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A chemical process industry case regarding human rights

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Developing social life cycle assessment based on corporate social responsibility: A chemical process industry case regarding human rights

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ABSTRACT

MSocial Life Cycle Assessment (S-LCA) uses a life cycle perspective to assess social impacts of products, and the S-LCA guidelines describe developing the system boundaries based on a factory-level perspective. However, such a perspective may exclude stakeholders with a negative social performance which are cooperating with a factory but are not directly involved with the product under study, and it can result in a step back on corporate social responsibility (CSR). Our study aimed to align S-LCA with the CSR concept. Therefore, we designed a case study for the manufacturing sector in which we practiced expanding the system boundaries of S-LCA. Our results showed larger social risks after expanding the system boundaries due to subsidiary and supplier companies located in countries with less strict regulations than the Netherlands, which is where the main organizations and parent company existed. We conclude that system boundaries expansion can result in more complete picture of the involved organizations, and lead practitioners to approach S-LCA with the goal of improving social conditions and identify companies which deserve excellent or poor social scores. Its usefulness is mostly expected when S-LCA practitioners aim to identify social hotspots in supply chains in socially sensitive markets.

1. Introduction

Two reasons why multinational corporations transfer parts of their production lines to other countries or purchase companies at several locations are to reduce production costs or to expand to new markets. However, in some cases, this may also result in an undesired increase of social impacts. The question of parent and subsidiary companies' liability is explained by the UNGP and the OECD Guidelines (UNGP, 2011), but the question of buyer and subcontracting company liability for abuses of human rights committed at locations other than the main location of the parent company remains mainly in the field of tort law (den Heijer and Lawson, 2009). Social performance goals of organizations are in line with the sustainable development goals (SDG), such as "SDG 8: Decent work and economic growth" (Pogge and Sengupta, 2016) and Social life cycle assessment (S-LCA) is a framework that uses a life cycle perspective to calculate social impacts of a product. Therefore, subsidiary's and subcontracting companies' liability is addressed in the S-LCA system boundaries only when it is directly related with the analyzed product. As a result, production lines of subsidiary and subcontracting companies which are not part the product's system boundaries are not considered and companies which cooperate with the former receive excellent social scores.

Over the last decades, companies have been able to decrease their bottom line significantly by sourcing materials and products internationally. However, this also resulted in several incidents of workers exploitation and workers committing suicide. In addition, communities were affected negatively due to lethal accidents in neighboring factories, and multinational companies were boycotted due to labor practices of subcontractors (Sutherland et al., 2016). Research on CSR of multinational companies shows that, apart from purely commercial drivers, country employment, workforce quality and benefits to local consumers are the main drivers when deciding locations for their subsidiaries. Country employment concerns human rights, such as minimum wages, rights to association, women empowerment, and worker safety, while

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workforce quality and benefits to local consumers regard local community and workers characteristics, such as experience and local employment (Ike et al., 2019).

The right to just and favorable working conditions, the right to work and the right to join trade unions are well-established and protected human rights by governmental laws and international documents, such as the United Nations Guiding Principles on Business and Human Rights (Human Rights Council, 2011a) and the Organization for Economic Cooperation and Development Guidelines for Multinational Enterprises (Bueno, 2017). The United Nations have highlighted the corporate responsibility to human rights respect as a standard expectation for all companies (Human Rights Council, 2011b).

Vicarious liability concerns the type of liability which emerges when an entity is held liable for a wrong executed by the other (Kravtsova and Kalinichenko, 2016); for instance a parent company is held responsible for the acts of its subsidiary. To date, there is often an insurmountable hurdle to hold parent corporations liable due to activities of (foreign) subsidiaries . This happens due to the absence of international law about parent-subsidiary liability and the fact that responsibility for parent companies goes against primary principles of tort and company law. Therefore, there is no consistent approach regarding decisions of the courts concerning parent-subsidiary liability and states must provide domestic remedies (Kravtsova and Kalinichenko, 2016; McConnell, 2014; Petrin and Choudhury, 2018). As a result, recent literature has investigated whether a parent company can be held responsible due to the its subsidiary's acts. However, less focus has been on whether a buyer can be held responsible due to the insufficient governance of its supply chain (Salminen, 2018). Soft-law initiatives, such as OECD Guidelines on Multinational Enterprises (OECD, 2011) and 2011 UN Guiding Principles, were developed with a focus on buyer's liability because of contractual suppliers. However, any international hard law instrument which aims to regulate global value chains faces an uncertain political pipeline (Salminen, 2019).

