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Framework for selecting and setting boundaries for social sustainability indicators in a life cycle perspective

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Abstract. The historical consumption of natural resources to fulfil the demands of the growing population have resulted in severe environmental degradation. Therefore, understanding the role of fulfilment of human needs and the social aspect of sustainability is crucial in the transition towards more sustainable societies. We present a methodological framework for a social sustainability assessment that includes a full life cycle perspective and is based on the Sustainable Development Goals (SDGs). The framework comprehends operationalisation of the social aspects of the SDGs and includes means/tools to achieve the environmental targets through a six-step guide. A demonstration of the method's application is given by applying the six-step framework to a case study: the Danish building sector focusing on SDGs 3 *Good health and well-being*, 7 *Affordable and clean energy*, 8 *Decent work and economic growth*, 9 *Industry, innovation and infrastructure*, 10 *Reduced inequalities* and 11 *Sustainable cities and communities*, 12 *Responsible consumption and production*, 13 *Climate action* and 15 *Life on land*. The final social indicators and the associated targets indicate in which areas a building is absolute social sustainable and in which areas the social performance falls short. The developed framework supports an informed and transparent selection of relevant social indicators across the life cycle while setting objective absolute targets.

1. Introduction

It is imperative that humanity reduces its pressure on the environment to a level within the safe operating space while fulfilling the needs of the global population. Indeed, this is captured in the doughnut economy concept (Raworth, 2012). The doughnut defines a safe and just operating space where we must act above a social foundation while staying within the safe operating space. This is also reflected in the United Nations' Sustainable Development Goals (SDGs) that provides a holistic view on sustainability by both including prosperity and environmental considerations and the interlinkage that emerge among them.

While the environmental boundaries are well quantified in frameworks, such as the planetary boundaries (PBs) (Steffen et al., 2015) that are operational at product level through absolute environmental sustainability assessments (AESA) (Ryberg et al., 2018), the definition of a social foundation level that represents a state of 'well-being' is less well defined. Understanding universal needs, how they contribute to reaching the state of 'well-being' (O'Neill et al., 2018) and how to

measure them, are essential elements of social sustainability assessments and for setting targets i.e. defining the social foundation.

To develop strategies for decoupling the environmental pressure from the fulfilment of needs it is essential to translate the definition of social foundation from the global doughnut economy into operational indicators that can be applied at non-global scale in assessments of industrial activities. Many certifications social focus for buildings exist e.g. The Nordic Swan label (Ecolabel Denmark, 2016), WELL (International WELL institute, 2016), and several studies i.e. Janjua et al. (2020) and Bragança et al. (2010). However, these only include the use stage. Social LCA only includes the raw material extraction and production stages and focus on avoiding/reducing negative impacts. The product social impact assessment (PSIA) and the study by Liu and Qian (2019) include both the positive impact in the use stage and the whole life cycle (Goedkoop et al., 2020), however, these methods are not based on the SDGs.

An absolute perspective indicates when a product is good enough and not just better than an alternative (Hauschild, 2015). Absolute social sustainability is generally lacking in social assessment methods such as the SDG assessment method (Weidema et al., 2020) where each SDG indicator score is compared to a benchmark product. Therefore, we regard the need to develop methods to assess the contribution to the social SDGs on a sector to product level with the purpose selecting and setting boundaries for social sustainability indicators in accordance with the SDGs taking a full life cycle perspective. The framework facilitates operationalisation of the SDGs through a six-step guide. We demonstrate the framework in the case study of the Danish building sector with SDGs 3 *Good health and well-being*, 8 *Decent work and economic growth*, 9 *Industry, innovation and infrastructure*, 10 *Reduced inequalities*, and 11 *Sustainable cities and communities*. The method worked correspondingly when identifying indicators with the means of actions to reach the environmental targets. Hence, we included this type of environmental indicators as well, and illustrate the method for this type of indicators with SDG 7 *Affordable and clean energy*, 12 *Responsible consumption and production*, 13 *Climate action and* 15 *Life on land.*

2. Method

The method presented in this study builds upon the initial steps defined by PSIA (Goedkoop et al., 2020) and the Guidelines for Social Life Cycle Assessment of Products and Organisations (UNEP Setac Life cycle initiative, 2020) referred to as the UNEP/SETAC guideline in the rest of the paper.

