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SOCIETAL LCA

Social organizational LCA (SOLCA)—a new approach for implementing social LCA

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Abstract
Purpose Current product social life cycle assessment (SLCA) addresses social aspects from a life cycle perspective, but it is not yet broadly implemented in practice. We propose a new organizational perspective to boost SLCA—the social organizational LCA (SOLCA). The paper answers four guiding questions: Why do we need SOLCA? How can we apply it? How can its implementation benefit from existing experience? Which are the foreseen limitations?
Methods First, challenges of SLCA which may be overcome by an organizational perspective are identified, and potential solutions are described. An analysis of the indicators proposed by SLCA is conducted. Second, first ideas for a conceptual framework for SOLCA are developed. The two underlying methodologies: the guidelines for SLCA of products and the guidance on organizational LCA (OLCA)—which adapts product LCA to the organizational perspective—were reviewed, compared and adapted to a social organizational perspective. Third, different implementation pathways were identified, showing how SOLCA could be applied in practice by considering different levels of organizations' experiences with social and environmental assessments.
Results and discussion Existing SLCA case studies do not really evaluate the social performance of products. From the 189 indicators proposed in SLCA, only eight refer to the product level, while 127 and 69 refer to the organizational and country level, respectively—including overlaps and according to the methodological sheets. This fact clearly favors an organizational approach to social LCA. SOLCA may streamline allocation, data collection, and application in practice. The conceptual framework for SOLCA is focused on scope and inventory, which were found to differ most from SLCA and OLCA; all relevant steps like definition of unit of analysis or multi-functionality are addressed. Three SOLCA implementation pathways are proposed. Existing experience of organizations in social organizational approaches —like Global Reporting Initiative (GRI) or product SLCA— and environmental approaches —like environmental management systems (EMS) or OLCA— can be used as starting points as they can provide useful information on the organization´s structure, value chain, etc.
Conclusions SOLCA helps to overcome some major challenges of SLCA and thus is a promising approach for putting it into practice. The frameworks of SLCA and OLCA can be integrated into SOLCA, and existing experience from organizations can be used for implementing it. However, new challenges arise. This includes potential difficulties for primary data collection in complex organizations with many different sites or the difficulty to distribute or aggregate social aspects within the organization. Further development and testing of SOLCA is recommended.

Keywords CSR · OLCA · Organizational level · Product level · SLCA · Social assessment · Unit of analysis

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1 Introduction

The importance of considering the social dimension in sustainability assessments and reporting is reflected by an increasing number of initiatives like UN Global Compact or Ethical Trading Initiative and sustainability reporting schemes like Global Reporting Initiative (GRI), as well as social and fair trade labels, etc. All these approaches refer to the social performance of organizations, partly including value chain actors like suppliers.

The guidelines for product social life cycle assessment (SLCA[1]) aim at complementing these approaches (UNEP/SETAC 2009). They differ from existing ones, as they take a product perspective and consider the whole life cycle following product LCA standards (ISO 2006a, b). The main methodological and practical challenges and limitations of SLCA, resulting from the complexity of the social dimension and the novelty of the method, as well as the need for further development, are highlighted in the SLCA guidelines.

However, the 5-year experience of applying the SLCA method, represented in numerous published papers dealing with methodological development and case studies, has not shown significant progress in overcoming its challenges and its actual use is not yet visible (e.g., Lehmann et al. 2011, 2013; Jørgensen 2013; Martínez-Blanco et al. 2014; Neugebauer et al. 2014). Among others, it is still hardly feasible to allocate social indicators and impacts[2] to the product level, as they usually refer to organization's behavior.

ISO/TS 14072 (ISO 2014) and the guidance on organizational LCA (OLCA) (UNEP 2015) were recently launched. They adapt product LCA to the organizational perspective, providing guidelines for organizations to conduct LCA considering their value chain. Such an organization-related assessment approach seems promising to overcome some of the methodological and practical challenges of SLCA. Also, the Guidance on OLCA (UNEP 2015) already mentioned it as an interesting field for further development and research. Organization Environmental Footprint (OEF), published in 2013 by the European Commission (EU 2013), is another approach for LCA of organizations. Although OEF is not described in detail in the current paper, the reasoning stated why the organizational perspective of OLCA could be beneficial for SLCA and how the OLCA framework can be considered for developing the new SOLCA approach generally applies also for OEF.

The goal of the current paper is to propose a new approach namely social organizational LCA (SOLCA) and to present its first outline. It starts with discussing why SOLCA is needed by describing how it helps to overcome major challenges of SLCA (Section 2). Then, first ideas of the conceptual framework of this new method are suggested (Section 3) followed by presenting how SOLCA could be implemented in practice considering different levels of organizations' experience in social and environmental assessments (Section 4). After drawing some conclusions, the last section of the paper focuses on some specific challenges related to this new method (Section 5).

SOLCA is not understood to replace existing approaches but rather to complement them both by enhancing the scope (addressing the whole life cycle and/or additional social aspects) and by making them more applicable (using an organizational instead of product perspective).

2 Rationale for the SOLCA approach

Several challenges of the current SLCA method are still not tackled and thus hinder a feasible and meaningful use of it in practice. The organizational perspective of OLCA can help to overcome some of these restrictions. Therefore, it offers a chance to actually use the benefits of life cycle-based social assessments of products and organizations, namely to contribute to an improvement of living conditions of stakeholders along the whole value chain. The most obvious challenges of the current SLCA approach for which organizational perspective may offer potential solutions are described in the following and summarized in Table 1.

2.1 Allocation of indicators or impacts to product level

One main challenge in SLCA is the difficulty to link social indicators and impacts to a product. The indicators proposed in the SLCA guidelines (UNEP/SETAC 2009) and the related methodological sheets (UNEP/SETAC 2013) are classified into generic and specific (depending on the data source level), with generic data typically collected at country or sector level and specific data usually at organizational or facility level, and very seldom on product level.