The primary goals of corporate social responsibility (CSR) and S-LCA are the protection of human rights, and protection and promotion of human well-being (Dreyer et al., 2010). In general, both CSR and S-LCA are voluntary, non-regulatory instruments which aim at self-regulation and corporate responsibility (Tuomasjukka et al., 2014). CSR aims to measure and document services and well-being of the employees and society, including impacts to the environment, due to corporate actions (Andersen and Skjoett-Larsen, 2009; Carroll, 2016). To make CSR more applicable, in 2010 members of the ISO created a standard to offer guidelines on how organizations can operate in a socially responsible manner (Mahjoub, 2019). For instance, Crilly et al. showed that the foreignness' liability is greatly decreased when corporations proactively engage to create positive externalities but is considerable when they engage in "do-no-harm" CSR (i.e. focus on attenuating negative externalities) (Crilly et al., 2016). In contrast to CSR, S-LCA has a developed framework, but practitioners' ways of application vary considerably due to the absence of standardization.

S-LCA was developed by the United Nations and Society of Environmental Toxicology and Chemistry (SETAC), but in comparison to environmental LCA, S-LCA is still in its infancy and under development (Iofrida et al., 2018). There are two main guiding sources for S-LCA, the S-LCA guidelines (UNEP/SETAC Life Cycle Initiative, 2009) and the methodological sheets (UNEP/SETAC Life Cycle Initiative, 2013). The goal of S-LCA guidelines is to "provide a map, a skeleton and a flash light for stakeholders engaging in the assessment of social and socio-economic impacts of products life cycle" (UNEP/SETAC Life Cycle Initiative, 2009, p. 5). Even though it focuses on a product's life cycle, and consequently to product-oriented assessments, the S-LCA guidelines emphasize on organization-oriented assessments as well (UNEP/SETAC Life Cycle Initiative, 2009, p. 100). Even in product-oriented assessments, S-LCA practitioners need to develop their system boundaries based on involved stakeholders and identify how the latter affect the local community, workers, value chain actors, consumers and society. The guidelines explicitly state: "S-LCA will collect additional information on organization-related aspects along the chain" (UNEP/SETAC Life Cycle Initiative, 2009, p. 38). On page 42 the guidelines state: "if S-LCA looks at organizations' management practices, its focus is always the product and it will always try to get to the information that is related to the facility where the unit process is located. That said, for many subcategories, e.g. public commitments to sustainability issues, the information is available solely at the enterprise/organization level" (UNEP/SETAC Life Cycle Initiative, 2009, p. 42). The S-LCA definition includes two strengths that distinguish S-LCA from other social assessment methods: 1) its focus on the product and 2) the large range of social impacts, which covers both the company's behavior and socioeconomic perspective (Zamagni et al., 2011). As a result, it is clear that even though the guidelines suggest product-oriented and facility-level perspectives, they also aim to cover companies' behavior and the perspectives of entire organizations.

The S-LCA guidelines mention a way of thinking that is similar to environmental LCA when conceptualizing system boundaries. "There are two scope dimensions impacted by this conceptualization: the processes or activities that are regarded part of the product life cycle, and the 'elementary flows' or 'pressures' or other attributes of those processes/activities that may be accounted for in the data inventory" (UNEP/SETAC Life Cycle Initiative, 2009, p. 55). Furthermore, in the impact assessment phase, the social implications to be considered are associated with the conduct of organizations along the life cycle. These social aspects affect: 1) workers employed in the involved organizations, 2) surrounding local communities and 3) the society of the country. National and regional socio-economic conditions, e.g. the cultural setting, the legislation, etc., significantly influence an organization's conduct (Hauschild et al., 2008; UNEP/SETAC Life Cycle Initiative, 2009; Zamagni et al., 2011).

Based on the above, conceptualizing system boundaries in S-LCA considers organizations directly involved with the product life cycle. Furthermore, in the S-LCA guidelines (UNEP/SETAC Life Cycle Initiative, 2009) and methodological sheets (UNEP/SETAC Life Cycle Initiative, 2013), the term "liability" is mentioned only once, while the word "subsidiary" is not mentioned at all and "subcontractor" is also not mentioned but falls under the stakeholder category "Supply chain actors". Consider the following example: company A is selling product X and one of their suppliers (supplier A) is manufacturing a component of product X and other products at the same time. Supplier A might employ child labor to manufacture other products but not a component which is part of product X. When a practitioner applies S-LCA to evaluate the social performance of product X by concentrating on the product system itself, this lamentable behavior of supplier A will not be taken into account because supplier A is carrying responsibility only for that part of production comprised in product system X. This would constitute a step back with regard to CSR and sustainable development because CSR encourages companies to develop a strong sense of responsibility for and within the whole organization (Zamagni et al., 2011) and was the underpinning theoretical perspective of the S-LCA guidelines (Baumann and Arvidsson, 2020).

