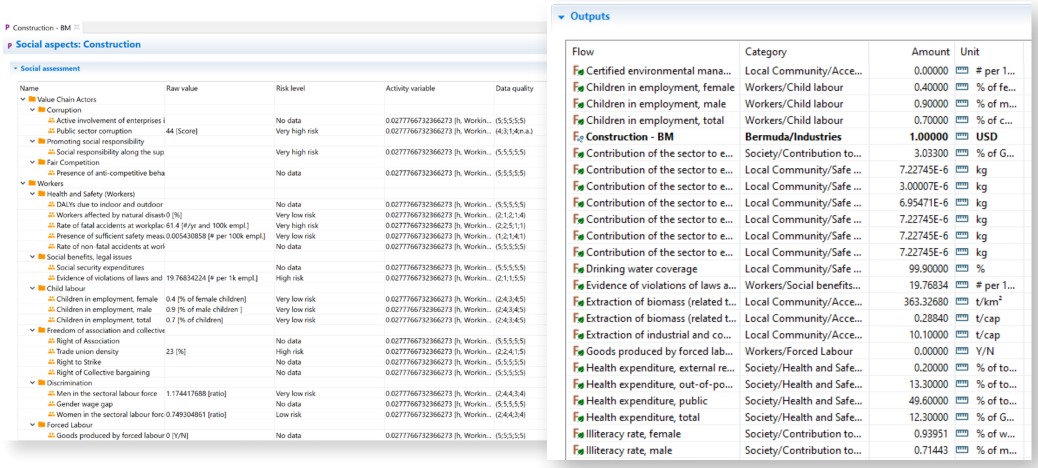

Figure 1: Social aspects for a process (Construction, Bermudas) in PSILCA, left, with identical activity variable amount in worker hours, and process with social indicator amounts in indicator units, right

To allow this, the indicator units need to be transformed so that they can be directly calculated. In some cases, this is directly possible (extraction of biomass as access to resources, t/km^2), in some cases the amounts and units need to be recoded, e.g. in risk scales.

This indicator quantification is the first of two steps needed for a direct quantification. The second step is a consideration of the overall contribution of each process in the system to the overall results.

This is needed since otherwise, a process chain of 3 processes, each exchanging exactly 1 unit of product and with a drinking water coverage of 99%, would yield an overall result of 3*99=297% drinking water coverage, and this number depends on the number of processes in the analysed system. We propose to therefore "normalize" the calculated results by the division of all results by the scaled diagonal of the technology matrix A (g_k: result, r_k: normalized result for indicator k, a_{ii} diagonal in the technology matrix, s_i scaling factor for process i):

$$r_k = \frac{g_k}{\sum_{i=1}^{n} a_{ii} s_i}$$

Results

Results will be shown for different sectors and countries, mining in the USA, Finland, and South Africa; construction in these same countries, compared to the worker hour results, and discussed. Fig. 2 shows the calculated results again for Bermuda, construction sector.

Name	Category	Sub-category	Amount	Unit	R	C	T	G	F
Active involvement of enterprises in corruption and bribery	Value Chain Actors	Corruption	0.12179	%	2	2	2	2	3
Certified environmental management systems	Local Community	Access to material resources	0.54070	# per 10k empl.	1	1	2	1	1
Children in employment, female	Workers	Child labour	0.54799	% of female children	2	4	3	4	5
Children in employment, male	Workers	Child labour	1.13073	% of male children	2	4	3	4	5
Children in employment, total	Workers	Child labour	0.89456	% of children	2	4	3	4	5
Contribution of the sector to economic development	Society	Contribution to economic development	9.72357	% of GDP	2	3	2	1	3
Contribution of the sector to environmental load, CO, I-AIR-CO_agg	Local Community	Safe and healthy living conditions	0.28577	kg	2	2	2	1	1
Contribution of the sector to environmental load, CO2-equiv, I-GHG-C(	Local Community	Safe and healthy living conditions	33.86613	kg	2	2	2	1	1
Contribution of the sector to environmental load, NMVOC, I-AIR-NMV(	Local Community	Safe and healthy living conditions	0.18154	kg	2	2	2	1	1
Contribution of the sector to environmental load, NOx, I-AIR-NOx_agg	Local Community	Safe and healthy living conditions	0.20726	kg	2	2	2	1	1
Contribution of the sector to environmental load, PM10, I-AIR-PM10_a	Local Community	Safe and healthy living conditions	0.14727	kg	2	2	2	1	1

Figure 2: calculated, normalized results with directly quantified social indicators (excerpt) for Bermudas, construction sector. The colored cells on the right are results from the quality assessment

Discussion

We believe the approach shows that worker hours are often not needed and also overshadow the real values of social indicators in supply chains, and hope to contribute with the proposal to a wider use of social LCA. That said, the calculated result is of course a fully linear system result, and therefore does not "preserve" extreme values such as very high risk. In the presentation, we will show an example how this averaging of extreme values can be avoided, as an outlook.

Assessing social impacts of cobalt artisanal mining using primary and secondary data

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Introduction

The New European Commission agenda includes in its priorities "A European Green Deal", and a "free and fair trade" which entails highest standards of environmental and labour protection, with zero-tolerance policy on child labour as well as development assistance for Africa[1]. African countries supply many raw materials to global supply chains, and the Democratic Republic of the Congo (DRC) alone provides more than 60% of the global supply of cobalt (OECD 2019), a material used as cathode in rechargeable batteries. In the case of cobalt mining, NGOs and media repeatedly reported cases of severe human rights abuses and child labour in the DRC, where some of the sector issues being linked to Artisanal and Small-Scale mining (ASM sector), while other problems (e.g. corruption or use of armed forces) more related to Large Scale Mining (LSM) (e.g. OECD 2019; Amnesty International 2016).

Given the role of batteries for achieving carbon reduction objectives and the forecasted growing demand of batteries, ensuring that materials are sourced responsibly is a crucial policy objective. Some initiatives for ensuring that cobalt is sourced in a responsible way have been launched in the last months. However, little is known about their capability of improving social conditions on the ground.

This paper illustrates a part of a broader project aimed at: i) identifying hotspots in the supply of primary raw materials used in batteries, combining data on the materials supply with relevant social indicators from the PSILCA database and other publicly available sources ii) qualitatively assessing the impact of responsible sourcing initiatives at the mining stage. The hotspot analysis carried out in the first part of the study identified several important social risks. Social risks are not necessary impacts, as site-specific primary data are needed for an impact assessment. Moreover, a comparison with the local conditions (baseline scenario) is needed to evaluate if the system under evaluation is better, equal or worst of the regional/national value. Figure 1 shows the results of the hotspot analysis for cobalt, where DRC emerges as a hotspot for what concern governance, conflicts, child labour and forced labour.

1 https://ec.europa.eu/commission/sites/beta-political/files/political-guidelines-next-commission_en.pdf

		Materials supply (mining stage)			Governance		Conflicts			Human and social rights			Environment	
Material	Country	% reserves and resources	% global mining production	% EU sourcing	Resource Governance Index	Worldwide Governance Indicators	INFORM - HH	Fragile State Index	Global Peace Index	Child labour*	Fair salary*	Global Slavery Index	Environmental Performance Index	Water Risk Index
COBALT	Australia	10	4	1	1	1	1	1	1	1	1	1	2	3
	Canada	5	5	5	n.a.	1	1	1	1	1	1	1	2	1
	China	1	7	0	n.a.	3	3	3	2	3	2	1	2	3
	Congo DR	46	57	69	3	4	4	4	4	4	2	4	3	1
	Finland	1	1	14	n.a.	1	1	1	1	1	1	1	1	1
	Russian Federation	1	2	5	n.a.	3	3	3	4	2	1	3.5	2	1

Figure 1: Hotspot analysis of Cobalt

In the second part of the project, a primary data collection was performed in the DRC ASM sector in copper and cobalt mining sites (as they are often mined together) in the Haut-Katanga and Lualaba provinces. Data collection was based on standards in the sustainability and responsible sourcing area as well as on S-LCA UNEP/SETAC guidelines, adapted to the context of the artisanal mining sector. The study aimed to understand the local conditions of two pilot projects on responsible sourcing compared to the current local situation of ASM in the sector at large, and in the same time to implement the S-LCA guidelines throughout the development of a data gathering matrix to understand their feasibility in assessing ASM.

Methods

Figure 2 illustrates the main steps of the methodology, which consisted in:

- Comparison of standards demands and overlaps[2]
- Consolidation of standards' relevant demands
- Development of first information matrix (based on feedbacks received)
- Data collection, based on a combination of direct observation, document consultation and stakeholder interviews
- Characterization and qualitative assessment of improvements (or deterioration) for each category compared to the baseline; assessment of the impact (direct or indirect) of the implemented system.

Complementing these information, a list of contextual information to collect has been designed based on the consultant expertise. The data collection was performed in two mining sites where responsible sourcing initiatives have been implemented: Better Mining in the Kasulo site ("Kasulo") and the Mutoshi Cobalt Pilot ("Mutoshi"). Moreover, a baseline scenario representing a mining site where no initiative is in place was built based on a mix of direct observations and data from literature.

2 The standards under consideration were: OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas v3 (OECD Guidance); IFC Performance Standards (IFC PS); The China Chamber of Commerce of Metals, Minerals & Chemicals Importers and Exporters' (CCCMC) Due Diligence Guidelines for Responsible Mineral Supply Chains (CCCMC Guidance) and the Social LCA guidance

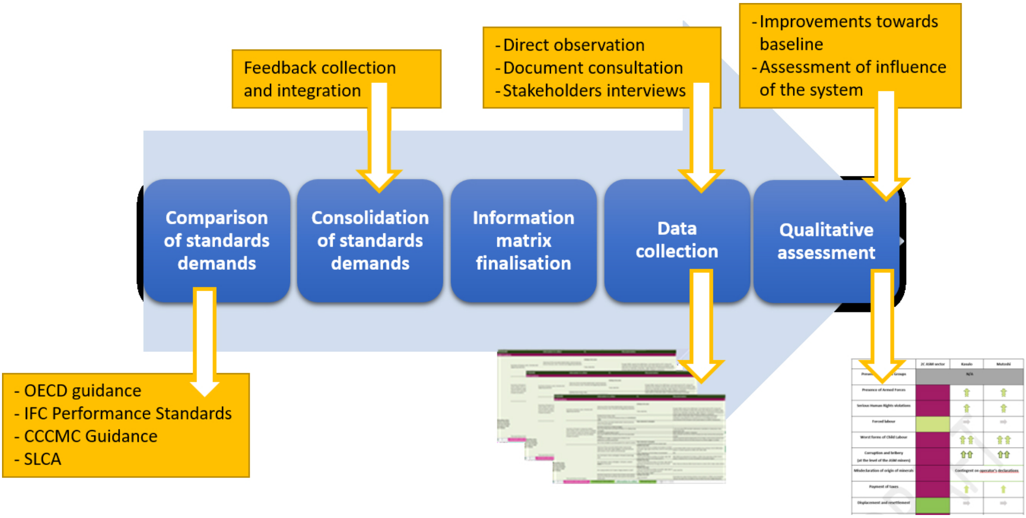

Figure 2: Methodological steps

Results and discussion

The collected data allowed to characterize 45 indicators within the S-LCA framework, in addition to 70 aspects related to responsible sourcing (RS) standards and a set of contextual information.

Applying S-LCA framework to ASM presented considerable potential as well as some important challenges, such as:

- S-LCA is more suitable to assess formal working relations and labour rights, while artisanal miners are not employees and don't receive a salary (wages depends on production). Therefore, some categories used in S- LCA (for instance, stability of jobs or flexible working hours) are not applicable in this context.
- cultural perspectives in the DRC context are different from those in developed countries and therefore application of certain impact categories was challenging (e.g. gender equality)
- as data quality is very poor in the context of ASM, it was difficult to get a semi-quantitative assessment; narratives were often more useful in order to get nuances and different perspectives into the assessment. This bottom-up approach, even though useful to validate top-down results, can have limitations due to, for instance, limited literacy and lack of confidence from the interviewed. Moreover, extensive consultations and involvement of stakeholders are time and cost intensive and their results are barely scalable and have limited comparability.

- S-LCA brought interesting insight on relevant aspects that are not included in RS standards, e.g. income (which was perceived as a very important aspect by stakeholders) and community beneficiation from mining (jobs creation and local economy). S-LCA, indeed, includes positive impacts, while RS standards aim at avoiding major risks.

Limits and potentials of the methodology and information matrices, as the lessons learnt will be presented and discussed.

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Quantifying the impacts of sanitation on health

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Introduction

Access to safe drinking water and adequate sanitation are considered minimal hygiene and comfort items. Nevertheless, in 2014, 700 million people still lack access to improved water, and 1 billion people do not have access to sanitation at all (WHO UNICEF, 2014). Historical studies regarding the 19th and early 20th centuries have linked the child mortality to the improvement of water, sanitation and hygiene investments. If such physical conditions are poor, it could be a major risk factor for child mortality (Mara et al., 2010). These are the main environmental factors behind child deaths following the pathway described in figure 1.

Public authorities are concerned about this issue, as well as certain NGOs, and certain companies whose mission is to install sanitation systems. More generally, companies located in areas without sanitation facilities may decide to finance them, but they need to compare the effects on health caused by the exposure to sanitation, while the expected progress in infant survival depends on the initial conditions. It is therefore necessary to explore these topics. Here, we will focus on exposure to sanitation only and infant mortality (children under 5) only. You have to answer two research questions. The first is "What are the quantifiable effects of sanitation on under-five mortality?" and the second "how important are the different conditions, known in the literature to influence the results of the exposure to sanitation on the mortality of children under 5?"

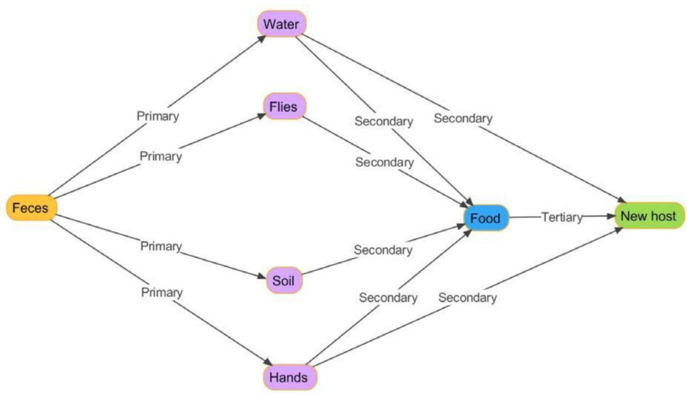

Figure 1: Pathway between sanitation and health – Collinet-Adler and Naumova (2020) adapted from Wagner and Lanoix (1958)

Methods

To answer the first question, we question the Headey's and Palloni's (2019) recent work. They used a subnational (442 regions in 59 countries) panel data set (around 1,500 observations) aggregating Demographic Health surveys collecting data over relatively long periods (in average each 5 years, during 14 years). The control variables accounted for are the variables commonly cited in the literature as determinants in mortality, and for which they can get data. Here are i) at the household level: housing characteristics, maternal education, demographic indicators, health service; ii) at the national level: national income, food security, health expenditures, foreign aid, urbanization, population, and malaria incidence; iii) at the sub-national level: density. Nevertheless, certain data representing important conditions like breastfeeding were not available. Headey and Palloni could not provide a conclusion about the hierarchy of local conditions. To elaborate our own proposal we presume a dose-response function linking sanitation coverage and health improvement, as supposed by (Burger & Esrey, 1995), and the conservation of the relationship at any scale. To answer the second question, our proposal stems from the meta-analysis by Burger and Esrey (1995) and from analysis of detailed specific works about the different local conditions. Nevertheless, we excluded the important topic of the interference between sanitation and access to water.

Results and discussion

When survey fixed effects are included, only basic sanitation (pit latrines) is significantly associated with drop in under-5 child mortality. Progress caused by improved toilettes, neither quantity nor quality of water, can be detected, at least for the mortality rate. A 1% increase in sanitation coverage (all other things remaining equal) is associated with a decrease in under-5 mortality of between 0.34 (survey fixed effects) and 0.38 (global region trends) per 1,000 births (Headey & Palloni, 2019). Control variables matter a lot, because they account for 0.42 avoided deaths per 1,000 births thanks to their positive evolution during the same period. Extending sanitation coverage (from 0% to 100%) would entail a decrease in under-5 mortality between 34 and 38 per 1,000 births. Yet these improvements occur with a high initial death rate in 1990. If the World average rate is 93%° (data 1990, World Bank, 2019), the saved lives (34 to 38 infants) stands between 36 % and 41% of the mortality. If the rate as low as 42%° (data 2015, same source), the rate of saved infants would not be the same.

The improvement range is consistent with the meta-analysis by Burger and Esrey (1995). They distinguished 6 observational or experimental surveys addressing infant mortality linked to exposure to improved water and sanitation, experiencing different levels of infant mortality and other uncontrolled variables. Extending the exposure (from 0% to 100%) of the studied groups improves child survival between 20 to 82 %! Thanks to the works from Butz et al. (1984) and Habitch et al. (1988) about breastfeeding, Alam et al. (1989) about domestic hygienic practices and Merrick (1985) about mothers' education, we tried to graduate the influence of the different conditions. Assuming that certain items are bounded ("low educational level of mothers" with "less than 3 daily hygienic practices"; "high infant mortality" with "no breastfeeding") we suggest the following hierarchy (table 1). We assume also that the range of values (from 20 to 82%) got by Burger and Esrey (1995) is evenly distributed on the whole of the combinations of conditions.

Table 1: Combination of conditions and likely survival gains

	Initial conditions met on the ground				**LICSSE**
	Infant mortality	**Breastfeeding**	**Daily hygienic practices**	**Literacy/ education of mothers**	**about**
A	Low rate	Total	More than 3	Good level	**20%**
B	Low rate	Total	Less than 3	Low level	35%
C	Middle rate	Partial	Less than 3	Low level	51%
D	High level	Partial	Less than 3	Low level	**66%**
E	High level	No	Less than 3	Low level	82%

LICSSE = Likely improvement of child survival (infant less than 5 years) by 100% sanitation exposure starting from 0% exposure

In context A (e.g. infant mortality rate is 30%°) shifting from 0% to 100% exposure to sanitation likely improves the infant survival of 20% (6 infants saved per 1,000, so the new rate is 24%°). In context D (e.g. infant mortality rate is 90 %°), it is 66% (59 infants saved per 1,000, so the new rate is 31%°). Evidently, uncertainties around the effective values on the ground remain high, but the table is helpful to hierarchize the urgency of intervention bringing sanitation. Despite their importance, are not accounted for the interferences between sanitation and water access. Most of the time, companies plan to bring clean water and sanitation at the same time. The new pathway to be included in the toolbox of the social LCA of type II (Parent et al., 2010) makes it possible to attempt a quantification (of saved lives, e.g. 6 versus 59 per 1,000 in examples above) when the actors are considering different conditions and solutions for sanitation. The question of health linked to sanitation is a present concern for many actors in developing countries. It will likely become a concern for diverse populations, everywhere on the globe, in the next decades.

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Time-based indicators of forced labour, local employment and equal opportunities in social LCA

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Introduction

Much work within the social life cycle assessment (SLCA) field is based on so-called type-1 indicators, which relies on semi-quantitative ordinal scales, specifically on the assigning ordinal values (e.g. 1, 2, 3 and 4) to impacts occurring along the life cycle. Such ordinal-scale values typically reflect companies' ethical performance and legal compliance, for example with 3="fulfils basic requirements" and 4="proactive behaviour". However, this approach has been criticised for its mathematical limitations; strictly, it is not allowed to add, subtract, multiply and divide ordinal-scale values, since it is not certain that 2 is twice as much as 1, while this is still common practice in such SLCAs (Arvidsson, 2018). In contrast, there is also a type of indicators called type-2 indicators, which are effectively the same type of quantitative, cardinal-scale indicators as are typically used in conventional LCA. An example in the field of SLCA is the use of disability- adjusted life years (DALY) for assessing various health impacts. Type-2 indicators allow for any type of relevant mathematical operation, including addition, subtraction, division and multiplication. Since there is typically an interest in adding social impacts along product life cycles, type-2 indicators have a clear benefit, provided that such indicators can be developed to capture important social impacts. This can be difficult, since the impact pathways going from the product system, over midpoint impacts, to endpoint impacts are often challenging to map and quantify for social impacts.

This contribution contains a proposal of a number of type-2 indicators for use in SLCA. The indicators are based in time and inspired by the early SLCA work by Hunkeler (2006). He proposed labour hours as a social midpoint indicator and specifically conducted an assessment of two detergents. In that work, labour hours are understood as something positive, contributing to the local well-being by enabling jobs, incomes and subsequent tax revenues that can be used for health care, education and other important services. However, labour hours can also be socially problematic – for example, they can be in the form of forced labour or be unevenly distributed among e.g. females and males. In addition, as pointed out by Hunkeler, if labour hours indeed are to contribute to local well-being, the labour must also be conducted locally. A critique against the original labour-hour indicator proposed by Hunkeler can thus be that the labour hours in themselves give limited information about the social impacts related to the labour hours – they could be beneficial, hazardous, harmless, unequal, etc. In this sense, labour hours are more akin to inventory-level rather than midpoint-level indicators in LCA. For example, they are quite similar to the inventory-level indicator of land area occupied along the life cycle, measured in square meters, which is sometimes used as a simple indicator for land use. For this indicator too, it is clear that some square meters used are more problematic than others: occupying one square meter of cut down rainforest is arguably more damaging than occupying one square meter of set- aside land. The same goes for labour hours – one hour of interesting work under good conditions is less damaging (and might even be beneficial) compared to e.g. one hour of forced labour under harsh conditions. Consequently, it would be interesting to disaggregate the labour hours and categorise them into different relevant groups, which better reflect social impacts.

Methods

The guidelines on SLCA by the United Nations Environment Programme and the Society for Environmental Toxicology and Chemistry (UNEP/SETAC) contain an extensive list of social impacts, referred to as subcategories (Benoît et al., 2009). Three of these fit well into the idea of defining more detailed categories of labour hours: forced labour, local employment and equal opportunities. For forced labour, it is in theory possible to quantify the share of the total number of labour hours that are forced (i.e. conducted under slavery-like conditions). In this way of thinking, the inventory data is the total number of labour hours (*t*) and the share of the hours conducted as forced labour (x_{FL}) becomes akin to a characterisation factor, enabling the calculation of the life-cycle forced labour impacts (I_{FL}) on a midpoint level over all life-cycle processes *i*:

$$I_{FL} = \sum_i t_i x_{FL,i} \text{ (Eq. 1)}$$

Exactly what constitutes "forced labour" can be debated, but modern interpretations of slavery include the "classical", chattel slavery where people are born, captured or sold as slaves, but also debt bondage slavery (trapped by loans for an undefined length of time) and contract slavery (trapped by fake contracts luring workers into trafficking and enslavement processes). Regarding local employment, it is possible to assess the share of labour hours occurring at some geographical location (x_{LE}), e.g. a place where the foreground system is located and there is a wish to increase employment rates in order to increase incomes and tax revenues:

$$I_{LE} = \sum_i t_i x_{LE,i} \text{ (Eq. 2)}$$

where I_{LE} is a midpoint-impact indicator for local employment. Regarding equal opportunities, that can encompass many different things, but one part can be than both genders take part in labour and earn incomes, allowing them both a certain control over their lives. For this purpose, it is possible to quantify the shares of labour hours conducted by the respective genders (x_G, where G is either female or male):

$$I_{EO} = \sum_i t_i x_{G,i} \text{ (Eq. 3)}$$

where I_{EO} is a midpoint-impact indicator for equal opportunities.

Results and discussion

The three indicators proposed all have the unit time, e.g. “hour” or some other preferred time unit. Figure 1 shows a fictional, schematic result from applying the indicators. The first bar is the total labour hours, equal to the indicator proposed and assessed by Hunkeler (2006). Then comes the forced labour hours, which constitutes a share between 0 (best case) and 100% (worst case) of the total labour hours. The third bar is the labour hours conducted locally, which is also a 0-100% share of the total labour hours. Finally come two bars showing the share of female and male labour hours, which together make up 100% of the total labour hours (unless some gender-neutral or data-wise uncertain category is included). For all the three indicators, the *absolute* values can be interesting, e.g. for product comparisons. However, more interesting than that is probably the *distribution of impacts* along product life cycles. Specifically, for local labour hours, the distribution along the life cycle is key and built into the indicator – unless a significant share of the labour is conducted at a certain selected location along the life cycle, a product can hardly be claimed to contribute to local employment. For equal opportunities, the distribution between men and women is interesting, and so is the gender balance along the life cycle. This contribution provides the possibility to assess several important subcategories with type 2-indicators, although they remain to be tested in SLCA case studies. As for any newly developed indicators, data availability might be a challenge which needs to be addressed. Additional indicators might be developed by considering other relevant types of labour hours.

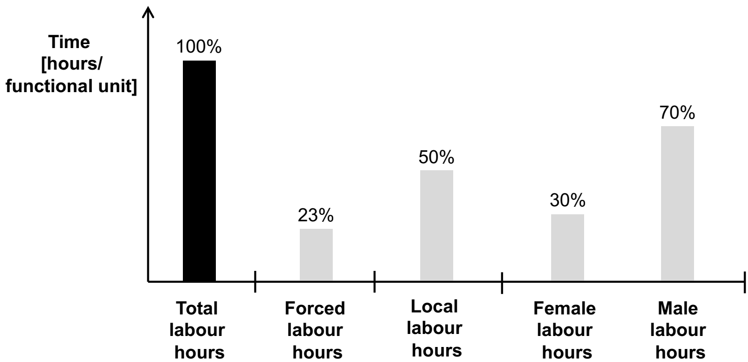

Figure 1: Fictional, schematic example results for the total labour hours (black bar) and the proposed time- based social indicators (grey bars).

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Social impact valuation of the PSIA scale-based approach

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Introduction

To date, few approaches have been proposed to transpose the results of Social Life Cycle Assessment (LCA) in monetary units other than QALY and DALY-based approaches, as proposed by Weidema (2006; 2020), and which prove to be an interesting alternative to direct monetization. Certainly, impact valuation (IV)—understood here as the action of putting a monetary value on social impacts (i.e. monetization)—as gained momentum in the past years particularly with the publication of frameworks and standards such as the Natural Capital Protocol, Social and Human Capital Protocol and ISO14007 and ISO14008. IV is considered by many actors as the best approach to measure and value the effects of business activities because of its potential to facilitate comparability and communication of results across different companies and sectors (IVR, 2017). The Handbook for Product Social Impact Assessments (PSIA) has developed a proven method that provides a clear and consensus-based methodology to qualitatively assess potential social impacts of products and services throughout the life-cycle of creation, use and disposal (Goedkoop et al., 2018). The PSIA methodology proposes predetermined reference scales, and performance indicators for 24 social topics related to four stakeholders. An overview of the key components of this framework is presented in Figure 1. By providing a clear framework, PSIA amplifies the ease of the data collection process which opens the possibility to streamline valuation studies.

In the initial process of developing the PSIA method, no formal guiding principles were proposed in order to pass from qualitative results on the scales-based approach to quantitative results in monetary units. Thus, this paper explores the creation of an approach that will enable PSIA's framework users to systematically monetize the qualitative results of their assessments.

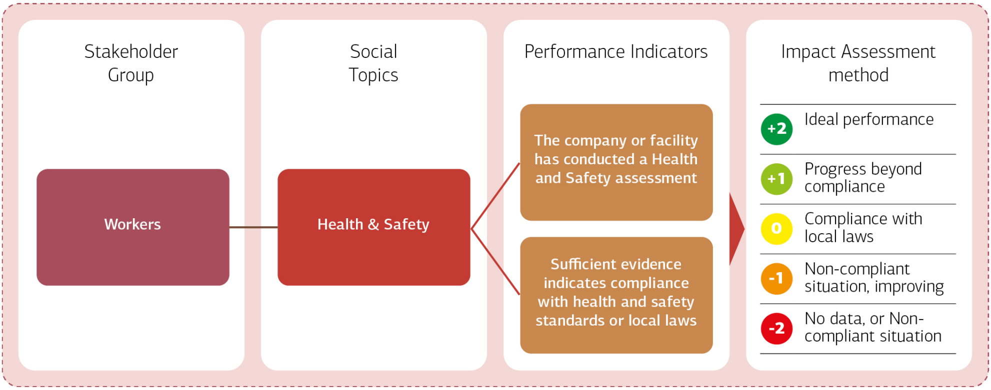

Figure 1: Key components of PSIA methodology

Methods

In order to develop the monetization methodology, we have chosen to rely on two concrete case studies proposed by members of the Roundtable for Product Social Metrics. Each of the case studies that have been documented focused on companies primarily engaged in producing palm oil, but in two different parts of the world, Papua New Guinea and Indonesia. The work was done in three stages:

1. Conducting a literature review allowing us to gain a better understanding of the existing valuation methods pragmatically applicable social capital, human capital and the prioritized social topics;

2. Conducting a literature review in order to gain a better understanding of the hotspots and social topics of materiality associated with the case studies; and

3. Developing rigorous, replicable and consistent monetization methodology (for three social topics) whose foundations could be relevant for each of PSIA stakeholder groups and social topics.

It was considered relevant to develop further on phase three of the methodology. After prioritizing three stakeholders as well as a social topic per stakeholder, we have used the theory of change (ToC) to outline the inputs, activities and outputs contributing to outcomes and potential impact attributable to the company. The definition and modelling of the impact pathways assisted by the ToC allows us to be transparent about choices and assumptions that were made as the process progresses. For each of the selected social topics, regionalized reference value has been linked and distributed according to PSIA's reference scales performance levels on the basis of primary data and completed with data available on international databases (e.g. SHDB, WHO, OECD, ILOSTAT, etc.). For each of the case studies, the reference scale performance is assessed to determine the actual performance compared to level 0 scenario. Assumptions are made to evaluate the monetary value of the potential impacts of the enterprise using a fit-for-purpose valuation technique. The monetary value was then re-associated with the reference scale depending on the context. In other words, we have attempted to correlate the qualitative reference scales with the potential social impacts measured by the impact valuation method.

Results and Discussion

Review of the literature on valuation approaches allowed us to specify the methods most likely to contribute to monetization of three of PSIA's social topics in addition to providing us with details on the data needed to convert our inventory indicators to monetary value using a suited valuation approach. These clarifications were obtained by reviewing market-based approaches, revealed preference techniques, stated preference techniques, cost-based approaches, value transfer, life satisfaction and selecting and retaining those being best suited to our needs.

The second stage of our methodology allowed us to identify that for our case studies the main subject of materiality was for workers the social topic "health and safety", for local communities the social topic "employment and skill development" and for small-scale entrepreneurs the social topic "meeting basic needs". Our selection also called for pragmatism by making sure to consider the availability of primary and secondary data as a determining factor for the social topics that would be selected.

Guiding principles were proposed in order to pass from qualitative results on the scales-based approach to quantitative results in monetary units. A path of interest for the valuation of social topics is to causally link the potential impacts to human health using DALY and a change on economic variables which can be linked to PSIA's characterization scales by determining the value created in the region concerned by the benefits emanating from the activities of an organization. The application of the proposed methodology is promising and allows—thanks to PSIA's predetermined social topics and performance indicators—more ease for the data collection process. The fact remains that in the context of our implementation data collection was a significant obstacle considering an application to a generic case where initiatives were already completed. Such methodologies should be launched in parallel with the implementation of initiatives for which social benefits are expected and not following the completion of these initiatives. The valuation of certain social topics can also be challenging since it requires the conceptualization of an approach adapted to this specific topic. The next steps are to carry out a mapping valuation approaches that are suited for each of the social topics that were not covered by our work and hold application cases from the start to the end of a project in order to clearly establish the starting situation and the contribution of inputs, activities and output to the change of state in the targeted region.

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Social hotspot assessment using the sustainable development goals (SDG) as guiding elements

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Introduction

The new methodological approach described here, follows several steps to find relevant Hotspots for every alternative that is assessed a life cycle of products. For an accurate consideration of social impacts in the life cycle of products, a first generic overview, but as well a deep dive into social hotspot(s) of the value chains, are needed. After an expert evaluation of relevant topics considering the SDGs is performed. The definitions of the SDG help to find key aspects that should be considered. In the analysis, main social focus topics discussed by stakeholders, societies, NGO etc. will be selected and highlighted. If there is a negative effect found, it will be linked to the most relevant SDG and should be able to support decision-makers in the interpretation of the results. This approach is seen as a risk-based approach for the identification of activities contributing negatively to the SDG defined for countries. Even if the SDG are defined mainly for countries, companies often focus on them as well because they can contribute with their production conditions significantly to the realization of SDG of countries. Companies are part of the local communities.

Methods

The method of the Social Hot Spot Assessment identifies impacts to the Sustainability Development Goals (SDG) and is displaying the results with the most significant SDG effects. A specific overview reflects all information identified and enables the support of strategic decision-making.

The identification of the most relevant life cycle steps follows some basic questions or qualification of a possible focus. It is considered to discuss the topics of most salient social risks, the need for more detailed information and contextualization, links to social risk in direct/indirect business relationships, leverage and improvement potentials. Furthermore, the relevance for stakeholders and recent or evolving public attention is considered. Figure 1 shows the summary of the findings of the Hotspot Assessment linked to the relevant SDG.

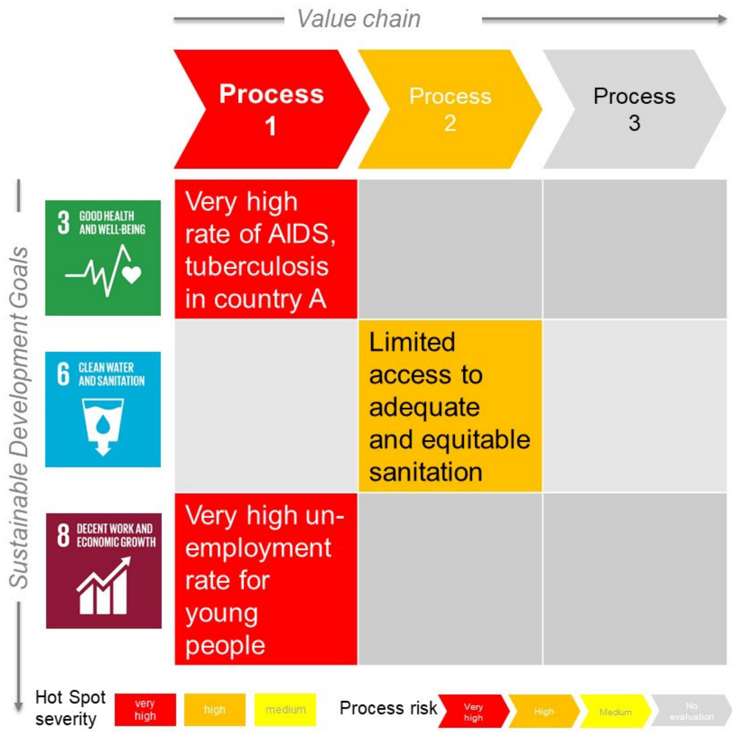

Figure1: Overview of finings of Hotspots linked to process steps and SDG

Results and discussion

Deep dive assessment steps with the Social Hot Spot Assessment enables analysts the generation of a clear picture of the social impacts and improvement potentials of alternatives fulfilling the same functional unit. Key findings of the Social Hotspot Assessment are translated to goals and targets which are defined in the SDG. With the matching process a SDG is identified where the alternative of the study conflicts with. This will be assessed in the previously identified area of Hot Spots. It will be identified and highlighted if and how life cycle activities and actors' conflict with the SDG. The alternatives in the study are reflected and transferred in an assessment matrix using color codes as well.

The evaluation does on one hand display the hot spots aligned to the SDGs and links them to the identified step in the system boundaries. In addition, it exposes the severity of the issue compared to other regions of concerns. It is a kind of a normalization step, transferring the result a color code system as used in the Social LCA as well. This assessment is achieved by comparing, on an international level, the regional hot spot to other countries' performance in the specific issues. The alternatives assessed can be displayed in an overview graph as well for easier interpretation (Figure 2).

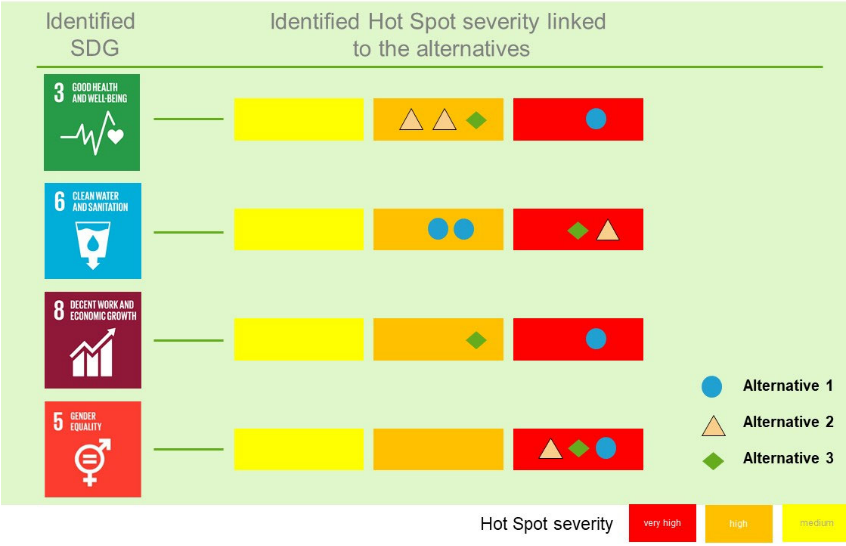

Figure2: Plot of results form different life cycle steps in the Social LCA assessment

The overview in Figure 2 is the basis for further interpretation of improvement potentials and can be used in decision- making processes. It compares the alternatives and gives indications, where improvements might be more meaningful and in which way improvements of working conditions might be realized.

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How the DPSIR framework can be used to build cause-effect chains in social life cycle assessment?