Based on this, a first analysis and categorization of the indicators proposed in the UNEP/SETAC (2013) was conducted by the authors. The indicators were evaluated based on the data sources proposed in the methodological sheets. The data sources refer to different levels: product (e.g., product labelling), organization (e.g., GRI reports), and/or country/sector (e.g., national statistics) level. For example, the indicator "extraction of material resources" refers to country level

[1] The two publications "Guidelines for product social life cycle assessment" (UNEP/SETAC 2009) and "Guidance on organizational life cycle assessment" (UNEP 2015) use the acronym "S-LCA" and "O-LCA", respectively. However, according to the *International Journal of Life Cycle Assessment* editorial policy, the acronym used by ISO/TS 14072, without hyphen, should be used here for "OLCA" and the same policy is used for "SLCA" and "SOLCA."

[2] Indicators (e.g., number of working hours) are used to measure social impacts (e.g., health and safety). Usually, several different indicators are used to assess one impact category.

Table 1 Relevant challenges of the current SLCA approach (UNEP/SETAC 2009) and potential solutions offered by the organizational approach SOLCA

SLCA challenges	Description	Potential solutions offered by the organizational approach SOLCA
Allocation of indicators or impacts to product level	The difficulty to link social indicators/impacts to the product or function is noted in the SLCA guidelines and experienced in case studies. Most case studies define functional units but do not link results to the functional unit/the specific product.	Linking social indicators and impacts to the reference unit of SOLCA—the reporting organization—instead of a product seems both more logical, practical and feasible.
Data collection	Generic databases are missing and the few existing ones only refer to risks on country/sector level. The collection of site-specific data is mostly done on an organization (or facility) level but not on a product level. Consequently, so far, no case study addresses the whole life cycle; all use a big share of generic sector/country data.	SOLCA could partly facilitate data collection as specific data is more likely to be available on organization, than on product level. An assessment on the organization level may be more comprehensive for the management than one on the product level; thus, further resources needed for data collection may be mobilized.
Application and use in practice	Most case studies do not clearly define the intended application and do not evaluate social performance on a truly product level.	SOLCA clearly refers to the assessment of organizational behavior and performance. Comparison of organizations is not an intended application of SOLCA (see Section 3.1.1).

according to the proposed data source (i.e., OECD data on extraction of material resources by country), while the indicator "number of consumer complaints" refers to product and/or organization level according to the proposed data source (i.e., enterprise specific reports or interviews with retailers). Overall, the analysis revealed that only 8[3] of the 189 recommended indicators show a direct relation to the product level (see Fig. 1 and Electronic Supplementary Material SM1). The vast majority refers to the organizational level (127) and/or country level (69).

A second analysis and categorization of the indicators (independently of the advices given in the methodological sheets) was conducted by the authors. Here, the categorization was not done based on the data sources in the methodological sheets but based on the criteria if the indicator could be principally used to assess product, organization, and/or country/sector performance. The conclusion, i.e., the prevalence of organization-related indicators, was the same, though the numbers slightly changed (see Fig. 1).

In both analyses, an allocation of indicators to more than one category was possible; thus, the three categories together add up to more than 189 indicators. For instance, the indicators "extraction of material resources" or "evidence of restriction to freedom of association and collective bargaining" were categorized at country level in the first analysis (due to the suggestion in the methodological sheets). As "evidence of restriction to freedom of association and collective bargaining" actually can be also specific to an organization, the indicator was allocated to both organization and country level in the second analysis. Similarly, the indicator "extraction of material resources" can also be specific to an organization or even a product and was thus allocated to country, organization, and product level.

The prevalence of organization-related indicators is in fact reasonable, as most impacts addressed in SLCA are linked to organization´s behavior and not to a product/process (as in environmental LCA) (Jørgensen et al. 2008; Wu et al. 2014). Consequently, there is no straightforward relation between the social indicators and the product performance, i.e., potential social impacts related to a particular product. The resulting difficulty to link SLCA indicators and impacts to the functional unit is also noted in the SLCA guidelines and reflected in other publications dealing with methodological developments (Dreyer and Hauschild 2006; Jørgensen 2013; Wu et al. 2014) and practical application of the SLCA guidelines. In most case studies, if not all, functional units are defined, but the SLCA results are not really linked to them (e.g., Hunkeler 2006; Franze and Ciroth 2011; Ekener-Petersen and Finnveden 2013; Hosseinijou et al. 2014).

The facts that the majority of currently used SLCA indicators (and described social aspects) refer to the organizational level, as well as the unclear relation of these indicators and aspects to the product level (to the functional unit), favor an

[3] The eight indicators which can refer to the product level are as follows: "number of consumer complaints," "total number of incidents of non-compliance with regulations and voluntary codes concerning health and safety impacts of products and services and type of outcomes," "quality of or number of information/signs on product health and safety refer to the product level," "quality of labels of health and safety requirements," "consumer complaints regarding transparency," "certification/label the organization obtained for the product/site," "disputed products (labelling, etc.)," and "contribution of the product/service/ organization to economic progress."

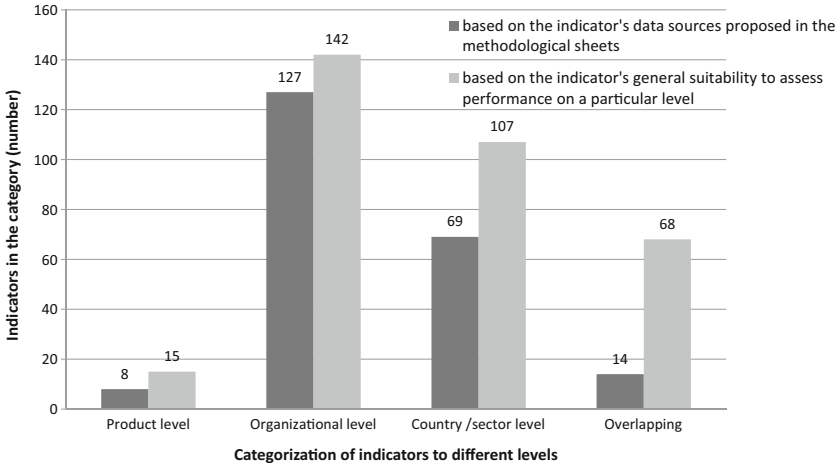

Fig. 1 Categorization of the 189 indicators from the methodological sheets to product, organization, and/or country/sector level based on (1) the data sources provided in UNEP/SETAC (2013) and (2) their suitability of to assess product, organization, and/or country/sector performance ("Overlapping" means that the indicator could be allocated to more than one category)

organizational approach for SLCA. Linking social aspects to a "reporting organization"—the reference unit of OLCA and SOLCA (see Section 3)—seems more logical, relevant, and practicable than linking them to the product.