The relative nature of companies' behavior in S-LCA is in contrast with absolute physical flows in environmental LCA. Furthermore, it is not certain if the concept of company behavior, i.e. considering the involved companies' and their subsidiary's and suppliers' responsibility in product's life cycle, can co-exist with the goal of S-LCA of improving social conditions. In our previous work we showed that organizations should aim to purchase equipment from suppliers which promote social equality or suppliers operating in developed countries with strict social, environmental and ethical regulations (Tsalidis et al., 2020). The aim of this study is to investigate whether including subsidiary and subcontracting facilities, which do not belong to the product's strict life cycle, would result in increasing the completeness of social scoring and performance assessment with S-LCA. To do that, we developed an example based on the Dutch chemical industry case study in order to investigate

the difference in terms of S-LCA results with and without the hypothetical boundaries expansion. We selected the Dutch chemical industry due to having strong ties to CSR reporting (CSR Netherlands, 2015).

2. S-LCA background

So far there are a few S-LCA publications which mention CSR. Initially, researchers did not aim to develop S-LCA based on CSR, but to convince companies to apply S-LCA in order to broaden their social responsibility perspective (Jørgensen et al., 2009). A recent editorial on the rigor of S-LCA (Grubert, 2018) presented that CSR literature contains large amounts of empirical data which can be used as inputs for S-LCA models. On the other hand, Sakellariou (Sakellariou, 2018) concludes that even though CSR may provide the institutional frame within which S-LCA becomes understandable, it may also conceal the historical authenticity of sustainability engineering.

In this study it has been argued that there is a methodological limitation regarding system boundaries conceptualization in S-LCA. In particular, we focused on human rights and how to account for liability in S-LCA. Table 1 presents an overview of the literature review findings. Sousa et al. (Souza et al., 2018) followed the S-LCA guidelines and assessed the impact of Brazilian ethanol production. Therefore, these authors used averaged Brazilian sectoral data for the ethanol production process and expanded their system boundaries to the entire ethanol supply chain. These authors did have a broader approach since they were assessing the social impact of various sectors related to ethanol production in Brazil, but they considered only processes/sectors which were directly related to ethanol production in Brazil. Karlewski et al. (Karlewski et al., 2019) followed a life-cycle S-LCA approach to conceptualize system boundaries and collect data only at company level. Ekener-Petersen and Finnveden (Ekener-Petersen and Finnveden, 2013) assessed the social impacts of producing one generic laptop. Therefore, these authors considered in their system boundaries all the laptop's life cycles and they used national level data to perform a hotspot analysis assessment. Peruzzini et al. (Peruzzini et al., 2017) assessed the social performance of a kitchen sink using surveys to result in a cradle-to-grave system boundary. Zamani et al.(Zamani et al., 2018) and Lenzo et al. (Lenzo et al., 2017) assessed the social performance of textile consumption in Sweden and production in Italy, respectively. While both collected data from the Social Hotspot Database (SHDB), only Lenzo et al. used facility-level data for the manufacturing process. Van der Velden and Vogtlander (van der Velden and Vogtländer, 2017) assessed the social performance of clothing production based on eco-points calculated through LCA. Baumann et al.(Baumann et al., 2013) assessed the social performance of airbags and considered cradle-to-gate system boundaries with data collection based on literature and conversion of LCA indicator results to S-LCA indicators. Last, Subramanian et al. (Subramanian et al., 2018) followed a cradle-to-grave perspective to assess the performance of exposed softwood exterior cladding for 1 year. Table 1 shows that all these researchers limited their scope on companies which were directly linked with the system under study or used the SHDB, and consequently considered an average social performance of a whole sector.

Table 1
Data sources and system boundaries conceptualization

Reference	Supply chain	Manufacturing	Use	Scope 2 bBoundaries expansion
(Karlewski et al., 2019)	Company level	Company level	Company level	Indirectly
(Ekener-Petersen and Finnveden, 2013)	National level	National level	National level	Indirectly
(Zamani et al., 2018)	SHDB	SHDB	SHDB	Indirectly
(Lenzo et al., 2017)	SHDB	Facility level	-	No
(Souza et al., 2018)	Sector	Sector	-	Indirectly
(Peruzzini et al., 2017)	Company (survey)	Company (survey)	Company (survey)	No
(Baumann et al., 2013)	Literature and DALYs	Literature and DALYs	Literature and DALYs	No
(van der Velden and Vogtländer, 2017)	Eco-costs	Eco-costs	-	No
(Subramanian et al., 2018)	Company level	Company level	Company level	No

All reviewed publications accounted for social impacts due to the supply chain actors, but none of them accounted for stakeholders with already existing equipment which was part of the production line. For instance, Karlewski et al. (Karlewski et al., 2019) considered the supply chain of involved materials in the production of a car, such as steel, textile, biopolymers, etc., but they did not consider the production of the machinery used in the car factory. Ekener-Petersen and Finnveden (Ekener-Petersen and Finnveden, 2013) considered a generic laptop production based on Ecoinvent database, therefore, they accounted for national level data of all global organizations that exist in different life cycle stages of a generic laptop. In environmental LCA it is common to exclude from the system boundaries processes which contribute to the final impact results minimally. However, in S-LCA the stakeholders and processes which are expected to contribute to social impact results may derive mainly from developing countries with higher social risks.