Table 1 Six-step guide to select and set targets for social SDG indicators for a homogeneous sector

Step		Description
1	What?	Define the goal of the study: purpose, homogeneous sector and product type. Define functional unit and consider the main need that the product fulfils (need or luxury?)
2	Where?	Identify life cycle stages for the product system and the expected geographic location for the different activities.
3	Who and how?	Identify stakeholders and the risks, opportunities, burdens and benefits they experience related to the SDGs in each life cycle stage, and create the first version of the subgoals and indicators based on identified risks, opportunities, burdens, and benefits.
4	Validate	Involve stakeholders to change and/or validate subgoals and indicators.
5	Formulate	Formulate final social indicators based on the stakeholders' evaluation and a set of criteria, in units that can be measured in absolute terms
6	Set targets	Divide the indicators into two groups of needs (quantitative/qualitative). Determine the absolute target for each of the final indicators with the method of the associated group of needs.

2.1 What

In the first step, the goal and scope of the study are defined by specifying the purpose and the homogeneous sector it considers. We define a homogeneous sector as a sector or subsector that provides similar products in the terms of scope, system and life cycle e.g. textiles and electronics. Non-homogeneous sectors such as food production or infrastructure must be divided into fractions at the highest homogeneous level (e.g. dairy or road infrastructure). Within a homogeneous sector, the identified indicators are applicable for most product systems with only minor adjustments or few additional indicators, usually in relation to the use stage.

The functional unit (FU) is defined by ISO 14040:2006 and 14044:2006 as a quantified performance of a product system for use as a reference unit. The positive impact in the utilisation is typically defined in the FU (UNEP Setac Life Cycle Initiative, 2020).

We suggest a critical approach when defining the positive impact (fulfilment of needs) provided to the user by the product, to avoid delivering a luxury product in the most sustainable way but rather focusing on delivering a product that is truly sustainable in an absolute perspective by fulfilling needs and not luxuries (Gough, 2019).

2.2 Where

Identify the main activities in the life cycle stages and where the activities take place. Depending on the complexity of the product and the supply chain, emphasis can be on countries expected to contribute most to the social hotspots. The hotspots can be identified with the Social Hotspot Database (SHDB) on country and sector level.

2.3 Who and how

The locations identified in each life cycle stage in Step 2 are central for identifying the stakeholders related to the product system and how they are affected. We use the four stakeholder groups as defined by the PSIA method (Goedkoop at al., 2020): Workers, Users (divided into: Primary, secondary and passive users), Local community, and Small-scale entrepreneurs, which belong to the different life cycle stages shown in Figure 1.

<table>
<tr><td></td><td colspan="5">Life cycle stages</td></tr>
<tr><td></td><td colspan="2">Raw material extraction, production and construction</td><td>Use</td><td colspan="2">End of life</td></tr>
<tr><td rowspan="2">Stakeholder</td><td>Small-scale entrepreneurs</td><td>Workers</td><td>Users (Primary and secondary)</td><td>Small-scale entrepreneurs</td><td>Workers</td></tr>
<tr><td colspan="5">Local communities</td></tr>
</table>

Figure 1 Life cycle stages and the identified stakeholders. The figure is modified based on PSIA (Goedkoop et al., 2020)

The risks, opportunities, burdens and benefits on the stakeholders are identified by systematically going through SDG 1-17 using different methods such as analysis of the sector in the SHDB, literature studies and interviews of experts. The risks, opportunities, burdens and benefits should be translated into subgoals with associated indicators.

The transformative goals (7 *Affordable and clean energy*, 8 *Decent work and economic growth*, 9 *Industry, innovation and infrastructure*, 11 *Sustainable cities and communities*, 12 *Responsible consumption and production* and 17 *Partnerships for the goals*) are not goals in themselves but can be seen as instruments to reach the other goals (Richardson, 2019). With the Driver-Pressure-State-Impact-Response (DPSIR) framework, by Nykvist et al. (2013) the perspective of the same issue changes and hence fits into several the SDGs depending on measuring approach and location of the indicator in the life cycle. For example: an innovative new technology is used in the production stage (driver in SDG 9 *Industry, innovation and infrastructure*) to reduce the negative impact of toxicity on the worker and user (pressure in SDG 12 *Responsible consumption and production*) and thus improve the health (impact in SDG 3 *Good health and well-being*). In this example, the health of the worker and user are the desired outcome, and thus what is important to measure if possible. Nykvist (2013) state that people can only directly control or influence drivers and pressures (not states or impacts), however the impact or the state is the desired outcome. The drivers are more action oriented and, thus, easier for companies to relate to (and interlinkages and trade-off are more explicit at this stage). On the other hand, drivers are measured far from final impact on the subjects that are sought protected purpose hence they include additional uncertainty. Therefore, the driver cannot stand alone as a subgoal or indicator and should be supported by an indicator measuring the impact or state if possible due to the time horizon for the impact to occur.