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Introduction

Social life cycle assessment (S-LCA) is the last tool developed among the three tools of life cycle sustainability assessment. There is growing interest in S-LCA from the life cycle assessment community, especially when it comes to the aggregation of social data collected in the impact assessment phase (Benoit et al., 2009). Social life cycle impact assessment (or S-LCIA) still remains an active field where different methods are being developed and proposed (e.g. Arvidsson et al., 2018; Ramirez et al., 2016) with two main approaches proposed by the UNEP/SETAC S-LCA guidelines referred to as Types I and II (UNEP/SETAC, 2009). Type I assesses and aggregates data collected for the performance of subcategories using performance reference points such as international conventions and common standards (Parent et al., 2010; Hannouf and Assefa, 2018). Type II uses cause-effect chains to analyze relationships between inventory indicators and midpoint or endpoint categories (Parent et al., 2010). Cause-effect relationships are popular in environmental life cycle assessment where human health impacts caused by emissions are evaluated using the disability-adjusted life years (DALY). However, these cause-effect chains are still challenging in S-LCA due to the qualitative nature of social phenomena (Sureau et al., 2019) and the difficulty in mapping and validating the causality chains in S-LCA. Despite these challenges, previous studies have proposed different approaches for Type II S-LCIA. A recent study by Sureau et al. (2019) has reviewed the different approaches in Type II S-LCIA and found that most of these methods have followed a top-down approach and a macro-level scale focusing on income and health related impacts of some social aspects. This leaves many social variables usually addressed in Type I S-LCA without assessment in Type II approaches. Additionally, even though the aim of S-LCA is to improve the social performance of product systems, as concluded by Sureau et al. (2019), there is still a lack of investigation of the root causes of social issues that should be focused on to improve the social sustainability of product systems; most Type II S-LCIA approaches focus only on social impacts, avoiding analysing the sources.

Therefore, this study explores the use of the driver-pressure-state-impact-response (DPSIR) framework for analysing the cause-effect chains associated with social issues in S-LCA. Our approach in this study follows three steps. First, it extends the impact pathways of Type II S-LCIA, using a bottom-up approach to include a larger variety of variables addressed in Type I of S-LCIA, covering the list of subcategories in UNEP/

SETAC S-LCA methodological sheets. Second, we build generic cause-effect chains by mapping health impacts using Quality Adjusted Life Years (QALYs) associated with social subcategories in S-LCA. This mapping will identify health impacts associated with social subcategories in S-LCA and thus, to explore potential solutions that improve QALYs by changing the underlying causes, i.e. social aspects from S-LCA.

Methods

As this is an on-going study, this paper deals with the first step of the approach: the exploration of using the DPSIR framework to analyse the cause-effect chains associated with social issues in S-LCA. The DPSIR framework helps in identifying cause-effect relationships between socio-economic and natural systems (Ness et al., 2010). It has the ability to integrate knowledge across disciplines and to organize complex socio-ecological problems and to help identify solutions. Therefore, it has the potential to formulate and analyse cause-effect chains in relation to social issues in S-LCA, as these social issues are connected with environmental and economic problems and thus need an appropriate interdisciplinary framework. The DPSIR framework extends the cause-effect chains beyond the current focus of approaches on latter parts (impacts of social issues) to the early parts of the chains by investigating connections between causes and impacts of social issues. This holistic and detailed analysis serves the purpose of S-LCA by proposing solutions to improve the social performance of product systems through analysing not only impacts but also the main sources of the issues and cause-effects of social subcategories. In building the cause-effect pathways associated with the subcategories in S-LCA, we build on existing social science theories, as suggested by Sureau et al. (2019) and on public health related studies and evidence.

Results and Discussion

Figure 1 presents one example of using the DPSIR framework to analyse the cause-effect chain associated with the subcategory of “working hours” under ‘workers’ stakeholder group. In analysing impacts, we built on the study by Weidema (2006) of estimating the QALYs associated with social aspects. However, in this study, we developed this association further by using the DPSIR framework, the list of subcategories in S-LCA methodological sheets and by building on public health related studies to map connections between social aspects and QALYs.

Building these cause-effect pathways include identifying indicators that need to be used to collect data on the social impacts on different scales (i.e. country, sector, company, product, technology) in relation to each of the social issues (e.g. excessive working hours). Table 1 presents an example of data to be collected in relation to the impacts of two subcategories. In collecting these data, we will be using different data sources such as the World Health Organization, public health related peer-reviewed studies, country reports, social databases (SHDB, PSILCA), companies’ reports and primary data when available.

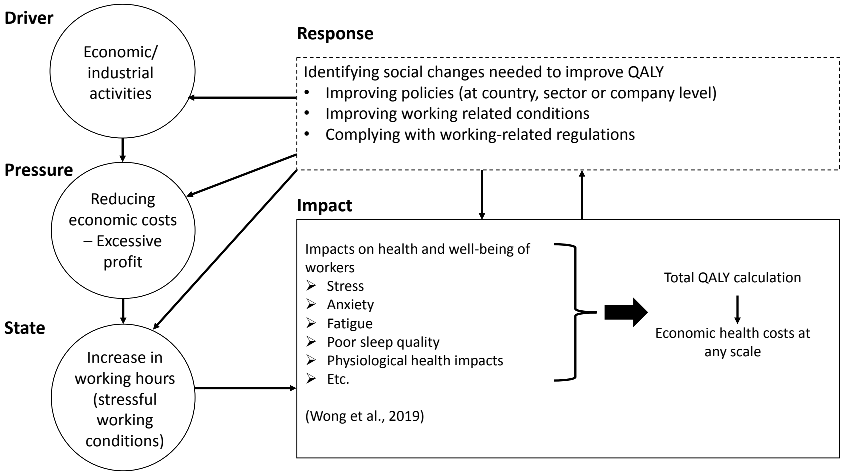

Figure 1: Cause-effect chain using DPSIR framework for "working hours" subcategory of 'workers' stakeholder group.

Table 1: Examples of data and indicators to be used in assessing the impacts related to the subcategories

Subcategories	Data to be collected			Indicator
Excessive working hours	Number of incidents involving excessive working hours	Health and well-being impacts caused by excessive working hours	Disability weights and well-being weights	Calculation of QALY associated with the probability of associated health impacts
Absence of proper or satisfactory safety measures and standards	Number of occupational health and safety accidents	Health and well-being impacts caused by no proper safety measures	Disability weights and well-being weights	Calculation of QALY associated with the probability of associated health impacts

The approach taken in this study to build the cause-effect pathways in S-LCA is significant due to its bottom- up approach, considering all subcategories and from its analysis of the early steps of the cause-effect chain of social aspects and not only the latter parts of the chain. In addition, the approach builds on public health related studies in mapping health impacts (QALYs) associated with social aspects. This will help to identify social changes that improve health associated impacts (QALYs). The overall research will help identify indicators and thresholds in relation to subcategories based on the developed cause-effect chains.

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Exploring new impact pathways in SLCA: An approach based on subcategories

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Introduction

The development of methods for the assessment of social impacts in the life cycle of products (S-LCIA) has been taking place since even before the publication of the Guidelines for SLCA of Products (UNEP/SETAC 2009). Since the beginning several approaches have been adopted as a way to measure such impacts, which resulted in the classification of models into Type I and II. As pointed out by Parent et al. (2010) and Wu et al. (2014), both approaches have certain limitations. In Type I methods there is a lack of clarity regarding the relationships between the inventory indicators and the subcategories, and for Type II, some methods present uncertainties in the way the impact pathways are established.

More recent publications present the use of more robust estimation techniques to support the development of Type II S-LCIA methods, such as Feschet et al. (2013) and Bocoum et al. (2015), which used regression techniques to estimate characterization models or Wu et al. (2015) and Chang et al. (2018), which use Structural Equation Modeling (SEM) as a way to confirm social impact pathways. However, even in these studies, only a few specific subcategories are linked to social cause-effect chains.

Thus, in view of the limitations, there is a need to develop a social impact assessment model that establishes a link between the subcategories and the social impact pathways. In this sense, the aim of this article is to present a Type II method, with an impact pathway and characterization model based on the subcategories of the SLCA.

Methods

The method was developed following three stages:

- **Stage 1 -** Human well-being has been considered as AoP in several published SLCA methods, such as Dreyer (2006) and Neugebauer et al. (2014), among others. However, due to the complexity of fully measuring the effects related to this AoP, the social impact models end up focusing on the understanding of the effects on certain endpoints related to well-being. Thus Life Expectancy at Birth (LEX) comes being used as a parameter to measure the potential impact on human health, which can be considered an endpoint related to well-being. In this sense, this study proposes to follow this same line, however, starting from an exploratory and confirmatory analysis, the identification of possible correlations existing between the subcategories of the SLCA and the category of human health endpoint, using LEX as a parameter.

- **Stage 2 -** In view of the objective of this study, it is important to understand how the subcategories can be correlated and whether together they represent some social dimension (constructs/ factors), as well as establishing correlations between these dimensions with LEX. In this way, it was necessary to select estimation techniques that would meet this proposal. For this, based on the study by Araujo and Ugaya (2018), was identified that the techniques of Exploratory Factor Analysis (EFA) and Structural Equation Modeling (CB-SEM and PLS-SEM) would be the most appropriate.

- **Stage 3 -** The collection and choice of indicators representing the subcategories was carried out for a sample of 189 countries, for a period of at least two years, bearing in mind that a sample is needed for the exploratory step (EFA) and another for the confirmatory step (CB-SEM / PLS-SEM). The data requirements were availability for the year 2017 and 2018. The data sources should be international, national or, in the last case, research institutes, and the indicator should be representative by country and aligned with the definition of the subcategory presented in UNEP/ SETAC (2013). In addition, the organization and treatment of missing data was performed with the use of multiple imputation. After the collection, organization and treatment of the data, an EFA was carried out as a way to identify correlations between the subcategories, and possible social dimensions that they could represent together. Based on the results obtained through the EFA, a confirmatory analysis was performed, using the CB-SEM, and later, using the PLS-SEM, a model was elaborated that related the social dimensions identified with LEX. Treatment of missing data and implementation of EFA, CB-SEM and PLS-SEM were performed using software R v.3.6.1.

Results and discussion

The results of Stages 1 and 2 were presented together with the method, as they were necessary for the selection of estimation techniques, indicators and sample to be used for the development of the impact pathway. As results of Step 3, the collection and choice of indicators was based in part on the study of Juchen and Ugaya (2017) and also a complementary collection and choice of indicators. It was possible to develop a database composed of 21 indicators, representing 15 subcategories related to 4 stakeholder groups, whose data come from various international sources, such as the World Bank and ILO. The subcategories and indicators covered were: Fair wage, Equal opportunities, Social benefits, Access to material resources, Access to immaterial resources, Delocalization and migration, Safe and healthy living conditions, Community engagement, Local employment, Secure living conditions, Contribution to economic development, Prevention and mitigation of armed conflict, Corruption, Fair competition and Respect of intellectual property rights.

From the exploratory analysis with the EFA and confirmatory with the CB-SEM, it was possible to identify and confirm that the subcategories contemplated in this study, were organized in two social dimensions, "Economy and competitiveness" and "Access to water, sanitation and conflict prevention". Finally, through the PLS-SEM, it was identified that there is a strong correlation between these social dimensions and LEX, which allowed us to establish the path of impact shown in Figure 1, starting from the subcategories and reaching the endpoint.

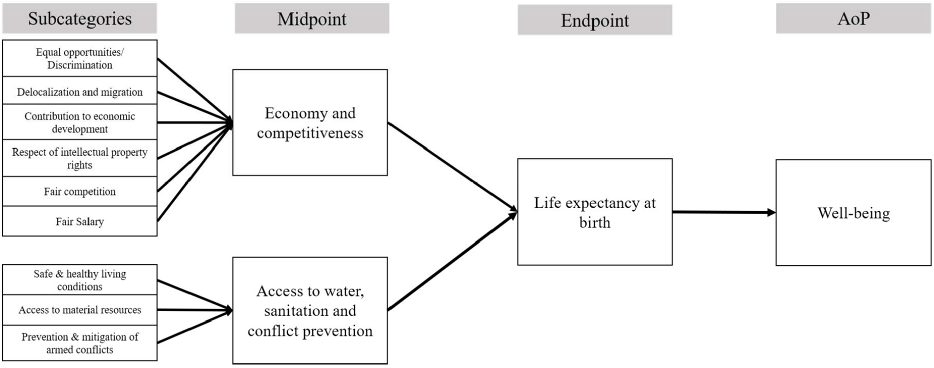

Figure 1: Impact pathway identified.

Conclusions

Through the use of social indicators related to subcategories and multivariable techniques, such as EFA and SEM, it was possible to identify and estimate an impact pathway, "Economy and competitiveness" and "Access to water, sanitation and conflict prevention" related to the endpoint LEX. Finally, although it was possible to achieve the proposed objective, it is important to highlight the limitations identified in the conduct of the study, such as the absence of generic data at the country level for various subcategories, especially those related to the Consumer stakeholder, or the availability of data for only selected groups of countries, incurring the problem of missing data. Future advances include the possibility of identifying new impact pathways from the subcategories, with the use of exploratory techniques and methodological advances in already identified pathways.

Acknowledgments

The authors appreciate the Grupo Boticário, Capes and Fundação Araucária for the financial support for the realization of this research.

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Development of a normalization method for social life cycle assessment

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Introduction

Normalization is voluntary, but an important step in the interpretations of life cycle assessment results. It enables comparison of data across impact categories and puts the results of the impact assessment into context, providing a measure of relative significance to each category (Norris, 2001). In other words, it allows the identification of processes in a supply chain that cause greater impact, in comparison to a given reference scenario. Normalization is commonly utilized by practitioners of environmental life cycle assessment because it facilitates the comprehension of the results and supports improved decision-making (Laurent & Hauschild, 2015). There has been little published work that has focused on normalization for S- LCA. The objective of the present research was to develop a normalization method for S-LCA generic databases, and to create normalization references (NRs) to be applied to social footprint assessments.

Methods

The normalization inventory data - total yearly value of outputs per country-specific sector (CSS) and the risk-hour value per each US dollar of product sold by each CSS came mainly from the Social Hotspot Database (SHDB), version 4. The SHDB is based on the input/output (I/O) model from the Global Trade Analysis Project (GTAP; version 9), a platform that offers statistical estimates on trade activities for 57 clusters of economic sectors and 140 individual or aggregations of countries (Benoit Norris, Bennema, & Norris, 2019). The social risk information in the SHDB came from the national, regional, and global quantitative statistics and qualitative information collected from authoritative sources (Benoit Norris, Bennema, & Norris, 2019). The risk level assigned by the SHDB for each indicator per CSS informs the most likely socio-economic scenario in which a given economic sector operates in a specific country (Garrido, Parent, Beaulieu, & Revéret, 2018). The SHDB also contains information on labor intensity (worker-hour information), used in the SHDB as an activity variable to capture the magnitude of each CSS according to the size of their contribution to the total product under analysis (Benoit Norris, Bennema, & Norris, 2019). Data on population came from The World Bank (n.d.-a;), as well as the clustering of countries that informed the reference systems (World Bank, n.d.-b). The methodology for modeling the normalization inventory is also from the SHDB system (Norris & Benoit Norris, 2019). It can be applied at the category level or the subcategory level (Benoit Norris, Bennema, & Norris, 2019). In this research, we created NRs for both levels.

In order to test the NRs, we conducted a S-LCA of two case studies: annual imports of seafood by the United States of America and the annual average expenses of an American consumer unit. Data for the case studies also came from the SHDB V4 and from desktop research.

Results and discussion

A normalization method to calculate NRs for S-LCA studies was developed. The method is comprised of nine steps, adheres to the structure of the SHDB, but a similar method could be developed for other database systems. Sets of NRs for seven geographic regions, with respective per person figures, were created, along with a per person extra set for the global region. These eight sets of NRs can be applied in S- LCA studies intended to assess an organization's or an individual's social footprint, especially if those studies are based on data from generic databases. Each set presents NRs for 26 subcategories and five impact categories.

Two S-LCA case studies were conducted with a normalization step at the interpretation phase.

Normalization was applied by comparing the impact assessment results of each category against a common reference. The results allowed to measure the dimension of the impact per category (or subcategory), to visualize where the risk of social impact was at a significant higher level compared to the risk shown in the other categories (Figures 1 and 2). This procedure signaled where the largest source of risk for negative impacts exists within the product system – the hotspots – which are also the areas that offer greater leverage for action, since these two studies did not include a weighting step.

Normalization reveals the relative weight of the social risks when compared to a reference scenario, allowing the identification of the categories (or subcategories) most at risk in a given context. Normalization procedure also allows an enhanced communication of the results of a S-LCA study, and it provides greater efficiency and objectivity to the management of social impacts in supply chains. The two case studies provided examples of the benefits described above: they supplied a clearer image of the categories and subcategories most at risk in the supply chain (Figures 1 and 2); these results optimized the number of social issues which root causes should be investigated; and also reduced the number of categories and subcategories where hotspots should be identified during the interpretation of results.

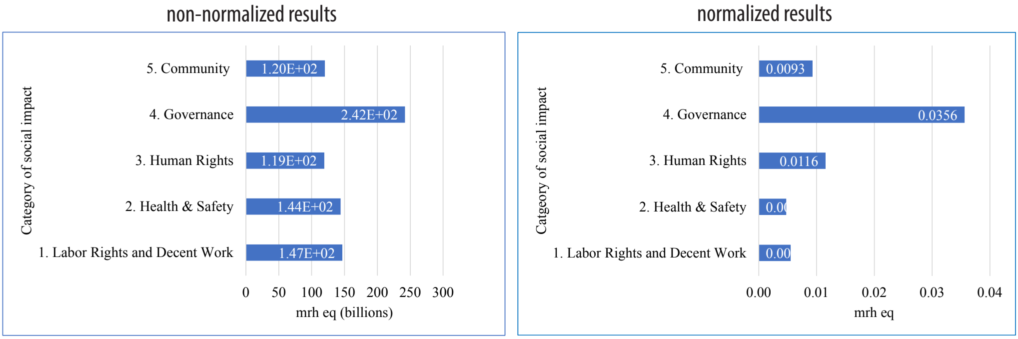

Figure 1: Comparison of non-normalized and normalized results of the American seafood imports study, at the category level, using the North America reference system. mrh eq = medium risk hours equivalent.

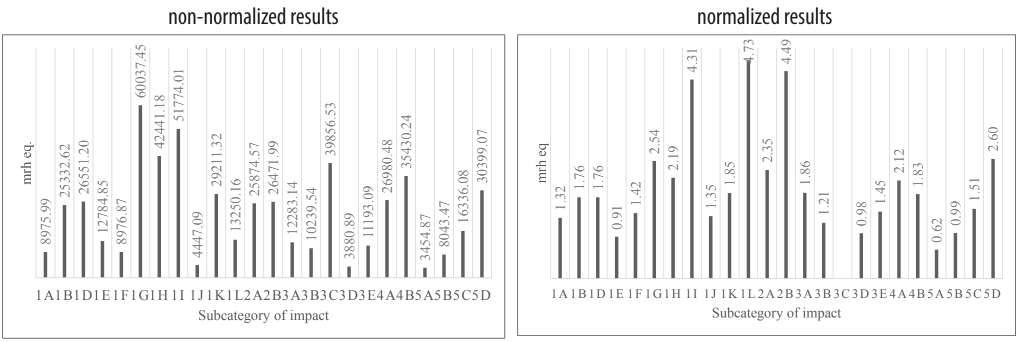

Figure 2: Comparison of non-normalized and normalized results of the average American consumer unit study, at the subcategory level, using the Global per capita reference system. mrh eq = medium risk hours equivalent.

Future S-LCA studies could benefit from the normalization references created by adding this step to their projects and by offering results that are easier to comprehend and that can inform a wider variety of stakeholders. The evaluation of sustainability impacts throughout the supply chain is becoming an imperative for organizations all over the world. The use of S-LCA studies with normalized results is a time- and cost-saving tool for institutions that need to improve their corporate responsibility beyond their gates.

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Track 2

Applications and their methodologies

Road testing of the revised guidelines for social life cycle assessment of a product

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Introduction

Social Life Cycle Assessment (S-LCA) is a methodology developed in order to assess the negative and positive social impacts of products and services, along their life cycle (Joergensen et al, 2007).The first guideline of S- LCA was published in 2009 as a project of UNEP/SETAC Life cycle Initiative (today EN Environment Life Cycle Initiative) (Benoit and Mazijn, Eds. 2009; Benoît et al., 2011). In the last 10 years, further developments and hundred implementations have been carried out, defining in a more details way the methodology, its indicators and impact assessment methods. After those ten years, a revision of the current version of the guidelines is necessary. This project started in September 2017 but only since May 2018 has been sponsored from the UN Environment Life Cycle Initiative. As lesson learnt from the first guidelines redaction in 2009 was the necessity to have a phase of implementation already during their development to guarantee its feasibility. This is the main reason why, two phases have been planned for the current S-LCA guidelines revision project: 1) methodological revision the guidelines and 2) road testing phase. The third draft of the revised guidelines delivered in December 2019 will be used as reference for the road testing. First results and outputs from the road testing will be presented in this study.

Method

The new version of the guidelines will be the main reference document to implement the social life cycle. The interest is to implement S-LCA and SOLCA to different products in different sectors. Nine pilots project are planned, they covered different sectors, geographical locations and dimensions of the organization involved. Sector involved are: food, raw materials, automotive. An example of public administration is also planned.

All phases of the S-LCA and SOLCA will be implemented starting from the definition of goal and scope, stakeholder categories and system boundary to life cycle inventories and impact assessment. A hotspot analysis will be implemented as first step to identify those stakeholder categories and impact subcategories which are relevant for the chosen products and organization. The hotspot assessment can be implemented by using one of the two database on social LCA available: Social Hotspot Database and PSILCA (Ciroth & Eisfeldt, 2016). Both database allow identifying the main impact categories according to countries and sector social risks.

After the Hotspot analysis a collection of primary data for the S-LCA and SOLCA will be done for those impact categories defined relevant by the Hotspot analysis for each of the pilot project. The collection of primary data will allow to define the current positive and negative social impacts, because it will be possible to compare with the local reference conditions.

Results and Discussion

Activities organized for the training of the pilots as well as all tools and documents, such as questionnaire, to support the participants of the road testing will be presented. The first feedbacks for the participants will be presented as well as the first results on the life cycle inventors.

The first overview of challenges and benefits of the road testing will be presented and discussed.

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The role of social aspects evaluation in circular economy

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Introduction

Circular economy model not only concerns economic models and political guidelines, but also represents a cultural model and behaviour that is becoming increasingly important on a global scale to the level of production, consumption and institutional framework in order to pursue the reduction of the usage of primary raw materials towards models of reuse and recycling of quality materials (Notarnicola et al., 2016). For both European and national levels, there is an institutional thrust accentuated towards a circular economy, as represented by EU Action Plan for the Circular Economy at the community level and by environmental connections to the law of stability, 2016 "Law of 28/12/2015 n. 221".

A circular economy (EC) is an economy designed to regenerate in which the trade may relate to the raw materials, waste, energy, water, services and expertise in order to establish a "closed loop" according to the "green economy" approach as an alternative to classic linear model of production systems (Ellen MacArthur Foundation, 2016 in Stahel, 2016).

Already in the second half of the nineties, several studies were carried out, showing that the presence of innovative networks among companies can influence the behavior and the outputs of the companies involved (Arcese et al., 2013).

Beyond the material aspects, additional key principles of cradle-to-cradle are the use of renewable energy sources and the promotion of biodiversity as well as cultural and social diversity (McDonough & Braungart, 2002).

The object of this research is to identify the most appropriate indicators in assessing the social impacts of the circular economy.

Methods

Starting from the Social LCA framework an extensive literature and case studies review was conduct. From S- LCA approach useful basis social indicators are: Job creation, Job security, Health and wellbeing, Community stability, Education standards, Community services, Crime rates, Equality/Accessibility, Protecting and Enhancing Cultural Heritage, Local Identity and Assets.

Results and discussion

This part of research describes the social aspects of the general framework and the social life cycle assessment inclusion in the general model.

Based on an extensive literature review, this research provided a discussion about the concept of the circular economy, an overview of the main circular economy processes, their applications in different sectors and their economic, environmental and social impacts.

Several case studies highlight of Job creation and Job development from circular economy practices. While the employment impacts of the circular economy in terms of the number of jobs have been analyzed in various studies, assessments of other social and employment impacts appear to be less present the literature, specifically, there is limited information available on social aspects such as gender, skills, occupational and welfare effects, poverty and inequalities.

A crucial role in the realization of circular economy models is played by the environmental and social communication and education actions that must be started in order to allow the training of personnel and citizens, also trying to influence consumers of goods and service users towards sustainable consumption practices.

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The relevance of circular economy towards sustainable development: The case of employment effects

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Introduction

The Circular Economy (CE) is one of the concepts for rebuilding and reframing the economy of the sustainable growth. The concept was introduced to underline its potential to benefit the environment and its special character as smart economies. The key idea is instead of linear flows of materials and products through the economy, the CE promotes circular flows as a means to reduce environmental impacts and maximize resource efficiency. It is presented as a set of strategies and the way to sustainable patterns of production and consumption. Moreover, right policies will be needed to maximize positive and minimize harmful effects of the CE strategies. So far, there has been much focus on the environmental benefits of the circular economy: how it could minimize the extraction and use of virgin materials, reduce waste and pollution, cut costs and mitigate supply chain risk, among others. However, less attention has been paid to how the circular economy can boost and guaranty positive effects on the society, especially in the labor market, both through its potential to create new structure of work ensuring skilled jobs, human rights compliance, and avoiding unemployment. In this respect, some efforts have been undertaken to analyze the employment effects of the CE, for example the Club of Rome (2016) of International Institute for Labor studies also explored the direct-cause-effect of employment gains by implementing CE strategies. It was concluded that academia, government and firms should achieve a comprehensive understanding and valid measurement of social performance and social impact to influence the overall implementation of CE as a means for moving forward a sustainable development. Another report by the WRAP & Green Alliance (2015) suggests that employment in the circular economy can generate jobs for a range of skill types and has the potential to boost employment areas with among the highest unemployment rates. The report uses different public policy scenarios to 2030, and estimates that, with no policy change, 200,000 new jobs will be created, reducing unemployment by 54,000. Under a more aggressive policy scenario, the report estimates that a circular economy could create 500,000 new jobs and permanently reduce unemployment by 102,000. Nevertheless, yet articulation on how circular economy has impacts/benefits to society both on global and local level is absent from current policies and frameworks for CE. Therefore, this work attempts to develop an approach to measure the beneficial effects on the labor market compared with the linear activities they replace by creating a labor circularity index (WCI). This WCI could also help in the development of evaluation of social Life Cycle Assessment. The province of Quebec, in Canada, was selected as a case study to implement the proposal approach.

Methods

In order to carry out the objectives and the above questions, it was identified key features and sectors within the circular economy and also to understand the wider socioeconomic impacts of moving to a circular economy. The approach that we used to estimate the scale of the impact from circular economy activities is primarily based on an input-output analysis of the key sectors that this study assesses. The approach information for each of the sectors is taken directly from analysis of sector profiles. Then, results are modeled to provide estimations of the economic and labor market impact in Quebec and by sectors, based on the level of circular economic activity and circular jobs proposed by WRAP & Green Alliance (2015). We assumed scenarios based on different levels of circular economic activities in the focus sectors.

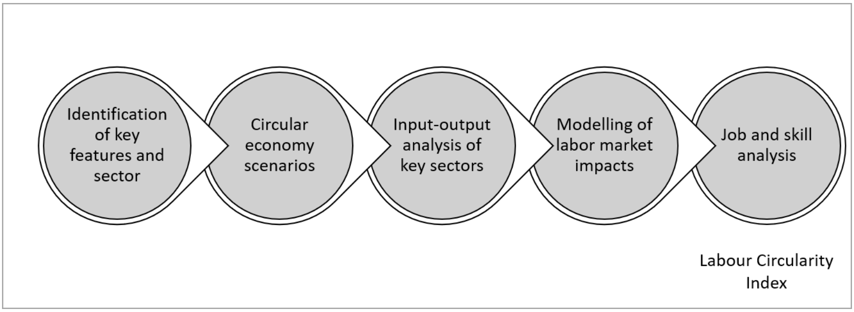

Figure 1: Methodology proposed in this study

These results are further disaggregated to provide occupational and skills impacts which allow us to draw policy recommendations. Finally, it is created a Labor Circularity Index. (Figure 1)

Identification of key features and sectors

A preliminary analysis to identify sectors with high potential in Quebec was conducted by combining results from the literature and the 2014 Supply and Use Tables released by Statistics Canada. The industry and resource (products and services) aggregates were evaluated based on their value-in-use of the industries in terms of percentage of GDP to highlight their significance to Quebec's economic context.

Therefore, we have chosen five key focus sectors, which are broad enough to represent the most important circular economy sectors and activities in Quebec. These five sectors are significant in terms of GDP percentage in production and consumption. The sectors are agro-food (22.29%), energy (16.63%), construction (14.66%), metal and electronic products (12.48%) and recyclable materials (7.49%). These four sectors hold good circularization potential since major environmental and economic gains seem possible.

Circular economy scenarios

Two different scenarios were constructed based on different levels of CE strategies in the focus sectors (moderate and ambitious). These are the scenarios modeled to assess labor market impacts.

Table 1: Overview of the CE scenarios

	Agri-food	Energy	Construction	Metal and electronics	Recyclable materials	All
Baseline	Business as usual (Reduce by 2030 GHG emissions by 37.5% as compared to 1990, and to in-crease renewable energy production by 25% and bioenergy by 50% and improving energy effi-ciency by 15%)					
Moderate	Moderate uptake of the CE (Baseline + recycling rate 70 % + remanufacturing rate 20% + reuse slight growth + servitisation modest growth)					
Ambitious	Ambitious uptake of the CE (Baseline + recycling rate 90% + remanufacturing rate 50% + reuse significant growth + servitisation significant growth)					

Preliminary Results and discussion

So far, the preliminary results suggest that job creation in a growing circular economy in Quebec (business as usual scenario) does not represent an increment in jobs related to clean technologies and environmental protection, as it can be seen in Figure 2.

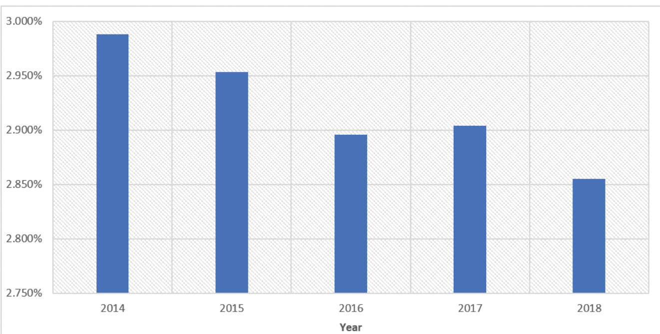

Figure 2: Employment (basis 100%) in the environmental protection and clean technology sector in Quebec

Advantages and limitations of the approach (preliminary)

- The method employs up to date, reliable and existing data to calculate the number of jobs in the circular economy. There is no need to collect new data, a time-intensive and costly process.
- The method employs data that is structured in internationally standardized classification system. This allows for replication and comparison of results over time and across borders.
- The method employs a proxy to calculate the circular share of jobs in enabling and indirect circular sectors. This proxy is derived from economic interaction between sectors (input-output analysis) and can therefore lead to an under- or overestimation of circular jobs in enabling and indirect circular sectors.

Considering both the opportunities and limitations, the method employed for this approach forms the basis – and first iteration – of a labor circularity index for employment in the circular economy in Quebec, Canada.

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The use of Pugh Matrix for the identification of social issues within Social Organisational Life Cycle Assessment: a methodological outline

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Introduction

The achievement of social sustainability is influenced by the way in which the organisation interacts with society by providing or protecting social and socio-economic aspects. These conditions can be assessed through social life cycle tools that allow the social aspects to be considered from a life cycle perspective by managing the social sustainability of the company over time within a systematic approach. Social Life Cycle Assessment (S- LCA) is a methodology which assesses the social and socio-economic aspects, both negative and positive, of product from a life cycle view (UNEP/SETAC, 2009). Nonetheless, a complete consensus on some methodological aspects is not reached yet (e.g. defined set of subcategories as well as indicators used for assessing a specific product or organisation from a life cycle perspective). This leads to the need to define valid social indicators for a specific analysed social context. For this reason, the selection of the subcategories (i.e. social themes as child labour, forced labour, cultural heritage, etc.) and indicators can be done through the participatory approaches (Sureau et al., 2018) which allow the stakeholders to be involved by considering their opinions on specific social themes (D'Eusanio et al., 2019). The synergies reachable from the integration between S-LCA and participatory approaches are evident in the literature (e.g. Halog and Manik, 2011; Manik et al., 2013; Mathé, 2014; De Luca et al., 2015; Ren et al., 2015). Among the participatory approaches, the Pugh Matrix "is used to logically compare different options based on predefined criteria and it can be used in situations where there is more than one factor that may be the significant driving force in a project" (Cervone, 2009, pp. 228). The Pugh Matrix is a two-dimensional matrix that allows m alternatives to be compared by means of a set of j evaluation criteria (Chauvel, 1993; Raudberget, 2010). From this standpoint, this study proposes a methodological outline for the definition of a set of relevant social issues for a specific sector. The aim is to address the assessment from an organisational perspective and for this reason, the methodological outline is developed to be integrated with Social Organisational Life Cycle Assessment (SO-LCA). SO-LCA is modelled upon S-LCA and Organisational Life Cycle Assessment (O-LCA) (UNEP/SETAC, 2015; Martinez-Blanco et al., 2015) and is implemented following the

ISO14040:2006 framework. SO-LCA still needs methodological developments in its implementation as well as its integration with participatory approaches.

Method

This paper involves a local wine consortium located in Abruzzo (Italy) which includes nine local cooperatives. The finalised approach is based on five main phases: 1) Selection of stakeholders to be involved; 2) Identification of social issues to be investigated; 3) Modelling the Pugh Matrix for each stakeholder; 4) Conduction of the interviews; 5) Elaboration of the results.

Four stakeholder categories (i.e. workers, local community, consumers and value chain actors) and the subcategories, respectively proposed by UNEP/SETAC (2009), were analysed and for each stakeholder, a Pugh Matrix was drawn. The Pugh matrix was submitted to the stakeholders via interviews by comparing two alternatives, i.e. subcategories, by asking different stakeholders/interviewees if Alternative A is more, less or equally relevant than Alternative B. For example, the Local Community Pugh Matrix compares pairwise subcategories (i.e. Cultural Heritage, Local Employment, Community Engagement, etc.) by assigning a score (through the interviews) based on defined evaluation criteria. The set of the evaluation criteria is based on a seven-score scale: three negative, (i.e. -1, -2, -3); one neutral (i.e. 0), and three positive (i.e. +1, +2, +3). Consequently, through the Pareto Principle (Craft and Leake, 2002), the most relevant social issues for the interviewed stakeholders have been identified.

Results and discussion

In total, 102 interviews (28 workers, 36 local community, 31 Consumers and 7 Value chain actors) were conducted depending on the availability of the workers, the consumers and local communities met by means of the organisation under study. The results show that Health and Safety is a social topic relevant for different

stakeholders (workers, local community and consumers). The value chain actors recognise the relevant role of the prevention activities concerning unfair competition and monopoly practices. Furthermore, the local community identifies the secure living conditions, in terms of safety and health, as a relevant social topic that needs to be guaranteed to society. This approach can be integrated within a SO-LCA framework as well as in S-LCA in terms of identification of the relevant subcategories for the assessed sector or product. Moreover, it can be used as a social hotspot analysis that allows a screening of social aspects that affect a specific community. Indeed, through Pugh Matrix, a first definition of the social risks of the analysed social context may emerge and enables the expectations of different stakeholders to be considered as well as to know the needs to be pursued for the well-being of people.

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Social life cycle assessment in a circular economy context – A mixed-method analysis of 97 SLCA publications and its CE connections

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Introduction

In the last years, both Circular Economy (CE) and Social Life Cycle Assessment (SLCA) concepts gained momentum in legislation and politics, as well as among researchers and practitioners (Kirchherr, Reike, & Hekkert, 2017; Petti, Serreli & Di Cesare, 2018). On the one hand, CE is a potential vehicle to implement and a concept to operationalise sustainable development into business to ensure the extension of useful product life cycles and minimisation of waste (Kirchherr et al., 2017). The CE concept suggests strategies for handling resources and the R-framework indicates that some value retention options for products and resources are, from an environmental point of view, more appropriate than others. Yet, knowledge about the social impact of different value retention options for products in a CE is lacking (Kirchherr et al., 2017) and the scientific literature of CE is virtually silent on the social dimension (Murray, Skene & Haynes, 2017). On the other hand, SLCA is a tool to assess the potential negative and positive social impacts of a product along its whole life cycle. It aims to support improvements for all stakeholders along a product's value chain, and its ultimate goal is to ensure the well-being of society (UNEP/ SETAC Life Cycle Initiative, 2009). In 2009, a first guideline was introduced from the UNEP/SETAC Life Cycle Initiative, and in 2013 methodological sheets with more comprehensive suggestions on how to apply SLCA followed. The guidelines (2009) suggest dividing the SLCA process into four main steps which follow the ISO 14040/44 framework as in Life Cycle Assessment (LCA), but SLCA has no international standard yet. However, SLCA is still in its infancy (Venkatesh, 2018) and most of the currently proposed CE concepts are lacking attention on the social dimension of sustainability (Murray et al., 2017). Therefore, the following questions guided the research process: The first research question (RQ) aims to provide a quantitative overview of the current state of scientific literature on SLCA and CE based on keywords from the 9R-framework described by Potting, Hekkert, Worrell & Hanemaaijer (2017). RQ1: What is the current state of scientific literature that links SLCA and CE´s 9R-framework? The second question aims to qualitatively summarise a subset of the SLCA studies that were identified in RQ1. It aims to clarify the current use of SLCA studies and to explore potential connections to CE's value retention options. RQ 2: How are SLCA studies described and utilised in the scientific literature and is there a link to CE´s 9R-framework?

Method

This work is based on a sequential mixed-methods approach (Teddlie & Tashakkori, 2006) in which the results of the quantitative analysis informed the scoping of the subsequent qualitative analysis. First, a systematic literature review was carried out to map and evaluate the body of literature (Fink, 2005; Seuring & Gold, 2012) which was extracted from Scopus and Web of Science and aimed to link two research fields of SLCA and CE. For the quantitative part, "bibliometrix", an open-source tool to perform bibliometric analyses was used. It is a package that provides a set of tools for quantitative research for bibliometric analyses in the program "R" (Aria & Cuccurullo, 2017). Second, a qualitative-content analysis (Kuckartz, 2014) was used to analyse selected papers to understand how CE issues are dealt with in SLCA studies.