1 aimed to collect inventory data on a plant level. However, some researchers claimed that this is impossible for many indicators, such as "Salary" and "Hours of work", because even if a company allows the publication of such data of individual locations, there is usually no central office to harmonize data of different locations. For instance, a great deal of effort will be involved to ask for manage to collect data for each individual location. Therefore, it is difficult to evaluate indicators with a local reference (Karlewski et al., 2019).

3. Material and methods

Various researchers (Dreyer et al., 2006; Norris, 2006; Spillemaeckers et al., 2004) argue that S-LCA is a company-based approach that is solely based on companies' conduct instead of on processes embedded in a product life cycle. Their rationale is that most impacts on people, aside from direct health effects on workers, are not caused by the physical conditions of industrial processes. Rather, they argue that companies' principles, rules, procedures and management are the main driving force causing social impacts to occur on stakeholders in a product life cycle. The researchers therefore do not consider a process approach as is taken in an environmental LCA to be suitable for S-LCA.

For the system boundaries setup, a primary question to ask is whether to evaluate an entire supply chain or product life cycle, or a shortened one. Schmidt et al. (Schmidt et al., 2004) argue that a system boundary should cover the full life cycle of the product because the impact can be present at any part in the product life cycle. Thus, these researchers suggest that a product life cycle should not be shortened for a S-LCA because other impacts may then be left out. In contrast, Dreyer et al. (Dreyer et al., 2006) claim that only a focal company and its closest value chain actors are relevant in a system boundary for a S-LCA. Their view is in alignment with the suggested organizational-based S-LCA approach (Martínez-Blanco et al., 2015), which highlights the companies and stakeholders related to a specific part of a product life cycle. In this study, the latter viewpoint is chosen and the boundaries include only the stakeholder groups that are affected by the organizations in the closest value chain.

3.1. Case study

In order to investigate the effects on social performance of a parent company and buyer, and when they are liable for the subsidiary's and supplier's company social performance, respectively, a case study is developed. The case study concerns the Dutch chemical industry because many Dutch multinational chemical companies operate outside the Netherlands and there is a strong connection between the Dutch chemical industry and CSR reporting. The case study is developed based on a facility level perspective to conceptualize the initial system boundaries, and these initial system boundaries are expanded based on an organization level perspective. Therefore, we considered past incidents which took place in the involved organizations facilities. We decided to limit the case study to "Human rights" impacts due to being one of the key themes of social sustainability. Guidelines (UNEP/SETAC Life Cycle Initiative, 2009) assign six impact subcategories to human rights: "Freedom of association and collective bargaining", "Fair salary", "Hours of work", " Equal opportunities", "Social benefit" and "Consumer privacy".

Moreover, there are two kinds of S-LCA studies, Type 1 and 2. Type 2 studies use characterization based on causality, meaning that causal relations exists between inventory data and considered social impacts. On the other hand, Type 1 studies use a Performance Reference Point (PRP) approach to characterize the inventory data to social impacts based on established nominal reference values. This case study is a Type 1 S-LCA study.

3.2. Goal and scope definition

Two scopes are considered: 1) a facility-based scope which includes companies directly linked with the demineralized water plant (DWP) and 2) an organization-based scope which includes subsidiaries and the parent company. The first scope of the case study covers upstream Dutch suppliers and downstream Dutch consumers of the DWP in Rotterdam, the Netherlands. The second scope complements Scope 1 with a subsidiary of the downstream consumer in China, the parent company in the broader Rotterdam area of the DWP and a supplier of the parent company in India. Table 2 presents the three main companies chosen for analysis based on Scope 1, each with different functions in the system: the DWP, the salt supplier and the chlorine consumer. Table 2 also presents the three added companies for Scope 2. Selection of locations for companies in Scope 2 was done based on the locations of subsidiaries and suppliers of companies in Scope 1 and also on data retrieved from the Social Hotspot Database (SHDB) 2.1 (Benoit-Noriss et al., 2013; Norris and Norris, 2015). Fig. 1 shows that China and India result in high risks with respect to social behavior for "Human rights" subcategories. There has been progress for labor rights in China and India but they remain considerably lower than in developed countries (Puddington and Roylance, 2016; Sarkar, 2019). Therefore, a subsidiary and supplier were selected in those two countries. The system functionality is to produce ultra-pure demineralized water, but a functional unit is not essential in S-LCA studies. Impacts may not be possible to be expressed in relation to the functional unit when dealing with data and semi-quantitative and qualitative indicators (UNEP/SETAC Life Cycle Initiative, 2009; Zamagni et al., 2011). Therefore, no functional unit was used in this study to compare potential risks due to the operation of each stakeholder.