2.4 *Validate*

Stakeholder involvement is an essential element of social sustainability assessments (UNEP Setac Life Cycle Initiative, 2020). Key stakeholders are identified e.g. as suggested by Schmeer (1999), and they are involved through surveys, interviews or advisory boards representing the sector of interest to validate or bring their perspective on the identified subgoals and indicators from Step 3. The indicators should satisfy all criteria presented in Table 2. The combination of Step 3 and Step 4 should ensure that all relevant indicators are identified and included across all SDGs.

Table 2 Selection and validation criteria for indicator subjects

1	Relevance: The indicator must reflect the problem/area in a sectorial context
	1.1. Ability: It should be possible for the sector to influence the indicator
	1.2. Responsibility: It is the responsibility of the sector to influence the indicator (who else can influence the specific indicator?)
	1.3. Materiality: the sector contributes to this indicator significantly
	1.4. Representativity: the indicator must reflect the issue of concern

2	Measurable: The indicator should be quantifiable
3	Reliability: The data source method and content are well documented
4	Accept: Both researchers and stakeholders from the industry supports the indicator
5	Additionality: Consider the need for an additional indicator that capture side effects
6	Data availability: The indicator should be based on available data
7	Resources: Measuring the indicator should be done within a reasonable amount of resources (time, cost).

2.5 Formulate

In the fifth Step the final indicators are formulated based on the validated initial subgoals and indicators. The formulation and the unit of the indicators should be compatible with absolute scales, therefore, Step 5 is competed in an iterative process with Step 6.

2.6 Set targets

Several studies divide human needs into two groups (see Table 3), where both groups are universal and can be fulfilled with different satisfiers (e.g. different diets can provide sufficient nutrition). The difference between the groups is that absolute social thresholds are possible to define for Group 1 by identifying an objective source (for example statistics, standards, or experts). Whereas Group 2 consists of more qualitative and subjective dimensions of social needs e.g. emotional and social well-being (Gough et al., 2007), which are more challenging to measure and set targets for. Therefore, we suggest using the method described in Table 4.

Table 3 Division of human needs into two groups depending on the type of need and how the needs are obtained by people.

Group 1 of human needs	Group 2 of human needs	Reference
Objective Physiological	Subjective	(Rogers et al., 2012)
health, survival Quantitative	Autonomy / Phycological needs	(Mathes, 1970)
Basic needs	Qualitative	(Gough et al., 2007)
	Psychological and self-fulfilment needs	(O'Neill et al., 2018)
Pertaining individuals	Pertaining collectives	(Gough, 2019)
Absolute deprivation	Relative disadvantage	(UNDP, 2018)
Physical needs (1, 2, 3, 4, 6)	Social rights/ human rights (5, 8, 10, 16)	The UN SDGs

3. Case study

Each step is tested on a case study of the Danish building sector. The building sector includes all building typologies but excludes construction of infrastructure. The indicators should be broadly

applicable, however when the indicators are used for a specific building project there might be a need for developing specific indicators to measure how well the building's functions are delivered to the users.

3.1 What

The purpose of the case study is to identify social SDG indicators and indicators with means to stay within the environmental boundaries and absolute sustainability targets for the Danish building sector. Some indicators are broadly formulated to include the difference between building typologies.

3.2 Where

Most of the materials in the construction sector are of Danish origin. With the SHDB we identified locations and social risks in the supply chain outside Denmark at the same time (see description in the next paragraph).