Results and discussion

By early 2019, 158 publications (duplicates excluded) could be found in the two databases from combining SLCA and CE keywords and 97 publications were selected for the bibliometric analysis. The selection process included a check of the language (English) and subject area as well as a screening of the abstract and the acronym used for SLCA. The majority of documents were excluded in the first selection round due to a missing subject link and different acronym used for SLCA such as "streamlined life-cycle assessment", "simplified life cycle assessment", "stochastic life-cycle analysis", "static life cycle assessment", "screening life cycle assessment", "scores of life cycle assessment". The results from analysing the first sample (n=97) depict an increasing number in scientific publications with peaks in 2013 and 2018. The bibliometric analysis also shows the fragmented state of SLCA research. Although it was particularly searched for SLCA studies, more than half of the studies in the sample are related to LCA, Life Cycle Costing (LCC) or Life Cycle Sustainability Assessment studies. After a second quality screening of the 97 publications, 14 studies were selected for an in-depth investigation. The selection was made based on the document type (inclusion of articles and proceeding of peer-reviewed journals) and stand-alone SLCA case studies or mixed with theoretical contributions with a link to End-of-Life (EoL) or value retention topics. The qualitative content analysis of those 14 SLCA studies that exhibited a link to CE issues (e.g. studies on recycling activities) showed that SLCA approaches could help to achieve a better understanding of the social impacts of value retention options. However, the lack of an international standard and the various approaches suggested by scholars in the form of theoretical contributions and case studies make it difficult to achieve a broader level of consensus. This fragmentation could lead to a hampered advancement of the SLCA approach. Thus, an iceberg model was developed with suggestions for future research topics towards SLCA in a CE context (Figure 1).

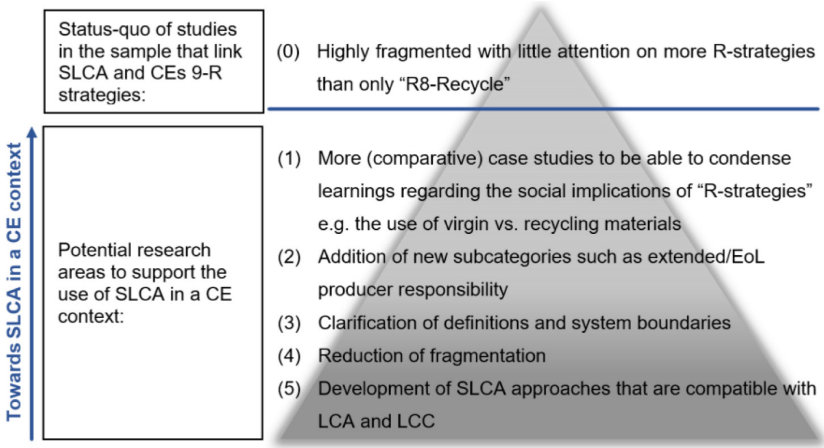

Figure 1: Iceberg model for further research on SLCA with CE related aspects (own illustration)

Regarding the connection to CE's value retention options from the 9R-framework, it was found that they are still a peripheral area in SLCA, where most attention is given to recycling issues in developing countries and waste management topics. Applying SLCA in a CE context could be beneficial for supporting CEs broad implementation possibilities and may lead to avoided problem shifting between the three pillars of sustainability. The results should support the enhancement of SLCA approaches applicable in a CE context. In this study, it was of particular interest to investigate the different concepts proposed in SLCA studies and its potential links to value retention options in the current body of scientific literature. The momentum of the two fields could be used to further advance SLCA with a particular emphasis on the advancement of SLCA aligned to the assessment of CEs R-strategies. Ultimately this should support decision-making processes for a sustainable CE and a more holistic sustainability assessment where social impacts are imperative for sustainable development. It is planned to build on the preliminary findings by further investigating the social issues of CE strategies and to what extend SLCA could be applied to assess and measure them.

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Social footprint of US industries: A first step to manage supply chain's social risks, consider opportunities and formulate government policies

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Introduction

Social Life Cycle Assessment is often applied at the product level but there are multiple benefits to start studies at the company or industry level. For instance, this is often how the information about expenditure (purchases) is available in the private sector rather than by product. Once a Social Organizational LCA (SO- LCA) exists, it is easier to then map to specific products because the information about the supply chains and potential social impacts are already available.

This paper illustrates how to conduct Social Organizational LCA's starting from generic industry-level data by presenting case studies of typical US based companies and their supply chain. Starting with available industry data addresses the blank page syndrome while making it easier for company to then gather the necessary purchases information while addressing gaps and providing a benchmark. The outcome of these SO-LCA's can set the stage for a due diligence assessment in the context of corporate social responsibility and/or formulate policies. We focus on three typical US-based industries (computer electronics, home furniture and wearing apparel). We calculate their respective social footprints, identify their salient social risks and social hotspots. We then describe a process to refine these baselines with company specific information about each of their respective supply chain and their associated social risks and provide some ideas about how the industry benchmarks can be used for policy development.

Methods

S-LCAs, like E-LCAs, can be applied at different level, for instance at the product, organization, country and consumer supply chains and life cycles (Hellweg et al., 2014). In our studies we have applied it at the level of the organization. Calculating a product or an organizational social footprint generally follows the same steps as conducting a social LCA. There is a guidance specific to organizational LCA (O-LCA) (Martinez Blanco et al., 2015a), which has been adapted for social LCA (S-LCA) (Martinez

Blanco et al., 2015b). By broadening its scope from a product to an organization, Social organizational LCA (SO-LCA) complements S-LCA.

As shown in Figure 1, the method developed starts with building an in-depth understanding of a company social footprint. These initial steps consist of an industry supply chain materiality and footprint assessment, a company supply chain hotspots and baseline assessment and baseline refinement. These steps may also contribute to a human rights' due diligence process. A research based materiality assessment enables to identify the important topics and can be combined with a stakeholder process.

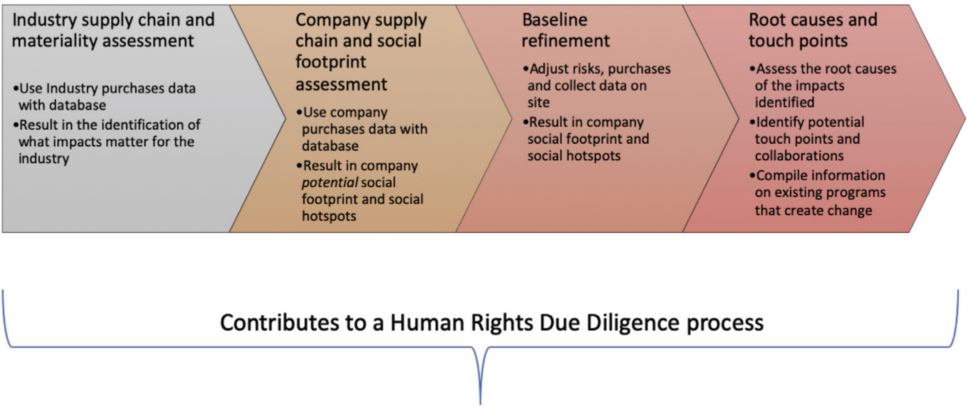

Figure 1: Assessment process

For the assessments we use national input-output tables from the US department of commerce (Yang et al., 2017). It provides the data about the inputs used by a typical company for each industry. Those purchases are then refined for the sake of relevance and 10 to 20% of the purchase items are excluded. We then link the final list of purchases to the Social Hotspots Database (Benoit Norris et al., 2019). It enables us to model the supply chains using its global trade model (Global Trade Analysis Project, GTAP) and analyze the social impact risk levels and labor intensity for each country and sector providing us with the respective social footprints, salient risks and hotspots. The SHDB provides information on 22 social impact subcategories and over 155 different indicators. The risk data address five main impact categories: labor rights and decent work, human rights, health and safety, governance and community.

Results and discussion

For each industry we have analyzed the social footprint, social hotspots and salient risks. The social footprint is the total medium risk hours equivalent by impact category for the purchase(s) supply chain contributing most to it. The social hotspots are the individual production activity/country which contributes most to the risk (overall, by impact category or subcategory). The salient risks are the social impact subcategories that account for a greater share of the overall risk and/or that relates to the most vulnerable groups.

Table 1: Results of the case studies

Industry	Social footprint	Social hotspots	Salient risks
Apparel manufacturing, USA	Textiles, USA	Plant based fibers: Pakistan, India, Uzbekistan, Malawi	Corruption, Freedom of association, Child labor, Migrant labor
Office furniture, USA	Wood products, USA	Wood products: USA, China Forestry: China Metal products: USA	Injuries and fatalities, Social benefits, Freedom of association, Migrant labor
Computer manufacturing, USA	Computer storage device readers, USA	Electronic equipment: China, Myanmar Machinery and equipment: China Chemical, rubber, and plastic products: China	Toxics and hazards, Child labor Improved sanitation, Excessive working time

Table 1 presents the main results of the case studies. The results gained help to prioritize further data collection from the literature and on-site. The next step is to collect purchasing and country of origin data from companies and use it to refine the profiles at their specific image. This is interesting because you can then benchmark with the industry average. Next would be to adjust risk level based on evidence collected via certifications or social audits. Companies have different profiles of data collection with some having many years of experience collecting social audits data and some not collecting hardly any data from suppliers.

Therefore, the challenges are different depending of the level of maturity of the ethical compliance program of each company. When data exists, organizing it can be a dubious but rewarding task.

The objectives of this assessment process are ultimately to understand the root causes of the main sources of risks/impact in order to be able to bring positive changes and hence create handprints. We understand root causes as the most basic cause (or causes) that can reasonably be identified that can be resolved and, when addressed, will prevent (or significantly reduce the likelihood of) the problem's recurrence.

Some of the weaknesses of the method used are related to the reliance on Input Output modeling because of the uncertainties that are ingrained. However, we apply this as a starting point and use the results to guide more specific data gathering, thus actively managing the drawbacks.

Starting with an industry profile is a non-threatening way to get engaged while also providing a comparison point. Since collaboration is often needed to remedy and address social impacts, it is useful to start with this general portrait. The application of these and similar SO-LCA's for due diligence in the context of social responsibility for specific companies and/or as a base for policy development will be discussed.

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Social Hotspots in the Textiles Global Value Chain

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Introduction

About the industry

The textiles industry has grown to become one of the largest global industries. Environmental and social impacts associated with the textile value chain are significant and therefore of increasing concern to the global community. Generally, sustainability considerations in the production of textiles have gained traction, particularly for labour issues. However, the global textile value chain is still far from closing loops and reducing environmental impacts, and addressing social concerns. With sales expected to grow further, accelerated through ever increasing demand for fast fashion, actions for a sustainable textile value chain, including new business models, are indispensable. The global growing fashion appetite has also a potential to be a highly visible engine for lifestyle change and consumer education (UNEP, 2019). Trade statistics data shows that articles of apparel and clothing, knitted and non-knitted are dominating the global textiles & clothing sector, followed by other made up textiles (including used articles) and cotton (ITC Trade Map).

About the study

This submission presents the research work done for a UNEP-funded project on mapping the textile value chain, identifying key hotspots at the global level and assessing trade barriers & opportunities. The project was aimed at evaluating the current state of textile value chain's global environmental and social performance and providing key data-driven takeaways to be used for supporting sustainable textile value chains. The project activities were divided into three broad segments, viz. environmental and social hotspots analysis [1], analysis of trade, market access and competitiveness, and global value chain mapping and analysis of key actors This submission presents the results from the social hotspots study along with priority actions discussed in a workshop organized by UNEP in January 2019 [2] based on which a final report on sustainability and circularity in textile value chains is soon to be published.

Methods

Data Sources

The study undertook an assessment of the textile and clothing industry's impacts throughout the life cycle. While analyzing the impacts, the study took into consideration all identifiable inputs for every life cycle stage. The functional unit used for the study was the global textile annual production. Impacts were calculated based on the global textile yearly consumption per capita. For the social hotspots in particular, analysis was undertaken for natural and synthetic fibres and to differentiate between natural and synthetic fibres, the breakdown of the life cycle costs along the value chain was based on a common garment piece. The use phase and the disposal could not be considered here as the analysis is based on the cost repartition of the garment's production and the costs of those phases are very difficult to assess. The data on global fibre production was taken from The Fiber Year, 2017 [3]. The model was calculated using the World Apparel Life Cycle Database (WALDB) as well as Ecoinvent and the Social Hotspots Database (SHDB) was used for the social aspects. The SHDB covers 113 countries and 57 economic sectors and includes an extensive list of indicators around labour rights, health and safety, human rights, governance, and community infrastructure.

Indicators for social impact analysis

The analysis was done using SHDB database, therefore the 10 social impact indicators available in SHDB were taken up for analysis: child labor, corruption, excessive working time, forced labor, risk of gender inequality, risk of high conflict, risk of fatal and non-fatal injury, risk of fragility in legal system, risk of exposure to various toxins and hazards, and risk of sector average wage below country minimum wage.

Results and discussion

Key hotspots identified

Figure 1 shows the quantitative results of the social hotspots analysis for each life cycle stage. Highest impact comes from the fibre production stage for all selected indicators, and highest risks for social impacts occur in countries of the Asian regions, where also most of the textile production is happening. This is related to the higher social impact risks in agriculture as compared to industrial production.

Since social LCA using SHDB could only assess impacts on pre-defined impact indicators from existing inventory datasets, the LCA-based social hotspots analysis was therefore supplemented with additional hotspots identified from contemporary literature that did not show up in the quantitative analysis. Combined list of key hotspots identified from quantitative analysis and literature review comprises of risk of fatal/non- fatal injury, risk of corruption, risk of gender inequality, child labor and forced labor, corruption, excessive work time, gender inequality, high conflict, wages below country minimum wage, occupational health impacts, and adverse impacts on local textile industry in countries importing used/discarded clothing.

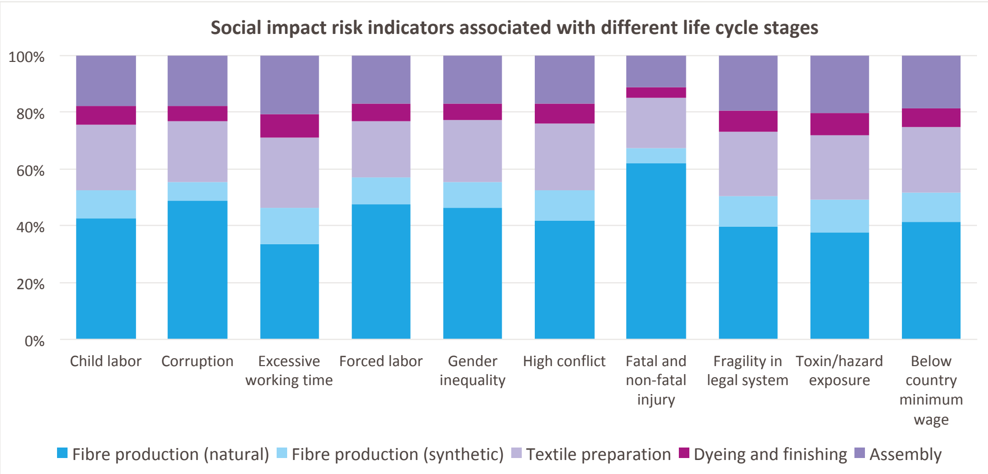

Figure 1: Results of social hotspots analysis for each life cycle stage using SHDB

Recommendations

Building on the insights from the assessment, the recommendations are presented in three parts, mapped to the three key stakeholder groups: supply chain actors, global buyers, and third parties. The first part maps direct and enabling actions within the ambit of different actors in the value chain, viz. yarn, fabric and garment manufacturers, garment users, and garment recyclers; and also recommends regulatory instruments by public authorities. The second part focuses on global buyers with highest share in the economic value chain and recommends specific actions by them for enabling the switch to greener and more sustainable practices. The third part focuses on effective use of sustainability standards as instruments for improving traceability, transparency, and sustainability performance along the value chain [4]. Overall, priority actions to enable the value chain to become circular include stronger support from governments, funding to scale up new business models, and a global platform that makes information accessible to all actors and facilitates the deep level of collaboration required.

Assumptions and Limitations

For this LCA study, uncertainty of the monetary flows was high and granularity of the industrial sectors was low. This did not allow differentiating between the single industrial steps of the textile value chain and hence the quantitative results should be considered as a compass for further analysis.

Furthermore, while buying behaviour of affluent customers in developed and developing countries indicates purchases in excess of needs and premature discarding of usable garments [5], in the absence of any benchmarks or generally agreed principles on these issues, actions to rein in wasteful consumption are not considered in the recommendations. Also, it was not possible to assess the extent of environmental and social impacts attributable to domestic consumption versus exports. The recommendations from this study are therefore mainly focused on export-oriented production. As domestic consumption rises in developing countries, the focus on production for domestic consumption will also start gaining importance.

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Social LCA in the EU policy context

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Introduction

The policy intentions written by the chair of the new European Commission, Ursula von der Leyen signals the intention to announce a new Green Deal in the first 100 days after December 1st 2019. According to these intentions this Green Deal will include improving social conditions in the Life Cycle of products on the European Market. Although much is still unclear, this would require a Social LCA approach that can fulfil the requirements such policies require.

Goal

The goal of this presentation is to start the discussion on what the main requirements are in order to make the approach robust and practicable enough to support such a policy and to investigate what is needed to further strengthen social LCA approaches, that can be used in a policy context.

Methods

While it is not expected that there will be a direct, copy and paste, social equivalent of the EU Environmental Footprint Policy (PEF), the main inputs to understand the requirements come from analysing the implicit and explicit requirements that are posed to the product and organisational environmental footprint pilots. This was also further discussed with EU representatives that were involved in the pilot project. Typically the following rather conflicting requirements can be distilled:

1. The methodology should be robust enough and science based, key data need to be verifiable.
2. At the same time the procedures should be so easy to apply that also SMEs can apply the method without high investment.
3. The entire process should not become a trade barrier, while there are indications that social conditions are worse in countries outside the EU
4. It should be applicable in the assessment of circular economy strategies

Another source of information was a lively discussion with the members of the Product Social Metrics Roundtable, with the aim to understand which parts of the work done in the past six years can now be seen to be mature and robust enough to be proposed as a solution for the challenge.

Results

The discussion resulted in a short paper that tries to address the challenges and provide some solutions for the challenges posed by representatives we spoke at the commission.

We believe that the currently leading initiatives in this area, such as the Roundtable on Product Social Metrics, the Social LC Alliance and the Social and Human Capital Coalition are in the process of addressing the above mentioned (and other) challenges in a pragmatic way and can demonstrate this with case studies.

Challenge 1: What is the correct baseline?

In environmental metrics one could consider the baseline as zero emissions or zero resource use. In social issues, such as Health and Safety, Remuneration and Freedom of Association, this is not the case. For Work-life Balance for example working zero hours means no job, working 100 hours per week is harmful; there is clearly an optimum. The challenge is therefore, how do we define the optimum, and how can we avoid that a single western perspective can set baselines that are not realistic or even desirable for non-western cultures?

Challenge 2: Quantitative vs. qualitative?

Both have their merits and application areas. Especially for SMEs and applications the qualitative approach is important. The Roundtable has dropped the quantitative approach, as it turned out difficult to use; the S-LC alliance has both a quantitative and qualitative approach. The Roundtable however works on impact valuation in the next 12 months as an alternative way to express qualitative data as a quantitative result.

Challenge 3: Which indicator can be made actionable today?

This is probably the key question. A question preceding this question is, why a topic should be assessed at all. The Roundtable Methodology Report describes how companies are dependent on social, human, financial, natural and manufactured capital. This was combined with an analysis of how they have positive and negative impacts on these capitals, and thus strengthen or weaken the society they operate in. Understanding the dependencies on these capitals is an important part of the business case. It is hard for a company to function in a society that malfunctions[1].

This analysis has resulted in the selection of 24 social topics for four stakeholder groups. Some topics can be considered to be more mature then others. This is also quite strongly related to challenge 1, the base line, as without a clear baseline a topic cannot be considered to be mature enough to base EU policy on.

1 This thinking was also based on the work of the Social and Human Capital Coalition that recently merged with the Natural Capital Coalition, see www.capitalscoalition.com

Challenge 4: How to include positive impacts?

Not really an issue in a qualitative approach, but if policy is to be based on quantitative assessment, guidance on when (i.e., in which application area) positives can compensate negatives, would be welcomed.

Challenge 5: How to allocate social indicators to products and services?

Not our biggest challenge, mere a factor that adds some uncertainty. There are however significant challenges in collecting data anyhow. Companies usually have no fundamental objection disclosing their CO2 data, but admitting they use forced labour is not happen; this means questionnaires can hardly work, and alternative ways to find out what is happening in a company must be used.

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Social impact assessment of the photovoltaic poverty alleviation program in China

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Introduction

Boosted by impressive technological innovation and cost reductions, renewable energy in a growing number of countries is now primarily considered for its social and economic benefits. In the new term of SDGs, Goal 7 (affordable and clean energy) calls for access to affordable, reliable, sustainable and modern energy for all. Among the renewable energy promotion actions at the global level, photovoltaic poverty alleviation program in China is a very unique movement since the targeted users are villagers in poverty regions. In 2014, the Chinese National Energy Administration and the Poverty Alleviation Office of the State Council issued the Work Plan on the Implementation of Photovoltaic Poverty Alleviation Projects. In 2016, Chinese government issued the "Opinions on the Implementation of Poverty Alleviation by Photovoltaic Power Generation". Till now, 1.640 villagers are reported to have been benefited from the Solar PV poverty alleviation program.

Under this condition, it would be quite necessary to understand how are the photovoltaic poverty alleviation program carried out. Are the local villagers really benefiting from the photovoltaic application? How to evaluate the social benefits of renewable energy application? What lessons China's Solar PV poverty alleviation program can offer to the international renewable promotion movements? How to promote the sustainable development of renewable energy at a global level?

Methods

Indicators for evaluation are selected from the social impact assessment indicators SLCA, economic and social development indicators of China's five-year plan, and indicators commonly used for evaluating the social impact of renewable energy. An evaluation system including four categories and twelve indicators was established in this study (see in Fig.1).

Questionnaires are designed based on the selected indicators. In July and August 2018, we carried out photovoltaic poverty alleviation investigation in three counties in western China, including Dingbian county of Shaanxi Province, Yanchi county of Ningxia Hui Autonomous Region, and Guazhou county of Gansu Province. Villagers and village cadres related with the solar PV application are our key interviewees.100 valid questionnaires were collected.

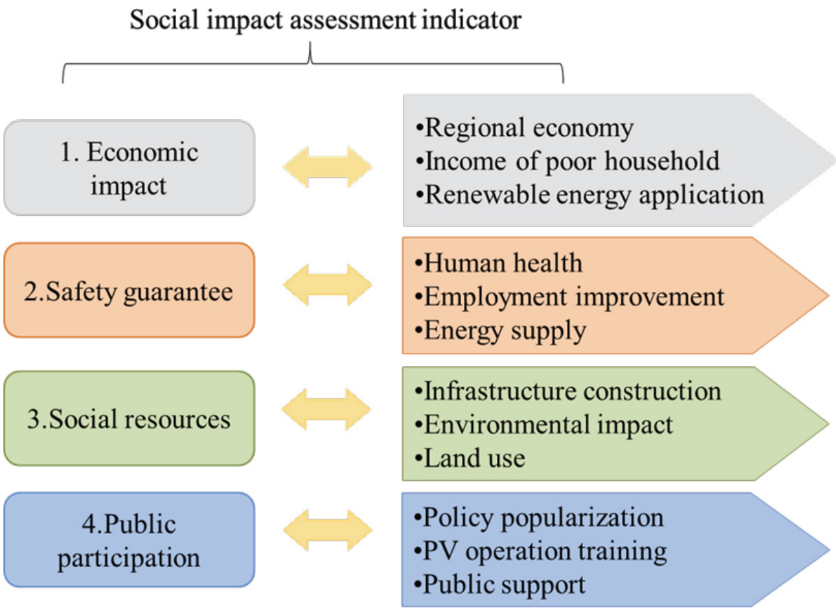

Figure 1: Selected social impact indicators for Solar PV application in this study

Results and discussion

Our investigation reveals that the economic contribution of solar PV application in the three regions is obvious. Local villagers can get benefit of 2000-3000 RMB per family per year, which can greatly support villagers' life. Solar PV alleviation movement also appears to have positive contribution for the local economy. Solar PV has largely contributed in local villagers' energy supply, with a proportion of around 30% of the total energy supply. The employment contribution is also obvious in the three investigated regions, with contribution effect as 16, 18, 22 persons/MW respectively.

On the other hand, our investigation also reveals some problems of Solar PV alleviation program in China. Villagers appear to have very limited knowledge of supporting policies and solar PV technology maintenance. They also have no idea of the potential environmental and ecological impact from Solar PV. Meanwhile, abandons of installed solar PV panels still exist. Local grid network rate is still low in two of the three investigated counties, with 18% in Dingbian and 63.2% in Yanchi.

The established social impact assessment system and evaluation result would offer references for other regions aiming to installing renewable energy, especially those poverty regions. Recommendations for improving the sustainability of renewable energies based on the findings are also proposed.

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Level of implementation of Social-LCA criteria in the Spanish public procurement furniture sector

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Introduction

In the European Union, the public purchase of goods and services has been estimated to be worth 14% of the Gross Domestic Product (GDP) (European Commission, 2016). Since consumers are more frequently questioning where, by whom and under what conditions products are being produced, more transparency is required in public procurement (Benoit-Norris et al., 2012). In fact, with the implementation of Green Public Procurement (GPP) in 2008, public institutions have been progressively introducing environmental criteria into calls for tenders and, more recently, Directive 2014/24/EU on public procurement (European Commission, 2014) urged to incorporate other requirements into tenders, such as social, work and innovation aspects, in order to boost sustainability being achieved in the production and consumption market.

The requirements set in tender documents determine what kinds of companies will be able to participate, which are more competitive considering their internal organisational, production and management processes, and finally which ensure the wellbeing of human assets involved in the production process. So, it is vitally important the role of public institutions on stating these requirements during tender drafting (setting technical and administrative specifications) and also on awarding companies during tender evaluations.

In this context, and from the social perspective of sustainability, Social Life Cycle Assessment (S-LCA) incorporates indicators aimed at measuring the human wellbeing. The Guidelines proposed by UNEP/SETAC (2009) established the framework, split into stakeholder categories (workers, local community, society, consumers and value chain actors), impact categories (human rights, working conditions, health and safety, cultural heritage, governance and socio-economic repercussions) and subcategories, being these later the basis of the assessment through indicators.

However, how S-LCA criteria is implemented in public procurement in real practice? What kind of criteria and to which extent are introduced into tenders to award public contracts? These concerns were approached and discussed in this work.

The Spanish furniture sector was selected as a case study in order to explore the level of implementation of social criteria in public procurement, the weight conferred in the awarding process and the relationship of the criteria with the S-LCA framework.

Methods

A representative sample tenders related to the furniture sector and published by Spanish Public Authorities since Directive 2014/24/EU came into force was selected. The available budget per Spanish Autonomous Community (SAC) was calculated and the tender's selection was proportionally distributed. Selecting a minimum of 5% of the contract budget of all the calls for furniture tenders and a minimum of 1 tender per SAC were the selection criteria. Finally, 43 tenders representing 7.39% of the contract budget were analysed, considering the geographical scope, the budget range and also the contracting authority type. The methodology used is as follows:

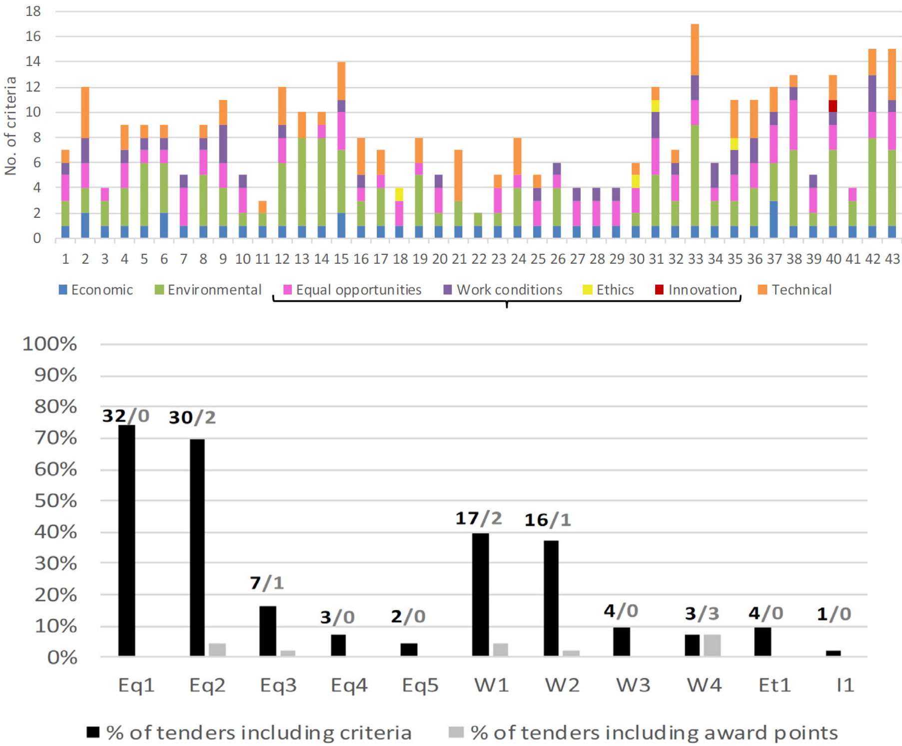
- **Step 1.** Tenders were thoroughly analysed and the included criteria were identified.
- **Step 2.** The criteria were clustered according to 7 aspects: economic, environmental, equal opportunities, work conditions, ethics, innovation and technical. The weight conferred to each aspect was determined according to the number of criteria included in the tenders. Besides, the award criteria used for the tenders' evaluation were also identified.
- **Step 3.** The social-related criteria (equal opportunities, work conditions, ethics and innovation) were cross checked with the categories/subcategories proposed in the S-LCA framework, in order to explore the level of coverage and to identify potential gaps.

Results and discussion

After analysing the 43 tenders and identifying the criteria included (Step 1), these were classified into the 7 aspects (Step 2) according to Braulio-Gonzalo and Bovea (2020). In this study, it has been assumed that social criteria aggregate aspects belonging to the categories of Equal opportunities (Eq), Work conditions (W), Ethics (Et) and Innovation (I). Figure 1 shows the number of social criteria included in each tender and the percentage of tenders including such social criteria and percentage of tenders that grant award points to them.

Finally, in Step 3, the social criteria included in the analyzed tenders were related to the subcategories of the S-LCA UNEP/SETAC framework (Table 1). The Spanish furniture tenders mostly covered those subcategories related to workers, ensuring their rights at the workplace. As seen, child and forced labour and fair salary were not included, since they fitted better with developing countries context, rather than the Spanish one. Only few of them considered local community and society, which would directly impact on people positively. These specifically contributed to cultural heritage, safe and healthy living conditions and economic development. Also, only one criterion was related to value chain actors (fair competition). Finally, none of the criteria included in the tenders considered the social impact on consumers.

All things considered, there is lack of commitment from both the public and private sectors and more efforts should be made to cover the wellbeing of all stakeholders involved in public procurement.



Eq1 To support the social and professional integration or reintegration of disabled and disadvantaged persons, such as the unemployed, members of disadvantaged minorities or otherwise socially marginalised groups
Eq2 To promote equality of women and men at work, the increased participation of women in the labour market and the reconciliation of work and private life
Eq3 To take into account universal accessibility criteria for people with disabilities and design for all users
Eq4 To promote the official language(s)
Eq5 To include good practices on gender perspective
W1 Promote job stability and indefinite employment contracts, avoiding temporary contracts and job instability
W2 Compliance with legislation on labour, public health and health and safety at work.
W3 Ensuring compliance with collective agreements in accordance with Union law in public contracts
W4 Offer training in the skills needed for the development of the contract.
Et1 Supply or utilisation of fair-trade products in the course of the performance of the contract to be awarded
I1 To promote strategies to increase economic growth and competitiveness

Figure 1: Analysis of social criteria considered in tenders

Table 1: Cross checking between tenders' criteria and S-LCA framework subcategories

S-LCA Stakeholder category	Subcategory	Social criteria from tenders	S-LCA Stakeholder category	Subcategory	Social criteria from tenders
Worker	Freedom of Association and Collective Bargaining	W3	Consumer	Health & Safety	
	Child Labour			Feedback Mechanism	
	Fair Salary			Consumer Privacy	
	Working Hours	W1		Transparency	
	Forced Labour			End of life responsibility	
	Equal opportunities/ Discrimination	Eq1, Eq2, Eq3, Eq5	Society	Public commitments to sustainability issues	
	Health and Safety	W2		Contribution to economic development	I1
	Social Benefits/Social Security	W2		Prevention & mitigation of armed conflicts	
Local community	Access to material resources			Technology development	
	Access to immaterial resources			Corruption	
	Delocalization and Migration		Value chain actors	Fair competition	Et1
	Cultural Heritage	Eq4		Promoting social responsibility	
	Safe & healthy living conditions	W2		Supplier relationships	
	Respect of indigenous rights			Respect of intellectual property rights	
	Community engagement				
	Local employment				
	Secure living conditions				

Acknowledgements

The authors are grateful to the Ministerio de Ciencia, Innovación y Universidades - Spain (Project DPI2017-89451-R).

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Social impact indicators in electrical electronic equipment reuse

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Introduction

Waste Electrical and Electronic Equipment (WEEE) or e-waste is one of the fastest growing waste streams worldwide. More than 40 million tons of e-waste are created globally each year. The management and disposal of this kind of waste is complex and sometimes related to illegal e-waste trade towards developing countries (European Commission 2015). In several countries dumping of WEEE in landfills without proper treatment, unsafe/semi-illegal handling from scavengers or illegal exports of WEEE from industrialised countries to developing ones constitutes an everyday practice.

In order to enhance the public perception towards the reuse of electrical electronic equipment (EEE) and the prevention of WEEE generation, the LIFE+ ReWeee project has been undertaken by a group of partners (ReWEEE, 2017). The project aims to prevent the generation of WEEE. In order to achieve this objective, two WEEE sorting centers were established and are currently operating for the first time in Greece. The core activity of those centers is the collection, storage and sorting of WEEE depending on their condition, followed by their preparation for reuse; if reuse is not feasible, treatment as WEEE follows.

Methods

The full supply chain of an electrical or electronic product is very complex. Ekener-Petersen & Finnveden (2013) simplify it into the following life cycle stages: (i) resource extraction, (ii) refining and processing of raw materials, (iii) manufacturing and assembly (including manufacturing of components, assembly of complex components and final assembly), (iv) marketing and sales, (v) use (i.e. customer relations), and (vi) recycling and disposal.

The aforementioned life cycle of EEE extents across different parts of the world (see Figure 1). Raw materials are extracted from different quarries, manufacturing and assembly takes parts in Asia while the use phase takes place in Europe. The recycling of WEEE takes place within the geographical context of the use phase while the final disposal takes place, mostly, in different parts of the developing world. Note also that among the life cycle stages of EEE depicted in the following Figure 1, transportation of materials and equipment plays also a pivotal role. Therefore, social impacts are generated throughout the supply chain of an EEE.

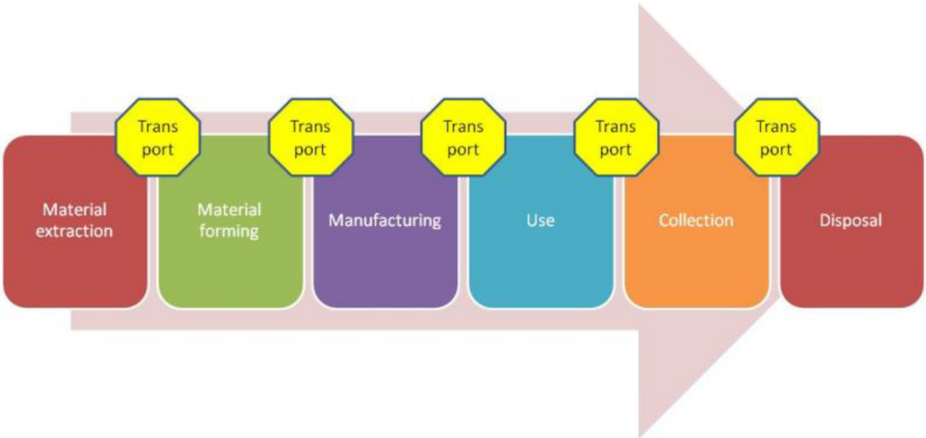

Figure 1: The life cycle of an EEE product.

So far, the social impacts of the reuse phase of EEE has not been addressed in the literature. As a first contribution to this discussion, the aim of the current manuscript is the presentation of the key parameters that need to be taken into account in order to assess the social impact resulting from the operation of the two sorting centers for EEE reuse in Greece via means of Social LCA. Based on the market driven demand, emphasis of the sorting centers is placed on the repair of ICT-related appliances, such as laptops, smart phones, and tablets.

The following lines outline the social impacts resulting from the operation of a WEEE collection and sorting centre in the entire supply chain of an electrical or electronic appliance:

- Collection of WEEE requires personnel. Therefore, it has a positive social impact since it generates new jobs. In order to assess the employment impacts, data will be collected from the main collector of WEEE in Greece.
- Sorting of WEEE for preparation for reuse and repair of recovered appliances generates jobs, which has a positive impact at the local level. Employment data will be collected from the operators of the two centers. Moreover, job satisfaction of the employees will be collected via a structured questionnaire.

- Reuse of EEE extends the life span of appliances. Therefore the demand for new appliances is reduced in the geographical context where appliances are manufactured or assembled. The repaired EEE from the centers will be donated to socially challenged groups. The attitudes of the people that receive the repaired appliances will be recorded via a semi-structured questionnaire.

- Lower demand of appliances affects also negatively all the other stages in the supply chain of electrical and electronic equipment (transportation, use, collection). In order to assess that, the percentage of repaired EEE that replaces new appliances will be taken into account.

Results and discussion

In order to assess the social impact of the operation of the two sorting centers, the following key parameters (subcategories) are proposed for each one of the stakeholders:

- Workers: relevant parameters: health and safety; fair wages; no child labor; appropriate working hours; freedom of association; work-related health problems; number of accidents; gender pay gap;
- Local community: healthy and safe living conditions; security; land and property rights;
- Society: full time jobs; part time jobs; male and female employment; safe environment;
- Consumers: healthy and safe products;
- Value chain actors: corporate social responsibility actions; rate of appliances production; rate of appliances trade;

More specifically the operation of the two sorting centers in Greece is expected to:

- increase male and female employment rates, especially among low-skills workers;
- increase demand for part-time jobs and thus provide employment opportunities to specific age- groups (elder workers, young adults);
- enhance ICT use among less privileged social groups; this is of essential importance given the country's underperformance in ICT use and diffusion, as described in the Greek National Digital Strategy 2016-2021.