2.2 Data collection

Another central challenge addressed in the SLCA guidelines as well as in most SLCA case studies is data collection. While for environmental LCA generic product-specific data exist, the few available databases for SLCA, like the Social Hotspot Database (SHDB 2015), only provide generic data or risk values on a sector and/or country level and thus do not allow for assessing the social performance of a particular product or organization. To do so, the practitioner would need to collect specific data both for the background and the foreground system of the life cycle. This is hardly feasible as collecting data for the foreground system alone already involves high efforts. But also, if the practitioner focuses on specific data for the foreground system, the data collected are typically only on an organization but not on a product level. Due to these challenges in data collection, none of the existing SLCA case studies address the whole life cycle and all use a big share of generic country or sector data.

The assessment from an organizational perspective would not necessarily make data collection easier per se but more meaningful, as the relation between the assessed indicators and the social performance of the organization is more visible and more straightforward. Furthermore, a comprehensive assessment of the social performance of organizations, or of products produced/traded by them, requires the involvement and support of different departments and management levels and further resources may be mobilized. This means that in the long-run, this may lead to increased data availability and an easier data collection. For instance, when the whole organization is assessed, the organization may see the need to establish specific data collection schemes or tools (or adapt/extent existing ones) and request all the facilities or suppliers to use them. Using such data collection schemes or tools would allow for collecting the high volume of data needed for a life cycle-based social assessment. However, a successful data collection generally depends strongly on the willingness and social responsibility of companies along the value chain. While socially responsible companies may put effort in data collection, others may not.

2.3 Application and use in practice

A third relevant challenge in current SLCA we would like to address here is the gap between theory and practice regarding the intended application of SLCA studies. Among others, the SLCA guidelines list the assessment of the consequences of a decision to be made, the comparison of different products, or decision support within organizations to improve their social performance as potential goals. None of them are yet properly reflected in existing case studies. This is closely related to the challenges outlined above: if the relation between products and assessed social aspects is not clear, how can alternative products be compared? And how can SLCA results support decision-making processes in a robust and meaningful way if they are based on generic country or sector data or risks only?

As the organizational approach can help to overcome some of the major challenges of current SLCA, its implementation in practice seems more likely. The framework provided by the SLCA guidelines generally fits for the organizational perspective, and the developments and experience achieved during the last 5 years can be implemented to the organizational perspective without too many difficulties. Moreover, once established, SOLCA also can help to make assessments on a product level—which current SLCA strives for—more feasible. For example, data and knowledge of the value chain provided by SOLCA studies, as well as data collection schemes established in organizations, can be potentially used also for product SLCA.

It should be also noted here that the description of the challenges does not refer to any particular phase of the life cycle. However, overcoming any of the challenges would benefit all the steps of the new methodology not only the inventory or the definition of the goal but also it would streamline the scope delimitation and the interpretation of the results.

3 Conceptual framework

In this section, we want to lay the ground for the conceptual framework of SOLCA. To do so, we made a comprehensive revision and comparison of the two methodologies that are the basis of this new approach. Main reference methodological documents were considered here for SLCA (UNEP/SETAC 2009) and OLCA (ISO 2014; UNEP 2015). The two methodological schemes were combined, and first requirements and recommendations were derived for SOLCA. None of the two methodologies can be considered as consolidated and few real experiences of broad implementation exist (Jørgensen 2013; Lehmann et al. 2013; Petti et al. 2014; UNEP 2015). Nevertheless, the scant available practice, along with previous insights and agreements on the assessment of social aspects and of the organization level, pointed out in the reference documents, should guide the definition of the particularities of the new concept.

The analysis performed for the two existing methodologies and the derived proposals for SOLCA focus on those steps and elements of the LCA methodology that differ between the three methodologies and where difficulties or additional questions may be encountered. The four LCA phases—goal and scope, life cycle inventory (LCI), life cycle impact assessment (LCIA), and interpretation—are the backbone of the three approaches and generally include the same elements. The steps identified for OLCA as more affected by shifting to organizational perspective are goal and scope and LCI (Finkbeiner and König 2013; ISO 2014; Martínez-Blanco et al. 2015a; UNEP 2015), and this is also observed for SOLCA.

In this section, we do not aim at presenting a comprehensive explanation on how to apply SOLCA step by step but rather focus on definition and on some selected elements of the phase goal and scope and life cycle inventory; impact assessment and interpretation of SOLCA are mostly based on the SLCA outline. A complete, but schematic, analysis for almost all the steps and elements of SOLCA and the corresponding proposals are presented in the Electronic Supplementary Material SM2.

A preliminary definition for SOLCA can be produced by merging the definitions of OLCA and SLCA: "social organizational LCA is a compilation and evaluation of the social and socio-economic aspects and the positive and negative impacts of the activities associated with the organization as a whole or a portion thereof adopting a life cycle perspective."

3.1 Goal and scope

The foremost elements for the goal and scope definition of SOLCA are summarized in Table 2. The stakeholders should be involved during the definition of the goal and scope of the study, apart from during data collection as in OLCA. Other items required in the framework of LCA according to ISO (2006a; 2006b) and that were not detailed here, or in the Electronic Supplementary Material SM2, are to be included in SOLCA scope, like the elements "assumptions and limitations," "value choices," and "optional elements."

3.1.1 Goal

The results of a SOLCA study are not intended to be used in comparative assertions intended to be disclosed to the public. This is in contrast to SLCA but in line with the OLCA approach, claiming that "the comparability step is neither meaningful nor robust at this point in time, due to the lack of a consistent basis for comparison between organizations, […as] different organizations have vastly variable product portfolios" the guidance on OLCA (UNEP 2015) and even within the same sector, the size, location, and overall business model can be significantly different (Finkbeiner and König 2013).