Table 2
Involved plants characteristics in Social Life Cycle Assessment system boundaries development

Plant	Location	Capacity (ktons.year^{-1})	Product	Employees
Scope 1: based on S-LCA guidelines				
Salt plant	Delfzijl	3,000 [1]	Salt	400 [1]
DWP	Port of Rotterdam	12.6 [1]	Demineralized water	70 [1]
Chlor-alkali plant	Port of Rotterdam	600 [1] 650 [1]	Chlorine Sodium hydroxide	230 [1]
Scope 2: based on system boundaries expansion of this study				
Chlor-alkali plant 2	China	38 [3]	Chlorine	500 [3]
Water company	Rotterdam	158,800,000 [2]	Drinking and industrial water	730 [2]
DWP supplier	India	100 [3]	Equipment	100 [3]

[1] (De Santo, 2019), [2] (Water company, 2019), [3] fictional values

Fig. 2 illustrates the system boundaries. Based on the system boundaries we employed a gate-to-gate approach, which is a partial LCA that assesses only one value-added process in an entire production chain. This is different from a cradle-to-grave or a cradle-to-gate approach but we expect the results of this study to be applicable to the other two approaches.

3.2.1. Activity variability

Activity variables measure the effects of process activities on process outputs. They represent the product system in order to show how much each unit process contributes to the system, and consequently which parts of the product system contribute the most to the impact categories and stakeholder groups (UNEP/SETAC Life Cycle Initiative, 2009). Activity variables were not considered due to the limited involved stakeholders in Scope 1 and the lack of physical links between Scope 2 and Scope 1 stakeholders in relation to the system functionality. However, if activity variables were implemented in this study, the specific scores in Scopes 1 and 2 would change, depending on the activity variable (e.g. working hours to provide the functional unit).

3.3. Life cycle inventory

Scope 1 consists of real data, and Scope 2 consists of theoretical data from the developing countries and the Netherlands. For Scope 2, the links with Scope 1 companies do not necessarily exist. Nevertheless, the impact assessment calculations for Scope 2 companies was based on data retrieved from the SHDB. This data (seen in Fig. 1) formed the expectations for impact assessment of Scope 2 companies. Regarding Scope 1, the data collection was made through a desktop search of the most recent (2018) corporate annual reports per stakeholder and the stakeholders' websites were also consulted to acquire preliminary information about company-wide policies and practices. Then, interviews were performed so as to determine if these indications of the desktop and website search were met for the considered plant. The interview protocol and collected information during this phase are available in the Supplementary Materials (Tables S2-S4).

3.4. Life cycle Impact Assessment

The Subcategory Assessment Method (SAM) (Ramirez et al., 2014) was used to perform the social impact assessment step. SAM offers two benefits: first it converts qualitative data into semi-quantitative data and, second, it is able to compare different data types in a standardized manner and arrive at meaningful results. For this purpose, PRPs are used as thresholds (such as international agreements) to show the magnitude and significance of collected data. This way, organizational performance is calculated at four levels (A, B, C or D) for each social impact category in relation to the achievement of PRPs, i.e. basic requirements, as presented in Table 3. The definition of the Basic Requirements can be found in Table S1.