In conclusion, reuse of electrical and electronic equipment is among the top priorities in the EU waste hierarchy. In order to enhance the public perception towards the reuse of electric appliances and the prevention of WEEE generation in Greece, an initiative has been undertaken by a group of partners. In the framework of this initiative, two WEEE sorting centers are established and operating. In order to assess the social impact of the operation of the two sorting centers in Greece, the methodology of social LCA will be applied. The key parameters for the application of social LCA in the field of WEEE reuse have been identified and presented. These parameters include positive employment implications, increase of EEE donation to socially-challenged groups, and enhancement of ICT use and digital skills upgrade among the aforementioned social groups. Based on the results of our analysis, policy makers can link the prevention of an environmental and resource depletion problem, such as WEEE generation, to a positive paradigm that generates jobs from EEE preparing for reuse and repair and enhances the ICT skills of less privileged social groups.

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S-LCA of a novel slaughter meat factory cell concept

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Introduction

The meat industry is facing many societal problems linked to decent working conditions, labor rights and health and safety at work. The Meat Factory Cell (MFC) concept is re-organising -from production lines to workstations – the concept of the cell, where the carcass is disassembled from outside in (Alvseike et al., 2018). The conventional slaughterhouse is at a point where it is not effective enough, when applied in smaller markets with low volumes, long transport distances, non-specialized slaughterhouses and low workforce density. The MFC aims to provide opportunities for better and more flexible utilization of slaughter carcass and the by-products, improvement of the working conditions (job enlargement and enrichment) and addressing the challenge of recruitment, as faced by the meat sector today.

Goal

The overall goal of this study was to perform Life Cycle Sustainability Assessment to compare a conventional slaughter and cutting process of pig carcass (CSCP) with the Meat Factory Cell concept. However, in this abstract, we focus only on presenting the method and the results for the S-LCA analyses, since most LCA studies agree with the feed production has the greatest environmental impact, and the actual slaughtering process means little in the overall life cycle. A sensitivity analysis was carried out for measuring the robustness of the results and highlighting the effect of changing the most critical input data in the analysis.

Methods

A combination of a top-down (generic assessment) and bottom-up (specific assessment) were the approaches in use for carrying out the S-LCA. The generic assessment was made by using the PSILCA database (Ciroth and Eisfeld, 2016) for finding out the social hotspots in the feed ingredients production (the results will be presented at the conference). Instead, in this abstract, only the results for the specific assessment (regarding a gate to gate assessment at the Norwegian slaughterhouse) are presented. The productivity and yields model v4.8 developed by Siles (2018) was used for estimating the number of required workers and the productivity in the two concepts, based on an assumed product output.

The research included the following steps:

I. the state-of-the-art of S-LCA studies regarding the meat products (literature review);
II. the interviews with the Norwegian experts from meat industry and research institute;
III. the selection of the most appropriate social sub-categories and indicators in the Norwegian meat sector based on the results from the PSILCA database and the opinions of meat industry and researchers;
IV. the questionnaire filled out with data from the meat industry, extracted by internal report;
V. the assessment of data and comparison of the two concepts;
VI. the sensitivity analysis to measure the robustness of the S-LCA results.

Results and discussion

The MFC concept is still in pilot phase, thus the results are based on the assumptions made by experts to evaluate how the new concept performs compared to the traditional slaughterhouse system. Figure 1 presents the results in a mind map where the hypothesized relationships between the social sub-categories are shown for the MFC concept. The reader should start from the middle i.e. from the green text box (our explanatory variable) and follow the arrows connecting the MFC concept to the multivariate (dependent variables, outline in green) defined social sub-categories (outline in purple).

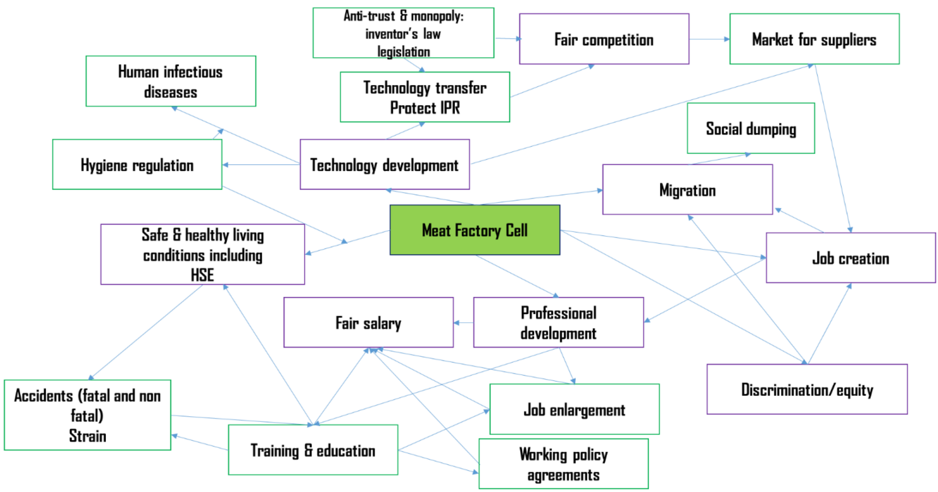

Figure 1: Social impacts of MFC concept at slaughterhouse

The results highlighted that the social hotspots at the slaughterhouse were linked to the following social sub- categories: health and safety, fair salary, discrimination/equity, professional development (for the stakeholder category workers); job creation and migration (for the stakeholder category local community), technology development and fair competition (value chain actors). The MFC concept showed lower risk of injuries and less noise at the workplace compared to the CSCP, and substantially no changes to the low number of lethal accidents and health and safety. The increase in equal opportunities (more women and senior employees) was expected in the MFC, because of likely less physically demanding work. Higher wages for the employees were assumed in the MFC, because of higher qualifications and diverse skill would be required. Further education would be asked in the MFC. In the novel concept, the work would be more stable, but fewer people were supposed to be employed at the slaughterhouse. A reduction in the practice of social dumping (employment of migrant workers) was also projected in the novel concept, because the working environment at the slaughterhouse would be more attractive to local workforce. The sensitivity analysis indicated that the job creation/loss was notably affected by the assumptions for the MFC concept.

Data have certain weaknesses (data availability, MFC scenario is based on estimates) and some strength (primary data from industrial and research partners). In conclusion, the social impact for MFC might be favorable compared to CSCP, due to lower risk of injuries and incidents, less physically demanding work and request of higher competence leading to higher salary. On the other hand, this may also lead to loss of jobs for lower qualified workers.

Ongoing work are dealing with further social aspects such as animal welfare (traditionally, S-LCA address human well-being, but not animal welfare), working environment especially focusing on job quality and employment generation for small and medium enterprise. Preliminary results will be presented at the conference.

Acknowledgements

This study was supported by the Norwegian Research Council; Meat 2.0 (grant ID 256266), and also from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871631 (RoBUTCHER).

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Using the materiality assessment and PSILCA database to identify and assess the social and governance issues for stakeholders along the value chain of new bio-based materials

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Introduction

The three research projects are part of EU funded research that aims to develop new bio-based products and processes for the New Bioeconomy in Europe. As part of these projects, the potential social impacts of the products and processes were evaluated along the value chain. The NeoCel project aims to develop new textile processes based on forest biomass (NeoCel, 2019). The SaltGae project aims to develop new algae- based process for saline wastewater treatment (SaltGae, 2019). The KaRMA2020 project aims to develop new value chains for bio-based waste like feathers (KaRMA2020, 2019).

The goal of this work is to use S-LCA in early process development and value chain creation. Social LCA was used to answer stakeholders' questions on potential social risks in the value chain of NeoCel, SaltGae and KaRMA2020.

The social life cycle assessment (S-LCA) methodology and PSILCA database were chosen to analyse these social risks and compare them to products on the market. Similar research questions for the three cases are regarding the hot spots of social impacts along the value chain in Europe and comparison with competitors like in China, as for the textile value chain.

Method

Social LCA is a method to assess the social impacts of products and services (UNEP 2009). It is important to select and reduce the number of social indicators in S-LCA studies. Product social impact life cycle assessment (PSILCA 2015) covers 54 qualitative & quantitative indicators, 16 subcategories, and 15 000 industrial sectors and commodities. In order to select indicators, the Handbook for Product Social Impact Assessment (HPSIA, 2018) recommends the used of Materiality Assessment (MAT), already used on CSR (Corporate Social Responsibility) work in companies.

The **Materiality Assessment** (MAT) is a tool for companies to identify and assess potential Environmental, **Social** and Governance (ESG) issues that could **impact** the business and its **stakeholders**. The **assessment** allows companies to inform company strategy, targets and reporting (CSR, 2019).

In this paper we present the results from using MAT and PSILCA when choosing social indicators and give some reflections on how stakeholders in the value chain understand the results of SLCA and how they are presented, for example the use of risk hours.

Results and discussion

The results build on previous S-LCA studies on Mobile Bio-refineries (Brunklaus et al 2018) and D-Factory (Peñaloza et al 2018). These helped to choose and load the PSILCA database for the indicators in KaRMA2020. The other two, NeoCel and SaltGae, are based on materiality assessment for the processes as well as the locations they took place (Italy, Israel, Sweden).

The materiality assessment was performed based on the GRI guidelines (GRI 2016). Four stakeholders and their documentations were identified with a stronger insight on what is considered materiality in the forestry industry. These included: The Nordic Council of Ministers, The Confederation of European Paper Industries, Swedbank and their Sector Guidelines for CSR in Forestry, and a research group and its research publication on social indicators for LCA of forest products. The number of times the social topics/indicators appeared in stakeholder reports was recorded and analyzed in a materiality graph (Fig 1). For example, the 'accident rate at the workplace' was mentioned in almost all reports, and this indicator can be highly influenced within the production of fibers. The blue-highlighted bubbles were the relevant indicators identified and applied in the PSILCA database.

The materiality assessment was used to identify the most relevant social indicators for the stakeholders and for the process design of the new value chain. Since the time of the SLCA was limited in scope, only a selected number of relevant indicators was chosen based on the materiality assessment. The results are presented as materiality of stakeholder (Fig 1, x-value) and process influence (Fig 1, y-value) (see the example graph below for NeoCel).

The materiality assessment results for the case of NeoCel include the following social indicators: Non-fatal accidents, Social responsibility, Industrial water, Biomass consumption, certified EMS, Contribution to environmental load. The results for the case of SaltGae include DALYs, Fatal accidents, Non-fatal accidents, Safety measures, and Industrial water depletion. The results for the case of KaRMA2020 include The Risk of DALYs due to pollution and the contribution to economic development. The benefits of having the material assessment lies in finding relevant social indicators for stakeholder with an interest in the forestry industry.

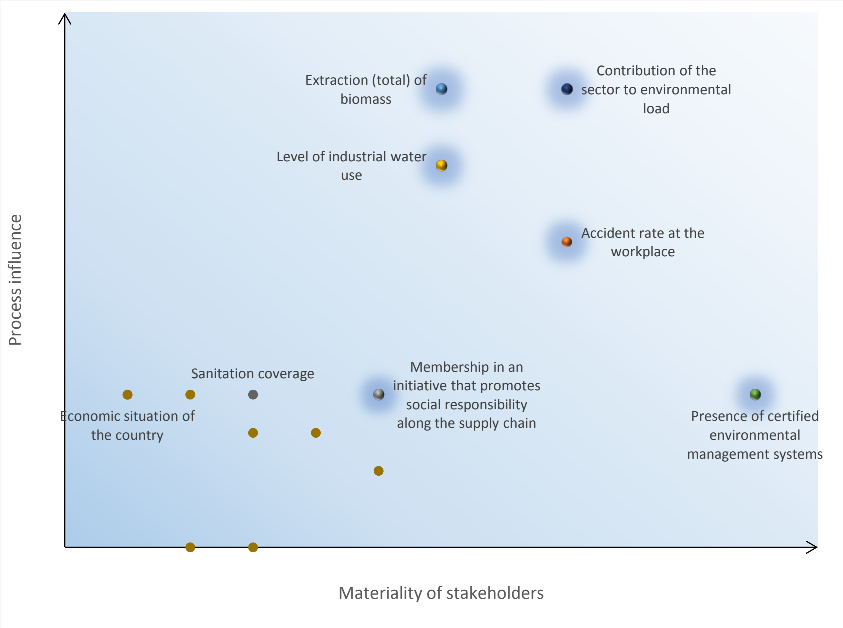

Figure 1: Materiality assessment for the case of NeoCel.

The PSILCA database was used to assess the social impacts and govern the value chain of new bio-based materials. The S-LCA results and the use of medium risk hours equivalents has been discussed by stakeholders in the three research projects. Recently, the use of scoring in social LCA has also been discussed scientifically (Arvidsson 2019). Based on the feedback from the stakeholders in the three research projects, it was difficult to understand the scoring of social impacts in form of medium risk hours and subsequently to use the assessment for value chain creation. This might be due to the fact that S-LCA are not performed on its own and include mostly also an E-LCA. While the results and the scores of an E-LCA are understood by stakeholder, the results of an S-LCA might be more difficult to understand. Therefore, good care should be taken when communicating results since social LCA is a rather unknown tool and the PSILCA database is one of several social hotspot databases to be used in social LCA.

Acknowledgments

The EU projects in this article are funded by the Bio Based Industries in EUs Horizon 2020 No 720729 (NeoCel), H2020-WATER-1b-2015 (SaltGae) and Horizon2020 TOPIC SPIRE-03-2016: (KaRMA2020).

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Life cycle social assessment: selection of indicators for a prospective approach to the insertion of new technologies

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Introduction

The challenge of assessing emerging activities, processes or services has been increasingly discussed in the field of Life Cycle Assessment (LCA) (Arvidsson et al., 2018). Most LCA studies have some kind of future oriented feature. Thus, in LCA there are studies evaluating ways to improve the environmental performance of an existing product in the near future (5 ~10 years) or at an early stage of development. These future-oriented LCA studies may be called prospective LCA studies. A methodology to develop a prospective E-LCA study was proposed by Arvidsson et al. (2018). However, for the Social Assessment of the Life Cycle (S-LCA), this option has not been explored so far. Lack of studies for future and diagnostics scenarios in S-LCA is mainly due to the degree of complexity of the subject and the developmental stage of the method and tools used. In general terms, the S-LCA is currently developed for retrospective approaches, based on the existing information, such as information about workers' welfare, workers' or consumers' degree of contentment, etc. However, due to the variety of available indicators, it is possible to make a social assessment before the activity is carried out, when there are still opportunities to use social aspects for major considerations and definitions. The social assessment can be for diagnostic purposes, to assess the social context of the sector, to define the base scenario for comparison after the activity is implanted or for general country context in how this activity in improving socially in the sector. Aiming to advance in the social assessment of the new technologies, we have performed a selection of the existing indicators with a more prospective vision and applied them in different scenarios to test its feasibility.

Methods

For the selection of the indicators, four studies were used: Benoit et al. (2010) (for selection of important subcategories), Franze & Ciroth (2011) (generic social study) and van Haaster et al. (2017) (for being a study that deals with social assessment for new technologies). Subsequently, the generic indicators proposed by UNEP / SETAC listed in the supplementary document to Benoit et al., (2010), 'The Methodological Sheets for Subcategories in Social Life Cycle Assessment' (S-LCA) (Benoit et al., 2011), were compared to the indicators of the selected studies. Criteria to select indicators were based on the feasibility of indicators to change over time, adapting to new and relevant identified contexts.

Results and discussion

As a result, 26 indicators (positive and negative, qualitative and quantitative) were selected for the five S-LCA stakeholder groups (Table 1).

Table 1: Selected indicators to provide prospective social analysis

Workers	Evidence of country/sector/ organization or factory non respect or support to Freedom of association and Collective bargaining; Women in the Labor force participation rate by country (%); Social security expenditure by country and branches of social security (e.g. Healthcare, sickness, maternity); Minimum wage by country; Forced labour; Country gender index; Occupational accident rate by country; GINI coefficient; Percentage of children working by country and sector ranking;
Supply chain actors	National law and regulation; Sectoral regulation - Agriculture
Local Community	Human Rights Issues Faced by Indigenous Peoples; Indigenous Land Rights Conflicts/ Land Claims; Human Rights Issues Faced by Immigrants; State of Security and Human Rights in Country of Operation; Pollution Levels by Country; Rate of unemployment - Age (Youth, adults): 15-64
Society	Relevance of the considered sector for the (local) economy (GDP - Agriculture); Risk of corruption in the country and/or sub-region; Sector efforts in technology development, Research and development costs for the sector; 'Is the organization doing business in a country with ongoing conflicts?'; Potential use of the technology that causes harm to people or society
Consumers	Existence of a mechanism to protect consumer privacy; Strength of national legislation covering product disposal and recycling; Sector transparency rating; number of organizations which published a sustainability report

For the 'Workers' group were selected ten indicators, two for 'supply chain actors', six for 'local community', five for 'society', three for 'consumers. It is important to note that this list of indicators may be shortened or lengthened according to the S-LCA application sector and the actual relevance of the indicator when the prospective approach is adopted. The prospective bias of this work is in the application of the proposed methodology in evaluations of new technologies, including to test and work in potential different social scenarios. It was compared the selected criteria in four different countries: Brazil, Spain, Netherlands and Sweden. For each indicator attributed scores from 1 (worst) to 4 (best) for each country. Public databases as International Trade Union Confederation (ITUC), Central Intelligence Agency, International Labour Organization, OECD, United Nation Human Rights, World Bank and Amnesty International were used. Sweden scored 90, Netherlands 74, Spain 71 and Brazil 49 (Figure 1). Sweden scored best in the stakeholder's group 'workers' and 'local community'. Brazil scored worst in the stakeholder's group 'workers', 'local community' and 'society'.

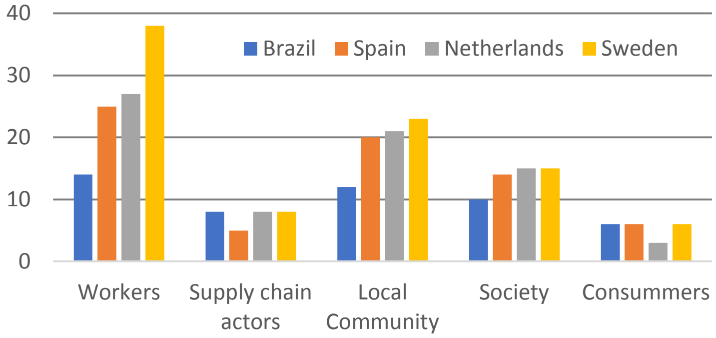

Figure 1: Scores obtained by Brazil, Spain, Netherlands and Sweden according to the stakeholder's group

Spain scored worst in 'supply chain actors' and Netherlands scored worst in 'consumers'. It is important to note that the fact that Sweden has better indicators than Brazil, for example, it does not imply the exclusion of Brazil for the development of new activities to the detriment of the European country. However, when developing new products in Brazil, industries or companies will have a greater challenge in being better socially to compensate for the country's social deficiency, and, thus, reduce the negative social impact of their product and increase its positive impact. From indicator selections such as done in this work, it is expected that more S-LCA studies will be applied in decision making or area diagnosis, increasing the number of applications of the tool, allowing its growth and advancement as a sustainability assessment tool. Since there is still no standardized methodology for SLCA, there is more freedom in the choice of indicators, but these choices must be well-founded to increase the credibility of the applied study.

The further development or adjustment of indicators specifically for prospective studies in S-LCA would be required for the improvement of this type of work.

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Social life cycle assessment of an integrated solution for slaughterhouse wastewater treatment in a circular economy context

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Abstract

Water2REturn is a Circular Economy project co-funded by the European Commission under its Horizon 2020 programme.

Goal of the project is to implement an integrated solution for slaughterhouse wastewater treatment, recover-ing nutrients to produce biogas for slaughterhouse operations and to manufacture organic-sourced fertilisers and bio stimulants for agriculture.

The Water2Return technology is being developed at Matadero del Sur, a slaughterhouse in Salteras, Andalu-sia (Spain) a region well known for the challenges it faces in terms of water scarcity.

The role of Social LCA within this project is to integrate the environmental and economic assessment with social criteria in the development of the Water2Return technology.

The methodology chosen for the assessment is the latest version of the Handbook for Product Social Impact Assessment (Goedkoop et al., 2018) to evaluate the wastewater treatment at Matadero del Sur and the de-velopments introduced by the Water2Return technology.

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Transforming a challenge into an opportunity: Social life cycle risk assessment of emerging technologies/novel products. A case study of gold nanoparticles embedded in product

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Introduction

Social Life Cycle Assessment (S-LCA) is a methodology developed to assess the negative and positive social and socio-economic impacts of products and services, along their life cycle (Benoît et al., 2013). Therefore, when performing an S-LCA of a product or service, the companies or enterprises being part of the supply chain become object of the assessment as well. Based on its definition, it seems quite difficult to apply the S-LCA to emerging technologies for two main reasons: firstly, the supply chain of the product is not defined yet; secondly, when referring to emerging technologies we usually refer to processes/technologies at development phase, and thus a scale-up/out would be required. Some studies (Lehmann et al., 2013; Souza et al., 2018; Valente et al., 2018; Zamani et al., 2018) focused on identifying hotspots along supply chains, and developing methodological framework to assess the social impacts of novel technologies (van Haaster et al., 2017). The main aim of this study is to assess the social impacts of the potential supply chain of a novel product, by using the S-LCA as assessing methodology. We chose as object of our study an antimicrobial keyboard cover integrating gold nanoparticles. Nanoparticles, especially gold nanoparticles (AuNPs) have been attracting a lot of attention due to their huge potential in healthcare applications (Ghosh et al., 2008; Dreaden et al., 2011; Noimark et al., 2014). This case study refers to a lab scale production developed at University College London, within the EPSRC funded project named MAFuMa (UCL, 2019), which uses gold nanoparticles as antimicrobial agent (Huang et al., 2001).

Methods

The objective of this work is to identify a supply chain that minimises the social risks of manufacturing antimicrobial keyboard covers to be used in hospitals. In the assessment, we considered the main steps involved in the production of antimicrobial keyboard covers, namely, the synthesis of gold nanoparticles, the manufacturing of silicone keyboard covers, and the integration of AuNPs into them. For all of these steps, we took into account the production of the chemical reagents and materials required for the manufacturing process. We investigated which are the countries producing and exporting to Europe the materials required in the product system under study, by using data from "the Observatory of Economic Complexity" (Simoes et al., 2011). Afterwards, for the identified countries, we looked for the main companies producing the chemicals required in the system. We collected data directly from the companies' websites, financial reports and sustainability reports to get information concerning the number of employees, annual production, salaries and working hours. In the standard practice, this type of data is instead retrieved from databases that are usually not specific and hence are source of uncertainty. The collected data were used to estimate the working hours referring to the functional unit (WFU), as in (Petti et al., 2018). Subsequently, we identified the impact categories, subcategories and indicators of our interests (Goedkoop et al., 2018; Mancini et al., 2018; Traverso et al., 2018) and collected the data on the risk levels for each country for the specific production sector from the Social Hotspots Database (SHDB) (Benoit-Norris et al., 2012; Benoit- Norris et al., 2019). By using the scoring suggested in the SHDB, we assigned a score to each risk level of each indicators and multiplied it by the WFU. These results allow a comparison between the countries producing the same material/chemical, as well as the identification of the hotspots at a very detailed level.

The second part of the study focused on the definition of a potential supply chain by the application of weights to understand the relative relevance of a specific social issue over the others. Therefore, we applied weights at both subcategory and category levels. Weights are useful to indicate the relative importance of subcategories and categories. Their estimation was based on the results of a survey we created, named "Social Life Cycle Risk Assessment 4 Nano" and sent to the Social LCA community to be filled in. By using the outcomes of the survey, the final weighted-results were calculated for all the possible country- suppliers of each material input, and those with the lowest social risks were selected as preferred potential actors of the supply chain of the antimicrobial keyboard covers.

Conclusions

By applying the S-LCA methodology to a novel product in order to define a potential supply chain, we encountered different problems, mainly due to the lack of data and the difficulties in quantifying the working hours in both the background and foreground system. On the other hand, this analysis enables the exploration and understanding of the possible social risks that can be connected to future products, and explore the different possible suppliers. In addition, information and results coming from the study can be useful for LCC and LCA studies, allowing a more deep integration of the three methodologies for further sustainability studies, and sensitivity analyses.

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Social materiality assessment of algae-based products

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Introduction

The environmental and social urgencies of the climate crisis demand for innovative solutions, able to match the supply of food, feed and fuel with the demand of the world's increasing population in a sustainable way. Aquatic feedstock can be a solution to these needs: in particular, algae are among the most promising feedstock for the production of food and feed, and the extraction of bulk and fine chemicals for a range of applications. The cultivation and use of algae could provide an alternative protein source to soy, with the potential thus to combat deforestation in soy-producing countries, and related social issues. This challenge has been taken up by the BIOSEA Project (Innovative cost-effective technology for maximizing aquatic biomass-based molecules for food, feed and cosmetic applications), a three-year project that aims at validating and scaling-up a complete production process of ingredients from main compounds from four micro- and macro algae species, using a cascading bio refinery approach. In the context of the project, a Social LCA is being carried out, aimed at identifying and evaluating the social materiality aspects of algae-based products in the food, feed and cosmetic sector. In particular, the process of stakeholder engagement will be discussed, together with the approach adopted for measuring the social performances.

Methods

The Social LCA methodology, as defined in the Social LCA Guidelines, has been adopted as main methodological reference for the study. The products investigated are a veggie burger, a feed for fish and piglets and a skin care product, whose macronutrients are obtained by micro and macro algae, which are not yet on the market, and the functional unit analysed is 1 kg/1 piece of final product with defined properties and formulation.

The product system under investigation has been defined at two levels:

- Technological level, i.e., processes needed for delivering the output of the system, building upon the causal relationships that connect the level of two activities within the domain of technology. The technological level is presented in figure 1.

- Stakeholders' level, i.e. driven by the stakeholders that at each steps might be potentially affected.

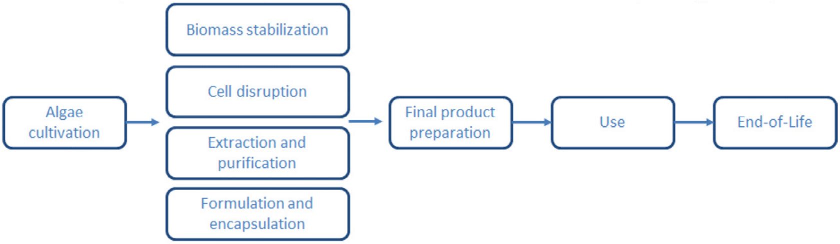

Figure 1: Technological system boundaries

The geographical context of the study is Europe, and the social performances, both positive and negative, are analysed in comparison with the following alternative products already on the market: veggie burger with soy, soy-based feeds, plant-based skin care products.

The identification of the affected stakeholders and of the relevant social aspects has been carried out according to a threefold approach, as represented in figure 2.

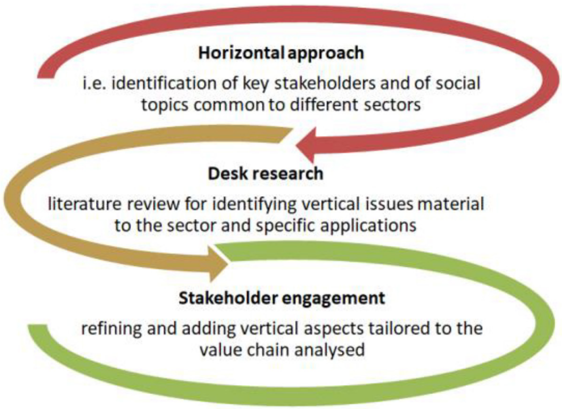

Figure 2: Approach for the identification of affected stakeholders and relevant social aspects

The horizontal approach and the desk research pointed out the relevance of the stakeholders' categories *workers* and *consumers* (Mesnildrey et al., 2012; Lillås, 2017;

Tiwari and Troy, 2015), on which the analysis of the social materiality has been then carried out. However, the desk research delivered a limited amount of useful information on algae, mainly focused on macro algae, on algae cultivation in extra EU countries, and on the algae cultivation step, while the users' perspective was less addressed. For this reason, stakeholders have been engaged for identifying their needs, wishes and concerns, from the social and socio-economic point of view.

Results and discussion

Overall, 35 people participated in one-day workshop, from 5 EU countries, covering the whole algae-based products value chain, i.e., micro and macro algae experts and cultivators, experts in extraction and formulation of the products, producers of the final products, either soy-based and algae-based producers. Soy cultivators could not be involved in the workshop, and this might affect the legitimacy of the outcomes, and a fair comparison. The social issues of concerns related to the soy cultivation stage have been taken into account through the literature review, and the different data quality for these stakeholders will be taken into account when drawing conclusions and recommendations.

Final consumers, of both algae-based and soy-based products, were indirectly represented through the companies that sell the products into the market. The workshop was structured as follows:

- Stakeholders to be invited were identified considering: their expertise, positioning in the algae-based products value chain, geographic representativeness, gender balance, industrial sector (food, feed, cosmetic);
- During the workshop, an overview of the context of their engagement was provided, including the project and the S-LCA methodology;
- Stakeholders were divided in groups, with 2 moderators for each group, and the discussion was structured along 4 topics: i) Current Business Environment – Consumers and Business Models; ii) New opportunities; iii) Legislation and support systems; iv) Workers in the Algae Cultivation Stage;
- Each topic was structured into 4-6 themes, and for each of them all participants were invited to provide first written feedbacks, and then to complement them during the common discussion;
- All the collected feedbacks were re-organised by the moderators, according to the intended scope of the analysis and S-LCA structure, and then discussed during a plenary at the end of the day.

The feedback received during the workshop are currently under further elaboration, in order to translate them into either semi-quantitative and quantitative indicators, as basis for the measuring of the social performance. The project will end in May 2020, and the study will thus be completed at the time of the conference and the results will then be available.

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Working conditions for ion adsorption clay mining: influence on Social Life Cycle Assessment of dysprosium

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Introduction

Measures against climate change include the use of more renewable energy sources. Many wind power plants use permanent magnets in the turbines. The strongest permanent magnets are neodymium iron boron magnets, requiring neodymium, praseodymium, and dysprosium (Dy) as rare earth elements (REE) (Schreiber et al., 2019; Wulf et al., 2017). With increasing demand of renewable energy sources, public interest lies on the background of wind turbine production. Most of world-wide REE reserves are mined in China (Gambogi, 2020). Ion adsorption clays (IAC) are one of four principle rare earth (RE) ores and contain the greatest amount of heavy and thus most valuable REE (Wübbeke, 2013). IAC are mined in Southern China, where both legal and illegal miners work (Packey & Kingsnorth, 2016). Taking the mining of Dy as an example for a heavy REE, we compare data from the Chinese sector of non-ferrous ore mining (ILO, 2017a; ILO, 2017b) with data from literature regarding illegal mining in Chinese IAC deposits (Packey & Kingsnorth, 2016) in the course of a Social Life Cycle Assessment (S-LCA). For this, we focus on working conditions during Dy mining. In the past, our working group has already investigated permanent magnets' production using the PSILCA 2.0 database (Werker et al., 2019). The current analysis enhances the past work by improving values of working hours differentiating between legal and illegal mining, which allows us to calculate medium risk hours indicating the relative risk of improper working hours and improper pay. We use the concept of S-LCA to analyze the influence on the mining process, i.e., to see how much of improper working conditions' risk can be traced to the actual mining process and how much is rooted in the supply (pre-chain) to RE mining (with components like transport, electricity, etc.). In particular, we focus on the social indicators of *Working time* and *Fair salary* as an example, representing important indicators for the mining process.

Methods

In a previous publication, Werker et al. (2019) have performed an S-LCA of RE magnets in China, Malaysia, Australia, and the USA. We use this model as well as the PSILCA 2.0 database (Eisfeldt & Ciroth, 2017) to assess the social risk of mining IACs, as information on working conditions in Chinese RE mines is hardly to be found. For the specific case of IAC mining in Southern China, values for indicators like *Fair salary* (indicating the risk of improper pay) and *Working time* (indicating the risk of improper working hours) differ between the PSILCA 2.0 database and findings for illegal mining from Packey and Kingsnorth (2016). Thus, we investigate these data using independent sources (as the WageIndicator Foundation, 2019). By means of an S-LCA, we compare the effect of these differences on the social impacts. For this, we divided the mining process into two phases. One phase is the actual mining process in Chinese IAC mines and the other phase is the pre-chain of this. The analyses are done with OpenLCA version 1.9.0 by Greendelta (2019). On the basis of numbers regarding employees (ca. 2,300; Wübbeke, 2013), RE mining volume (ca. 130 million t; Vahidi et al., 2016), and the share of illegal mining (ca. 40%; Packey & Kingsnorth, 2016), we estimate a total of ca. 11,400 workers engaged in illegal IAC mining. Combined with information on the RE mix's Dy share (6.7%; Glöser-Chahoud et al., 2016) and the production of Dy (1,350 t; WWF, 2014), a theoretical number of 540 t of Dy is mined illegally per year by ca. 760 miners. Taking 44 working hours per week (WageIndicator Foundation, 2019) and about 50 working weeks per year, 3.15 working hours must be invested for 1 kg of Dy. This number is used to assess the direct effect of the foreground process and serves as a basis for the calculation of medium risk hours regarding the specific social indicators.

Results and discussion

The analyses focus on the stakeholder group of workers. In the values of the two indicators of *Working time* and *Fair salary*, we identified differences: In the indicator *Working time*, the ILO database indicates 44.6 hours of work per week in non-ferrous ore mining (ILO, 2017a). According to Packey and Kingsnorth (2016), however, illegal miners are required to work 12-hour night shifts. Combined with the information from the WageIndicator Foundation (2019) that in this sector, miners work six days per week, we conclude that in this case, miners work 72 hours per week. This changes the risk level used in PSILCA **from *low risk to very high risk***, which raises the characterization factor in the impact assessment by 1,000. On the other hand, concerning the indicator *Fair salary*, illegal workers are reported to earn 300 Yuan (ca. USD 42) per day (Packey & Kingsnorth, 2016). In case they work six days per week every week of the month, the monthly wage is ca. USD 1,083 (***low risk***), which is more than assumed by ILO database (sector average wage: USD 830, ***medium risk***; ILO, 2017b), lowering the characterization factor by 10.

The results of the S-LCA show that regarding the social indicator of *Working time*, there is a much higher risk of improper working hours if numbers of illegal mining are used compared to sector average wage values (315.57 instead of 0.89 medium risk hours). The increase of *Working time*'s medium risk hours from the pre- chain to the actual mining is impressive (third column in Table 1). The social indicator of *Fair salary* paints a slightly different picture. If the monthly wage of ca. USD 1,083 is assumed, the risk of improper salary is lower than assumed for the average sector in PSILCA. This results in slightly lower medium risk hours of 51.00 compared to 53.83 for average numbers.

Table 1: Medium risk hours regarding Working time and Fair salary.

	PSILCA data for legal mining		Own calculation for illegal mining	
	Working time	**Fair salary**	**Working time**	**Fair salary**
Pre-chain	0.57	50.68	0.57	50.68
Actual mining	0.32	3.15	315.00	0.32
Overall mining process	0.89	53.83	315.57	51.00

Looking at data from our own calculations, the increase of *Working time* medium risk hours (first and third columns) regarding actual mining is extreme. Especially the information of 12-hour shifts (Packey & Kingsnorth, 2016), resulting in 72 hours per week instead of 44.6 hours per week raises the characterization factor by 1,000. In the case of *Fair salary*, however, medium risk hours for actual mining decreased only moderately (second and forth columns). The fact that the medium risk hours of actual mining is relatively low shows that the risk of improper pay seems not to be caused in the actual mining process but rather in the pre-chains. This means that the improper working hours of 72 hours per week are reason for *Fair salary*'s risk assessment to be lower than indicated in the PSILCA database. The research shows that risk levels (like those regarding *Fair salary*) can seem unproblematic while at the same time the risk to be exploited by working 12-hours night shifts is very high. Especially the risk of improper working hours seems to come mainly from the actual mining process rather than the pre-chains. Hence, future research should investigate the process steps that follow mining, such as beneficiation, separation, electrolysis, and magnet production. Further, it should ultimately be considered which measures can be taken to improve working conditions in Chinese RE ore mining in order to ensure a socially 'clean' energy transition.

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Social life cycle assessment of pork production systems

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Introduction

Sustainable animal food production is increasingly important to society. Yet for pork, the most consumed red meat in Sweden, no SLCA compares contrasting main production systems. The lack of consistency in quantitative approaches in SLCA makes the task challenging. Swedish pork production has two main systems: the conventional which produces 98% of the pork and the organic which produces 2% of the pork (Jordbruksverket, 2017). Our goal was to assess social impacts for stakeholders in the organic and conventional pig production systems from farm to fork with 1000 kg pork (slaughter weight) as the functional unit using a type 1 or a reference scale approach SLCA.

Methods

We used social impact time to measure the impact of pig production on workers and pigs. The approach is illustrated with this example: Assume it takes 10 h of work in total (including the whole production chain) to produce a functional unit of a product. Assume also that the production has a 50% risk of causing a social problem (e.g. low health) for the workers and this problem has 80% of the total weight, and 30% risk of causing another social problem (e.g. long work days) and this problem has 20% of the total weight in the evaluation for workers. Then the social impact time is 4.6 risk h ((10 h x 0.50 x 0.8) + (10 h x 0.3 x 0.2)). Since the worst possible social risk time in this example is 10 h, it has a social hotspot index of 0.46 (4.6 h/10 h). A higher social hotspot index means lower social sustainability.

We collected data for time units in the production chains (feed production, pig production, slaughter and consumption) for both systems. We also collected data for the Social Impact Index (SII) by comparing Swedish production parameters with European parameters as the reference points. Following the calculation of SII, we carried out a survey with a panel of experts to obtain weights (functional importance) for subcategories under each stakeholder category using the Analytical Hierarchical Process (AHP) (Satty, 1990). Finally, we calculated the Social Impact in Time (SIT) and Social Hotspot Indices (SHI) (as proposed by Tallentire et al. (2019) for animal welfare) from the time units, SII and weights from AHP (Figure 1).