3.1.2 Unit of analysis

As for SLCA and OLCA, a clear definition of the unit of analysis is a key element of the SOLCA scope. Function is the main basis for the definition of the unit of analysis in product SLCA. For the assessment at the organizational level, the organization and its portfolio are per se the unit of analysis (Martínez-Blanco et al. 2015a), which is named reporting unit by ISO/TS 14072. The concept was broken down by the Guidance on OLCA (UNEP 2015) into two items: the reporting organization that defines the organization (i.e., the reference unit) and the reporting flow, which ideally represents the quantification of its product portfolio.

The reporting organization should be described like for OLCA in terms of subject of study, sites that are to be partially or totally considered, and period when the organization is depicted. The subject of study should represent a clear unit of operation, the whole organization, or a segment thereof (e.g., business divisions, brands, regions, or facilities). However, for the overall purpose of SOLCA—analyzing the behavior of an organization in order to contribute to improving living conditions of stakeholders along the whole value chain—it seems irrelevant whether the impacts occur in only one segment or in the whole organization. Thus, particular attention should be paid to the possibility of using segmentation for the exclusion of particularly sensitive sites or locations. The application of a consolidation

Table 2 Methodological framework comparison for goal and scope of SLCA, OLCA, and the new SOLCA approach

	SLCA (UNEP/SETAC 2009)	OLCA (ISO 2014; UNEP 2015)	New SOLCA
Goal	1. The ultimate goal is to promote improvement of social conditions and of the overall socioeconomic performance of a product throughout its life cycle for all of its stakeholders. 2. The results may be used in comparative assertions intended to be disclosed to the public.	1. The ultimate goal is to identify and reduce environmental impacts of an organization and its value chain. 2. The results are not intended to be used in comparative assertions intended to be disclosed to the public but for internal decision-making, performance tracking, communication, etc.	1. The ultimate goal is to promote improvement of social conditions and of the overall socioeconomic performance of an organization and its value chain and for all of its stakeholders. 2. As in OLCA
Unit of analysis	1. It is defined by the functional unit and the reference flow. 2. Functional unit is the quantified performance of a product system for use as a reference unit (ISO 2006b). 3. Reference flow is a measure of the outputs from processes in a given product system required to fulfill the function expressed by the functional unit (ISO 2006b).	1. The concept used by ISO/TS 14072 is the reporting unit, which integrates the two items considered in the OLCA Guidance: the reporting organization and flow. 2. Reporting organization is the organization under study to be used as a unit of analysis. Includes subject of study, consolidation method, and reference period. 3. Reporting flow is a measure of the outputs from the reporting organization during the reference period.	1. The elements reporting organization and reporting flow are used here, following OLCA. 2. Reporting organization: same definition and elements as for OLCA with some specifications. Although for social aspects, it is irrelevant where the impacts occur, if properly justified, the definition of selected parts of an organization is possible. The attributes or characteristics of the units cannot be distributed according to equity share, as they are inherent to the unit. 3. Reporting flow: suggestion to express it in non-physical terms: economic revenue or number of employees or a combination of those.
System boundary	1. When product or intermediate product flows cross the system boundary, the associated elementary flows cannot be considered, as adequate social data do not currently exist. 2. Cutoff, according to social risks, preferably, or added value, worker hours, influence, etc.	1. Due to the existence of product LCA generic databases, the elementary flows associated to a product or intermediate product can usually be considered. 2. Cutoff according to environmental impacts, preferably, or mass, energy, etc. 3. Offsetting projects are not supported by the OLCA Guidance and shall not be aggregated with the final results.	1. As for SLCA 2. As for SLCA 3. As for OLCA

method[4] assists in representing the structure of the organization and its relationships with other organizations to consolidate its units (e.g., facilities). While the concept is meaningful for SOLCA, difficulties during its application may be encountered, for instance for the consolidation method equity share, which is defined in accordance to the share of equity interest of the organization over each unit. This method means that the attributes or characteristics of the units are distributed according to the share of equity interest. However, in SOLCA, the attributes or characteristics cannot be distributed as they are inherent to the unit. Furthermore, the environmental impacts should be expressed for a reference period, usually 1 year. While it may not be possible to express attributes or characteristics quantitatively per reference period, as in OLCA, they could be expressed as valid for the reference period.

The reporting flow is particularly needed to build up the value chain model. It represents the scaling factor to aggregate the inventory; hence, in SOLCA, it is somehow connected with the use and definition of an activity variable, proposed in UNEP/SETAC (2009). It should be defined based on the organization's size but not necessarily through the amount of products in the portfolio as done in OLCA. Because social aspects do not usually have a direct relation with physical world (products and processes), the reporting flow should not be defined based on the amount of products produced by the organization. Using a physical measure, as recommended for OLCA and SLCA, seems not necessarily to be suitable to report non-physical social impacts (see Section 2.1). Therefore, we suggest expressing the reporting flow in non-physical terms, like economic revenue or number of employees. The latter seems especially suitable for worker-related issues. A combination of number of employees and

[4] This is the approach to be selected by the organization for setting the reporting organization. It represents the structure of the organization and its relationships with other organizations. Note: three distinct approaches can be used, the operational control, financial control, or the equity share (UNEP 2015).

economic revenue (although being an artifact) may be the best option.

3.1.3 System boundary

The system boundary defines which unit processes are included in the system assessed. In SLCA, databases with secondary data that model processes with generic social data do currently not yet exist. As a consequence, existing SLCA case studies mostly focus on selected life cycle phases only, not on the whole life cycle (as addressed in Section 2.2). This challenge is not directly solved by SOLCA, although the broad application of it actually may contribute to the more comprehensive provision of secondary data.

In principal, all the processes and activities involved in the provision of the product portfolio of an organization should be included (e.g., raw materials and energy production, transportation, manufacturing, etc.). However, those processes which are assumed to be insignificant can be cutoff. Significance should be defined, preferably according to social criteria, alternatively also according to added value, worker hours, or influence, while physical criteria (like weight) may have little relevance for SOLCA.

Offsetting projects are not supported in OLCA "as hypothetical offsetting scenarios shall be defined for every impact category" (UNEP 2015), and if included in the study, they shall not be aggregated with the final results. Social impacts cannot be globally balanced out, because they are experienced by particular stakeholders who do not benefit from any project improving the conditions of other stakeholders, e.g., workers from other regions.