3.3 Who and how

A combination of expert interviews and literature studies of all SDGs including both academic and popular articles has been conducted. Every identified risk, burden, benefit, and opportunity that met all criteria were formulated as a subgoal in the context of the Danish building sector for a specific SDG and further supported by indicators. We performed a social risk assessment using the SHDB 2018. We analysed one dollar spend in the process "Construction/DNK U" in SimaPro. This resulted in the number of mean risks working hours (MRWH) in the countries, which the Danish construction sector trades with, per dollar spend in the Danish constriction sector.

We identified the countries and the associated sectors with high social risk, which Danish construction companies should be aware of (see the Appendix for results and details about the assessments). If the specific building project has suppliers or sub-suppliers from the risk list in Table A1 in the Appendix a flag should be raised. The collaboration should only proceed if it is documented that the working conditions meet the requirements (i.e., no human right violations).

3.4 Validate

We established an advisory board consisting of ten key representatives from the Danish construction sector, including CEOs, senior advisors and technical directors representing various parts of the industry: entrepreneurs, architects, municipalities, investors/developers, and consulting engineers. The role of the advisory board is to give feedback on the initial subgoals and associated indicators for every SDG and validating them.

The SDGs are interlinked and overlapping, therefore some subgoals and indicators fits into several SDGs and some indicators fits both into the social and environmental dimensions. For example, indicators considering energy saving initiatives developed in SDG 7 *Affordable and clean energy*, result in reduced cost for tenants, which has a positive social impact related to SDG 1 *No poverty* or SDG 10 *Reduced inequality*, but at the same time the initiatives would reduce the CO_2-footprint and thus contribute to SDG 12 *Responsible consumption and production* and 13 *Climate action.*

Double counting is not an issue with this assessment method since every indicator will be either "sufficient" or "insufficient", and there is no weighting or aggregation of the scores.

4. Results

4.1 Formulate and Set targets

The specific subgoals and indicators for SDG 3 *Good health and well-being*, 7 *Affordable and clean energy*, 8 *Decent work and economic growth*, 9 *Industry, innovation and infrastructure*, 10 *Reduced*

inequalities and 11 *Sustainable cities and communities* and 12 *Responsible consumption and production*, 13 *Climate action* and 15 *Life on land* for the Danish building sector have been discussed and validated by the advisory board (see an overview of SDG 10 in Figure 2, please contact the author for access to overviews of all SDG's). The associated targets are determined based on the four methods shown in Table 4 (Method 1, 2 (2a and 2b), only 2a, or 3) (the specific targets are not provided due to confidentiality, contact the author for more details).