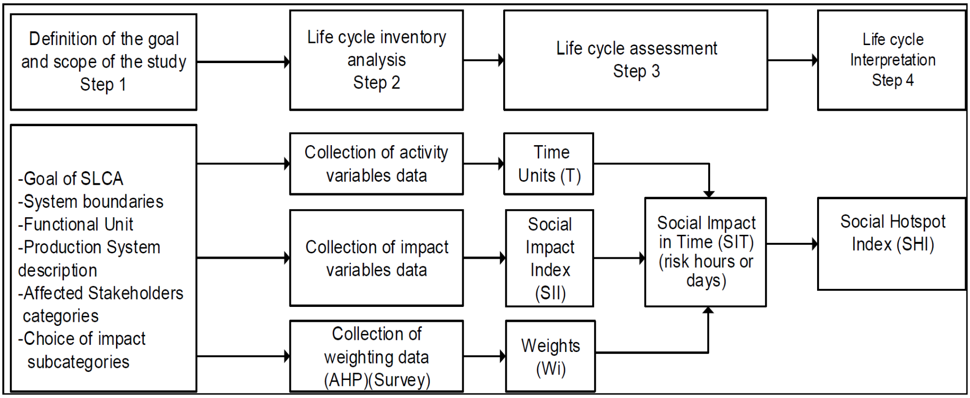

Figure 1: The outline of the SLCA method. Source: (Zira et al., under review)

Results and discussion

Our results show that the organic system had a more favorable SHI for pigs than the conventional as shown in table 1. SHI for workers was similar for both systems. The SIT for workers was more favorable in the conventional system than in the organic system, whereas the organic system had a more favorable SIT for pigs than the conventional system. This means that the organic system is potentially more sustainable than the conventional system with regards to pigs, as SIT and SHI are more favorable.

Table 1: Time units, Social Impact Index (SII), Social Impact Time (SIT) and Social Hotspot Index (SHI) for workers and pigs for 1000 kg of pork (slaughter weight)

Stakeholder category	Time units		Social Impact Index		Social Impact Time		Social Hotspot Index	
	Conventional	Organic	Conventional	Organic	Conventional	Organic	Conventional	Organic
Workers (hours)	7	37	0.4	0.4	3	19	0.4	0.4
Pigs (life days)*	3 540	3 783	0.5	0.2	1 253	858	0.4	0.2

* 18 pigs are required to produce 1000 kg of pork (slaughter weight), excluding pigs dying before slaughter
179 days are required for conventional slaughter pigs and 186 days for organic slaughter pigs
Pig life days of the sow during its entire life, divided equally amongst its litters, are also included

A sensitivity analysis for the indicators used was not carried out in this study but this should be the next step in the development of this SLCA methodology. The use of the physical mass of meat as a functional unit can be disputable if organic and conventional pork have different protein and fat composition. Future studies can have protein as a functional unit.

If two systems have the same negative social impact index (SII), the one with the lower time units will have a more favorable SIT. In our study, the high efficiency in the conventional pig production system resulted in more favorable SIT for workers than in the organic pig production system. On the other hand, if one system has higher time units, this system will have a more favorable SHI due to a dilution effect. Therefore, both SIT and SHI should be more favorable for a system to be regarded as more sustainable than another. The methodology presented in this paper was developed to assess Swedish pig production systems, but it can also be applied to livestock production systems in other countries.

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Human health impacts of natural diamond production

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Introduction

Natural diamond is formed at extreme pressures and temperatures underground. Annually, about 25 metric tons of rough natural diamonds are mined and extracted from the natural reserves, to be used either as gemstones (56% of the global production) or for other industrial purposes (44%) (USGS, 2018). About 13% of the global natural diamond production originate from artisanal mining in the Democratic Republic of the Congo (DRC) (USGS, 2018). In addition, the mining and trade of minerals are financing civil warfare and conflict in the DRC (Young, 2015). Internationally, this has gained attention for example via the introduction of the Dodd- Frank act, which defines tin, tantalum, tungsten and gold as conflict minerals. Diamond has also been associated with the conflict (Parsmo, 2015). The production of natural diamond is also associated with other impacts, both negative and positive, on human health. Negative impacts include occupational accidents in the production system and human health impacts associated with emissions from the production system. The former includes both occupational accidents during natural diamond mining and production but also accidents in the production and treatment of inputs and outputs, respectively, required for the natural diamond mining and production processes. At the same time, increased economic activity can lead to improved health of a population (Feschet et al., 2013). Thus, in addition to the negative impacts, positive impacts could stem from the artisanal diamond mining in the DRC. Different contributions to human health impacts in natural diamond production are illustrated in Figure 1. A number of previous studies have assessed human health impacts of products using life cycle assessment (LCA), including studies on for example an air bag (Baumann et al., 2013), a nano-enabled chemical gas sensor (Gilbertson et al., 2014) and tire studs (Furberg et al., 2018a). However, to the knowledge of the authors, no such assessment has so far been provided for natural diamond. Thus, the aim of this study is to conduct a screening LCA of human health impacts associated with the global natural diamond production.

Methods

A screening LCA on human health impacts of natural diamond production was conducted applying the disability life-year (DALY) indicator for the quantification of human health impacts. This indicator was developed for the World Health Organization and the World Bank (Murray and Lopez, 1996) and provides a measure for the years of life lost due to premature death and disability (Devleesschauwer et al., 2014). DALY can be applied to quantify both negative and positive human health impacts in LCA (Arvidsson et al., 2018) and positive impacts are then quantified in terms of years of life saved due to avoided negative impacts. This study is of a screening nature since the life cycle inventory for the production of natural diamond was limited to major inputs and outputs, such as fuel usage and electricity requirements. The human health impacts of global natural diamond production was modelled following USGS (2018) who stated that approximately 87% of the global production is non-artisanal industrial production while the remaining 13% is artisanal production from the DRC. Negative human health impacts associated with that revenues from the mining and trade of diamond contribute to the conflict in the DRC was quantified based on Furberg et al. (2018b). Occupational accidents in the production system were modelled following Scanlon et al. (2014) for global industrial diamond production while various data on artisanal mining, e.g. the number of artisanal diamond miners in the DRC and fatal accident rates in artisanal mining, was applied for the global natural diamond production that is artisanal. Human health impacts from production system emissions were modelled based on ReCiPe 2016 (Huijbregts et al., 2017). Positive impacts are not included in the quantification but discussed.

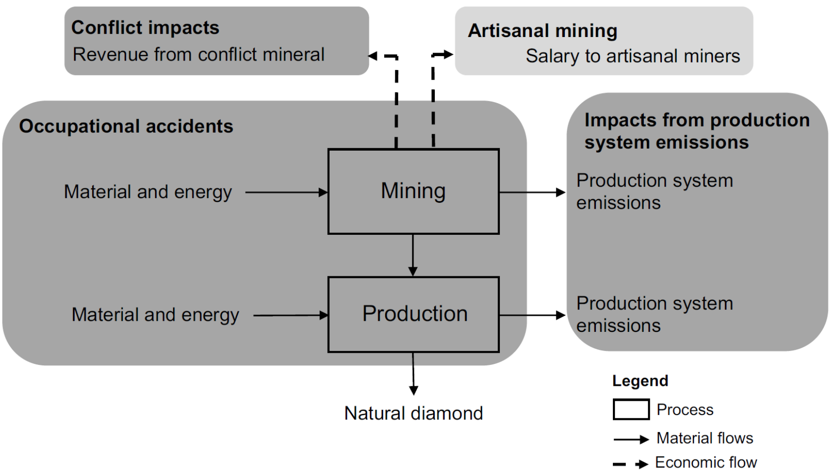

Figure 1: Human health impacts associated with natural diamond production. Negative human health impacts are highlighted with dark grey and positive ones with lighter grey

Results and discussion

Preliminary results indicate that production system emissions and occupational accidents in the production system, mainly from artisanal diamond mining in the DRC, see Figure 1, constitute the largest contributors to negative human health impacts in global natural diamond production. Thus, the results show that a large part of the negative human health impacts occur in a specific country, namely DRC, where about one tenth of the global natural diamond is produced. This screening LCA is limited to negative human health impacts, while potential positive impacts, such as improved health associated with that the artisanal miners get a salary, were not accounted for. Increased economic activity can lead to improved health of a population and there are methods to account for this, including the Preston pathway (Feschet et al., 2013). Focusing on the DRC, however, this method is not applicable. This is since Feschet et al. (2013) stated that the method is only applicable to poor countries where the generated wealth spreads over the entire economy. This is probably not the case in the DRC, as indicated by its high corruption perception index (ranked 161 out of 180 countries in 2017) (Transparency International, 2019). The preliminary results from this study can be applied in future studies on human health impacts of natural diamond and its products. The development of an approach to consider improvements in human health for artisanal miners is suggested for future research.

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Social assessment of miscanthus-based bioethanol in Croatia

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Introduction

In 2018, the Renewable Energy Directive has established a maximum 7% for the production of liquid biofuels with food-crop origin, while creating a compulsory target of at least 0.2%, 1% and 3.5% of advanced biofuels in 2022, 2025 and 2030 respectively, as a share of final consumption of energy in the transport sector (European Parliament, 2018). In this context, the development and production of innovative second generation biofuels, such as ethanol based on miscanthus (Han et al. 2011), gained relevance. Miscanthus is a perennial grass originating from South-East Asia, recognized by its low requirement for nitrogen fertilizer and its adaptation to a wide range of climates and soils (Lewandowski et al. 2000) including marginal lands and low quality soils (Xue et al. 2016).

For securing a transition to a sustainable economy in which bioenergy contributes to the reliable supply of renewable energy, it is important to take into account the effects that this technological and economic change will cause on societies around the world. According to the European Commission, the shift to a carbon neutral economy will be accompanied by an increase in the number of jobs in construction, agriculture and the renewable industry, while there might be a potential decrease of jobs in the mining and extraction industries (European Commission, 2018). In this way, a higher utilization of renewable resources for energy might foster regional development of isolated rural areas, sparsely populated regions or areas undergoing a process of industrial decline (European Parliament 2018). Social impacts of bioenergy production on stakeholders can be analyzed from different perspectives and under various methodologies and frameworks, such as the Social Life Cycle Assessment (S-LCA). S-LCA is a tool used for analyzing and comparing products, processes and entire value chains from a socio-economic perspective (Henke and Theuvsen 2014). The main objective of such an analysis is to support decision making for improving the social conditions along the value chain of a product (Benoit-Norris and Mazijn 2009). The aim of this study is to conduct an ex-ante S-LCA to assess the potential social impacts of a specific case study consisting of a project for the production of miscanthus-based bioethanol in the county of Sisak-Moslavina in Croatia. As the project has not yet been carried out and both the production of ethanol and the cultivation of miscanthus are new in the country, the social impacts of the system are predicted.

Methods

First, an analysis at local level was pursued. A Delphi study was conducted in order to focus on the most relevant social aspects. The Delphi technique is a common technique used for forecasting. It was initially developed to reach consensus among expert groups with trustworthy results (Dalkey and Helmer 1963; Okoli and Pawlowski 2004). As part of the Delphi, experts were asked to rank the most relevant social criteria for the specific case study and to explain their reasons behind the ranking. Indicators for each category were selected based on relevant literature. Then, at a value chain level, the database SOCA for S-LCA was used in order to identify social aspects that might affect suppliers located in other regions. SOCA contains information at country-level. The benefit of using this combined approach is mainly that it allows for deeper assessment at local level, while considering also suppliers, reaching a value chain perspective, see Fig. 1. The proposed methodology, combining a local analysis with expert opinion and a value chain analysis, using a database, follows a case study approach briefly presented in the following section.

Case study

The case study consists of an ex-ante analysis of the establishment of a biorefinery that will use miscanthus as the main feedstock for the production of bioethanol in the county of Sisak-Moslavina in Croatia. Sisak- Moslavina county is located in the southern central part of Croatia and is part of the continental area of the country, approximately 60 km away from the capital city Zagreb. While the city of Zagreb is home to 20% of Croatia's population, only 4% live in Sisak-Moslavina county. In 2018, approximately 23% of the population in this county was older than 65 years. In addition, the county experiences a natural increase of its population of -7.9 predominantly through out-migration (Croatian Bureau of Statistics 2018). Besides, in the agricultural sector in the city of Sisak a process of de-ruralisation was reported (Sisak Projekti 2015). This situation in combination with a high number of unemployed people of different ages gives a clue of the current difficulties that the residents undergo in this part of Croatia. The proposed methodology was applied to this specific case study with the aim of assessing the potential social impacts deriving from the establishment of the project.

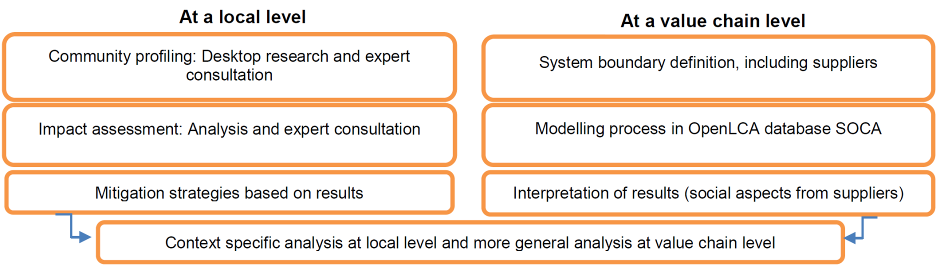

Figure 1: Methodology

Results and discussion

The project would not only generate jobs and potentially reduce the out-migration and thus improving the quality of life of residents, but it would also foster the agricultural production and the use of unused lands. An analysis of the structure of the rural population is essential to understand how biomass production will affect the community, especially because small-scale farmers prevail in the region. These are therefore an important stakeholder group to be considered. Potential negative impacts would arise from the biorefinery construction and operation, where workers might be exposed to different risks, typical for this kind of facilities, as for example fire danger. Mitigation measures to manage these risks are proposed. At value chain level, considering that inputs are acquired from suppliers at an international level, the results show potential social problems in the construction of facilities in the chemical industry.

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Social assessment of the main element of food production systems for sustainable strategies in cities

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Introduction

The implementation of new solutions in cities to reduce their dependence on external resources will involve new materials, manufacturing and deployment of new facilities. Manufacturing and deploying of these systems, such as photovoltaic panels, rooftop open-air farming, rooftop greenhouses, etc. operating and maintaining these systems throughout their lifetime have and will have environmental, social and economic impacts to multiple environmental media (Ramaswami et al., 2016). In the same context, as it happens in many other industrial sectors, the production of these systems tends to fall in countries with more lenient regulations regarding working conditions and health and safety conditions (Hoekstra and Wiedmann, 2014). On the contrary, developed countries take advantage of cheaper produces and benefit from better conditions in their environment (Riisgaard et al., 2010).

One strategy implemented in cities is urban agriculture, specifically the implementation of rooftop farming or rooftop greenhouses on roofs of buildings. It is widely spread in many cities to tackle climate change, reduce the demand for imported food, provide fresh produces and take advantage of underutilized spaces in cities (Pons-Valladares et al., 2015; Sanyé-Mengual et al., 2015; Toboso-Chavero et al., 2018).

Minimizing those impacts and developing strategies to manage the global transformation into a green society will require political and societal stakeholders to develop and implement approaches for sustainable growth along the value chain of industries that manufacture these systems. To analyse these new systems, the Life Cycle Assessment (LCA) is one of the most used worldwide. In particular the environmental LCA, but also the Social-LCA (SLCA) (Petit-Boix et al., 2017). The most used growing media in Spain is perlite and one that has the highest environmental impact (1.3 kg CO_2/kg) in the agriculture systems along with fertilizers.

Therefore, in this research, we assessed the social performance of only one growing media, perlite, used in the implementation of rooftop farming and rooftop greenhouses in Spain in the production phase and the social benefits in the use phase in urban agriculture.

We also identify current and future social "hotspots" of this product and the options for reducing the potential negative and positive impacts now and in the future.

Methods

Perlite is a growing media widely used worldwide for growing vegetables. It is an inert substrate and suitable to implement on rooftops because has lesser weight than soil, therefore it is optimal for the load capacity of rooftops (Bennett, 2018). The system under study is the extraction and production of perlite in different countries that import this product most to Spain and the use phase in Barcelona as part of the urban agriculture on rooftops. These countries were selected based on the last 5 years of perlite imports to Spain, these are Turkey, South Africa, Greece, the United Kingdom, Germany, Uganda, Brazil & Mozambique. This research has three different scopes: 1. To identify the hotspots of the perlite growing media imported to Spain and used for growing vegetables. 2. To investigate the social performance in the countries of origin, in particular, the ones that import most to Spain, which are Turkey, South Africa and Greece. Therefore, two different assessments are carrying out, first using the Social Hotspots Analysis (SHDB) (Benoît-Norris, Norris and Aulisio, 2013) which connects products and services from each country and aggregated sector with their social risks, taking into account nearly 150 indicators. The second part is the social performance based on indicators at country and sector scale in Turkey, South Africa and Greece, retrieved from official statistics, corporate social responsibility reports and conducted surveys to companies and institutions from the mineral sector within workers and community stakeholders. 3. To determine the potential social positive impacts in the use phase in urban agriculture in Barcelona (Spain) within consumer stakeholde

Results and discussion

Only the first part of the analysis has been finished. Figure 1 shows the aggregated risk hours per country and the imports to Spain (left-hand bar chart), and the risk hours disaggregated by five social impact categories (Community Infrastructure, Governance, Health & Safety, Human Rights and Labour Rights and Decent work) in the right-hand bar chart.

Countries which have higher risks are Uganda and Mozambique but they only export 3% and 5 % to Spain. Turkey is by far the country that exports more to Spain (32%) and have high risks in Health & Safety, Human rights and Labour rights and Decent work. Likewise, Turkey and Greece are the ones that export more worldwide, excluding China, and have the highest reserves of this mineral (Bennett, 2018). Hence, these countries are more pertinent to examine. This assessment is based on the aggregated mineral sector in these countries, so further a specific research is being carried out to know the social performance in the specific sector of perlite.

The following part will analyse this sector in the specific countries, Turkey, South Africa and Greece, for specific categories and subcategories, Health & Safety: fatal injuries and non-fatal injuries (Sector- specific (S)), Human rights: Gender inequality (Country-Specific (C) and Sector-specific (S)), Labour rights: child labour (S), forced labour (S), excessive work hours (S), poverty line and reduction (C) , job creation (S). The use phase of this substrate in urban agriculture will be scrutinized using different social indicators such as community cohesion, social employment, contribution to economic development, gentrification and green spaces (m^2) per inhabitant.

Subsequently, a comprehensive analysis will be performed, taking into account social impacts in the production phase in overseas countries and in the use phase in local areas. This will help to consider not only the actual and potential social impacts of the implementation of this strategy in the value chain but also the positive environmental impact urban agriculture has in cities.

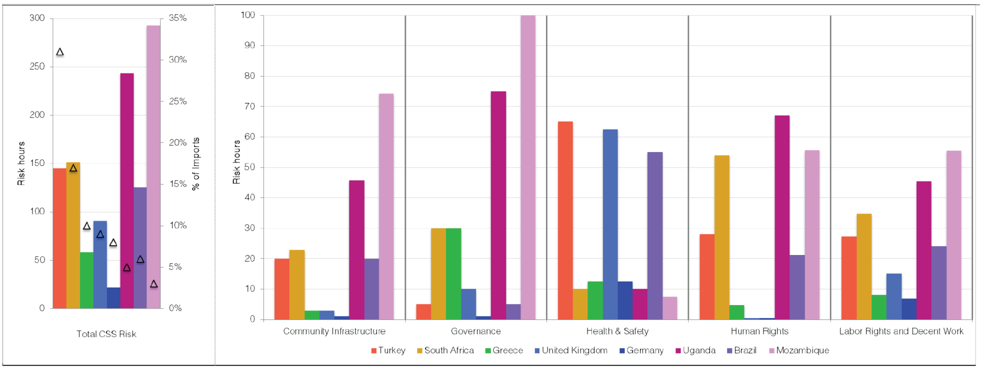

Figure 1: Characterization results for the social hotspots analysis for perlite imports. Δ = percentage of imports

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Track 3

Multidisciplinary perspectives on SLCA

Assessment of social impacts based on different data sources in SEEbalance®

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Introduction

The new SEEbalance® method is a methodology designed to evaluate all the three pillars of sustainability – environment, society and economy. This methodology has now been fundamentally revised in terms of assessing social aspects based on our own developments and the developments of the Round table for Products Social metrics where BASF is a member among other industrial partners. Within these frameworks we decided to develop qualitative factors to identify relevant social topics along value chains. For the assessment, different types of data sources were identified and applied, combined with a set of decision points of the data assessment. The main goal was the development of an applicable approach, where data can be implemented from accepted third party data providers and to transfer them to easy to understand information. In addition, this information should be able to support decision-makers in the process of further improvements of value chains.

Methods

The Social LCA in our approach is like an environmental LCA and considers system boundaries with the same logic. Life cycle steps are defined to produce a defined product with a defined function. To link the life cycle modules with relevant data, company specific, country specific or mixes of different data sets are prepared to integrate them in a life cycle approach. In an overall figure, social impacts by assessing 11 impact categories from different sources with different indicator sets are generated. An aggregation scheme that was developed within this setup can aggregate and display the results in a meaningful and easy understandable manner. The assessment of different life steps is performed by using different types of sources, following a defined hierarchy beginning with company specific data followed by sector specific and country specific data sets. The information is used directly from sources like Ecovadis, RepRisk or Maplecroft™ and are transferred to resulting scores and color codes. The applied process is shown in figure 1.

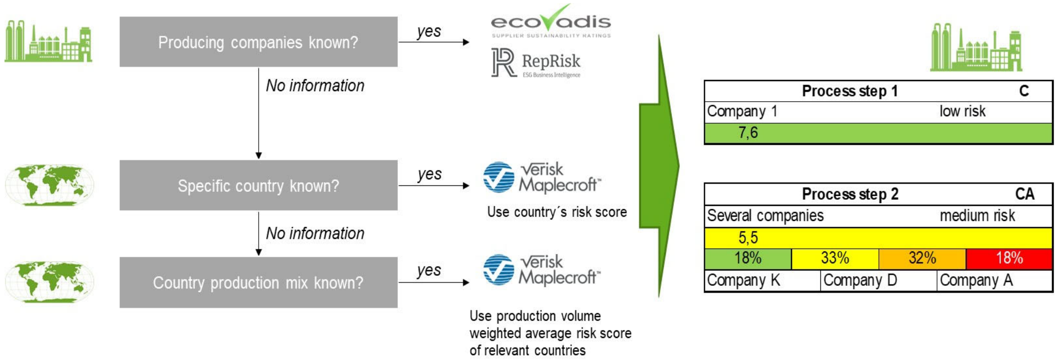

Figure1: Process flow sheet of data evaluation systems

Results and discussion

The Social Analysis is used for the identification of information on social impacts, risks and improvement potentials of product or process alternatives by the consideration of the whole supply chain with a life cycle approach.

In the Social Life Cycle Assessment, data along the supply chain in an LCA approach are collected and assessed. Different levels of the assessment are applied, beginning from specific company related data via regional data and regional average data. The results of the assessment are expressed in a specific 4 folded color and number code from “Red” via “Orange” and “Yellow” to “Green” and from 1 to 10. The numeric scale can be compared in different identification steps to generate final conclusions. Figure 2 shows an overview plot of different life cycle steps linked to their assessment results giving a clear indication what the preferable alternative is compared to others (Figure 2).

One important intention of the method development was to provide an easy to understand approach which consistently allows for the comparison of different alternatives, that fulfil the same functional unit. This approach should, to the largest possible extent, allow a similar interpretation irrespective of the practitioner conducting the assessment. We therefore developed a four-step interpretation approach.

In several cases, the new method was applied very successfully and delivered meaningful results.

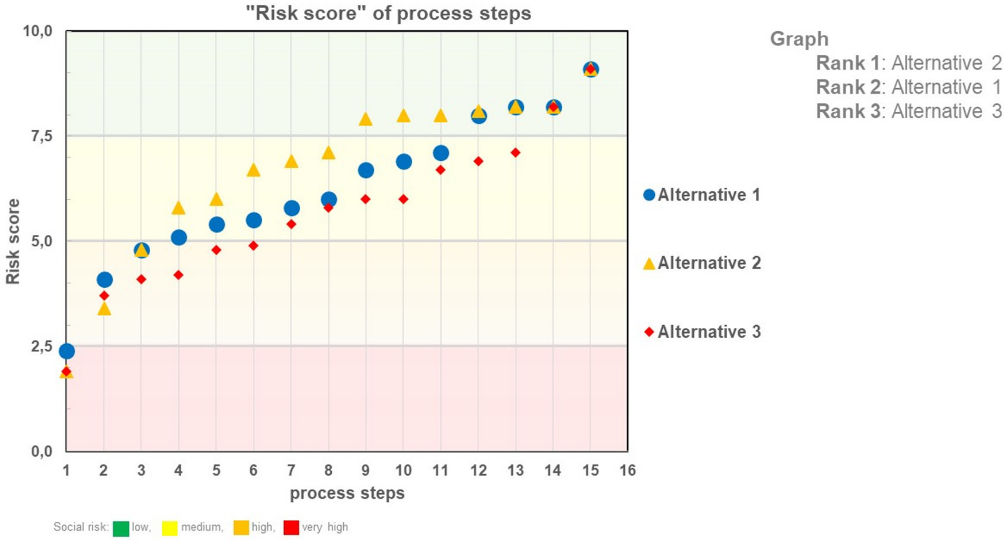

Figure 2: Plot of results from different life cycle steps in the Social LCA assessment

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A methodological application of SLCA and LCC to compare social and economic impacts of organic and conventional olive growing in Italy

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Introduction

Olive growing is the most important activity of rural economies in Italy: in 2010, it represented the 56% of national farms and the 76% of land used for permanent crops (ISTAT, 2012). Currently, consumer became more conscious in their buying behaviours, requesting more performing products, such as healthy, safe and quality products. Farmers are requested to produce green and socially sustainable products, while maintaining the profitability: that means adapting or modifying managerial and organizational features to preserve the environment and the workers' wellbeing in the working environment (De Luca et al., 2018).

The aim of this study is to assess the socio-economic sustainability of the Italian olive growing sector, by comparing the most common farming systems (organic and conventional agricultural practices) with the evaluation methodologies Life Cycle Costing (LCC) and social Life Cycle Assessment (sLCA) (Iofrida et al., 2020).

Methods

Two average scenarios have been designed, taking into account statistical data and primary data about farming operations (e.g. soil management, mechanization, yields, farming operations, local price of olives), gathered by means of a web-questionnaire launched on social networks (Iofrida et al., 2020).

The first scenario represents the conventional olive growing (Sc_1), that entails the use of chemical and synthetic fertilizers, herbicides (glyphosate) and pesticides (especially organophosphates), and mechanized soil management. The second scenario represents the organic olive growing (Sc_2), with the use of organic fertilizers, mechanical weeding, low impact pesticides (according to EU recommendations), and mechanized soil management. Average Italian farms surface is 1.25 ha (ISMEA, 2013); therefore, to simplify the evaluation, the functional unit has been approximated to 1 ha. 61% of Italian olive growing is located in hilly areas, therefore farming tasks have been referred to that typology of area. Likewise, the cultivar 'Frantoio' has been taken as example to account farming tasks. For both scenarios, a lifetime of 60 years was taken into account and the system boundary considered was "from cradle to farm gate". The olive orchard life cycle was divided into six main stages: (1) planting (year 0), (2) unproductive stage (1-6 years), (3) increasing production (7-18 years), (4) constant production (19-55 years), (5) decreasing production (56-60 years), (6) end of life (60th year).

Conventional LCC based on cash flows model was applied: all costs and revenues throughout the life cycle of each scenario were inventoried; all accounted costs were divided into initial investment costs, operating costs during the production stage and disposal costs were analysed. The total cost was accounted by its variable and fixed components. According to data from the 2011-2012 harvesting season collected by the Italian Services Institute for the Agri-food Market (ISMEA), it was supposed an olives average price of 0.50 € kg^{-1} for SC_1 scenario, and 0.60 € kg^{-1} for SC_2 scenario. Then, all costs and revenues were discounted with a discount rate of 1.8%, which was selected with a opportunity-cost approach in terms of alternative investments with similar risk and time. Cash flows assessment generated over the life cycle of the investment can provide useful information on long-term viability; thus, Net Present Value (NPV) and Internal Rate of Return (IRR) were calculated as indicators of investment feasibility. In the final step, a sensitivity analysis was performed by assessing the NPV and IRR as a function of the olives selling price and by excluding public subsidies, in order to reflect the market price dynamics in a free market (Stillitano et al., 2016). Social impacts were assessed in terms of hours of working conditions exposing to risk of psychophysical diseases or illness, therefore, a Psychosocial Risk Factors (PRF) impact pathway was applied (Silveri et al., 2014; Iofrida et al., 2019, 2020). The methodology consisted of four steps. The first step coincided with the LCC inventory phase; in particular, the hours of work were accounted per each agricultural task and per each life cycle phase, qualifying also the typology of task. The second step concerned the characterization of each task in terms of the typology of working condition, such as the exposure to a particular situation: pesticide (herbicides, insecticides, fungicides, fertilizers) exposure, noise, vibrations, temperature, work under pressure, etc. The third step consisted in collecting the odds ratios (OR) data from scientific literature, i.e. those published studies that statistically quantified the associations between working conditions and psychosocial health risks. The OR is a statistical measure of the intensity of association between two variables, such as the ratio between odds of exposure in sick people and odds of exposure in healthy people. Values >1 represent a positive association between the working condition and the disease/disorder; the higher the value, the stronger the association (Iofrida et al., 2020). A PRF Matrix has been constructed putting in relation to every working condition with one or more psychosocial risk. Finally, the assessment and comparison of the two scenarios, highlighting the main differences or similarities, has been carried out.

Results and discussion

Results of the economic analysis showed that, in terms of cost per life cycle stage, the SC_2 scenario achieves the better performance compared to the SC_1 scenario. The findings of investment feasibility analysis (Tab. 1) by including public subsidies revealed that the SC_2 scenario was the most economically feasible alternative, with a NPV of 7,519.54 € ha^{-1} and an IRR of 2.40%. This indicated that the profitability of the organic systems was positively affected by the higher olives market price, lower production costs, as well as the subsidies to organic farms. The sensitivity analysis performed by assuming diverse olive sale prices, which range from 0.50 € to 0.80 € for the conventional scenario and 0.60 t € o 0.90 € for organic one, and by excluding European subsidies. The simulations demonstrated that, at the current market prices, investments in olive production systems were not economically sustainable (Iofrida et al., 2020). To generate positive NPV and IRR values, the olive price must exceed 0.75 € kg^{-1} for SC_1 scenario and 0.80 € kg^{-1} for SC_2. Therefore, it can be affirmed that public subsidies strongly affect the economic sustainability of olive investments and, therefore, the final profitability of farms.

	Unit	Sc_1	Sc_2
Yield (constant production stage)	kg ha^{-1}	10,000	9,200
Olives sale price	€ kg^{-1}	0.50	0.60
Public subsidy	€ ha^{-1}	600	600
Subsidy to organic farms	€ ha^{-1}	-	700
NPV	€ ha^{-1}	-25,752.49	7,519.54
IRR	%	-0.25	2.40

Table 1: Feasibility analysis of conventional and organic olive growing scenarios

Concerning social impacts, the organic scenario SC_2 showed to be better than the conventional one, especially in qualitative terms: indeed, even if the average working needs are very similar (more than 11,500 hours for the whole life cycle of both scenarios, with a little supplement of 75.5 hours in SC_2 scenario), the conventional scenario SC_1 expose workers to severe health risks, such as diseases with possible mortal course. More in details, both scenarios showed similar results for the highest values: the most important exposures for workers are the musculoskeletal disorders (± 16,000 hours of exposure to the risk of back pain, followed by ± 12,000 hours of neck and shoulder pain), with a strong association (1.7<OR<8) (Bovenzi and Betta, 1994). Synthetic phytoiatric products such as insecticides, herbicides, fungicides, and fertilizers are the reasons for the main difference between the two scenarios. Indeed, the SC_1 scenario exposes workers, with a strong association, to the risks of colorectal carcinoma (1.176 hours), asthma (588 hours), myelodysplastic syndromes (588 hours), REM sleep behaviour disorder (300 hours), muscle weakness (212 hours), numbness (212 hours) and cutaneous melanoma (89 hours). In addition, with a moderate association, the SC_1 scenario exposes workers to the risks of amyotrophic lateral sclerosis (588 hours), renal cell carcinoma (89 hours) and non-Hodgkin lymphoma (89 hours). The only impact category for which the SC_2 scenario has a worse performance is the Parkinson disease (399 hours in SC_2 against 212 hours in SC_1), because of the frequent use of copper oxides in organic olive growing. As argued by Iofrida et al. (2020), further research should be necessary to investigate the social impacts on other stakeholders' groups, such as supply chain actors and consumers. Likewise, impact categories should be weighted to assess scenarios coherently to the importance of each impact category. A better mechanization of harvesting tasks would help reducing production costs, and the reduction of synthetic pesticides would be suitable to improve the socio-economic performance of the Italian olive-growing sector.

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Environmental and social impacts of the forest sector – A Portuguese case study

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Introduction

With 35% of its territory covered by forests and with the contribution of the forest sector revenue to the Portuguese economy being higher than the European average, Portugal is, in the European, and even in the international context, a country specialized in this sector (Instituto da Conservação da Natureza e das Florestas, 2017). It was on the forest sector that the concept of sustainability was first introduced at the beginning of the 18th century (Carlowitz, 1713). Since then, the sustainability concept has evolved with the economic, environmental and social areas being identified as equally important pillars (Department of Economic and Social Affairs, 1992). Life cycle assessment is a standardized methodology (ISO 14000, 2006) that can be used to assess the environmental (E-LCA) and social (S-LCA) impacts of a product life cycle from raw materials extraction to final product disposal. The environmental impacts of different forest products have been investigated in different studies using the E-LCA methodology, including a study by Santos et al. where the environmental impacts associated with the life cycle of different products (such as tissue paper) produced in Portugal were assessed (Santos et al., 2018). The study by Corcelli et al. where an environmental assessment of papermaking from chemical pulp in Finland was conducted (Corcelli et al., 2018); and the studies by Demertzi et al. and Rives et al. where an environmental analysis of the production of natural cork stoppers in Portugal (Demertzi et al., 2016) and Spain (Rives et al., 2011) were conducted, respectively. However, contrary to the environmental impacts, little attention has been given to the social impacts associated with these forest products. Even less common in the literature is the combined analysis of the environmental and social impacts of these products.

Thus, the objective of this paper is to analyze the environmental and social impacts associated with different forest products produced in Portugal using the E-LCA and S-LCA methodology. Because the pulp and paper industry along with the cork industry are responsible for 49% of all revenue generated by the Portuguese forest sector (DGAE, 2017), two different products from these industries will be used as illustrative case studies. These two products are printing and writing paper, and cork stoppers, since these are the most produced products by the pulp and paper industry, and the cork industry, respectively. The E-LCA and S-LCA will be conducted using the ReCiPe (Huijbregts et al., 2016) and the Social Hotspot Index (Benoît-Norris et al., 2018) methods assessed through SimaPro, the leading LCA software.

Methodology

According to the ISO standards, an LCA study is composed of four main phases:

1. **Goal and Scope Definition –** In the first step of an LCA, the main objectives of the study, the functional unit, and system boundary are defined. The main objectives of the study influence the choice of functional unit, which is a representative element of the system under study. The system boundary is also critical, since it limits the parts of the life cycle that should be considered. The main objective of this study is to analyze the environmental and social impacts associated with the Portuguese production of printing and writing paper, and cork stoppers. In this study, a functional unit of 1 hectare of forest (eucalyptus or cork oak) and a system boundary cradle-to-gate has been selected. This means that the life cycle of both products will be considered from raw materials' extraction to product manufacture.

2. **Inventory Analysis or Life Cycle Inventory (LCI) –** The next step of an LCA is the data collection. Both methodologies, E-LCA and S-LCA, differ on the data that is collected. In an E-LCA, this step consists in collecting a list of inputs (e.g. raw materials and electricity) and outputs (e.g. emissions and solid waste) and the corresponding quantities. In a S-LCA, this step consists in collecting the socio-economic interactions of the activities involved in a products' life cycle (Garrido, 2017). Collecting this kind of data can be time-consuming and a cost-prohibitive endeavor (Benoît-Norris et al., 2018). For this reason, databases were developed where environmental and social data is available. The Ecoinvent database (Ecoinvent, 2018) is the most utilized LCI database used in the context of E-LCA. The Social Hotspots Database (SHDB) (Benoît-Norris, et al., 2018) is a database developed specifically for the purposes of supporting S-LCA. This database has generic social data for 160 indicators at country and sector levels based on statistics and information issued by governments and international organizations such as the World Health Organization. These databases will be used in this study to collect generic environmental and social data.

3. **Impact Assessment or Life Cycle Impact Assessment (LCIA) –** In the LCIA step, the data collected in the preceding step is converted into environmental and social impacts. In an E-LCA, the inventory list is converted into potential environmental impacts using characterization factors. In a S-LCA, the social data is converted into potential social impacts by comparing the social data with performance reference points (Wu et al., 2014). These environmental and social impacts are calculated considering different impact subcategories (also known as midpoint categories), which can be further aggregated into impact categories (also known as endpoint categories). These impact categories can be normalized

using normalization factors and multiplied by a weighting factor. The normalized and weighted results can be added to calculate a single score. The ReCiPe method is one of the most recent and most utilized LCIA method used in the context of an E-LCA. This method considers 18 midpoint categories (e.g. climate change and terrestrial acidification) and 3 endpoint categories (human health, ecosystems, and resources). The Social Hotspot Index was developed to be used in the context of S-LCA and considers 24 midpoint categories (e.g. forced labor and gender equity) and 5 endpoint categories (labor rights & decent work, health & safety, human rights, governance, and community). These two methods will be used in this study.

4. **Results Interpretation –** The last step of an LCA consists in analyzing and interpreting the results of the three previous steps to identify the hotspots (i.e. parts of the life cycle responsible for most of the environmental and social impacts) of the system being studied and suggest possible improvements. Pareto analysis can be used to identify the most critical environmental and social impacts.

Results and Discussion

The results of applying the environmental and social life cycle assessments to the two forest pro ducts considered will be analyzed considering the midpoint and endpoint categories but also the environmental and social single scores. The analysis of these results has as main objective to identify:

1. The most critical environmental and social impacts associated with the life cycle of these products;
2. The main source (i.e. hotspots) of these impacts;
3. The life cycle, between the two analyzed, expected to bring fewer environmental and social impacts.