3.2 Life cycle inventory

The inventory is the phase when data is collected, systems are modeled, and life cycle inventory results are obtained, based on the study's goal and scope. Main issues to bear in mind for SOLCA inventory phase are summarized in Table 3. The inputs and outputs of the processes and activities along the value chain, which basically build the inventory for OLCA, are used in SLCA and SOLCA to identify the involved organizations, locations, and stakeholders in the several steps of the value chain.

In general, for SOLCA, and also for SLCA, the location of the facilities, the suppliers, and other partners of the value chain are of high importance to assess the potential social impacts and should be included. The location information in OLCA is optional but useful for refinement of the OLCA results, for example regarding to country-specific electricity mix, or when region-specific impact methods are used.

3.2.1 Data needed and data collection

Social data are information on product- or organization-related social aspects and can be qualitative, quantitative, and semi-quantitative. Also, subjective data (e.g., consumer perceived level of satisfaction with the product) may be considered. The type of data influences the feasibility of the inventory analysis and impact assessment. Qualitative data, for instance, can hamper further steps of the assessment, like allocation and aggregation (see Section 3.2.2 and 3.2.3).

In SLCA, a social hotspot analysis is recommended before starting the main data collection, and it is an option in SOLCA as well. A social hotspot analysis could be performed based on generic data and social risk assessment (on sector/country level), for example by using the Social Hotspot Database (Benoît Norris et al. (2014)) assessed the hotspots of 100 products). However, the uncertainty of the hotspot analyses and databases needs to be critically reflected in order to avoid focusing on the wrong issues or overlooking actual hotspots. During data collection, the use of specific data for the organization assessed is expected, at least for the identified hotspots.

3.2.2 Relating data to unit of analysis and multi-functionality

In SLCA, qualitative data may not be expressible per unit of process output nor per functional unit or reference flow. Even quantitative data may be difficult to interpret from a social perspective when it is expressed per unit of process output. In SOLCA, the same applies, but as the unit of analysis is the organization (and not a product) and data collected are typically related to the organization, the results are already per unit of analysis (see also Section 2.1).

However, in certain situations, when only a part of an organization (or a facility or a brand, etc.) is included in the study, this would require allocation of the social aspects or impacts, and it may be necessary anyway to express them per unit of process output. This is the case when only some of the products of a supplier's portfolio are consumed by the reporting organization or when the reporting organization shares facilities, activities, or processes with other organizations.

3.2.3 Aggregation of data

Aggregation of social life cycle inventory data should not be done in a way that leads to a loss of information about the location of the unit processes and thus related social aspects. Site-specific information may be necessary during impact assessment. Therefore, for SOLCA, aggregation (e.g., of the results along the value chain or for different sites of the organization) may be more convenient at the impact assessment phase of the study. In SLCA, the use of an activity variable (e.g., working hours and/or added value) is suggested to inform on the relative importance of each unit process regarding a particular social aspect. The same approach may fit for SOLCA.

Table 3 Methodological framework comparison for life cycle inventory of SLCA, OLCA, and the new SOLCA approach

	SLCA (UNEP/SETAC 2009)	OLCA (ISO 2014; UNEP 2015)	New SOLCA
Identify data that needs to be collected	Inputs and outputs of the processes and activities are only used to identify the involved organizations, locations, and stakeholders.	Direct and indirect processes and activities are the source of impact, due to the associated resource use and emissions. It should consider supporting activities (e.g., business travel, cleaning services).	The list of indirect activities proposed for OLCA may be useful to identify the organizations involved in the value chain. Supporting activities should be considered.
Data collection	1. The use of specific data for the product assessed is expected, at least for the identified hotspots. Social hotspot analysis based on generic data is particularly recommended in SLCA. 2. Data collection is suggested at the facility level.	1. Specific data should be used for direct activities. The use of generic or extrapolated data may be used for indirect activities. Prioritize data collection efforts according to the criteria set for cutoff (Table 2). 2. Data collection performed with a bottom-up (at the product level) or a top-down (at the organization or facility level) approaches.	1. Specific data should be used for direct activities, at least for the identified hotspots (based on generic data). The use of generic or extrapolated data may be used for indirect activities. Prioritize data collection efforts according to the criteria set for cutoff (Table 2). 2. Data collection is suggested at the organization or facility level.
Relating data to unit of analysis	Qualitative data, and even some quantifiable data, may not be expressible per unit of process output nor per product.	Most of the data used in the inventory is quantitative and physically related to the unit process output. Thus, it can be allocated in principal.	In most cases, the social aspects relate to the organization, hence no need to express them per unit of process output.
Multi-functionality	1. It occurs when a process has more than one co-product and only one is assessed. The share of impacts for the product assessed should be modeled. 2. Solution: use the ISO 14044 hierarchy. 3. Only solvable for data expressible per unit of process output. It may not be feasible for qualitative and semi-quantitative data.	1. It occurs when only some of the products in the supplier's portfolio are consumed by the reporting organization or when the latter shares facilities, activities or process with other organizations. 2. Solution: modified hierarchy from ISO 14044 (no system expansion). 3. All the data of the inventory can be, in principal, allocated.	1. As for OLCA 2. As for OLCA 3. As for SLCA
Aggregation of data	Aggregation is recommended at the impact assessment phase of the study, in order not to lose location information.	Life cycle inventory data with the same units may be aggregated in principal.	As for SLCA

3.3 Impact assessment and interpretation

The same standpoint and main parts of SLCA apply to SOLCA, as well as most of the indicators, impact categories, aggregation schemes, etc. Similarly, product and organizational environmental LCA also share the same approach for LCIA (UNEP 2015). Therefore, the impact assessment step in SOLCA is strongly affected by the existing limitations and challenges of that issue for SLCA.