4. Results and discussion

Table 4 shows the case study results per stakeholder based on Scopes

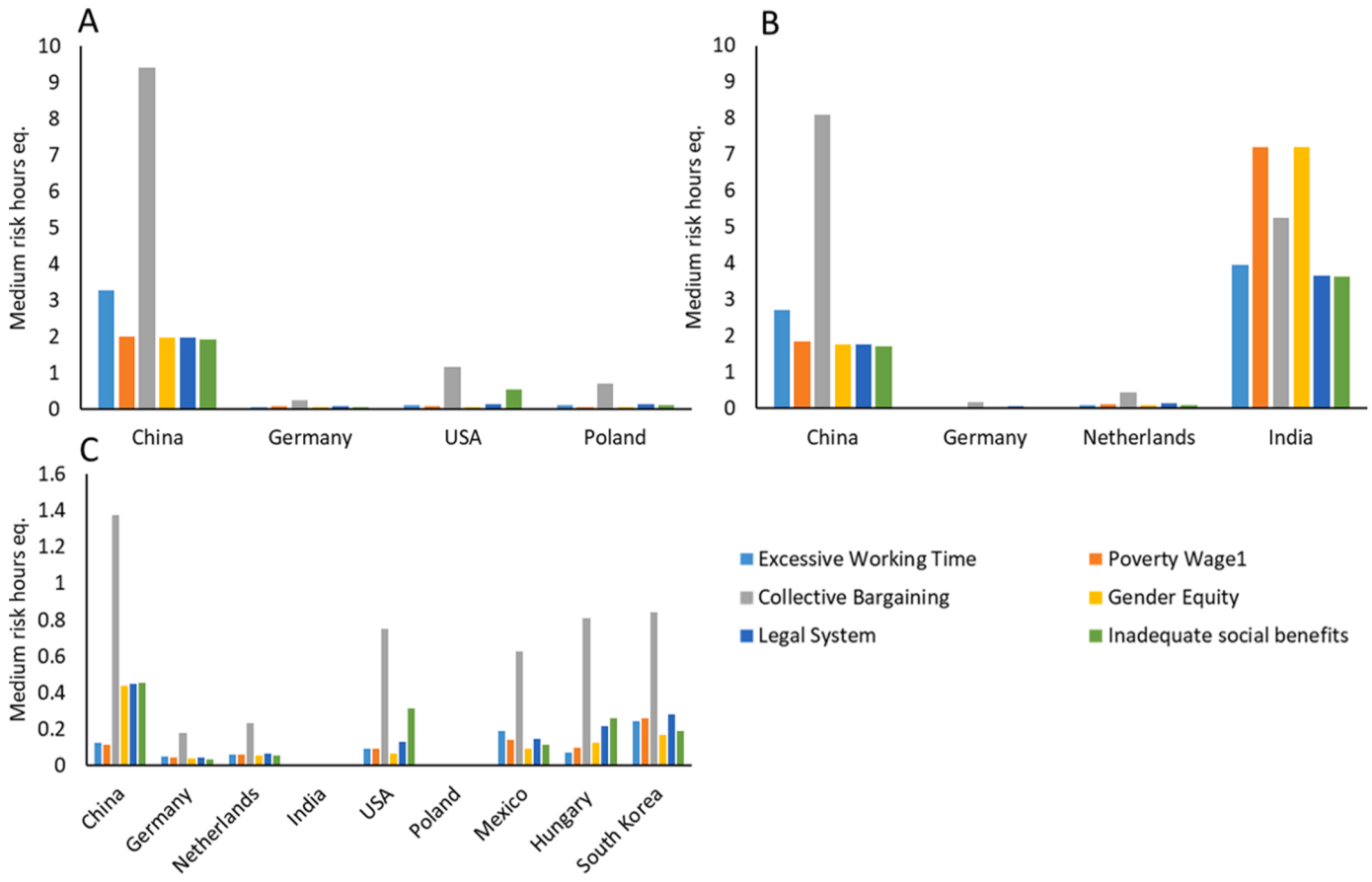

Fig. 1. Medium risk hours equivalent for "Human rights" subcategories per country and price (in $) of commodity, A: Chemicals, B: Metal products and C: Ferrous metals (data retrieved from SHDB 2.1, Update 2016) (Benoit-Noriss et al., 2013; Norris and Norris, 2015)

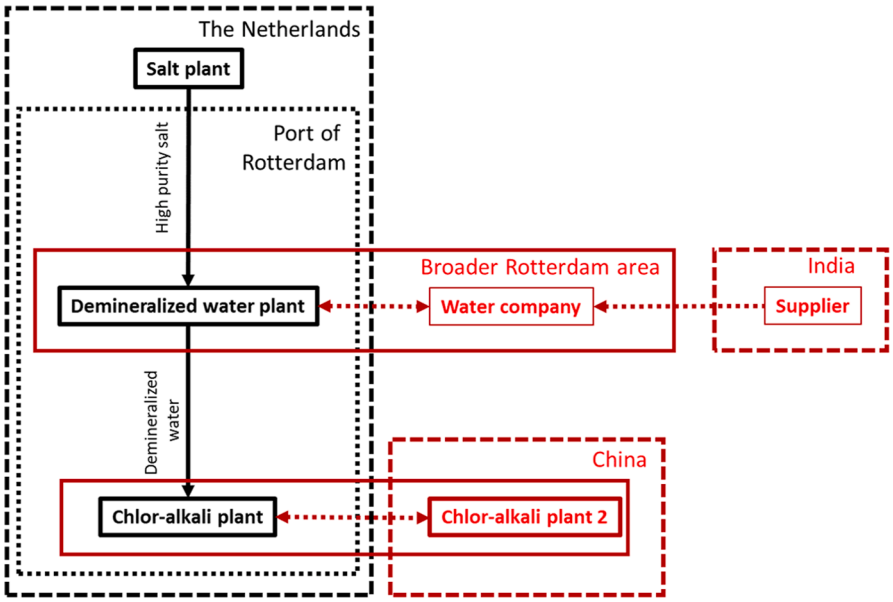

Fig. 2. Social Life Cycle Assessment system boundaries of theoretical example. Black color indicates plants based on Scope 1 and red color indicates added plants due to Scope 2

1 and 2. For Scope 1, all considered stakeholders fulfill or exceed the BR per subcategory. Room for improvement remains, but it is limited and to a certain extent not compulsory from a stakeholder's perspective because they already fulfill the BR based on Scope 1. On the other hand, when Scope 2 is considered and due to working conditions in China and India (Werker et al., 2019), the social risk due to the operation of the Chlor-alkali plant in China and supplier in India is higher than Scope 1 stakeholders and Water company (parent company of DWP) in Scope 2.