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Exploring the environmental and social performance of a new value chain for valorizing waste wool in outdoor garments

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Introduction

The clothing industry has been identified by a number of studies to account for a large share of environmental impacts from personal consumption, especially due to the current "fast fashion" paradigm we are experiencing. Goals and targets for the clothing industry have already been outlined and communicated, with many industry representatives highlighting the importance and expectations for circularity in the sector [1, 2]. As such, various industrial clothing industry firms and researchers are attempting to develop systems to recycle, reuse, and offer clothing libraries to reduce the environmental impacts of clothing, production and use, through circular approaches [1]. Inspired by a recent report on the amount of waste from sheep farming, and the decline of prices and wool production in a once-dominant industry in Sweden, this study follows the valorization process of waste wool from a farm north of Stockholm, Norrby Gård, to the production of a wool sweater. As such, the study provides an assessment of the environmental and social performance of a specific product from Röjk, a wool sweater called 'Norrby.' The aim is to highlight important aspects in both environmental and social life cycle assessments for developing new, unconventional, supply chains.

Methods

This project assesses the environmental and social performance of the valorization process for the Norrby sweater. This includes following the new valorized supply chain of Swedish waste wool to Europe for scouring, knitting and final sweater production before turning back to Sweden for retail. We review different supply chains for comparing supply chains including scouring of the wool either on Gotland (currently conducted, denoted as SE-EE) or in Belgium (denoted as SE-BE-EE), with subsequent spinning, knitting and production all in Lithuania and Estonia. This is also compared with conventional wool supply chains from e.g. Australia and South America.

The environmental performance of the valorized wool system was assessed using life cycle assessment (LCA). The life cycle impact assessment (LCIA) method ReCiPe Midpoint (H) was employed, including impact categories such as greenhouse gas (GHG) emissions, acidification and eutrophication impacts, abiotic resource depletion, water resource depletion and human toxicity in order to provide a screening of the potential environmental hotspots and areas (to assess both local and global environmental impacts for agricultural products) for improvement of the studied systems. A social LCA (SLCA) was also completed using the PSILCA database [4] employing direct input from Röjk on all associated monetary flows and costs for the different processes. The modeling of the system, and conducting the LCA and SLCA, was developed in OpenLCA. The monetary flows for the Uruguayan and Australian, as well as parts of the Baltic-Belgian supply chains partly derived from Röjk's direct input or were estimated using various freight calculation tools. The functional unit for the LCA and SLCA is one mid-weight wool sweater (roughly weighing 600 grams). While the LCA focuses solely on waste-wool, the SLCA includes waste-wool as well as virgin wool from Uruguay and Australia for comparing the potential social impacts of conventional wool supply chains.

Results and discussion

The results illustrate that the GHG impacts ranged between roughly 3-12 kg CO_2-eq per sweater. As illustrated in Figure 1, a significant share of the environmental impacts are from processing in Europe, i.e. energy used during the scouring, knitting and final production. This was slightly increased when the scouring was conducted in Belgium (SE-BE-EE) instead of on Gotland (SE-EE). While the shipment of the wool to the processing in Europe, the by-product lanolin also shows significant environmental impact reductions if it can be captured and used as a product (and may even negate transportation emissions). Transportation of the wool to the processing and back also contributed to the environmental impacts, although in comparison to the processing, this was not significant. Furthermore, as the wool was assumed to be a waste product, it contributed only slightly to the impacts.

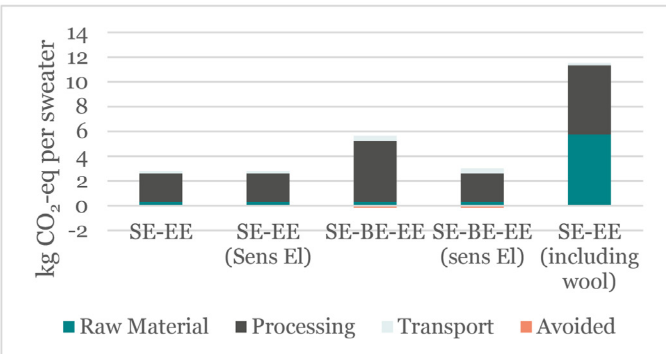

Figure 1: GHG emissions per sweater (measured in kg CO2-eq)

However, if it is included, as in the SE-EE (including wool) scenario, this would greatly increase the impacts form the system, where the results are in line with findings in Nolimal [3]. In the scenarios reviewing 'sens' el, we changed the LCI data to Swedish electricity mix, which has much lower emissions than the mix employed in Belgium and Eastern Europe [4]. Furthermore, Figure 1 also illustrates that results are sensitive to the electricity mix employed.This points to measures that Röjk may take to reduce environmental impacts of the system.

Results of the SLCA show that the SE-EE and SE-BE-EE have large reductions compared to the Pacific and South American supply chains. Figure 2 shows an overview of four of the 49 indicators in the PSILCA database, of which eight were the focal point of this study. Of importance to highlight is that the SE-EE not score worse in any of these eight categories. The SE-BE-EE system scored lowest on *Contribution to economic development* and *Safety Measures*. As shown in Figure 2, Corruption and bribery were highest in the non-European supply chains. The SE-BE-EE supply chain, however, was significantly higher despite also only including European processes. This is due to requiring more transport and assumptions for transport costs. Risks for child labour is highest for the Pacific supply chain, due in part to more interconnectivity to Chinese and Indian industries, where child labour is more prevalent than in other areas included in the study. More than 50% of the forced labour present in the Uruguayan supply chain originates from Argentina, not from Uruguay itself. For all the European supply chains, the high potential risk in the indicator Social Responsibility is a direct result of the textile industries in Lithuania and Estonia. The Uruguayan supply chain scores highest here due to additional issues with the Argentinian and its own textile industry.

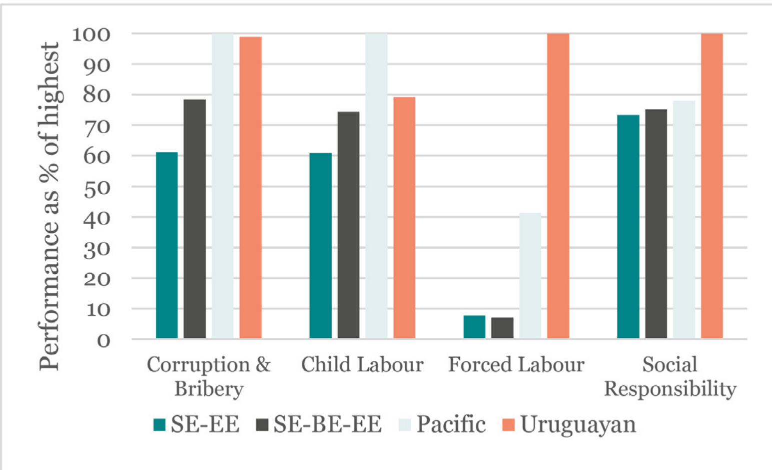

Figure 2: Overview of Four Indicators (Normalised to the Largest in each category)

In conclusion, comparing the supply chains in the SLCA showed that the interconnectivity of the globalized economy makes it difficult to have full control over the social performance of a supply chain. Since the assumptions based on transport costs might have resulted in transport costs being too high, the transport industry showed an overrepresentation in some of the indicators, especially in Child Labour. The PSILCA SLCA database can highlight hidden connections between worldwide industrial processes and illustrate the influence for the social performance of that supply chain. However, the quality of the results are very dependent on the quality of the data, both on where the process takes place and the costs of that process. Further uncertainties arise from PSILCA's foundation on IOTs, and the fact that fluctuating costs of goods and services do not represent exchanges between industries correctly. Nevertheless, conducting SLCAs using PSILCA can be a valuable first step into exploring the social performance of a supply chain due to it is depth and breadth.

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Social cost benefit analysis of operating compressed biomethane (CBM) transit buses in cities of developing nations: a case study

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Abstract

We present results from our recently published Life Cycle Assessment (LCA) supported Social Cost-Benefit Analysis (SCBA) of establishing a large food waste treating bio methanation plant in Mumbai, India. The food waste is anaerobically digested, and biogas produced is upgraded to compressed biomethane (CBM) and used as fuel to operate transit buses within the city. The SCBA results indicate that CBM driven buses can save 6.86 billion Indian rupees (USD 99.4 million) annually for Mumbai. The savings are made due to a reduction in fuel cost coupled with environmental externality costs if entire transit bus fleet operates on CBM fuel instead of current fuel mix (33:67 diesel to CNG). Also, the sustainable and private rate of returns of using CBM as a fuel to operate transit buses is much higher than passenger cars. The bus riders from lower income class can benefit significantly when Mumbai uses more sustainable CBM fuel.

From blockade to resilience: social perspectives for food security and sustainability in Qatar

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Introduction

In 2017, Qatar has faced up a diplomatic crisis with other Gulf States, which is followed by cutting diplomatic ties with Qatar and harsh embargo. Considering the fact that over 90% of Qatar's total food supply is provided by imports, the embargo has pointed out food security as one of the grand challenges faced by the nation (Kucukvar et al. 2020). Currently, Qatar lacks the capability of domestically producing enough food to meet the increasing food demand fueled by economic growth, increasing the nation's dependence on neighboring Gulf countries for importing food. Even though the recent Gulf crisis, along with the following Arab blockade, have influenced the global trade behind the supply chain of food that enters Qatar, resulting in serious transportation- and security-related challenges, these incidents have also played a catalyzer role in fostering local food production. However, it is a challenging task for Qatar to achieve an import-free domestic food market in the near future, given limited national natural resources. To this end, Qatar embargo significantly changed the international trade of food products and local food production capacity, which brings important research questions such as what are the socioeconomic impacts of Gulf crisis on Qatar food security and sustainability from a regional and global perspective? Moreover, is it a threat or opportunity for such a tiny peninsula?

Qatar Food Trade: Before-after Gulf Crisis

Figure 1 visualizes the monetary value of food imports for Qatar by country and year. The results clearly illustrate that in 2017, the United Arab Emirates and Saudi Arabia are ranked as third and fourth countries based on the contribution to Qatar's food imports with 14.18% and 12.88%, respectively. On the other hand, India and Australia had the largest imported food value with 24.28% and 16.63% respectively. In 2018, India and Australia had the highest amount of imported food value with 26.76% and 21.16%, respectively. Furthermore, Turkey experienced a considerable increase in value compared to previous years with 12.23%. Although GCC countries that imposed blockade in Qatar are not shown, the imported food value of those countries decreased sharply with a very small percentage comparing to the previous year. These results clearly proved that there is a dramatic change in international food trade for Qatar, which resulted in significant socioeconomic and environmental impacts due to changing transportation distance, source of production, supply shocks, price volatility and local impacts such as promoting local production with government incentives and creating new sectors and jobs.

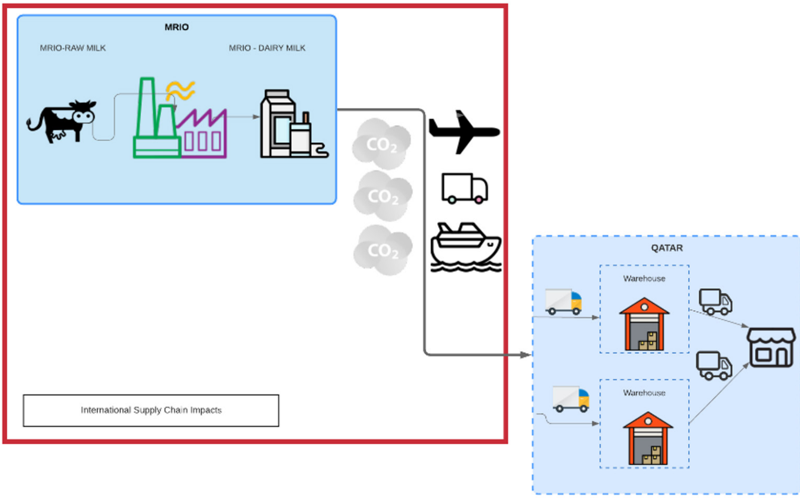

Figure 1: System boundary

Methods

To quantify socioeconomic impacts, a global multiregional input-output analysis (G-MRIOA) is preferred for analyzing impacts on the regional and global supply chains of Qatar economy considering the role of global trade (Kucukvar et al. 2019). This model enables the policymakers to evaluate regional and global supply chain impacts of embargo in main sustainability indicators, such as import dependency associated with national food security, cost of food supply due to changing trade structure, employment, human health impacts, carbon emissions and energy use related to changing import, long-distance transportation and production technology of food products. As a global multiregional input-output database, Eora database that is used by world's largest economies such as United States, UK, and Australia for analyzing the sustainability performance of G-20 countries is utilized to gather import and export data for Qatar national economy and the-rest-of-the world (Lenzen et al. 2013). To conduct a much-needed assessment of the economic and environmental impacts of the Gulf Crisis on Qatar food industry, this study integrates socioeconomic indicators with MRIO tables to provide a holistic sustainability assessment model, using macro-level socioeconomic sustainability development metrics such as import dependence, cost of food supply, employment and human health impacts due to increased transportation distance of imported food products after the blockade.

Results and discussion

Qatar has spent around seven billion Qatari Riyals to Saudi Arabia and the United Arab Emirates for the period between 2012 and 2016. After blockade has been imposed in the midst of 2017, it targeted the food supply chain in the first place with serious humanitarian and ethical concerns. There was a clear change in data, as India took over the first place with around 1.4 Billion in 2017. Furthermore, Oman, for instance, was not among the top 10 before, but it came in 7^{th} place in 2017. Most importantly, the blockade had segregated families, violate freedom of movement rights, and negatively affected the social cohesion. However, the target of food shortage was not achieved, and this made the people in Qatar secured in this aspect.

Worth to know that after the blockade, Qatar has reached a better food security index than 99 countries including the four Arab blockade countries that ranked UAE 31, Saudi 32, Bahrain 41 and Egypt 61. According to Baladna, which is a Qatari leading and largest dairy producer, the blockade was an opportunity for the nation to become in a position that fulfills the demand of the local market. Before the blockade, 18% of milk was produced locally and 82% was imported from outside. However, the production of milk from 2016 through 2019 was 9.80, 150 and 380 tons, respectively.

In conclusion, the embargo was a wake-up call for Qatar, which helped the nation to become resilient by fostering local production and updating the national food security program effective for the period of 2018 and 2022. Understanding the long-term socioeconomic implications of the embargo is of great importance for the country to become more resilient to such crises in the future and improve the national capacity building in terms of food production, diversified foreign trade, reduced food waste and enhanced circular economy practices in food sector.

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Financial influence on the Brazilian soybean – An integrative life cycle approach

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Introduction

In a time of rapid change, sustainability and climate crisis, it becomes extremely important to understand product flows, as well as understanding how human action and interactions enable and shape these flows. Financial actors, given their economic power, are one of the most important forces in product chains. However, the type of influence that they have, their interactions with other different actors and their link with environmental and social issues have seldom been elaborated in the life cycle literature. Hence, it is necessary to better understand their influence on global product chains in order to identify the positive and negative aspects of it. Today, the separated approach to the study of people and matter dominating in academia (Baumann, 2012) risks to overlook their interdependence on many important aspects. Financial actors are rarely in direct contact with the material flow, but their influence matters, nevertheless (Galaz et al., 2015; Galaz et al., 2018). Hence, it is necessary to develop a method that includes their influence over product life cycles. This would help to re- materialize concepts such as capital, resources and value into practical activities, giving them a context. Financial capital is often imagined as an abstract entity, which "circulates around the globe as a function of its profit-seeking imperative, impacting on households, communities, companies, regions, and ecosystems" (Ouma, 2016). However, the impacts are far from abstract, nor is financial capital and whoever directs it. Many specialized studies and methodologies can become too narrow or provide a too fragmented picture of these complex systems. As Kauffmann (2009) points out, "methodological pluralism is a necessary characteristic of sustainability science as a whole". In this regard, the field of Social Life Cycle Assessment (S-LCA) would benefit from including multiple social perspectives, other relevant and contextual actors influencing the product flow, going beyond the social scope suggested in the UNEP/SETAC S-LCA framework. In fact, the latter only focuses on the actors in direct contact with the product flow (Baumann & Arvidsson, 2020). Therefore, there is a need for more comprehensive, integrative methodologies that enable sustainability assessments of complex product chains. A complex case can be used for developing and testing a more comprehensive and integrative approach to the social study of life cycles. Soybean commodity chains and their sustainability challenges and governance constitute an interesting case for developing and testing a social life cycle method which includes both the life cycle, life cycle actors and other actors influencing the life cycle. Achieving sustainability means improving sustainability governance

(Bond & Morrison-Saunders, 2013). Given the complex socio-ecological problems of the soybean product chain, current methods are lacking the ability of capturing the width of the problem for analysis and solutions. The aim of this contribution is to present, develop, testing and evaluating an integrative and comprehensive methodology, covering the actor network around material flows by combining LCA, PCO methodology (Baumann, 2012) and financial chains. Combining different approaches, such a method aims at providing a richer description of actors, local and remote, involved in different steps of the life cycle, complementing the current limited vision of CSR-based S-LCA (Baumann & Arvidsson, 2020).

Method

First, the study of the case of soybean commodity chains originating from Brazil and the financial governance has been examined with an extensive literature and document study (Magnolo, 2019). Brazil has been chosen being home to two of the most important biomes on Earth, the Amazon rainforest and the Cerrado savanna which, for the past 30 years or so, have both been subjects of extensive deforestation. The agricultural sector, such as the soybean sector, has branched out different supply chains to serve global commodity markets, contributing to the clearing of land for extensive monocultures. After the global financial crisis, investments in agricultural land by foreign investors in Brazil increased. Pushed by capital injections, soybean products flow all around the globe in different forms, passing through a range of technical processes, involving different types of actors. All these interactions and their development are both difficult to track and assess. Hence, an integrative framework was developed including social, technical, ecological and financial information. A life cycle perspective was used, including actors close to the product flow as well as remote actors. The actors were mapped along the life cycle steps, using the PCO methodology (Baumann, 2012) (Figure 1). Financial actors were also included using the "financial chain" conceptualization, inspired by Galaz et al. (2018), linking the relationship between different financial actors at different levels, for each step of the life cycle. Finally, a detailed description of the soybean chain using the framework was performed. Interviews with financial chain actors linked to Brazilian agriculture were also held, the AP2 Swedish pension fund and its asset manager, Nuveen, in order to get an inside perspective on their role and their strategies for the soy chain.

Results and discussion

The integrative framework enabled a structured and systematic description of the multiple social systems of the soybean life cycle, covering either ecological, technical, social and financial dimensions. Three steps of the life cycle were studied in depth, due to their link to deforestation in Brazil and ecological impacts (Figure 2). The integrative application of LCA results with PCO and the financial chain, showed the importance of different types of actors along the chain and the links between them.

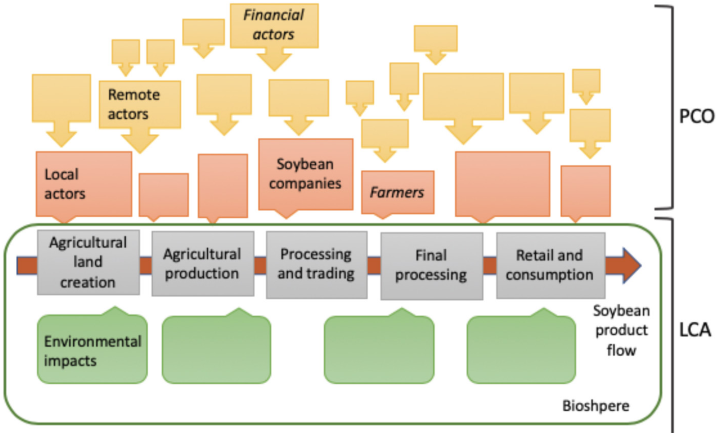

Figure 1: Theoretical framework

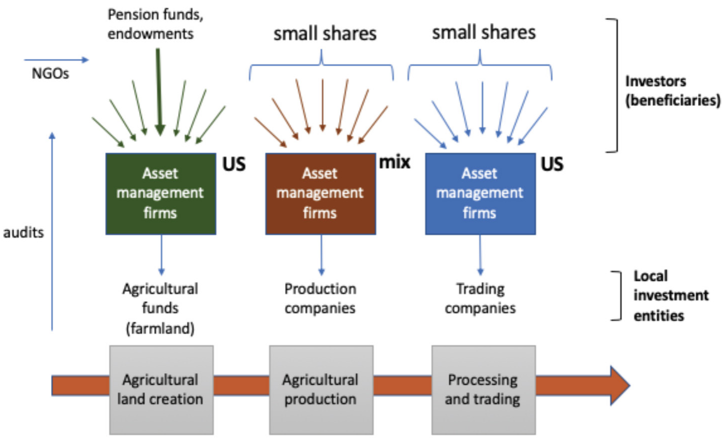

Figure 2: Direct and remote life cycle actors for the soybean case study

At a local level, very close to the product flow, we find farmers and communities working in or close to farmland where soybean is cultivated. The intermediaries between foreign investors, production and trading companies and communities, are asset management firms in all three different steps analyzed, the majority of them from America. Their role is similar in all the different steps. Instead, the type of investors whose capital is managed by the asset management firms differs among the three steps. Hence, financial governance differs for each life cycle step. Pension funds and endowments invest more in farmland with very large shares, while investors for the other two steps are of another kind and own very small shares in production and trading companies. Hence, the interactions in these two steps are minimal and only exist for investors to diversify their portfolio and for local actors to obtain capital. In the first step, where ownership shares are bigger, investors manage more directly and practically their local investments. The study of the financial chain actors showed that although some progresses have been made in terms of responsible and sustainable investing, especially regarding deforestation, fiduciary duty is still prioritizing financial benefits over social and environmental ones, missing an important opportunity of guiding climate change adaptation and mitigation, for the environment as well as for society and local communities. The increased deforestation and cases of land grabbing in the last two years are evidence of this.

The integrative methodology provided new perspectives on how specific steps of the soybean product chain are financially managed. The methodology developed by Galaz et al. (2018), using an economic approach, links financial actors to industry sectors modifying tipping elements in Earth's climate system. The integrative methodology developed in this contribution uses a product life cycle approach instead, helping to identify roles and responsibilities of financial actors for each step of the life cycle, to foster collaboration and enabling a better and more sustainable governance. Moreover, it provides an overall to study both consumers' and financial actors' interests. Further research is needed to study this relation, as well as the methodology's application to different types of products.

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SLCA and social impact risk mapping – A way forward for social risk understanding and actions?

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Introduction

Studying social impact risks associated with activities is a necessary step for companies wishing to establish a risk management strategy with a strong social sustainability component. The minimisation of these risks will require interventions at different levels of stakeholders and the end goal be fully understood by all. Indeed, a management process that aims at increasing sustainability will be ineffective or inefficient if the work or change management activities are too socially challenging, ethically wrong or people are just not willing to do the work.

The present study considered the potential social impacts of using previously underutilized proteins from side streams for novel food applications, as described through two assessment methods: Social Life Cycle Assessment (SLCA) and Social Impact Risk Mapping (SIRM). The aim of the study was twofold: (a) contribute to the development of the SIRM approach, and (b) highlight the synergies between SLCA and SIRM to provide actionable inputs for a company's risk management plan and an easy-to-understand representation of the risks to increase stakeholder understanding and buy-in.

Methods

Proteins from wheat (EU-based primary grain and protein production) and rice (TH/IT/EG-based primary grain production, EU-based protein production) were considered for the study. In the case of wheat protein, the processes assessed included wheat grain primary production, ethanol processing, water utilisation, sodium hydroxide production, de-ionised water production, and energy use in localities under study. For rice protein, it was considered that rice was grown and milled in three different locations before being transported to the protein production locations; the other processes were similar to those for wheat protein except for their localisation. The social impacts related to the use of proteins in novel foods, retail, consumption and disposal were not addressed in the study (for full model, see Prominent project, 2018).

Two methods were used to map the social impact risks involved – SLCA and SIRM. The SLCA framework was applied on the two types of proteins, with the assessment performed with generic data from the PSILCA database for the appropriate locations. All the social hotspots found were used as input for the SIRM work.

SIRM is a social sustainability-oriented application of risk mapping, a contextual risk management tool that allows management teams in establishing the context of risks in a particular production or area (ISO 31000) and address or monitor them. The method was originally adapted for SME risk management in Finland, and then adapted to farms included internal risks relating to farm assets and finance, products and production quality, worker safety, as well as risks external to the farm (Leppälä, 2016). In this work, SIRM focused on establishing an easily understandable and communicable social impact risk table to be used by the companies involved in the study. The inputs for the SIRM included information obtained through desk research (e.g. background information on companies, current risk management tools used), SLCA hotspot screening results, and interviews and factory walk-throughs.

Thorough uncertainty analysis was not performed on either the SLCA or SIRM approaches, as of the time of writing of this abstract.

Results and discussion

SLCA hotspot screening for wheat and rice protein production showed that the latter resulted in much higher associated risks. Five out of the six impact categories most linked to potential risks are identical for both (Table 1) and concern workers and the local community.

Table 1: SLCA total risk assessment for wheat and rice protein (impact categories listed in decreasing risk order for each of the types of protein).

1KG WHEAT PROTEIN			1KG RICE PROTEIN		
Impact category	Stakeholder	Total Risk	Impact category	Stakeholder	Total Risk
Fair Salary	Worker	0,50	**Biomass consumption**	Local community	1,72
Biomass consumption	Local community	0,44	**Fair Salary**	Worker	1,37
Industrial water depletion	Local community	0,39	**Corruption**	Value chain actors	1,22
Corruption	Value chain actors	0,32	**Child Labour**	Value chain actors	1,00
Health expenditure	Society	0,28	**Trade unionism**	Worker	0,98
Trade unionism	Local community	0,25	**Health expenditure**	Society	0,93

The mapping of risks in food production requires a deep understanding of the complexity of food processing activities, objectives, resources and associated risks. For each company or organisation under study, understanding, highlighting and addressing potential risks is easier if the management can categorize the main social sustainability risks as key factors in the production process (Leppälä et al., 2012).

An initial social risk map was drawn for five stakeholder groups, based on social impact literature, UN Social Development Goals and SLCA hotspot analysis (Table 2). Vulnerable social impact key factors were highlighted for each company under study based on company-specific information (e.g. factory walkthroughs). The aim is to bring stakeholder attention to all potential risks and use the key factors to prioritise actions and find the management tools to mitigate the main risks in the production process.

Table 2: Initial social risk map (observed key social factors indicated in red) for a case company.

Social key factors inside the organization		Social key factors outside the organization				
Other factors	**Workers**	**Consumer**	**Supply Chain** (value chain)	**Local community**	**Society level**	**Other factors**
	Health and safety - Work environment - Injury protection - Occupational heath and well-being - Working culture - OHS services - Social security **Human rights** - Freedom of association - Fair salary policy, contracts - Child labour policy - Equity of workers - Forced labour and trafficking - Personnel feedback - Complaints?	- Health and safety - Health protection - Feedback - Consumer data security - Information policy - Transparency policy - Consumer service ethics - Responsibility - Complaints?	- Customer service ethics - Contracts - Supply chain management - Supplier relationships - Fair competitions - Promoting - Marketing responsibility - Logistics - Complaints	- Local interest groups and stakeholders, partners - Community infrastructure - Culture - Services - Information and communication - Education - Community engagement - Local development - Local living conditions - Security - Local employees - Migration - Complaints	- Society interest groups and stakeholders - Social policy and values - Responsible actions - Sustainability - Education - Society development - Economy factors - Technology development - Society level security - Social sustainability reporting - Complaints from the interest groups and stakeholders	

The social risk maps developed as part of the study only presents preliminary results that must be further refined and edited to be easily readable and understandable for companies. While linked, the most important social risks highlighted as important by the SLCA and SIRM methods differed. A preliminary analysis of the differences shows that SIRM focuses in priority on risks that can be addressed directly by the company under study, while SLCA provides a broader approach. Thus, the methods can be complementary, highlighting to companies social risks that should be approached right away (SIRM) and social risks for which a specific risk management plan must be developed (SLCA). Social impact risks can include increasing limiting factors for production, environmental or economy management and must be taken more seriously in the future.

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Influence of potential impacts of novel mining technologies on the social license to operate

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Introduction

The social and environmental impacts of the mining industry can strongly influence the life of the mining communities and workers. Mining can bring economic development by means of job creation and infrastructure development but also environmental impacts like water pollution, and social impacts like resettlement. Mining companies have frequently been criticised for not taking into consideration the interest of local communities during operation, and design of community development programs. Nevertheless, the acceptance of a mining site among stakeholders is crucial to ensure that the interests, needs and livelihood of local stakeholders are considered. The Social License to Operate (SLO) has emerged during the 1990's as a somewhat catchy, easy to communicate term to summarise the stakeholders' acceptance to mining activities (Boutilier, 2014). The identified SLO drivers are the impacts on social infrastructure, the contact quality between stakeholders and company, and the company's procedural fairness towards the stakeholders (Moffat and Zhang, 2014).

This work explores the influence of impacts from mining on the SLO for the EU Horizon 2020 "Integrated Mineral Technologies for More Sustainable Raw Materials Supply" (ITERAMS) project, with the goal to identify the potential influence of the ITERAMS proposed technologies, including water recycling and tailings' valorisation, on the stakeholders' acceptance. Furthermore, the effect of company's behaviour related to stakeholders' engagement and consideration of their opinions on the SLO is described.

Methods

Firstly, the potential impacts from mining that can be influenced by the ITERAMS solutions, and the affected stakeholders, are identified based on the findings of the paper "Environmental and Social Pressures in Mining", results from a Sustainability Hotspot Screening (Di Noi and Ciroth, 2018) for the ITERAMS project.

A selection of the most common impacts related to mining and affecting SLO is the second step, and it is based on literature (Farrell et al., 2012; Saenz, 2019; Davis and Franks, 2014; Xavier et al., 2017).

The establishment of a relation between the potential impacts derived from ITERAMS and the identified SLO drivers provides the understanding on how the proposed technologies and the company's behaviour affect SLO. The impact categories under study are based on the Guidelines for Social Life Cycle Assessment of Products (Benoît et al., 2013).

The potential impacts, the selection of stakeholders, and the drivers of SLO are context specific. Nevertheless this work presents a general analysis that can be adapted to different locations. Although the SLO is granted by the local community, and the social impacts on workers are generally not included on research on SLO, mining workers are also included in this work, because they and their families also belong to the local community as residents.

Results and discussion

The identified social impacts potentially influenced by ITERAMS are presented hereafter, together with the pathways to the affected stakeholders:

- The water ecosystems can be affected due to the risk of acid mine drainage (AMD), and heavy metal leakage from tailings disposal, and water withdrawal for the mine operation. This may impact other economic activities in the area dependent on water access, as well as residents.
- Risk of dam accidents exacerbated by the dam size can affect the mine workers and the local communities.
- The degradation of nature that may have an impact on other economic activities like tourism as well as on the local population's free time outdoor activities.
- The land use for tailings' treatment may affect other economic activities like farming and residential settlements close to the mine.
- The dust from the tailings' ponds can have a negative impact on the workers and local community's health as well as on the fields for farming.
- The employment rate increase due to the mine operation can be positive for the local community if local workforce is hired.
- The technology for water recycling may affect the safety at the working place as a result of higher water temperature and pressure.
- The economic development in the area through investments is affected by the company's profit and has an impact on the local community.

The tailings valorisation and water recycling proposed in ITERAMS can affect impacts related to water, land and pollution. The financial benefits originated for the company can influence the economic development, and the employment rate.

Water is highlighted in literature as a matter of highest priority in the mining industry and hence, it has the strongest influence on the SLO. Moreover, stakeholders perceive that mining operations negatively impact air and water pollution, land access, living costs and access to nature. Positive impacts are economic development, improved infrastructures, higher local employment rate, and education. However, the equal distribution of benefits along the stakeholders, and the consideration of their problems, suggestions and needs is a key driver of SLO.

The ITERAMS technologies can create benefits and drawbacks for the affected stakeholders. They are grouped in impact categories in figure 1 for the stakeholder groups "local community" and "workers"; the benefits are marked in green and the drawbacks in orange. The impacts that can be directly derived are in the blue boxes, and the ones in the yellow box are dependent on company's behaviour.

Figure 1: Potential benefits and drawbacks of ITERAMS on local community and mining workers

The directly derived impacts of the ITERAMS solutions on local community, i.e. access to material resources, safe and healthy living conditions, and safe and healthy working conditions, contribute to the social acceptance of a mining site, and therefore to the SLO. The impact on health and safety working conditions is a benefit because of the reduction of dust, but also a drawback because of a higher risk of accidents. If the ITERAMS technologies enable a higher profit and hence higher investments on the community's development, the positive contribution to the SLO depends on the equal distribution of the benefits, and on to which extent the stakeholders' opinions are considered. In the same way, hiring new employees can be positive if local workforce is included. Moreover, the existence of company's education programs for the local workforce can be regarded as a benefit for the local community.

This work shows that the ITERAMS solutions can clearly contribute to gaining SLO, because of the reduction of issues related to access to material resources and safe and healthy living conditions. The influence of the impacts on workers needs to be further investigated. If the company's behaviour goes beyond the implementation of technologies by enhancing stakeholders' engagement and taking into consideration their opinions in decision making, the three drivers of SLO are covered and therefore the social acceptance would be higher. If the company's behaviour does not go in line with the SLO drivers, it may not gain or lose the SLO, even if the social impacts are positive.

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Socio-economic analysis based on a life cycle perspective: social and societal issues of new chemicals

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Introduction

The two research projects are part of EU Life funded research that aims to introduce new sustainable chemicals in Europe. As part of these projects, the potential social impacts of the new chemicals were evaluated along the value chain. The TRIALKYL project aims to develop new chemical intermediates (Trialkyl phosphites) that can be used in a variety of applications, including crop protection, flame-retardants and plastic products. The IREPRO project aims to develop new low-GWP refrigerants (REFRIX products) that can be used for industrial refrigeration and air conditioning.

The goal of this work is to better understand the socio-economic effects of the introduction of new chemicals on the market. This includes to better understand the effects on the environment, as well as social and economic effects on society.

The ECHA guidance methodology (ECHA 2011) was chosen to perform the socio-economic analysis (SEA). The evaluation includes economic, health, environmental and social impacts. Similar research questions for the two cases are regarding the benefits and risks of new chemicals in Europe. The analysis includes impacts along the value chain in Europe and comparison with similar products on the market.

Method

The socio-economic analysis (SEA) is a tool to evaluate the economic risk and benefits of an action (e.g. chemical plant) will create for society by comparing what will happen if this action is implemented or not. Under the REACH authorisation procedure (ECHA 2011), an SEA is a compulsory part of the authorisation whenever a potential risk to human health or the environment from a chemical substance occurs.

The SEA methodology includes the following impacts: Environmental impacts within SEA include among others GWP and other categories within Life cycle assessment methodology. Economic impacts within SEA include all relevant impacts (e.g. investments CAPEX and operations costs OPEX). Health impacts within the SEA are impacts on human health including morbidity and mortality effects, and covers health related welfare effects, lost production due to workers sickness and health care cost. Social impacts within the SEA are all relevant impacts that may affects workers, consumers or the general public, that are not covered under health, environmental or economic impacts (e.g. employment, working conditions, job satisfaction, education of workers, and social security).

In order to improve the social assessment in the ECHA guidance methodology, other methods might be of help. The Social LCA might be a suitable method to assess the social impacts (UNEP 2009). In order to select indicators, the Handbook for Product Social Impact Assessment (HPSIA, 2018) is a useful tool. Among the recent works in the chemical industry, the WBCSD product Social Metric guidance (WBCSD 2016) has helped to reduce the number of social indicators from 70 to a number of 25, and to a minimum of 11 social indicators. The SEEbalance method is an example of including SLCA in the eco-efficiency work in the chemical sector (Saling et al 2018)

In this paper we present the results from the two research projects using the SEA methodology based on ECHA (2011) and give some suggestions on using social metrics (WBCSD 2016) for the ECHA guideline regarding social and societal issues of new chemicals.

Results and discussion

The results of the TRIALKYL project has shown that despite the costs of a new production plant (CAPEX 1.154 Mill euro), the society benefits from human health (10% reduction) and significantly from environment (30% reduction), while social impacts and jobs have only slightly been changed. Further details can be found for the pilot plant (Brunklaus et al 2017) and recent results on the project webpage (TRIALKYL 2020).

The preliminary results of the IREPRO project are based on theoretical values and indicate the following: Environmental benefits (99% reduction of HFCs GHG emissions, 66% energy savings); economic benefit (Cost saving in production 20%); health benefits (safeguarding contribution) and social benefits (5% increase of jobs).

Reflections and suggestions on using SLCA for the ECHA guideline regarding social and societal issues of new chemicals.

The WBCSD (2016) product Social Metrics guidance based on SLCA methodology (UNEP 2009) include balanced and sector-specific guidance for the chemical sector. The guide addresses both positive and negative social impacts. It covers the key impacts that might be generated by a chemical product during its life cycle, regarding three key stakeholders (workers, local communities, consumers) and among five social areas (Basic rights and needs, Employment, Health and safety, Skills & knowledge, Well-being). The guidance covers material social issues for chemical products, within a selection of 25 social topics (of in total 70 social topics). The guidance minimum of 11 social topics excludes e.g. appropriate working hours and job satisfaction.

The ECHA guidance for SEA includes social impacts related to employment, job creation, working hours, job satisfaction. However, they are more rarely used since the focus lies on health issues and environmental issues. On the other hand, the societal impacts include aggregated results of all the key parameters in one indicator, the socio-economic indicator in terms of "economic value". The economic value for health impacts can be calculated in different ways (DALY per capita, willingness to pay, medical costs) based on WWF report "social impacts of chemicals" (ECHA 2011). Such an indicator might also be questionable in the light of "basic rights" in SLCA, while usable in the investment situation of a chemical plant and the production of new chemicals.

Acknowledgements

The research projects referred to in this article have been funded by the EU Life projects TRIALKYL during the years 2015-2020 and IREPRO during the years 2018-2020.

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The role of social life cycle assessment for human rights due diligence: a theoretical insight

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Introduction

Over the last years, the interest regarding the relationship between business and human rights has been growing significantly. Nowadays human rights issues cannot be considered a matter to be handled only at a public level, even if the international human rights law framework is addressed to States (Newton, 2019). Indeed, globalization has enabled companies to grow, accessing new markets worldwide, but at the same time it has emphasized the incapacity of States to prevent or address the adverse impacts on human rights caused by business activities in global supply chains (Newton, 2019).