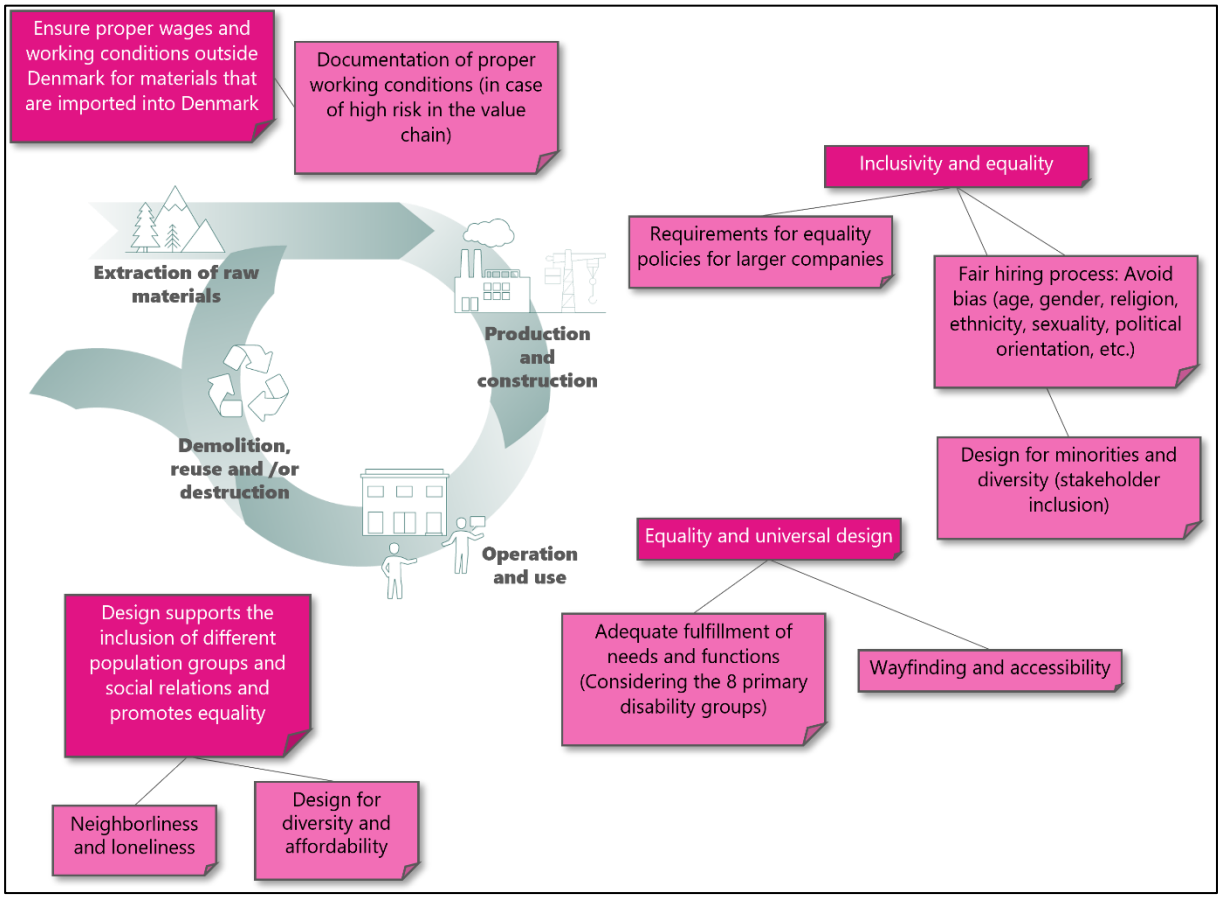

Figure 2 Overview of subgoals (dark pink) and indicators (light pink) for SDG 10 for the Danish building sector validated by the advisory board. The subgoals are placed in the life cycle where the impact occurs

Table 4 Method overview to identify absolute social targets and targets for the indicators that are means to reach the environmental targets

Method	Group of need (Table 3)	Method description to identify absolute target
1	1	Identify objective sources e.g., through industry experts, researchers, standards, statistics, legislation or certification schemes that contain quantifiable guidelines.
2 2a 2b	2	Measured bilaterally: a) Use of standard or method in design stage (identified as method 1 - if possible). Answered by yes/no.

		b) User survey or measurement in the construction or use stage Method 2a can be used without 2b in case it is not possible to ask the stakeholders or measure the actual impact due to long time perspectives.
3	1 + 2	Combining Group 1 + 2 applies to indicators where we know an interval where the users thrive (e.g., indoor temperature). We can simulate quantitatively how the building performs in the design phase and control the performance during the functional performance testing right before the use stage.

Absolute social sustainability is reached when all indicators are answered by "yes" or marked as green, and for the user surveys a sufficient level is reached when 90% reply "Slightly agree" or "Agree", which is based on the principles from indoor climate DS474:1993. In Figure 3 an example of subgoal, indicator and target are presented for SDG 10 *Reduced inequality*. This indicator is developed with method 2 and consists of a user survey in the use stage.