Table 3
Weighting factors for SAM levels

Weighting factor	SAM levels
D=4	Organization does not achieve the basic requirement in a positive context
C=3	Organization does not achieve the basic requirement in a negative context
B=2	Organization achieve the basic requirement
A=1	Positive and proactive organization behavior

The total SAM social score is up to two or three times larger between Scope 1 and Scope 2 stakeholders. this difference is a result of strict regulations present in the Netherlands in general as well as regulations imposed on the chemical process industry in particular. The chemical process industry can be considered to be under a microscope regarding issues such as health and safety of the workers, local community members and consumers, and thus there are extra laws around these aspects that organizations must abide by (De Santo, 2019). These results show that production of demineralized water in the Netherlands results in a positive social performance score. However, if one would compare the social performance of our system with a reference system where subsidiaries or suppliers exist outside Europe, the results could be similar to Scope 1 but different than Scope 2. Application of extended system boundaries from a parent company or a buyer can identify social risks due to Scope 2 expansion and take action in order to eliminate or reduce them. Such an action will also lead to beneficial outcomes in the social section of the company's CSR or annual report and can be used by the company for promotion purposes.

Fig. 3 shows that for Scope 1 "Equal opportunities" and "Social benefits" result in the highest median value, and for Scope 2 "Equal opportunities", "Social benefits" and "Fair salary" result in the highest median value. An interesting point to acknowledge is that, while the above-mentioned subcategories in Table 4 portray a negative performance for Scope 2, none of them exceeds a score of 3 when medians are calculated (see Fig. 3). This is a result of the data types (ordinal values, with median values calculated), stakeholders in Scope 1 performing well, the limited expansion for Scope 2 and the fact that no activity variables were used. If more plants in China, India or other countries scoring low in "Human rights" subcategories (see Fig. 1) would be considered, then the results would change. In addition, in this work we have added two plants in developing countries and a plant in the Netherlands for Scope 2. The latter scores well in "Human rights" subcategories, therefore, the average performance of the expanded system is levelled to the average performance of Scope 1 system. If the Water Company would not have been considered, a greater negative effect would have been observed in Scope 2 system.

Our case study concerns collecting data through interviews of involved stakeholders' representatives. This was not universally observed in S-LCA studies (Ekener-Petersen and Finnveden, 2013; Zamani et al., 2018; Lenzo et al., 2017; Souza et al., 2018; Baumann et al., 2013) of the manufacturing sector because it is a time and data intensive process. Furthermore, our study stands out of literature focusing on developing S-LCA because it expands system boundaries to comply with CSR (Jørgensen et al., 2009) and focuses on site-specific indicators, not hotspot indicators (Cadena et al., 2019). All stakeholders in Scope 1 shaped the system boundaries in a comparable way to studies in Table 1. Therefore, S-LCA results can only be applied in analysis of products supply chains. Our Scope 1 results are in agreement with relevant literature on the manufacturing sector of developed

Table 4
S-LCA results per stakeholder based on Scopes 1 and 2 (location in brackets)

Scope 2 Scope 1 Impact subcategory	Salt plant (NL)	DWP (NL)	Chlor-alkali plant (NL)	Chlor-alkali plant 2 (CH)	DWP supplier (IN)	Water company (NL)
Freedom of association and collective bargaining	1	1	1	4	4	1
Fair salary	1	2	1	2	3	2
Hours of work	1	1	2	4	4	1
Equal opportunities	1	2	2	3	4	2
Social benefit	2	1	2	4	4	1
Consumer privacy	1	1	1	2	2	1
Median	1	1	1.5	3.5	4	1
Interquartile range	0	0.75	1	1.75	0.75	0.75
Total score	7	8	9	19	21	8