The "Protect, Respect and Remedy" Framework (United Nations HRC, 2008) is also aimed to "narrow and ultimately bridge the gaps in relation to human rights" (United Nations HRC, 2008, para 3). It establishes different and complementary responsibilities and it is based on the following pillars: the State duty to protect human rights; the corporate responsibility to respect human rights; access to remedies.

Practical recommendations for an implementation of the Framework are provided by the United Nations Guiding Principles on Business and Human Rights (UNGPs) (United Nations HRC, 2011). According to UNGPs, the corporate responsibility to respect human rights requires that business enterprises carry out a human rights due diligence (HRDD), whose essential part is the assessment of impacts on human rights linked to their operations. Although this assessment has a core role in HRDD, the UNGPs establish only some criteria to assess human rights impacts (principle 18), thus business enterprises can conduct a stand-alone Human Rights Impact Assessment (HRIA) or incorporate it into other types of assessments (principle 18 commentary).

There are many HRIA approaches, but none of them is completely defined, since the assessment of human rights is a recent and still in development practices (Göztmann, 2014).

Therefore, starting from the existing literature about HRIA, the ultimate goal of this work is to investigate the potential role of Social Life Cycle Assessment (S-LCA) in supporting business enterprises in the assessment of human rights for the purpose of HRDD.

Methods

First of all, an analysis of the concept of due diligence and its meaning within UNGPs was conducted in order to avoid possible misunderstandings. Indeed, the UNGPs do not include an explicit definition and the term due diligence is used in both a legal and business sense (Bonnitcha and McCorquodale, 2017). Hence, particular attention was paid to the assessment of human rights as part of the process of due diligence. An analysis of the available literature concerning the existing guidance and practices of HRIA was conducted in order to define the way it has been dealt with from a theoretical point of view, with a particular focus on its essential phases and characteristics.

Finally, a comparison between HRIA and S-LCA was made in order to highlight their similarities and differences.

Results and discussion

The contact points between HRIA and S-LCA are various and considerable. This suggests that S-LCA can be considered to be a possible support for the HRDD required by UNGPs. However, because of the identified differences between HRIA and S-LCA, attention should be paid on the use of S-LCA to assess human rights impacts of company activities. Indeed, S-LCA requires some adjustments to permit a stronger evaluation of human rights impacts.

From this point on, further development will regard a more detailed analysis of the contact points and the differences between S-LCA and HRIA, in order to clarify whether and how business enterprises can incorporate HRIA into S-LCA and what adjustments are to be made to S-LCA for this purpose.

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On the introduction of a community resilience framework to social life cycle assessment

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Introduction

Social Life Cycle Assessment (SLCA) is still a new methodology and there is need of further research for its development (Benoît et al., 2010). The methodological problems concern the identification of reliable indicators for Type I and Type 2 impact assessment, their operationalization, and the selection of the impact assessment method (Benoît et al., 2009). In SLCA, human well-being is the main endpoint indicator to which midpoint indicators refer to. However, within the methodological sheets, but also in the scientific literature of social sustainability, well-being is still not well understood, nor it is well-defined (McCrea et al. 2014). While some scholars refer to human well-being as a state and others view it as a process-related concept.

Furthermore, one can adopt an individual or collective perspective on well-being. This latter distinction has been addressed in the SLCA literature by Soltanpour et al. (2019) by trying to identify the main differences between individual and societal well-being from a sociological perspective.

The current UNEP/SETAC guidelines report many indicators for Type I impact assessment, many of which are based in a Corporate Social Responsibility (CSR) framework (Baumann & Arvidsson, 2020). However, CSR aims to investigate social responsibility of firms, and not - in a strict sense - social sustainability. Also, CSR does not consider the change that a production process may generate on nature and society. These aspects represent a limit for the usefulness of SLCA. In looking for an alternative to CSR, community resilience (CR) (Magis 2010) has come to the fore as an interesting concept in relation well-being and social sustainability. The aim of this study is to investigate how introducing the CR within the SLCA may contribute to identify both Type I and Type 2 impact categories.

Methods

The research is divided in four steps. First, a literature review on the concept of well-being and CR is performed in order to identify key conceptualisations. Second, based on the knowledge from the literature review, the relation between human well-being and CR is investigated. Third, CR is explored and analysed to see how it can contribute to the operationalization of indicators and for measurement. To conclude, the strengths and weaknesses of introducing CR in both Type I and Type 2 impact assessment will be explored.

Results and discussion

In literature, well-being is a multi-dimensional and umbrella concept (Gasper, 2007) that can be investigated from multiple approaches. One of these investigates well-being by addressing a community and its context- related properties " (Wiseman & Brasher, 2008). From such perspective, community well-being is defined as "the combination of social, economic, environmental, cultural, and political conditions identified by individuals and their communities as essential for them to flourish and fulfil their potential" (Wiseman & Brasher, 2008). On the other hand, the CR concept has its roots in environmental sciences and can be intended as the capacity of a system to react to a change or to an external pressure (Berkes & Ross 2013).

McCrea et al. (2014) conceptually tested the relation between community well-being and CR showing that the former can be intended as a result of CR. Well-being reflects a specific 'status' as a given condition in time. However, it is also subjected to external pressures and it changes through time. It is therefore key to understand how communities responds to external pressures to reach desirable well-being conditions and, how CR is shaped focusing on its coupled and interdependent socio-ecological systems (Berkes & Ross 2013) .

In literature, researchers operationalize the CR looking at its several dimensions. McCRea et al. (2014) developed an explanatory model to integrate and classify features and dimensions previously identified by others. In their model, possible impacts of change create a pressure on community resources to be intended as "different types of community capitals or capacities at a point in time which underlie both community well- being and resilience". Resources belongs or better, compose the several natural, cultural, human, social, political and financial community capitals which guarantee to the community to flourish. The impact on the different capitals will determine a change in condition of CR and in its dimensions which are constituted by the strategic thinking, leading, linking, effectively using resources, commitment and perseverance and, collective efficacy.

The contribution that this model can give to SLCA Type I and Type 2 impact assessments lies on the possibilities to create a connection between community resources (and capitals) to what normally defined as inputs in the life cycle methodologies. More in particular, the different community resources may be considered potential inputs for a production process. Thus, they have to be taken into account in the SLCA inventory and treated as flows to follow along the life cycle phases. The CR framework may help to understand the mechanisms that occur in the community once that capitals are affected by external disturbances. Besides, it will better identify what processes start between the several CR dimensions in order to face the change. This would contribute to develop the socio-ecological model necessary for developing impact assessment methods.

Adopting CR as a framework for developing assessment methodology may enable more dynamic investigation of human well-being sensitive of changes caused by anthropogenic pressures. In this sense, at this moment the CR framework does not assess social impacts, but it can be used for modelling the community and how it reacts to impacts. Next, this can be used to advance impact assessment methods. The value of a CR is that combine social and ecological dimensions and not on political values or convention as the CSR does.

Therefore, with the theoretic framework of SLCA on CR it may reduce the number of subcategories and indicators because a single indicator can be informative for several dimensions (e.g. natural, social, financial capitals) of CR. In addition, it would eliminate the most common division of impact categories based on a stakeholder perspective. One possible added value is the chance to model connections between the social and the ecological dimensions of impacts on communities, contributing to develop Type 2 impact category assessment methods. Therefore, more efforts should be made to understand the -socio-ecological dynamics in order to design impact assessment methods that support the development of well-being.

CR is a promising approach that can be used for further developments of SLCA methodology.

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Evaluating social impacts of energy development scenarios: a mixed approach

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Introduction

Assessing social welfare is becoming common practice not only in the product development, but also in the context of policy improving or economy planning. To date, application of S-LCA macro scales is very limited. The present study focuses on application of S-LCA at the macro scale, with the aim of assessing its potential relevance and use in energy development scenarios.

The ongoing energy transition process is briefly defined as the shift from the intensive use of fossil fuel in the energy production process to carbon-free renewable energies. A more comprehensive definition of the energy transition would require including such vital aspects as the spread level of distributed generation (large power plants are often replaced by many small residential installations), energy democratisation and empowered consumers. All these issues determine the overall social impact of the energy transition, which, however, depends on the scenario. Energy development scenarios must fulfil different legal, environmental and other conditions as well as to be in line with technical constraints. Therefore, the analysis of energy transition social impacts must be based on technically and economically feasible scenarios. On the other hand, social impacts have a crucial impact on the choice of scenarios in democratic countries. Therefore, a comprehensive but fair and transparent methodology is needed to evaluate the social impacts of energy development scenarios.

This contribution presents our mixed approach that involves principles of social life cycle analysis, energy modelling, and computable general equilibrium (CGE) modelling. All these elements serve to provide a broad picture of social impacts.

Methods

The methodology used in this research extends the methodological approach introduced by Lekavičius et al. (2019) by including an additional module developed for the evaluation of specific social impacts.

Energy development scenarios are produced using energy planning model created in MESSAGE software environment (International Atomic Energy Agency, 2007) to ensure both technical feasibility and economic viability of the scenarios analysed. This model includes a number of energy technologies, additional constraints reflecting peculiarities of the energy system, and simulates the development of Lithuanian energy system beyond 2050. The level of details in the model allows a thorough analysis of wider impacts. For this, the basic results are enriched by using more detailed supplementary information about the inputs required in different processes. Economy-wide impacts are analysed in computable general equilibrium model EnEkonLT. It is a recursive dynamic computable general equilibrium model that covers four energy products; 19 other commodities and economic activities; the corporation, government, and household sectors; and international trade with the rest of the world. The model incorporates an aggregated reflection of the tax system, social security and other transactions. Similarly to other CGE models, it covers direct, indirect, and induced impacts. Its outputs include such indicators as the impact on value-added in different industries, gross domestic product, unemployment levels of workers with different skills, changes in employment structure by industry, etc. It is important to mention that energy development scenarios are depicted in EnEkonLT model using the principles of lifecycle analysis: scenarios are analysed on a project basis, all material inputs and outputs are considered. Moreover, the use of CGE model allows overcoming some of the limitations that are common for other research methodologies used to evaluate social and economic externalities (see Lekavičius and Galinis (2015) for an overview). The outputs of both the energy system and computable general equilibrium models are used to calculate additional social impacts based on the most relevant functional units or basic indicators.

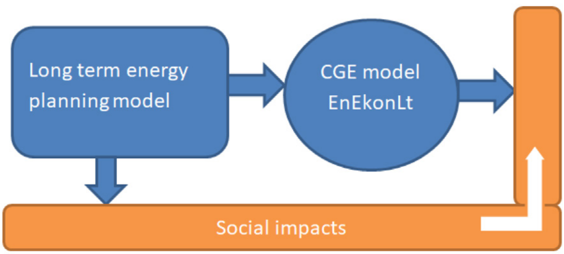

Figure 1: Modelling suite

A combination of bottom-up and top-down models used as a core of the modelling has several advantages for the social impact evaluation. First of all, different stakeholder perspectives can be addressed. For example, basic data about energy development scenarios obtained from bottom-up model are used to define local community indicators, while CGE model outputs are used to calculate country-level indicators. Some of the indicators can be calculated at both narrow and broad levels (e.g., impact on workers in a particular power plant and changing conditions in the entire country) or used directly based on CGE model output (e.g., unemployment).

Results and discussion

The results of the research include a broad range of social and related indicators that are derived from the core models directly or using supplementary data. The key energy system and economic results of different energy development scenarios are presented by Lekavičius et al. (2019), while the social impacts are extended beyond employment-related and general economic indicators. In fact, the variety of results (social areas covered) heavily depends on the availability of supplementary data used in the calculation of social indicators. The indicators can be used for both scenario comparison and dynamic analysis, although the latter case has to be considered with special care taking into account the nature of baseline projections.

The main limitation of the current methodology is that it mixes endogenous and exogenous variables in some cases and then overlooks feedback links. Such feedbacks would definitely arise as a result of social impacts. Although capturing various feedbacks and changes in inter sectoral relationships are among the advantages of the general equilibrium approach, this is not the case with a pure LCA as well as with Social LCA. Another related limitation is determined by the nature of supplementary data: in many cases, the most recent data is used even though energy development is a dynamic process. In other words, some relationships might become irrelevant due to changes in society. However, their endogenization is not always feasible due to the complex nature of social impacts.

In this research, we used existing models and energy sector as an example, but the intention is to extend the methodology to be able to cover different types of products and production processes in a single framework. In this context, the universal nature of life cycle analysis provides necessary preconditions for the analysis of changing production processes in different industries, while computable general equilibrium modelling can provide economically justified grounds to analyse changing inter sectoral relationships.

Acknowledgement

This work has been done under the Researcher groups project and has received funding from the Research Council of Lithuania (LMTLT).

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Social objective functions in optimization models for sustainable supply network design

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Introduction

Incorporating the social pillar of sustainability is one of the current challenges in quantitative supply chain optimization. The release of the Guidelines for Social Life Cycle Assessment of Products triggered a growing interest in quantitative social evaluation in general, and equally so in strategic supply chain design – a field that is traditionally dominated by environmental and especially economic optimization. However, compared to the other two dimensions, the case of social sustainability is more intricate. The complexity of social indicators, their subjective and often qualitative nature, and a lack of data render the inclusion of social indicators into quantitative optimization models difficult. This is particularly true for supply network design on a multi-regional or -national level, where generic indicators, as opposed to site-specific ones, are required due to the strategic and more aggregated level of decision-making.

First work

Methods

Against this background, in a first work, we review 91 articles that apply social indicators to objective functions or constraints in strategic supply chain optimization models. In particular, we examine 1) what social aspects, represented by which indicators, are considered, 2) how their selection is justified by citing frameworks and social standards, 3) whether the industry sector of case studies influences the choice of indicators, 4) how indicators are incorporated into models, i.e. which decision variables are attributed with which social impacts, and 5) how indicators with different units within the same objective function are aggregated in which way.

Results and discussion

We find that the *number of jobs* created is often the primary or even only indicator employed, and number of articles uses dimensionless social scores as model parameters, which are often the result of aggregating different indicators by e.g. AHP.

For objective functions that include terms with more than one social parameter and different units, for example *number of jobs* and *economic development*, the vast majority of articles reverts to weighing terms of objective functions towards a dimensionless, generic social score, too (Figure 1). However, only three of the 91 articles include more than four different social parameters, while 59 articles employ only one or two.

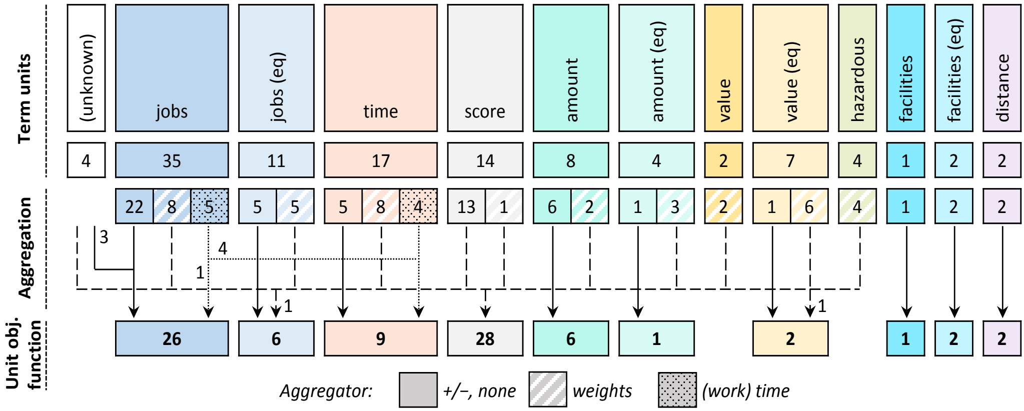

Figure 1: Number of articles that contain terms (in objective functions) and objective functions with different units, and use different aggregators per term (eq = equivalents, e.g. if weighted by a regional factor)

Second work

Methods

Pertaining to the results from this literature analysis, in a second work, we integrate the state of the art in social optimization into two existing optimization models for network design. For this, we propose a framework for a structured selection of social indicators for the use in optimization models. When introducing the social dimension to those kinds of models, we suggest that modelers evaluate, in every case study anew, for every potentially applicable indicator: 1) Is the indicator affected by decision variables? 2) Is it generic? 3) Is it quantitative, for use in an objective function, or at least semi-quantitative for use in model constraints? And 4) Is sufficient data available?

This framework is then applied to two existing mixed-integer linear programming models of supply network design, which hitherto only optimized towards economic and LCIA-based environmental objectives: The first model represents the case of Waste Electric and Electronic Equipment (WEEE) recovery in the European Union. Within the EU, the directive on WEEE obliges manufacturers to collect end-of-life products. High-value recovery (e.g. preparation for reuse) only plays a minor role for WEEE, because manufacturers often delegate their obligations to third-party logistics and recycling companies. Designing an OEM-based European high- value recovery network, however, could bear economic potential while environmentally and socially outperforming low-value recovery alternatives like recycling. The second model evaluates the potential of lignocellulosic bioethanol in the European Union. Lignocellulosic ethanol is a promising substitute for fossil resources in applications like solvents, intermediates in the chemical industry, or fuels, and could help to reduce i.a. greenhouse gas emissions substantially. Bioethanol can either be produced from crops (food or energy plants; first generation), or by agricultural residues (second generation), which entails a vast array of different environmental and social implications.

In both optimization models, decisions on facility locations and capacities, collection and transportation flows, as well as product distribution need to be taken (Figure 2). Those decisions can be optimized towards one economic, 22 LCIA midpoint and endpoint, and - unlike previously reviewed articles - a large number of social objective functions with a comprehensive set of social indicators.

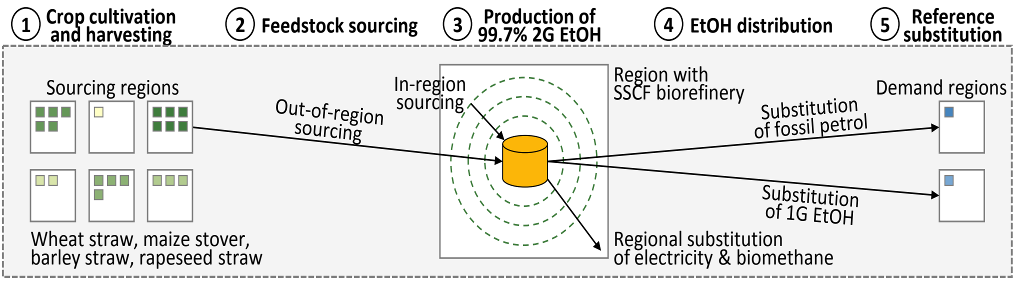

Figure 2: Decisions and superstructure of a supply network optimization model for bioethanol in the EU

Anticipated results and discussion

By introducing social objective functions to both models, we aim to achieve two research goals: 1) Environmentally or economically optimal decisions on i.e. locations, capacities, technologies, kind and number of products, and material flows can be compared with their social counterparts. Compared to the impact category towards which a network is optimized environmentally, the results in terms of a socially optimal network can either be largely congruent (here: when compared with optimization towards e.g. *global warming*, *ionizing radiation*), partially conflicting (with e.g. *land use change*), or contrary (with e.g. *mineral resource scarcity*). Congruencies and conflicts between the objectives are resolved by multi-criteria optimization. 2) We can evaluate how the respective case study and its scope and industry sector affects different social objective functions, as well as the array of includable social indicators.

With the results of both works, we strive to contribute to establishing a larger and more consistently applied set of aspects and to increased homogeneity in the way that indicators are incorporated and aggregated into quantitative models in general, and for strategic supply network optimization in particular.

Track 4

SLCA in practice

Insights on social-LCA in practice in Sweden

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Introduction

The aim of this contribution is to address the interest in better understanding how social life-cycle-assessment (SLCA) can be used in practice (cf., Swedish Life Cycle Center, 2019). Additional insights on developing knowledge about actual (potential) use of SLCA has been expressed by organizations active in Sweden through the Swedish Life Cycle Center (cf., Swedish Life Cycle Center, 2019). In addition, a better understanding of SLCA use can provide valuable input to the development of guidelines, software, and research on SLCA. We are therefore performing a study on SLCA use in Sweden by 11 major organizations that to considerable degrees recently have used life-cycle approaches. The abstract presents preliminary findings. We expect to present definite results at the conference, because the study is planned to be finalized by March 2020. The knowledge about how industry and other actors use SLCA seems to be very limited (Baumann, 2019). The focus in SLCA research has lied on methodology disagreements regarding, for example, the SLCA step of impact assessment (Chhipi-Shrestha, et al., 2015) and how to use concepts from environmental LCA (Iofrida, et al., 2018).

Methods

The study is an interview study with representatives of organizations active in Sweden at the time of the interviews. Sweden was deliberately chosen as the focus of the study, and this is supported by Baumann (2019). The country was found to have the highest share (12%) of businesses declaring to use a life-cycle perspective in their sustainability reporting (Stewart, et al., 2018). In addition, organizations in Sweden have, as mentioned, stated an interest in SLCA. Through the expert knowledge of among other SLCA-researcher Henrikke Baumann, we were able to identify 13 organizations that at the time of the interviews were active in Sweden and had a considerable interest in life-cycle perspectives. We have interviewed 14 SLCA experts in 11 of the 13 identified organizations about use of and ideas on SLCA in these organizations. The organizations cover: 6 businesses (BOs); and 6 'intermediary' organizations (IOs) that include research institutes and government agencies. The interviews are treated as dialogues in which all parties try to create their own knowledge through the discussion (Mishler, 1986). The interviews have been, and the analysis is being, directed by the overarching topics of why SLCA has been used where applicable, why it has not been used in other cases, and in which ways SLCA is considered or is not considered relevant onwards. The study runs between October 2019 and March 2020.

Results and discussion

In this section, we present preliminary results on the 11 organizations regarding the extent to which SLCA has been used, regarding opportunities for SLCA usage, and regarding current limitations; and a discussion of the implications in relation to the size of the study and the scope of the study.

We identify that the organizations have used SLCA to a considerably limited extent: one organization has used SLCA, another organization has likely used SLCA, and for one organization whether they have used SLCA or not could not be determined. In one BO, a few SLCA pilots were used to test if SLCA could be part of an existing framework for communicating environmental performance. In addition, we have indications that one IO primarily have used the methodology through screening-SLCAs in cooperation with businesses. In another IO, one interviewee was not sure whether the organization's SLCAs had been used for decision- making in addition to academic-research purposes.

SLCA as of today or in modified versions could, based on our responses, fill gaps that other approaches to social sustainability do not cover. The starting point for the identified potential usefulness is that issues such as child labor, slave labor, and labor conditions for persons performing the sorting needed for circular economy activities have been highlighted as important by three BOs and one IO. The consideration of social issues is SLCA-relevant because, in several of the organizations, only tier one or short parts of product chains were said to be included in the methods used for handling social sustainability (this was the case for three BOs, and possibly one IO, and not the case for one BO). In addition, one BO representative presented a combined pressure from social sustainability becoming increasingly more important, a problem with many different situations where customers raised questions about social sustainability, and the large number of suppliers to the organization. One BO interviewee also mentioned that the condition of SLCA being a scientific tool could attract the staff of their research and development unit and therefore be feasible for informing considerations already during product development.

Potential problems with the current SLCA methodology have been identified through the interviews regarding the coverage in SLCA, the procedures of the methodology, how SLCA relates to current business- approaches, and for whom the methodology could be useful. The coverage can be an issue because SLCA has not considered, for example, the global perspective over time (one IO), because SLCA was said being generic when social issues are highly context specific and vary rapidly (three BOs, maybe one IO), and because SLCA maybe enables the user too easily to exclude indicators (one IO). SLCA procedures were said not to allow assessment of improvements at existing product-chain actors but rather focus on the choice between different actors (one BO). Current business approaches may not be compatible with SLCA because it is costly and that its complexity makes it difficult to commission it well (three BOs, one IO, maybe one IO), because it does not consider the focus on risk that businesses have been using recently (4 BOs), and because SLCA-result are difficult to communicate (one BO, maybe one IO). Regarding for whom it could be relevant to use the methodology, the focus this far may have been too much on industries because retailers have a closer contact with consumers (one IO).

The preliminary results from the study have been discussed in relation to representativeness for each organization, and in relation to the relevance of SLCA-use and -ideas in these organizations from an international perspective. The explorative approach that we have used, rather than pre-defined interviews or questionnaires, seems to have enabled a type of interviews where we could get a reasonable understanding of the extent to which the interviewee had a grasp of SLCA-use and -ideas throughout the organization. Except for two minor cases, the interviewees where deemed to have a good or very good grasp of SLCA in relation to the whole organization. The choice of eleven major organizations with and from a country with a reportedly comparatively large focus on life-cycle approaches is by us seen as a sample that is of moderate importance when trying to consider SLCA-use globally.

To conclude, our soon finalized study on SLCA use in Sweden provides preliminary insights on the level of using the methodology, and on its opportunities and potential limitations. The studied organizations are found only to a considerably limited degree to have applied SLCA. SLCA in its current or future shapes could become useful due to a considerable focus on social issues and because other methods cover only short parts of product chains. Identified challenges with the methodology are that it does not handle sustainability aspects such as from a global perspective over time. It is costly to use, not handling the context dependent and rapidly changing social impacts well; maybe it is too easy for the user to exclude indicators, and maybe SLCA address industries rather than retailers to which it could matter more, among other. As a next step, the SLCA-research community may find a range of important aspects to study in order to search for developing SLCA to be in practice feasible for handling the important global social issues.

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From ad-hoc case studies to effective implementation of social metrics in organisations

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Introduction

We learned from the implementation of environmental LCA in the nineties, that companies start with ad-hoc case studies to understand the approach and to assess the potential business value of such a new metric (Frankl and Rubik, 2000). Often this first case study is rather unstructured if not chaotic; at least it is not a very efficient process, as people have to spend time discussing and thinking about ways to collect, structure and understand the data. After this first experience, companies either reject the new approach or start implementing, based on the learnings from the case. This process can take several years, before we can recognise a reliable and cost effective implementation in the organisation. A similar pattern can be seen in the adoption and implementation of social metrics, which, although it has many similarities with environmental LCA also has some very important fundamental differences. This results in a need for new solutions, approaches and new skill development in the organisation.

Goal

The goal of this paper is to describe the process that led to the Implementation Guidebook developed in 2019 with the Product Social Metrics Roundtable. The objective of this guide is to develop a structured approach to develop the in house capabilities and procedures to speed up the implementation process. The Implementation Guide was developed in a process that combines two work streams:

1) understanding the theoretical background of implementation processes from some management literature; mainly:
    a) The Capability Maturity framework and its associated Capability Maturity Matrix[1]
    b) The Kotter Change model
    c) The Natural Step approach
2) Working with the member companies who were developing case studies in parallel, and discussions with companies who have already implemented social metrics.

1 We build on various sources, but an important input is the UNEP-LCM CMM model, see https://www.lifecycleinitiative.org/activities/life-cycle-management-capability-maturity-model-lcm-cmm/

This was combined with an analysis of the business value of such an implementation, both focusing on reducing the cost of applying social metrics and increasing the business value of the results. Business value can only be realised if the benefits outweigh the cost.

Results

The research has resulted in a freely available Implementation Guide. It includes a self-assessment where member company representative assess themselves on a capability maturity scale and describe the ambitions the company representatives would like to formulate in the coming years.

	Maturity level 1	Maturity level 2	Maturity level 3	Maturity level n
Required capability 1		V		
Required capability 2			V	
Required capability n	V			

Figure 1: Simplified representation of the Capability Maturity Matrix

The Matrix has two axis; on the horizontal axis we distinguish 4 levels of capability maturity, as presented in table 1 below.

Table 1: The four levels of maturity on the horizontal axis

Levels of maturity	Description
Ad-hoc	Companies are aware that there is value in the assessment of social impacts and they are exploring what specific value there is for the company. Usually the company starts with a first pilot or case study, often after reading the Handbook or following a training. Some experience is gained with data tools. Often LCA experts are involved.
Formalised	Several case studies have been done and formal access is obtained with a variety of data tools. Processes are formalised in parts of the organisation. Engagement with departments outside the LCA department.
Measured	There is a target on which and how many product application region combinations (PARCs) are assessed via Product Social Metrics. Data collection methods and analyses are enhanced, and previous collected data are well managed.
Continuous improvement	Companies aim to stay at the forefront and move forwards with innovative new steps and methodology improvements. Clear value is reached by transparency in value chains and product benefits. Since stakeholder requirements will change overtime a need for continuous improvement is clear.

On the vertical axis, we developed key areas in which Capability Maturity Development should take place to reach a certain level of development.

Table 2: The areas of capability maturity development on the vertical axis of the matrix.

Key areas of development	Description
Guiding coalition	The person or team that is in charge of the implementation of social metrics in the company.
Level of understanding of social impacts	From basic understanding to full understanding of social impacts of all the products from the company.
Level of cooperation internally and externally	Usually companies start only internally and then involve a few first-tier suppliers. In later stages the involvement with external and internal parties increases.
Steps of an assessment	A company usually starts with a small number of steps and then either focuses on the end-use or the value chain. When social metrics is fully implemented the value chain, use-phase and end-of-life of products are assessed.
Data collection methods	Starts from input/output databases and internal information towards fully automated data-collection.
Incorporation in decision making	Development towards balanced decision making on positive and negative social and environmental impact.
Level of reporting and communication	In the first two levels the companies usually do not report externally. From then on communication is gradually expanded towards a full dialogue with external stakeholders.

The Implementation guide also describes the organisational challenges and explores how the business value of an efficient implementation can be understood.

The last chapter of the guide provides summaries of the cases companies in the Roundtable for Product Social Metrics developed. This case development and the discussions with the companies while working on the cases, provided very valuable input in to the development of the guide. The cases and the Implementation Guide are freely available on www.psia.info.

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Practical DSM Case Study of Implementation of Product Social Metrics Framework in the Supply Chain

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Introduction

DSM is a global purpose-led, performance-driven company specializing in Nutrition, Health & Sustainable Living. Our purpose is to create brighter lives for all, creating value for customers, shareholders, our people, and society-at-large. We are already reaching 2.5 billion people worldwide. Our Sustainable Products Portfolio consists of products and services that deliver high performance while giving additional benefits to our society and environment. We apply a product life cycle approach to our Sustainable Products Portfolio, evaluating their social and environmental effect across the value chain. This allows us to identify hot-spots for improvement in our own products and processes, enabling DSM products to improve the sustainability of our value chains.

DSM is one of the founders of Roundtable for Product Social Metrics and with the newest version of the handbook, DSM has initiated several studies on different product groups to test the methodology and engage the organization to understand the improved social impact assessment tool and identify benefits of its use.

These studies help to engage the organization to apply the methodology and steer the Sustainable Product Portfolio by identifying areas of improvements.

As a result of these studies a framework for product social metrics for companies (namely large corporations) was developed. The framework is defined by three levels of assurance:

1. Ensure policy is in place
2. Ensure methodology is available
3. Ensure clear process to assess product social metrics

Presenting this case study has the intention to show the learnings from the process and implementation of improvements internally and externally.

Goal and scope description

The main purpose of this study is to offer a framework for product social metrics for companies (namely large corporations).

Methods

The steps taken to conduct this study were as follows:

- Understand product application in its whole value chain
- Select stakeholders and social topics
- Select performance indicators relevant to the above
- Develop framework for product social metrics

Framework

The framework developed for product social metrics for companies (namely large corporations) consists of three levels of assurance:

1. Ensure policy is in place
   There were three policy procedures identified which should be in place and aligned in the organization in order to ensure the first level of assurance and line of defence against risk indicators: business code of conduct, supplier code of conduct and general purchase conditions for goods and services.
2. Ensure methodology is available
   A template was developed showing what can be measured and reported with the methodology at DSM. The results can be reported at country, stakeholder and life-cycle phase level with the corresponding risk score.
3. Ensure clear process to assess product social metrics

The guideline at the core of this process has its starting point the OECD-FAO Guideline for agricultural supply chain which DSM finds that it provides a general approach applicable to any industry.

Results and discussion

Stakeholders involved

It is important to have both internal and external stakeholders on board, because challenges may arise when the results are communicated and interpreted. A benefit of conducting the assessment involving internal stakeholders is the engagement of different functions within the company which gives the opportunity to break down silos and combine different expertise to best assess the risk indicators. With the involvement of external stakeholders, e.g. customers, DSM was able to exchange knowledge about how risk indicators are evaluated, which other social indicators and stakeholders are relevant. It gives the opportunity for collaboration and strengthens external stakeholder relations.

Scoring

Scoring and weighing the risk levels remain a challenge and may be sensitive to subjectivity. DSM continues to work on improving the methodology and align internally with other relevant functions, like procurement and corporate sustainability to create a consensus for assigning risk levels.

Sustainable portfolio assessment

It is important to align internally on tools used at corporate level and by different functions, for example tools which use artificial intelligence and could assess risks in the supply chain may be implemented at the corporate level and transferred from the life cycle assessment expert team. This could potentially be linked with sustainable product portfolio assessment and in the case of suppliers, be included in the supplier selection program.

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Track 5

Social analysis of product chains

How a missing group of agents inhibits development of the bioenergy sector in British Columbia

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Introduction

The westernmost province of Canada, British Columbia (BC), has large quantities of waste woody biomass that could be used as fuel to help meet BC's ambitious targets to reduce emissions of greenhouse gases (GHGs). Some applications for waste biomass that reduce GHG emissions should already be economically viable (Wang et al., 2020) but the bioenergy sector has been slow to develop. This contribution explores reasons for the slow development by examining the sector in terms of the agents needed, recognising "multiple and sometimes conflicting interests across actors in a production and consumption system" (Baumann & Arvidsson, 2020). Mapping the supply system reveals a critical but missing group of agents. Social description of the system and its governance culture exposes why this group of agents is absent from BC. The analysis reveals the non-economic barriers to full exploitation of bioenergy in BC and hence suggests policy changes, beyond simple economic incentives, needed to promote development of the sector.

Biomass in BC

Figure 1 shows potential sources (orange), utilization routes (blue) and uses (green) of waste biomass in BC. Sources include trees killed by infestation (primarily by Mountain Pine Beetle – MPB), residues from harvesting, and waste from saw mills and other wood manufacturing operations. Inputs and activities that would be displaced by using biomass are shown in red, including 'slash-burning', usually on-site, of uncollected biomass to remove potential fuel for wildfires (Roach & Berch, 2014). The available biomass is insufficient to meet all potential demands. Life cycle assessment, allowing for the inputs displaced, enables the potential uses to be prioritized in order of marginal GHG abatement cost (Clift et al., 2020) leading to the priority order shown from top to bottom in Figure 1. District heating or co-generation (CHP) should already be profitable, helped by the relatively high carbon tax in BC. Mainland BC has a few biomass-fired CHP and heating plants, fueled by waste from wood manufacturing. Further installations have stalled, partly due to opposition provoked by concerns over delivery traffic and possible harm to air quality but also for lack of investment and policy support. However, there is renewed interest in heat and CHP plants, notably in remote parts of Western Canada. The other potential uses are still at the discussion stage. The gasification route could potentially be viable, particularly to syngas for use in lime kilns, in pulp and paper mills, and for conversion to methanol for use primarily as an alternative marine fuel.

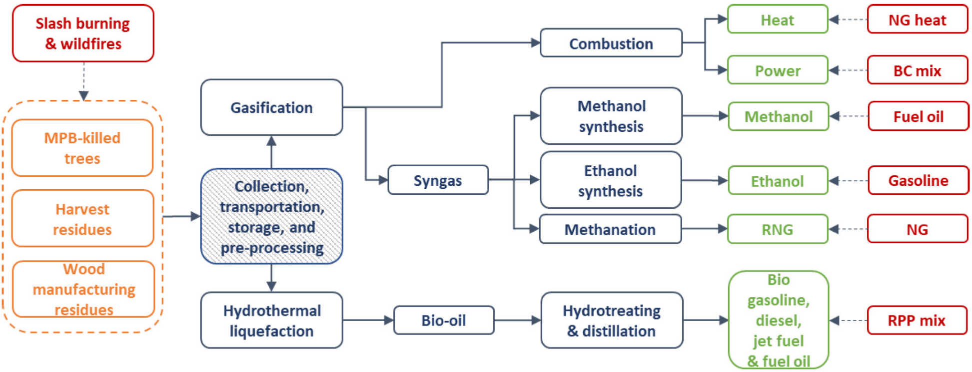

Figure 1: Potential systems for bioenergy production from forestry waste material in BC (after Wang, 2019). *NG=Natural gas; RNG=Renewable NG; RPP=Refined Petroleum Products; MPB=Mountain Pine Beetle*.

The activities in the shaded box in Figure 1 are clearly key for the whole sector. They require agents who collect waste biomass from distributed locations; process and store the material to form a reliable supply; and sell it on to users. In industrial ecology, such agents are known as *agglomerators*, a term originally coined by Frosch and Gallopoulos (1989) for actors who collect up waste metals to be sold on for recycling.

Empirical observations

In spite of the objections elsewhere to biomass-fired CHP, the University of Victoria (on Vancouver Island in BC) carried out a design study in 2013 for such a plant on its main campus. In the event, the campus energy plant was built to use natural gas, not because of concern over atmospheric emissions or traffic movements but because of lack of a reliable supplier and the cost of wood-fuel (UVic, 2019), notwithstanding the existence of large quantities of unused residues from forest harvesting on Vancouver Island.

In 2019, one of the authors (KK) cleared several hectares of wooded land in preparation for a new (legal!) cannabis production facility. The land clearance generated several tonnes of wood waste. No way could be found to get this material into beneficial use, so it was destroyed by slash-burning on-site.

Turning to a counter-example in the UK, London Heathrow Airport has installed a 'trigen' (power, heat and cooling) plant fired by wood chips (Tagliaferri et al., 2018) but only when a supplier was found to guarantee the fuel supply by collecting wood from managed woodland within a specified distance from Heathrow.

These observations do not constitute a systematic investigation (which remains to be pursued) but they point to obvious conclusions: (a) use of wood fuel in BC is limited by the capacity of the supply system to deliver fuel to potential users, not by the total available supply of forest residues which is a very remote constraint; (b) development of this sector in BC is inhibited primarily by lack of agglomerators. It is therefore appropriate to enquire what is needed to facilitate development of agglomerators in the bioenergy sector in BC.