Indicators are the link of the social information with social impacts; however, a fixed list of social indicators is not yet available, but a lengthy list of subcategories and related issues is proposed in the SLCA methodological sheets (UNEP/SETAC 2013). Indeed, there is a high variability on the social indicators and issues considered between studies. Besides, the current list of indicators includes a mix of indicators describing real impacts (e.g., "'number/ percentage of injuries or fatal accidents in the organization by job qualification inside the company"), risks (e.g., "risk of forced labor used for production of commodity") and inventory data (e.g., "percentage of permanent workers receiving paid time-off"). Currently, a unique and agreed approach for the assessment of the social impacts does not exist. The suggested schemes range from the use of performance reference points to proper characterization through social impact pathways (Parent et al. 2010). Comprehensive, applicable, and tested impact assessment models as for LCA are not yet available for SLCA and SOLCA.

As suggested for SLCA, during the interpretation step, apart from fulfilling the requirements in ISO 14044, the study should evaluate the level of engagement of the stakeholders.

4 Implementation of SOLCA—based on previous experience of the organization

The proposed conceptual framework for SOLCA (in Section 3) provides basic guidelines on how to conduct SOLCA from zero experience. SOLCA implementation can benefit from

organization's previous experience and existing practice with other social and environmental assessment approaches. Hence, if the organization has previously used social approaches at the organization (e.g., GRI) or product (e.g., SLCA) level, or environmental life cycle approaches (e.g., EMS or OLCA), it may not need to start from scratch the implementation of SOLCA (Fig. 2).

In the following, three pathways are introduced according to the organization's previous experience with social and environmental assessments, and it is discussed how they can be used to implement SOLCA and to streamline its application. All three pathways were developed based on the pathway scheme proposed for OLCA (UNEP 2015). In Fig. 2, the middle circle represents the key features of SOLCA, i.e., life cycle perspective, organizational perspective, and consideration of social aspects. The three outer circles represent the experience of organizations with social and/or life cycle-based assessment approaches. The three pathways indicate which of the three key features of SOLCA are missing in the approaches already applied by the organizations and which need to be included for implementing SOLCA. For example, existing social organizational approaches lack of a life cycle perspective. Thus, for implementing SOLCA, the life cycle perspective needs to be additionally addressed (pathway 1). In the following, the three pathways for implementing SOLCA based on organization´s experience are described in detail. Needless to say, the particular pathway for a certain organization may be also a combination of the proposed options.

4.1 Pathway 1: experience with social organizational approaches

Organizations that have applied social approaches at the organizational level may apply SOLCA using available results and experience as a starting point. These assessments are often performed within the context of sustainability reporting or Corporate Social Responsibility (CSR), but further circumstances could drive organizations to apply other approaches such as Social Impact Assessment (SIA) or others.

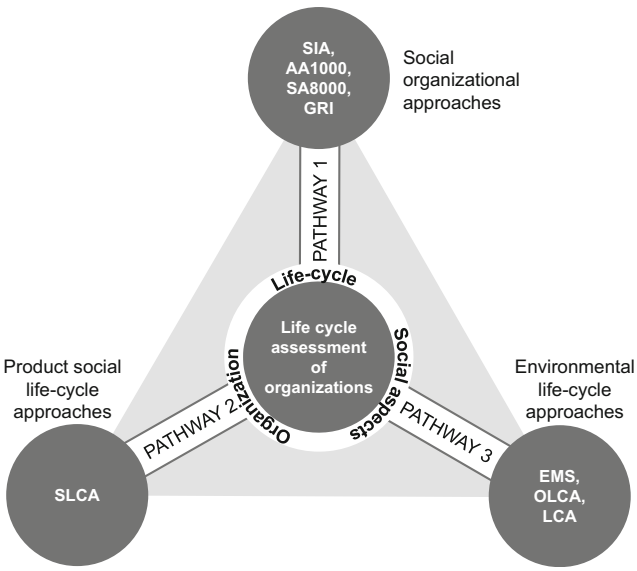

Fig. 2 The three experience-based pathways to implement SOLCA. Source: based on Martínez-Blanco et al. (2015b)

The European Commission (2011) defined CSR as a concept "whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis," meaning that organizations take responsibility for their impacts on society. Current CSR approaches can be categorized in three main types, according to the level at which data is gathered: type 1 are the approaches where data collection is conducted at the organizational level, for example Account Ability's standards (AA1000 series); type 2 focuses both on the organization and the facility levels, such as Social Accountability 8000 (SA8000) standard; and type 3 includes the latter and at least parts of the supply chain.

Within this pathway, we consider some of the approaches most widely used by organizations: SIA, AA1000, SA8000, Fairtrade certification, and GRI. In general, these approaches could be helpful in two different ways. First, data on social aspects for the organization and its facilities could be transferred to SOLCA to complete the inventory for direct activities, but its applicability would depend on which and how many indicators were assessed and how comprehensive the assessment was. Second, preliminary definition of the organization's structure, inputs and outputs, etc. can help regarding the definition of the system boundary, the data needed, and the identification of the network of suppliers.

SIA focuses on the plan, project, or facility level and analyses the potential social consequences of policy actions or project development in a particular region (similarly as environmental impact assessment (EIA) does for the environmental perspective). The information obtained, i.e., potential social impacts on the local community, could be useful for SOLCA inventory as well. AA1000 is a standard for social and ethical accounting, auditing, and reporting from a management organizational level and is addressing issues such as governance or business models. It is concerned about reflecting the needs of all stakeholders (e.g., providing guidance on stakeholder engagement) and using only data of high quality for the assessments (Göbbels and Jonker 2003; AccountAbility 2015). The available social data as well as the knowledge on and contacts to stakeholders could be a useful starting point for SOLCA. SA8000 (being among others based on the UN Declaration of Human rights and ILO conventions) enables to verify both ethical sourcing of products and decent working conditions (Göbbels and Jonker 2003; SAI 2015). Fairtrade certification has a similar focus as SA8000 but additionally assesses trading issues, for example, payments to producers in order to cover the costs of sustainable production (Fairtrade 2011). It mainly observes the issues

of labor on-site and focuses on developing countries. Both SA8000 and Fairtrade certification can provide data on the particular situation of the workers in the facilities of the reporting organization and especially help further on the identification of suppliers.