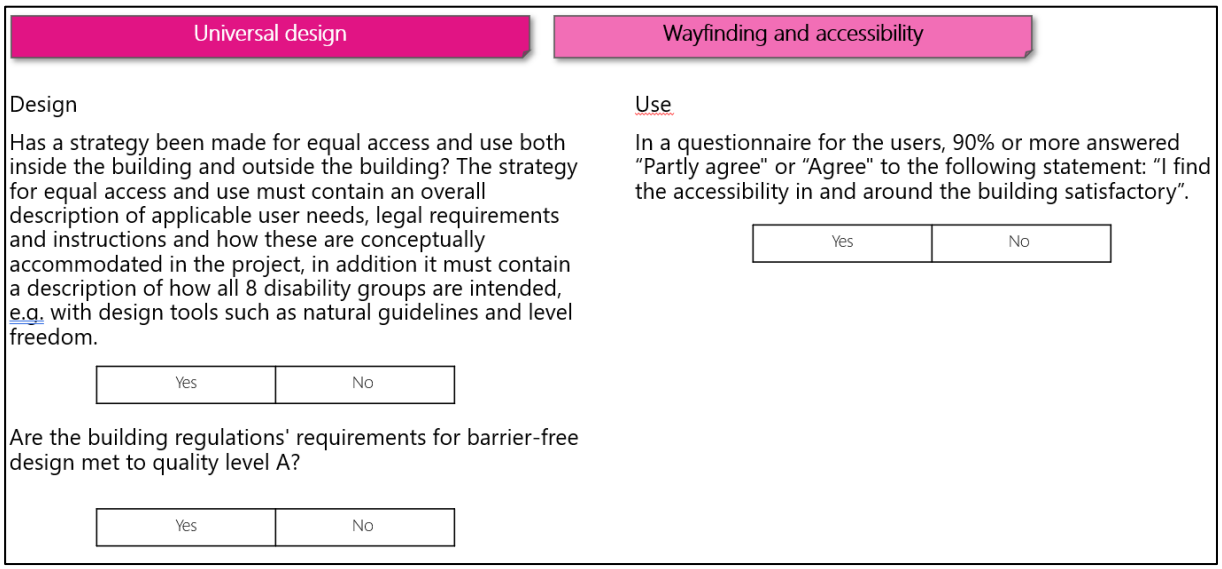

Figure 3 an example of subgoal, indicator and target in SDG 10 Reduced inequality. This indicator consists of requirements in both the design stage (Method 2a) and the use stage (Method 2b).

5. Discussion and Conclusion

This framework is a first attempt to introduce absolute social sustainability for industrial activities, by answering when a product is *good enough* throughout the life cycle in terms of social sustainability and not just better than an alternative. It is important to include the social perspective and fulfilment of needs to avoid producing unsustainable products (i.e., products that do not contribute to human well-being and/or restoration of ecosystems). Furthermore, the focus should be on both reducing the negative social impacts and optimise the social value that a product can create throughout its life cycle.

Taking its offset in the SDGs, the framework quantifies targets for an absolute social sustainable foundation in the Danish building sector on building level, which makes it a design tool for developers, engineers and architects. The focus of the indicators varies depending on whether they were identified as a risk/burden that should be reduced or avoided (e.g. injuries at the construction site) or an opportunity/benefit that should be pursued either to reduce the environmental footprint (e.g. through reuse of materials) or to increase the positive social footprint (e.g. through universal design).

A challenge with this framework is that absolute sustainability might be interpreted as the absolute objective truth, however, subjectivity can never be avoided. The values of the included experts and the authors will always be integrated into such a framework and transparency in the reporting is hence of essence. The indicators should be selected according to the specific context, in our case study this mean that some indicators might not be relevant for all building typologies, and some indicators target new buildings while others target transformation/renovation projects.

The rationale for not including SDG 1 *No poverty*, 2 *Zero hunger*, 4 *Quality education*, 5 *Gender equality*, 6 *Clean water and sanitation* and 16 *Peace, justice and strong institution* is that all relevant topics belonging to these SDGs are overlapping with other SDGs, which are included. For example, SDG 4 *Quality education* is not relevant for all building projects, except for topics that are overlapping with SDG 8 *Decent work and economic growth* (e.g. apprenticeships), thus, the relevant elements from SDG 4 *Quality education* are included in the SDG 8 *Decent work and economic growth* indicators. However, it might be relevant to develop specific indicators for SDG 4 *Quality education* if the specific building is a school. Hence, we recommend that additional indicators are developed for the specific building typologies. Moreover, 17 *Partnerships for the goals* was excluded because we suggest a different approach for this goal. Discussions with the advisory board led to the conclusion that a guideline for initiating the good building process to include the relevant elements from SDG 17 *Partnerships for the goals* should be implemented as a first step when using this design tool. We leave this topic for another paper. 14 *Life below water* was excluded because the impacts are measured through an LCA and is of environmental character only – except for the indicators that are overlapping with other SDGs.

The final set of indicators is very comprehensive. But only a few of the indicators are mandatory. The mandatory indicators are defined based on the criteria "the building cannot be socially sustainable if the indicator is not fulfilled" e.g. avoiding fatal working injuries at the construction site or human right violations in the supply chain. Generally, we recommend to use the full set of indicators and include all SDGs. Yet, the framework can be used with only a few selected SDGs or indicators. In case some SDGs or indicators are deselected it is essential to argue why they were left out.