Diagnosis and recommendations

Residues from manufacturing, currently the dominant source of wood fuel in BC, are a small part of the total potential supply. To develop toward its full potential, the sector needs to use harvest residues and MPB-killed trees. Costs of collection and seasonal storage make forest residues more expensive but, even so, their use should be economically viable (Clift et al., 2020; Wang et al., 2020). Collecting this material requires primary and secondary harvesting to be carried out cooperatively (FPInnovations, 2017). 'Integrated harvesting' is established practice in Europe (Diaz-Yáñez et al., 2013) but is counter to the culture in the industry in BC, where primary harvesting is carried out by large corporations that control 60% or more of annual production and show no interest in cooperating with local secondary producers. The legal basis of land ownership and management in BC enables primary producers to exclude agglomerators, in a way that would not occur under the system of land tenure prevailing elsewhere, notably in Scandinavia. To make matters worse, there is evidence that BC's system of assessing the "stumpage fees" paid for harvesting on public land is a disincentive to bringing out low-value secondary material (Parfitt, 2019).

Economic and fiscal measures that could be used to promote the development of the bioenergy sector in BC include higher carbon tax and possibly a tax on slash burning (Wang et al., 2020). However, the analysis here of the relationships between actors in the supply system suggests that economic measures alone will not be effective unless the problems in the governance and organisation of the forestry sector are addressed. It is necessary to change the license system to ensure that agglomerators can access the residual material generated by management and harvesting of BC's forests.

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The relation between social life cycle assessment and green building certification systems

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Introduction

The built environment has a great impact on environmental aspects, such as climate change, but also on social aspects of citizens, building occupants, and workers along the value chain. Different initiatives to evaluate the sustainability of the built environment have been developed. Environmental Life Cycle Assessment is more and more commonly applied for buildings. Often it is part of a green building certification system (GBCS). Life Cycle Costing is also increasingly used, while the application of social LCA (S-LCA) is very limited in the building sector.

The United Nations environmental program (UNEP) and Society of environmental toxicology and chemistry (SETAC) developed a set of methodological guidelines to identify current best practices available in the assessment of S-LCA. These guidelines are commonly used for S-LCA of products, but very few studies tried to apply them to buildings or building products.

Sustainability assessment frameworks such as EN 15643 have been developed to support designers in evaluating a building's performance in a standardised and systematic way. While the standard for the calculation of the environmental performance EN 15978 has been adopted by practitioners, EN 16309 for social performance assessment is currently not used at all.

GBCS have had great success in terms of industry adoption. They have contributed towards sustainable development by incentivising designers as well as building owners to make environmentally sustainable decisions. However, popular GBCS such as LEED and BREEAM have been unsuccessful in incorporating concepts of S-LCA in their methodology.

The goal of this project is to compare GBCS and EN 16309 to S-LCA methodologies based on a literature review. This aims to provide a better understanding of S-LCA in the field of buildings and construction and identify gaps in current tools and practices.

Methods

We follow a two-step approach of first reviewing methods used to perform an S-LCA and then comparing the methods to GBCS and EN 16309. The aim of the literature review in the first step is to a) Identify the popular assessment frameworks used within various industries and b) Identify popular S-LCA frameworks used within the building and construction sector. In the second step, we compare two GBCS focusing on their topical coverage of S-LCA subcategories. EN 16309:2014 was also included in the comparison to identify gaps and potential future development in the S-LCA methodology for the building and construction sector.

1. Initially, we surveyed 35 papers selected by subject experts to identify standard nomenclature used in the field of S-LCA. Then Scopus was used to conduct an online search of additional relevant papers for this study. The title, abstract and tags used in these papers were the focus of this step. The most common keywords identified in decreasing order of their frequency were "LCSA" (14), "S-LCA" (10), "SLCA" (6) and "LCA" (3). Keywords previously identified were used to narrow down the search in combinations with "building", "urban", "construction" and "material" using the "AND" operator. After omitting irrelevant papers, we populated the papers with fields such as region, country and industry in an Excel document.

2. We compare two popular GBCS, "LEED v4 for BD+C"(USGBC, 2016), a version of BREEAM adapted for Sweden, "BREEAM SE new construction"(SGBC, 2010) and EN 16309, the European standard for social performance assessment of buildings. We examined the technical manuals for the two GBCS and developed a comparison method. Both LEED and BREEAM use a credit or a point system to determine the certification levels of the buildings assessed. In contrast, EN 16309 uses a set of indicators with no predefined weights to analyse social performance. The individual indicators, as recommended in their respective frameworks, are normalised and ranked across two dimensions: stakeholders and life cycle stages to ensure a fair comparison. The aim and intent of the individual assessment tools were examined from the technical manuals to avoid any misinterpretation due to the nomenclature used.

Results

In the literature review, we identified a total of 196 papers, following which, we removed 89 papers as S-LCA was not their primary focus. A final list of 107 papers from over ten industries was obtained, of which, 50 papers belonged to the building and construction sector. We identified the "*Guidelines for social life cycle assessment of products*" by UNEP/SETAC (Benoît et al., 2013) as the most common methodology used across industries for the assessment of S-LCA. However, for the building and construction sector, the UNEP/SETAC guidelines were always modified by first conducting a survey or interview of experts from the field and then ranking or weighting the stakeholders and subcategories. Occasionally, researchers added or removed stakeholders as well. According to Kono, Ostermeyer and Wallbaum (2018) and Ioppolo, Traverso and Finkbeiner (2019), modification of the methodology is due to lack of data and availability or unwillingness in the exchange of information.

In BREEAM SE, the health and safety of "consumer" (building occupant) has the highest weighted priority, and in LEED, the health and safety of the "local community" scores the highest. Contrastingly, in both BREEAM SE and LEED, "workers" are not represented as much as the other stakeholders. Overall, both LEED and BREEAM SE have similar topical coverage of the S-LCA stakeholders.

Figure 1 represents the ranking of stakeholders within each of the three methodologies, UNEP/SETAC guidelines, GBCS and EN 16309. GBCS and EN 16309 rank the "consumer" and the "local community" higher than the other stakeholders in the "Use" phase. The UNEP/SETAC guidelines however, rank the "Local community" and "Worker" higher than the other stakeholders in the "Production" phase. Another key finding is that "workers" mentioned in the GBCS are exclusively those involved in the construction and end of life phase of the project and not those involved in the production phase of the building components and materials.

	Life Cycle Stages											
	Production			Construction			Use			End of Life		
Stakeholder	UNEP SETAC	GBCS	EN 16309	UNEP SETAC	GBCS	EN 16309	UNEP SETAC	GBCS	EN 16309	UNEP SETAC	GBCS	EN 16309
Worker	3	14		3	11					7	9	
Consumer		15			11		14	1	1		5	3
Local Community	1	13					12	2	2	4	3	
Society	6	8		6			14	4		10		
Value Chain Actor	9	6		9	13			8		11		

Figure 1: S-LCA stakeholders covered across building life cycle stages

Discussion

This research investigates popular methodologies of S-LCA and GBCS along with the European standard of social performance assessment for buildings. We find that S-LCA methods used across other industries do not translate easily when applied to the building and construction industries. The "worker" stakeholder category and the “production”, “construction” and “end of life” life cycle stages are relatively underrepresented in current building industry-specific S-LCA tools. We also identify the potential of GBCS to incorporate relevant S-LCA indicators to potentially achieve successful adoption of the concept in the building and construction sector.

Two fundamental differences among the assessment methodologies evaluated are in the targeted life cycle stages and stakeholders. The UNEP/SETAC tends to be dominant in the “production” stage of the life cycle, whereas, the GBCS and EN 16309 focus predominantly in the “use” stage of the lifecycle. GBCS and EN 16309 methodologies focus predominantly on the “consumer” (building occupant) and “local community” stakeholders. The high number of voluntary adoptions of GBCS shows that there is an established user-base of sustainability-conscious building stakeholders. Extending the scope of the rating systems across more stakeholders and life cycle stages to include S-LCA subcategories could lead to greater awareness and application of the S-LCA concept in the building and construction sector.

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Measuring the immeasurable: the contribution of social sciences to the assessment of social impacts in a life cycle perspective

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Introduction

In the last years, many efforts have been required in order to overcome critical methodological issues in Social Life Cycle Assessment (SLCA), such as improving the knowledge about the impacts to be assessed, collecting high-quality data, refining social indicators, promoting their operationalization and identifying new impact assessment methods. However, so far, it seems that practitioners in their case studies little deviate from what is suggested by the UNEP/SETAC guidelines and that the attentions are "more direct to social issues rather than on the methodology of SLCA itself" (Petti et al., 2018). A methodological problem is that UNEP/SETAC guidelines' are based on the theoretic framework of Corporate Social Responsibility (CSR) (Baumann & Arvidsson, 2020) because this may lead to an oversimplification of reality by dividing it into stakeholder categories and to the assessment of well-being according to political standards. These aspects may induce to select irrelevant indicators to the detriment of some more significant for the purposes of the analysis (Arvidsson et al., 2015; Alves, 2009) limiting the usefulness of the methodology. In order to avoid political oversimplifications of reality and to deepen the knowledge on social topics, a theoretical and methodological pluralism approach based on social sciences is desirable (Baumann & Arvidsson, 2020). This contribution aims at investigating to which extent social sciences can contribute in this development of SLCA. The reason behind this choice lies on the fact that social impacts are not easily described or quantified with methods from the engineering and environmental science fields. We therefore ask how human well-being (WB) – often mentioned as the ultimate area of protection in SLCA – is understood in social sciences.

Methods

What can be counted to the social sciences is "any discipline or branch of science that deals with human behaviour in its social and cultural aspects" (Nisbet, 2019), such as sociology, psychology, geography, economics and anthropology. Through a literature review, the aim is to investigate how different disciplines in the social sciences understand and define 'well-being' and identify their main strengths and limits. Next, we investigate the extent of WB indicators used in social sciences, their operationalization and available methods for assessing them. Finally, we discuss the feasibility for developing new indicator methodologies.

Results and discussion

Generally, in social sciences, individual WB is considered a multi-dimensional notion based on the objective and subjective aspects of three main dimensions: material, social and human (White, 2009). The material dimension deals with the access to the material goods; the social concerns to social relations and access to public good; the human dimension is about physical and mental health, personal relationships and attitude to life. Once these dimensions are identified, they can be measured by looking both at their "objective" aspects, namely their externally-observable aspects features (White, 2009), and at their "subjective" aspects, based on people self-perception of satisfaction and happiness (Western & Tomaszewski, 2016). The three dimensions mentioned above interact with each other, contributing to shape the WB conditions.

In sociology, the individualistic and the holistic perspectives are suggested to investigate on WB. The individualistic perspective derives from the individualism construction "which considers the starting point of sociological thinking to be human individuals" (Soltanpour et al., 2019). By contrast, the holistic perspective sees the society as starting point of the sociological thought. In fact, the individual WB is a dynamic concept that changes in space and time (White, 2009) and that is influenced by the society and its institutions. The relations between individual WB and the collective entity can be studied referring to the societal quality and to its capacity to react to changes (Soltanpour et al., 2019). Alternatively to the societal quality, it may possible to investigate the WB of communities (Brown & Westaway, 2011). Geographers try to measure WB in terms of QoL defined as "conditions of the environment in which people live (air and water pollution, or poor housing, for example), or to some attribute of people themselves (such as health or educational achievement)" (Pacione, 2003). QoL is therefore researched in the relation between persons and environment, places and spaces. For example, subjective WB notions may vary across places due to the different predominant cultures, values and norms (Diener & Lucas, 2000). The importance of the relation between WB and places is also investigated in the field of anthropology for which both culture and place are fundamental to know and understand human WB (Ferraro & Barletti, 2016). Focusing on universal indices may lead to oversimplification and inability to compare different cultures. In the field of psychology, the Critical Community Psychology (CCP) relates WB to social and collective contexts, claiming that WB is "a positive state of affairs, brought about by the simultaneous and balanced satisfaction of diverse objective and subjective needs of individuals, relationship, organizations and communities" (Prilleltensky, 2015). For this reason, the CCP multi-dimensional model investigates WB and its dynamics based on different dimensions. In economics, one of the most common approaches is to relate the individual WB to the function of utility to be intended as a set of preferences that a person needs to satisfy. Then, according to the utilitarian approach, societies and good governments should maximize the utility for as many individuals as possible. However, this is just one of the possible theories in the economic field. In the last decades, economists have promoted pluralism in order to deepen the complexity of the WB concept by shifting the attention from measurement and identification of indicators to the clarification of the existing socio-economic dynamics that can lead to a higher level of WB (McGregor & Pouw, 2017).

From the literature review, it becomes clear that the first challenge that the researchers and the practitioners of SLCA should face regards the definition of WB. This overview leads to two main conclusions. First, at this date, it is not possible to identify a unique definition of WB. Since there are different theories for WB it becomes possible to make different impact assessment methods. Second, WB is a complex concept with many influencing dimensions. This second results should lead researchers to adopt a multidisciplinary approach with the aim of identifying, describing and modelling the relations and the dynamics which occur between and within the dimensions. For example, sociology can help understanding how the notion of WB is shaped and constructed on a social level and how actors interact according to the several social theories. In addition, investigating the societal well-being gives the possibility to understand to which extent individuals can flourish and grow within a determined context. Geography could help describing the physical context in which individuals and societies develop, investigating the relations between physical and anthropogenic phenomena. Anthropology may contribute to explaining and identifying how WB is linked to a place or community. Last but not least, economics can explain which economic processes or relations may help to promote the WB. To this date, the UNEP/SETAC guidelines do not consider the dimensions mentioned above nor the relations which exist between WB and the context. Instead, the guidelines view WB through the stakeholder categories and the CSR perspective. By adopting a multidisciplinary and multidimensional approach when operationalizing WB, one can explore several impact models for WB. With better methods we can achieve better outcomes improving WB and social sustainability.

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Science communication and social LCA: can the twain meet? Initial findings from an Oatly study

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Introduction
Science communication models in social LCA

This contribution aims to propose a possible integration of science communication, which recognizes three modes of interaction (the deficit, dialogue and participation models) between experts and non-experts to the field of social LCA. The purpose of such an integration stems from the understanding that through the product chain, there are a wide variety of actors that enable the material product to "flow" and that are working with scientific and sustainability-relevant information. We first discuss the key arguments that evolved in science communication debates from one-way communication of scientific knowledge to public, to recent discussions on democratizing science and involving the public in the formative stages of science and technology. We then propose reasons why it could be worthwhile to combine these arguments in the growing literature on social LCA. We use Oatly, the Swedish oat drink company, and the types of communication in its product chain, as the case study to argue the relevance of science communication scholarly frameworks in social LCA.

Debates in science communication: from deficit to dialogue to participation

Extant literature in public understanding of science (PUS) deals with the assumption that, as we live in technoscientific societies, we ought to know about and engage with science and technology as they affect our lives. Much of the early discussion in PUS used the framework provided by the 1985 Bodmer Report of the Royal Society, UK, which prescribed educating the (lay) public about scientific truths thereby bridging the gap between experts and non-experts in scientific matters (known as the deficit model). The 2000 House of Lords Report titled 'Science and Society' criticized the 'deficit model' of the previous report and suggested that a two- way communication process between scientists and the public had to be developed so that the latter's voice could be heard. Multiple deliberations have taken place especially in the last two decades regarding the terms 'public', 'understanding', 'participation' and 'science' which have contributed further to the deficit and dialogue models.

It is primarily in the last decade of 20th century and with the turn of the millennium that the question of dialogue and rendering the public with more agency and the possibility to bring in their own expertise started to gain prominence. Increasingly, and especially in the last decade the trend has experienced a major upswing, and the public has been recognized as a stakeholder. Bandelli and Konijn (2012) define the various categories of the stakeholders as the following: schools, trustees, national and local governments, visitors, scientists, donors, civil society organisations, teachers, university, industry and the media. These are not water-tight categories and in fact the public can be any individual or groups from these categories.

Because of these transformations in academic debates, citizen participation has gained major attention in the fields of public understanding of science and science communication, which have been critical of the deficit model of the 1980s that casts publics as lacking in scientific knowledge (Irwin and Wynne, 1996). Irwin (2014) noted that the House of Lords report on 'Science and Society' (House of Lords, 2000), which brought on discussions on the 'dialogue model', triggered multiple European Commission activities culminating in concepts like Responsible Research and Innovation. Issues like climate change, energy, GMOs have found increased expression in citizen engagement activities (Chilvers and Kearnes, 2016). At the same time, scholars from non- European contexts and from various disciplinary fields have argued for the incorporation of 'local' knowledge and perspectives as scientific knowledge (Chakraborty and Giuffredi, 2019). These discussions on public engagement, citizen participation and co-production of knowledge open new platforms to democratize science.

Could science communication contribute to social LCA debates?

Much like in debates in public understanding of science and science communication, we find a definite convergence in discussions on participation of various stakeholders in social LCA. While Baumann (2011) talks about the need to populate life cycle studies so that actions of actors in different parts of the life cycle can be understood, Mathé (2014) argues explicitly for a participatory and multidisciplinary approach which would capture the plurality of stakeholder interests. De Luca and others (2015) ask for the involvement of local stakeholders and the integration of qualitative techniques in the study of social LCA. Furthermore, Benoit and Mazijn (2009) have argued for the assessment of social impacts in relation to stakeholder categories: which include, worker, local community, society, consumer and value-chain actor.

So how exactly would science communication debates be placed in the social LCA universe? What is proposed is a recognition the stakeholders delineated by social LCA studies are embedded in a communicative universe.

This, in turn, leads to questions about the kind of communication taking place between actors: when, where and who use the deficit, dialogue, participation communication models? Is 'perfect' participation possible when knowledge is localized and specialized? Do we see cases where experts and non-experts meet each other? The delineation of who is an expert and who is a non-expert itself would vary according to which section of the product value chain we focus on. Experts in one part of the chain would become non-experts in others.

Methods

To probe these matters further, we have selected the case of Oatly, a Swedish oat drink company, which uses LCA in their own research to produce and improve their product for better sustainability. As per a published interview in 2015 with Carina Tollmar, sustainability manager at the company, they are also working towards better external communication. Aside from displaying the carbon footprint of its oatmilk on each container, Oatly has lately run an advertisement campaign that became controversial. The poster will present the actors in the different stakeholder categories after semi-structured interviews with relevant officials of the company.

Results and discussion

The poster will present which are the sections of stakeholders who get to participate in the communication process, and which are the voices yet to be heard. Is democratization of voices in environmental decision- making taking place? If yes, to what extent? It will also indicate the role of LCA in communication especially with the consumers and comment on the model(s) of science communication prevalent in this case. The contribution will seek to underline that debates in the academic field of science communication could be a useful addition to the social life cycle studies. We intend to underscore the following: a) the need for a more 'bottom-up' description of impacts, the participatory approach, letting the actors self-describe the impacts (rather than analysts looking for impacts according to pre-determined categories), which matters for doing the study; and b) the possible usefulness of the deficit model, which matters in the communication of the complete study to a large section of the public.

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Track 6

Understanding and communicating SLCA

Communicating organisational social indicators: which and how

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Introduction

Directive 2014/95/EU arose from the need to improve the dissemination of non-financial information of organizations, relating to social and environmental factors. Although there are many frameworks for presenting this non-financial information (Social Responsibility Guide (ISO 26000, 2010); Environmental Management and Audit Systems (Regulation 1221/EC, 2009); Sustainable Development Goals (United Nations General Assembly, 2015); etc.), the sustainability reports based on the GRI-Global Report Initiative (GRI, 2019) represent the main framework used by organizations to communicate clear and standardized information related to their environmental and social performance.

This study is focused on analysing the communication of the social performance of organizations through their Sustainability Reports, from two different perspectives: what social indicators are being communicated and which metrics are used for that by companies. The aim is to perform an initial diagnosis for the case study of Spanish organizations, in order to identify patterns related to the type and number of social indicators. Finally, the relationship between the social indicators communicated and the categories/subcategories considered in the *Guidelines for Social Life Cycle Assessment of Products* proposed by UNEP/SETAC (2009) will be analysed. This will be useful to identify which UNEP/SETAC categories/subcategories are already being communicated by organizations and potential gaps.

Methodology

A sample of Sustainability Reports of Spanish organisations were analyzed following the methodology described below:

- **Step 1.** A content analysis of the Sustainability Reports was conducted by pairs, in order to identify social indicators communicated, both qualitatively or quantitatively.
- **Step 2.** Analysis of social indicators: percentage of organizations that communicate each social indicator.

- **Step 3.** Analysis of the relationship among those social indicators and the categories/subcategories proposed in the S-LCA framework (UNEP/SETAC, 2009).

Results and discussion

This study shows the preliminary results obtained from the analysis of 20 Sustainability Reports of Spanish organizations.

As a result of Step 1, Figure 2 shows the social indicators identified, aggregated by categories: equal opportunities, training programs, health & safety, reconciliation of work and family life, labour rights, interaction with stakeholders, social action (external investment), social benefits (internal investment) and anti bribery & transparency.

As a result of Step 2, Figure 2 also reports the percentage of organisations that consider each social indicator and if they do it quantitatively or qualitatively.

Finally, and as a result of Step 3, each social indicator reported in Figure 2 was cross checked with the categories/subcategories proposed by the S-LCA UNEP/SETAC framework (Figure 1), in order to explore the level of coverage and to identify potential gaps.

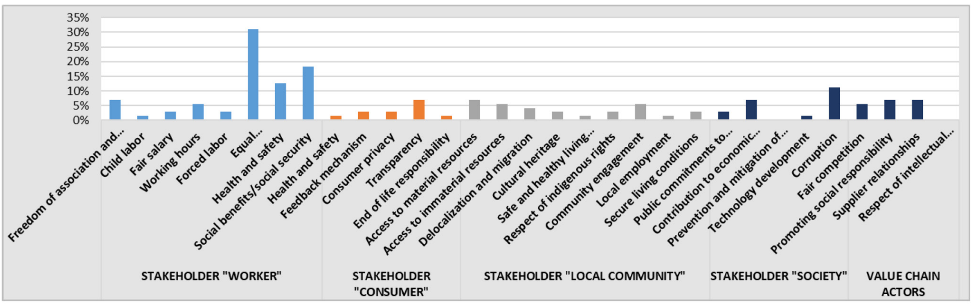

Figure 1: Social indicators in Sustainability Reports

Acknowledgements

The authors are grateful to the Ministerio de Ciencia, Innovación y Universidades - Spain (Project DPI2017-89451-R).

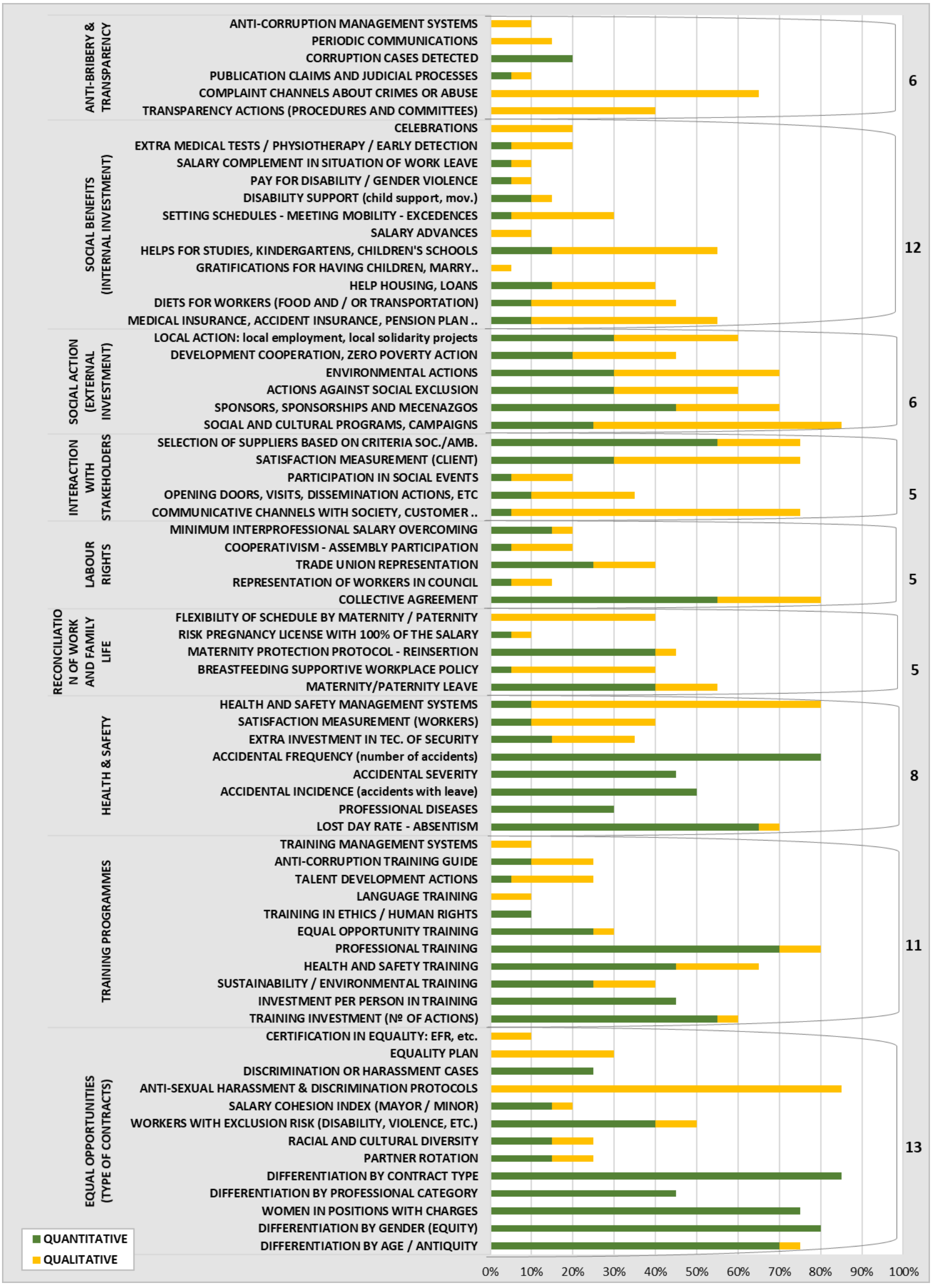

Figure 2: Social indicators in Sustainability Reports

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A beginner's level support for navigating the complexity of social sustainability of products

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Introduction

Industries are increasingly pressed to consider sustainability aspects when making strategic decisions regarding their products and manufacturing processes. It is still, however, a question of how to do this in the most efficient way. Although there is widespread consensus of the concept of sustainability being composed by at least an ecological and a social dimension, tools and approaches to support decision-making in the context of product design and manufacturing have largely focused on ecological aspects (Hutchins and Sutherland, 2008; Gmelin and Seuring, 2014). Gmelin and Seuring (2014) stress how the social dimension of sustainability has been largely neglected and that for new product development to be considered sustainable, the social aspects must equally be taken into account, and support for dealing with social challenges require further research and development.

Within Engineering education, students currently going through Bachelor and Master level higher education will require an understanding of the sustainability challenge facing humanity and the possible ways to design solutions that not only do no harm but also take into account the complexity of the underlying social and environmental systems on which we rely. John Barry (2012) coined the phrase 'technically competent barbarians' to describe current designers and engineers who are developing technological solutions that currently move humanity faster towards an unsustainable trajectory. Fitzpatrick (2016) takes John Barry's sentiments and argues that many current engineering educators are producing 'technically competent barbarians'. He states that "Moving into the future and in the context of sustainability, embracing the socio- economic dimension of engineering is becoming a very important aspect of the job of engineering educators" (ibid, p.10).

Despite the efforts in integrating sustainability in national and international higher education frameworks, the implementation of such objectives appears to still be a challenge, in particular regarding social sustainability. A study conducted at KTH Royal Institute of Technology (Edvardsson Björnberg et al., 2015) showed that the social pillar of sustainability is least developed one in connection to engineering education. Participants in the study also suggest that the lack of a conceptual framework that can clarify the contours of social sustainability in an engineering context creates uncertainty of how social sustainability can be best taught, learned and ultimately integrated in engineering practice. A further search on social sustainability in engineering education in Sweden delivered no valuable results.

Advances of Social LCA work can be seen as a promising avenue to bring the Engineering context closer to the social dimension of sustainability as it has brought great improvements in the understanding of products' social impacts, how to identify, qualify and quantify them. However, reviews of the literature on Social LCA (Jørgensen et al. 2008; Wu et al. 2014) point out a lack of a unifying framework that could allow the further development of the field and turn Social LCA into a more robust decision support tool. Examples of areas of divergence amongst approaches include: selection of impact categories, identification of relevant stakeholders, how to measure the social impacts and how to interpret results in a way that supports decision-making. In addition, at the moment, Social LCA is not an adequate methodology for engineering students or even engineering professionals who are not also educated in the social sciences. Conducting and interpreting Social LCAs require considerable amount of time and expert knowledge. So how can we advance the work with social sustainability in engineering education and begin training the future workforce of product design and manufacturing companies in assessing and managing lifecycle social impacts of products?

Methods

This paper presents a process created to help students work systematically with social sustainability in the context of product development. The process has been developed for a course in Sustainable Product Development that is part of the Masters of Science in Mechanical Engineering at Blekinge Tekniska Högskola (BTH). The learning objectives connected to the process were: to apply Social LCA thinking to analyze and compare social sustainability performance and identify opportunities for improvement of product concepts; to perform the social sustainability analysis even with limited information; and to use analysis results to critically explain the social sustainability performance of a product system.

The designed process built on four central pillars:

- Defining social sustainability upfront: we used a principled-based definition of social sustainability, as defined in the Framework for Strategic Sustainable Development (Missimer et al. 2017a; 2017b);
- Taking a full lifecycle perspective, that includes identifying the activities that take place in these life- cycle stages and the countries and sectors where these activities are embedded in;
- Considering different stakeholder groups;
- Connecting social problems with institutional and organizational practices in order to establish social sustainability performance.

Results and discussion

The process included several steps to break down the task in manageable parts and also to help students structure their thinking and see connections between the different elements of the process. These were: (1) Define social sustainability; (2) Create a product system's map including lifecycle activities, countries, sectors and stakeholders; (3) Using the definition of social sustainability, investigate social problems in the identified countries and sectors (for this step students were provided with background data from the Amnesty International reports on Human Rights and the Risk Mapping Tool from the Social Hotspot Database - SHDB); (4) Discuss the structures (official procedures/routines or rules/regulations/policies/laws or cultural norms/values/customs or organizational practices/patterns) at national/regional or sectoral level that contribute to the identified issues (being them positive or negative); (5) Using the understanding gained from the previous steps and the performance scales and indicators proposed in the Handbook for Product Social Impact Assessment (Goedkoop et al. 2018), create "performance profile" for the different organizations conducting lifecycle activities; (6) After completing the same steps for the alternative product concept, compare performances and discuss solutions for improving performance. For this final step, the students are introduced to different social management strategies (Yawar and Seuring, 2017; Schaltegger and Burrit, 2014).

Benefits and challenges can be identified from the testing of the process. In terms of benefits, we could see that students increased their level of understanding of social problems around the world and started reflecting on root causes of problems and how organizational practices can help worsen (if not directly create) or alleviate these problems. Students were also able to more clearly see the connection between product development and manufacturing and social sustainability, making sense of social issues that often times due to its complex nature are not so obviously connected to a product's system. The final step, designed to tease students into moving to the problem-solving space, helped students further their understanding of the interdependencies between local solutions and structural challenges.

In terms of challenges, students struggled to interpret social data as in the SHDB's Risk Mapping Tool. Also, because so many assumptions had to be made along the process due to unavailability of site specific data, students questioned the relevance of detailed assessments specially for the purpose of product concept comparison. Since the process utilized different sources of information and multiple approaches to working with social sustainability, the students often times struggled with the use of similar terms and categories that meant different things in the different approaches. "Unpacking" the terms, however, proved to be an additional point of reflection and learning about the complexity of the field and also how there is still a long way to go for Social LCA approaches to reach higher maturity levels.

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Social impact audit tool

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Introduction

Product design involves the choice of materials, the processes used to shape them, transport modes, characteristics of the way the product is used and of its disposal at end of its life. All of these influences the environmental and social impacts of product's life and can be negative or positive. Based on our survey of 220 academics, only about 30% of courses that introduce Sustainability to engineering students explicitly address Social impact (Vakhitova et al, 2015). The reasons include the complexity and vagueness of the subject and the limited teaching hours available even for the core programme (from personal follow-up discussions with academics). To help introduce ideas of Social Life Cycle Assessment (S-LCA) to students, we have developed an Excel-based Social Impact Audit Tool (the Tool) that is closely aligned with the UNEP / SETAC "Guidelines for Social Life Cycle Assessment (S-LCA) of products" (2009), widely accepted as the basis for social impact analysis. The Tool is visual and easy to use, filling a gap in available teaching resources to support the topic of the S-LCA in Sustainability teaching.

Its primary aim is one of education, introducing students to the methodology in the UNEP Guidelines. It provides data about social norms and practices in the Nations of the world, and allows case studies for activity-based projects. The Tool flags "social hotspots", the points in the life of a product at which potential harmful practices or opportunities to enhance well-being may exist. Extending it to the commercial world, this type of analytics can guide, for instance, CSR strategic planning in locations in which a company operates, suggesting where activities to improve local conditions might be the most effective.

In 2019, the Tool was trialed in two US universities. On completion, the lecturers provided feedback on its value, its ease of use, the clarity of the information it provides, and suggestions for increasing its effectiveness as way of introducing S-LCA concepts to students. Further development of the tool is planned. At this point it would be very helpful to get feedback from potential users in academia and also from users in industry, who would be willing to trial it.

Methods

The Tool uses a "top-down" analysis at national level, using publicly available data from NGOs, the World Bank, the UN, the OECD and Governments around the world. The Impact Categories from the UNEP/SETAC Guidelines, are mapped into these data sources, using them as social impact metrics (Table 1).

Table 1: Example of mapping impact categories onto available data sources (Ashby et al, 2019)

Stakeholder group	Impact category	Mapped to data source
Workers (group 1)	Freedom of association	ITUC Freedom of association
	Child labor	Child labor
	Forced labor	Forced labor and slavery
	Fair salary	Minimum wage
	Working hours	Hours worked per year
	Equal opportunity/Discrimination	Women's share of work force
	Health and safety	Fatal accidents at work
	Social security/Benefits	Social protection expenditure

Having converted all data into ranked lists and rescaled these ranking to span the range 1 to 100 (least-good to best practices), makes it possible to flag the impact categories in which conditions within the relevant nation fall significantly below best-practice and where (conversely) change of operation could bring positive result for each phase of product's life (more detailed description of this methodology in Ashby et al, 2019).

This exercise helps to address data in a comparable and neutral way, as the sources are implicitly suggesting good and bad practices. Table 2 gives an idea of how the scaled data ranking are presented in a look-up table with the nations of the world and social impact categories for selected stakeholder groups, namely workers and consumers.

Table 2: An extract from the look-up table with stakeholder groups and the scaled rankings (Ashby et al, 2019)

5 Stakeholder groups, 31 Social Impact Categories →

201 Nations ↓

Stakeholders Categories	S1 Workers					S2 Consumers			
Nation \ Indicator	Hours worked per week	Women's share of labor force	Fatal accidents at work	Social protection expenditure	ITUC freedom of association	Public health spend per capita	Press freedom	Rule of law	Corruption perception index
Afghanistan (AFG)	70.0			10.8		17.9	32.5	3.0	3.0
Albania (ALB)	70.0	37.1	59.0	58.9	60.0	41.0	56.5	42.6	50.0
Algeria (ALG)	70.0	11.9	50.0	47.9	20.0	56.3	24.9	21.8	39.0
Andorra (AND)	70.0					76.8	81.5	90.1	
Angola (ANG)	31.0	89.1		38.6	40.0	24.7	29.8	12.9	8.0
Antigua and Barbuda (ANT)	70.0			68.2		47.3	78.8	63.4	
Argentina (ARG)	9.0	41.3	24.0		40.0	73.7	70.1	22.8	54.0
Armenia (ARM)	70.0	63.9	61.0	45.0		26.3	54.9	43.6	41.0
Aruba (ARU)								86.1	
Australia (AUS)	85.0		92.0	91.9	60.0	83.7	90.2	94.1	93.0

The approach uses the same steps as an LCA process. These include the following steps: identifying the nations associated with each life stages of a product; setting a "threshold" (or a good practice limit) below which a social hotspot is flagged (highlighted in the spreadsheet) for each stakeholder category; considering options of "what if? scenarios" for those hotspots, and reflecting on social and environmental consequences of the suggested actions to tackle social hotspots. More detailed description of the approach is available in the White Paper "Social Life-Cycle Assessment and Social Impact Audit Tool" (Ashby et al, 2019). The Excel-based Tool is also available on request.

Results and discussion

This extended abstract introduces a new Tool developed to support teaching engineering students the concepts of Social Life Cycle Assessment of a product, following the UNEP/SETAC Guidelines. The Tool flags social hotspots, highlighting opportunities for socio-economic enhancement. The trials indicated that the Tool was found useful and it has stimulated further discussion on possible actions. Among identified challenges was a need for teaching resources in a video format, highlighting the key concepts and explaining the method. Another challenging aspect is placing S-LCA in a wider context of environmental and economic life cycle of a product, embracing possible trade-offs and synergies.

The trials support further development of GRANTA's EduPack teaching resources on the topics of sustainability and materials. The feedback collected will be used for enhancement of the software features, adding social dimension to Eco Audit, an existing streamlined LCA Tool. The Tool is available for trialing and feedback.

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FruiTrop Thema is a collection of **FruiTrop**

Publisher
CIRAD
TA B-26/C
34398 Montpellier cedex 5, France
Tel: 33 (0) 4 67 61 71 41
Email: info@fruitrop.com
www.fruitrop.com

Publishing Director
Eric Imbert

Editor-in-chief
Denis Loeillet

Editor
Catherine Sanchez

Computer graphics
Catherine Sanchez

Printed by
Impact Imprimerie
n°483 ZAC des Vautes
34980 Saint Gély du Fesc, France

ISSN: 2426-9654
ISBN: 978-2-9562141-2-0

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Social LCA

The SocSem meetings have generated a community of scholar engaged in the social dimensions of product life cycles. It is ten years since the first meeting in Copenhagen. The evolving field is reflected in the diversity of methods, applications and perspectives explored.

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These pre-proceedings collect the accepted contributions to the conference. In all, it brings together the work of 212 authors to 60 contributions.

Thema is a collection of FruiTrop
www.fruitrop.com / info@fruitrop.com
ISSN: 2426-9654
ISBN: 978-2-9562141-2-0
Price: 20 euros