The GRI offers principles and implementation guidance manual for the preparation of sustainability reports by organizations, including environmental, social, and economic aspects (GRI 2013). It is applied by many organizations worldwide, thus has a great potential for transferability to SOLCA. It expanded from type 1 to type 3 based on the G4 Sustainability Reporting Guidelines. However, the coverage of the value chain is still limited to few social aspects (UNEP/SETAC 2009; GRI 2013). The existing experience with GRI can provide useful information for goal and scope definition of SOLCA and useful data for the inventory. Moreover, it could guide the identification of the suppliers and give insight about the relations between different departments as well as internal management levels within an organization and with suppliers. Furthermore, the organizations can directly adopt some of the social indicators proposed by GRI, especially those involving the value chain.[5] SOLCA implementation can support organizations that have previously applied GRI to effectively and comprehensively identify further improvement opportunities throughout the value chain.

4.2 Pathway 2: experience with product social life cycle approaches

Pathway 2 considers organizations that have already performed SLCA of products from their portfolio and now want to further assess the social performance of the entire organization. At this point of SLCA development, it is hardly feasible that an organization has performed SLCAs of several products already. However, if such data exists in the future, this would be highly useful to perform SOLCA because, as it was pointed out in Section 2.1, most of the available social data and existing indicators used by current SLCA are actually at organizational, not at product level.

For small organizations with a small product portfolio, the existence of few product SLCAs could be particularly relevant for building SOLCA. For big organizations, even if only one or few product SLCAs exist, they may help to point out hotspots previously identified as relevant at the product level for a part of the portfolio of the organization.

When a similar experience-based pathway was defined for OLCA, UNEP/SETAC (2015) suggested that the existing environmental product LCAs should be weighted by the amount of products that are produced and summed, along with supporting activities. However, for the social dimension, the summation is not straightforward: first because qualitative or semi-quantitative values are difficult to sum up and second because such a summation could lead to double counting and potential bias due to the unclear cause-and-effect relations of social impacts, for example health impacts to workers involving different product production. As social data in SLCA is already at the organizational level, the social aspects considered may be the same for different products, sharing sites, and/or suppliers.

4.3 Pathway 3: experience with environmental life cycle approaches

Organizations that have applied environmental assessments—on-site (like EMS) or considering the life cycle (like OLCA)—are addressed in this pathway. Although the data collected for those approaches correspond to the environmental dimension, it could still help to streamline the application of SOLCA.

The existing experience can support with a preliminary definition of the goal and scope, which could be adapted to the social context. For instance, when OLCA was applied, it may already provide a definition of the reporting organization and boundaries. Indeed, if the organization's overall aim is a sustainability assessment for the organization and its value chain, it may prefer to use the same scope in both OLCA and SOLCA. These approaches may also provide a preliminary inventory (inputs and outputs) of the reporting organization which could be helpful for the identification of the suppliers, locations, and involved stakeholders. Furthermore, relations settled between different internal management levels and with suppliers, and data collection schemes developed by the organization for OLCA, may provide a promising framework to apply SOLCA and to implement the measures proposed to improve the social performance. For small organizations and/or organizations with narrow portfolios, one or few environmental product LCAs, or even single-indicator footprints for carbon or water, could also significantly help with regard to a future implementation of SOLCA.

5 Conclusions and outlook

An adaptation of the schemes for SLCA and OLCA allows presenting a first outline of the SOLCA methodology, and existing experience of organizations regarding social and

[5] Twelve indicators of the G3 and/or G4 of the GRI were already identified as transferable to SLCA in UNEP/SETAC (2013), and we consider that this applies for SOLCA as well, for example "total numbers of incidents of discrimination and actions taken," "benefits provided to fulltime employees that are not provided to temporary or part-time employees," "education, training, counselling, prevention and risk control programs in place to assist workforce members, their families, or community members regarding serious diseases," etc. (GRI 2013; UNEP/SETAC (2013).

environmental assessments may steer the implementation of the new SOLCA approach. Together with OLCA, SOLCA represents a step forward to a sustainability assessment at the organizational level including the value chain. Some of the challenges of SLCA may be overcome due to the organizational approach. However, other limitations of the parent methodologies are inherited by SOLCA and thus stay in the new approach (e.g., a yet missing LCIA method for social aspects or the lack of generic databases for background processes). We also identified that few of them may be intensified in certain situations by the combination of social and organizational approaches. These specific SOLCA challenges are addressed in Section 5.3 and need to be further explored.

5.1 Definition and implementation of SOLCA

Following the Guidance on OLCA (UNEP 2015) for the environmental dimension, the product SLCA framework has been adapted to the organizational level assessment. Main differences were identified at the goal and scope and inventory level, while impact assessment and interpretation are very similar to SLCA. Although the elements to consider during interpretation are the same, the organizational perspective will ease the understanding of the results.

Along with discouraging comparative assertions intended to be disclosed to the public, a new unit of analysis was drawn for SOLCA, including both definition and quantification, which also influences the delineation of the system boundary. The specificities of social and organizational perspectives affect also the inventory. Key elements are the behavior of involved organizations, locations and stakeholders, and the common use of semi-quantitative or qualitative indicators that are collected at the organizational level. The latter overcomes one of the major limitations in SLCA, i.e., the relation of the indicators to the unit of analysis (product level).

SOLCA implementation can benefit from organization's previous experience with social or environmental assessment approaches, like GRI, SLCA, LCA, EMS, etc. The data and experience generated can streamline SOLCA application by guiding the definition of the scope of the study, by identifying hotspots and main suppliers, by the connections established between different departments of the organization or with suppliers, or even by directly providing data to the inventory.

5.2 SOLCA in the context of sustainability

Social assessments from a life cycle perspective are strongly needed for sustainability assessment. Current SLCA has many unsolved methodological and practical challenges, leading to the fact that no real effect in practice, with regard to improved social conditions, is visible. We hope that the organizational approach may help to increase implementation of social life cycle-based assessments in practice as at least some of the major challenges could be tackled.

With regard to life cycle sustainability assessment (LCSA), it seems feasible to use an organizational approach as well, even though LCSA currently has a product perspective (Finkbeiner et al. 2010; UNEP/SETAC 2011). We see three main arguments: (1) LCSA is still young and not very much implemented in practice, thus open for adaptations; (2) existing SLCA studies also report rather at an organizational level or at least they usually do not relate the results to a product level; and (3) from a social sustainability perspective, an assessment on the organizational level would be feasible or even more valid as it gives the "full picture" of the organization considered. For example, when two alternative products from two alternative organizations have the same social performance, the organizational approach assessment may provide a more comprehensive idea of the overall social performance of these organizations by revealing the behavior of their producers in other countries or for other products and favor one of the options.