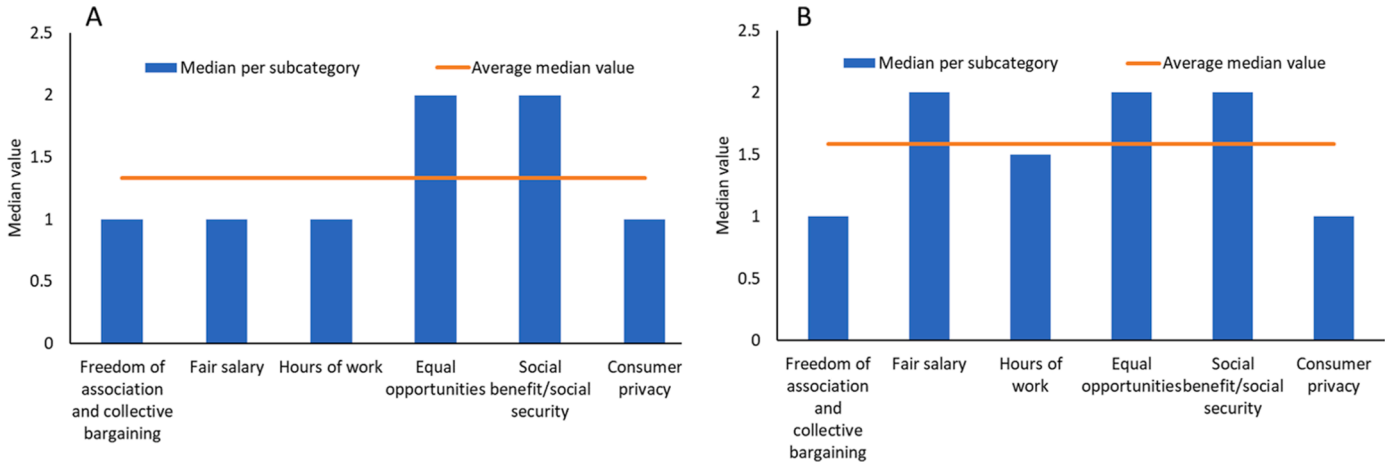

Fig. 3. Median values and average media value for A: Scope 1 and B: Scope 2

countries which shows that national regulations protect human rights (Tsalidis and Korevaar, 2019) (Karlewski et al., 2019). On the other hand, Scope 2 deviated from approaches followed from practitioners in Table 1 and shows potential social risks of subsidiaries, suppliers and in general companies which cooperate with the parent company in various ways. Scope 2 results can identify potential risks regarding violations of human rights in developing and emerging economies because the effects of these violations on local communities depict the risks of unmanaged supply chains (Govindan et al., 2021). As a result, such a boundaries expansion can assist decision makers in supplier selection based on sustainability principles (Yawar and Seuring, 2017). The latter can be considered a step forward to further link S-LCA with CSR because CSR can support organizations and products in socially sensitive markets (Tuomasjukka et al., 2014).

In this study, a top-down and a bottom-up approach were used in order to expand Scope 1 to Scope 2. This resulted in considering stakeholders that show a worse or the same social performance in relation to Scope 1 stakeholders. The reasoning behind that was that for vicarious liability the parent company or the buyer are held liable; this resulted in the top-down expansion to subsidiaries and suppliers. On the other hand, in the bottom-up approach the parent company of the DWP was considered. In both cases, if the goal is to identify places for improvement, then it can be concluded that the top-down approach results in more promising findings because the parent company is expected to be more influential towards the subsidiary than the other way around.

Limitations of our study exist due to the fact that we did not consider activity variables in Scope 1 and Scope 2 stakeholders. The use of activity variables for Scope 2 stakeholders is challenging because the latter may not be directly linked to the functional unit. Furthermore, it was not possible to perform interviews with Chinese and Indian manufacturing companies, instead the SHDB was used to select proper theoretical data for some Scope 2 stakeholders. Nevertheless, the SHDB consists of average sector data and these Scope 2 stakeholders may be outliers at those datasets.

5. Conclusions

Since marketing globalization, it can be argued that adhering strictly to a plant-level perspective in S-LCA does not give the complete picture of social performance as the authority at the corporate-level has a significant influence over the plant-level activities. Simply because indications of negative social performance may not be present in a plant considered in the system boundaries of the system under study does not mean that they are not present in other parts of the organization (De Santo, 2019). Therefore, in this work we investigated if an involved stakeholder deserves an excellent score for a given social subcategory of "Human rights" impact if its performance in other settings is actually quite negative through a system boundaries expansion to subsidiaries and suppliers. To manage that we demonstrated the effects of vicarious liability inclusion with a case study and its hypothetical expansion.

The case study regarded the chemical process industry with limited involved stakeholders, both for Scopes 1 and 2. Scope 1 consisted of stakeholders similar to existing S-LCA studies in the manufacturing sector. Whereas, Scope 2 included stakeholders that are typically omitted in S-LCA studies. It was found that the use of SHDB is an efficient way to identify potential hotspots of social risks due to Scope 2 stakeholders. In addition, even though Scope 2 stakeholders may score really low on "Human rights" subcategories, the median value per subcategory and average median value do not change significantly when Scope 1 is expanded to Scope 2. Therefore, we conclude that expanding the system boundaries can result in more complete picture of the involved organizations in the system under study, approaching the goal of S-LCA of improving social conditions, and identifying companies which deserve excellent or poor scores based on SAM levels. Such companies focus on proactive engagement, creating positive externalities. Furthermore, the usefulness of the Scope 2 expansion is expected when S-LCA practitioners aim to identify social hotspots in supply chains in socially sensitive markets.

A Scope 1 stakeholder should not receive a priori an excellent score when it cooperates with suppliers and subsidiaries where high social risks are identified but only after thorough investigation for potential Scope 2 companies and social risks. In addition, a top-down approach is suggested to be followed when expanding the system boundaries in order to identify places for improvement and key stakeholders which will steer change. Last, we recommend the following: to conduct more research on activity variables to improve understanding of the contribution of Scope 2 organizations in the overall social performance, to perform interviews with Scope 2 stakeholder to capture an accurate image of their social performance, and to select a large corporation to apply S-LCA (with system boundaries expansion) and discuss results with higher rank employees.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the reported work in this study.

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Supplementary materials

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