Another point in the framework is that the indicators of subjective character are formulated in a general format, making it possible to fulfil the indicators in several ways or with different tools. This is to accommodate and respect the architects' and engineers' competences and provide autonomy to reach the target for the indicators of subjective character in a purposeful way for the specific building project.

The expected added value from this design tool is that it will support a more sustainable building projects and facilitate a more holistic approach supporting environmental and social sustainability across the life cycle of buildings. The framework is expected to systematically help companies and sectors develop their own SDG indicators and targets that are translated and adapted according to the relevance of the sector and their abilities. Thus, the indicators and targets should complement environmental assessments when striving to keep humanity within the safe and just operating space and to avoid green washing.

Appendix

We performed a social risk assessment using the SHDB 2018. We analysed the process "Construction/DNK U" with the method: "Social Hotspot 2019 Subcat & Cat Method w Damages / Equalsubcatweights" to identify the number of mean risks working hours (MRWH) in the countries with the Danish construction sector trades with.

A sum of each counties total contribution to the risk for each endpoint category is shown in Table 1, this is done to identify which countries within each of the 5 categories are particularly problematic, which the industry should be aware of if and when trading with these countries. The total number of

points and mhreq depends on how large the financial flows are between the Danish construction sector and other sectors, as well as the risk in question.

Table A1 Top 4 countries by sum of countries' contributions to the 5 endpoint categories. The risk from all sectors in the country in question is summed up and thus highlights which countries the Danish construction sector should pay particular attention to.

We made a sum for each endpoint category to identify which countries within each of the 5 categories that are particularly problematic and which the industry should be aware of in connection with trading with these countries. The total number of points and mhreq depends on how large the financial flows are between the Danish construction sector and other sectors, as well as the risk in question.

Table A1 Top 4 countries by sum of countries' contributions to the 5 endpoint categories. The risk from all sectors per country are summed and thus highlights in which countries the Danish construction sector should document that the working conditions are satisfactory and does not comprise human right violations when/if trading with suppliers from the nations of high risk. The column to the right indicates the sectors that contribute the most.

Category:	Land	% of the score per nation	Sectors with a large contribution to the risk
1 Labor Rights & Decent Work	CHN	23%	Forestry, Electronic equipment, Wood products, Chemical, rubber, plastic products, Machinery and equipment nec.
	IND	9%	Business services nec.
	RUS	6%	Ferrous metals
	DNK	5%	
2 Health & Safety	DNK	49%	
	CHN	13%	Forestry, Machinery and equipment nec., Wood products
	RUS	4%	Ferrous metals
	DEU	2%	
3 Human Rights	DNK	30%	
	CHN	14%	Forestry, Machinery and equipment nec., Wood products
	IND	8%	Business services nec
	RUS	4%	Ferrous metals
4 Governance	CHN	24%	Forestry, Machinery and equipment nec., Wood products, Chemical, rubber, plastic products, Electronic equipment
	DNK	10%	
	RUS	9%	Ferrous metals
	IND	6%	Business services nec.
5 Community	DNK	28%	
	CHN	17%	Forestry, Machinery and equipment nec., Wood products, Chemical, rubber, plastic products
	IND	7%	Business services nec.
	IDN	3%	

China, Russia and India are represented in top 4 in all 5 endpoint categories.

It is particularly noteworthy that only 2% of the economic flow goes to sectors in China, 1% to Russia, and 0.3% to India. Nevertheless, the large risk per dollar spend in these countries result in a total large score on all 5 endpoint categories for these three countries. Denmark also appears in the top 4 for high risk, and this is largely since a large part of the economy (65%) is internally spend in the Danish construction industry.

Industries that contribute to high social risk in the various countries are shown in Table 1 on the far right.

China has particularly large risk related to forestry and wood products, machinery and equipment, electronic equipment, and chemicals, rubber, and plastic products.

For Russia it is metals that pose a large risk and for India it is business services.

In addition to analyzing the process "Construction/DNK U", we have also carried out the analysis for "Electronic equipment/DNK U". This is because we expect that especially installations and solar cells that come from countries with high risk. The analysis here again highlighted China and India, in addition the USA and the United Arab Emirates pose a high risk in several of the endpoint categories.

Source to the SHDB:
http://www.socialhotspot.org/tools.html

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