With OLCA, an organizational approach for the environmental dimension of sustainability was recently proposed, and some practical experiences already exist. As the new OLCA becomes general practice, it will steer an organizational approach also for the social dimension. This paper aims to lay the ground for the progress, improvement, and dissemination of a life cycle-based social assessment by using the organizational level. An economic life cycle assessment at the organizational level seems theoretically also feasible. One reason for it is that an organizational approach seems to be better related with the current (though not yet life cycle based) financial reporting schemes of organizations, where data is presented for the whole organization—or lower levels, like brands, but generally not for one sole product. Thus, we recommend that the development and potential of the economic dimension at the organizational level are further explored.

SOLCA results can certainly contribute to sustainability reporting not only by providing a high standard of quality data and a wider approach (i.e., including the life cycle) to existing reporting schemes but also by enabling a basis for direct communication of organization's social performance—as some examples in the Guidance on OLCA (UNEP 2015) did it for the environmental dimension. Furthermore, it could help organizations to reduce data and knowledge demands needed for applying other sustainability tools—apart from the other way round as described in Section 4.

5.3 Specific challenges of the new SOLCA

In this section, specific challenges identified for the new SOLCA approach are marked out and discussed. Additionally, priority areas for further development of the methodology are proposed.

5.3.1 Distribution of impacts

In SLCA, when using organization-related indicators to assess a product, which currently occurs in most of the cases, a certain attribute of the organization or a facility is considered as true for all products of the product portfolio (thus also for the specific one under study). This reasoning may be also used in SOLCA for example in those situations when only a part of a whole organization is considered, thus assuming that each part holds the same attributes as the whole system.

However, it may happen that the attributes are not the same in the whole organization, which is also often the case in environmental OLCA. In this context, if it does not really matter in which part of the organization (in the segment assessed or in other ones of the organization) the impacts occur, we can adopt an incident approach. This approach would only evaluate whether a certain attribute appears or not in the value chain without regard to the intensity, e.g., either you have child labor in your value chain or you do not. Only sometimes, it may be feasible to use more detailed data to the specific segment of the organization (e.g., facilities of the organization in a certain country). SOLCA users should "be specific about the attribute: whether it is an attribute of the enterprises owning the processes or an attribute of the workers involved in the production process" (UNEP/SETAC 2009). Therefore, this is as well a discussion on availability of generic and specific data.

If we look further, it would be useful that SOLCA shows that different parts of an organization (e.g., different sections producing different products) might differ in their social performance. Of course, this is not intended to offset any bad impacts by good impacts, but when SOLCA shows positive behaviors (as SLCA does), good practices in some parts of the organization could act as role models or incentives for further improvement and organizations which are maybe currently in the process of improving their social performance, but did not yet manage to do so in all parts, would not be penalized and/or discouraged by possible negative assessments.

5.3.2 Complex organizations

When in SLCA, a product is assessed, several organizations are usually involved in its life cycle, and the practitioner needs to assess them in detail and then relate all these specific organization-related data to a product. In many cases, this last step is overcome with SOLCA (see Section 2.1). However, some other existing challenges of SLCA may be intensified in SOLCA when the organization provides a broad portfolio (with more than one product) that involves many suppliers and various use phase and end of life scenarios. This is always the case in big and complex organizations though these organizations are also the ones with larger resources to invest, better pre-existing data collection systems, and more influence on suppliers in the value chain. Thus, these organizations are the ones better situated to apply SOLCA and induce an improvement of the social conditions for stakeholders in the value chain.

An example of an intensified challenge when SOLCA is applied to complex organizations is the limited feasibility of specific or primary data collection for all the individual sites of the organization and for all the products in its portfolio. The definition of clusters and proxy products/sites proposed for OLCA may not be possible for SOLCA. The variability of results when social aspects are assessed is expected to be much higher than for environmental impacts, as it is the behavior of the organization and the geographical context rather than the processes that induces the impacts.

Next to this, keeping the track of locations in big and complex systems may be particularly challenging. As noted earlier, knowing the location of the sites of the organization and the partners in the value chain is of high importance to identify the involved stakeholders, to assess the risk or hotspots according to the context of the specific geographical location, and in case that they exist to provide the insight needed to apply site-specific impact factors. Here, SOLCA may benefit from experiences and available software created for the regionalization of product environmental LCA inventories, although they are still under development (Muttel 2012; Berger and Finkbeiner 2013).

5.3.3 Social performance tracking

Many organizations already consider environmental and social aspects in sustainability reporting but not yet from a life cycle perspective. Thus, we would like to add some remarks about the prospect of performance tracking by using SOLCA.

SOLCA results for an organization may be different from 1 year to the following one, due to changes in the supplier network or the managerial behavior of the organizations involved. If we change the amount of products, it is difficult to tell the effects on social impacts, because the impacts result mainly from the organizations behavior, instead of being linked to the organization's product output. However, more products could demand more workers and could serve more consumers, thus an increased number of people being affected. On the other hand, if a company sells less products, it may reduce the number of employees but the remaining ones would work most likely under the same social conditions as before. If we change the type or nature of the products in the portfolio, two possible situations are foreseen: when these changes in the portfolio do not involve a variation in the network of suppliers (and their associated managerial behavior), social impacts are also likely to be the same, but in case they involve also different suppliers and activities, different social impacts can be expected.

Therefore, defining the changes in the network of suppliers and other partners involved is more important than identifying the changes in the product portfolio. However, it should be noted that a few social indicators, and thus impacts, do relate to the production process and thus to the product as pointed out in Section 2.1. This means that a change in the type of product may indeed affect those social indicators, For example, the indicator "total number of accidents of non-compliance with regulations concerning health and safety" is higher for certain sectors and activities, like mining and quarrying and construction in the USA (ILO 2015). That issue could be transparently addressed in the interpretation of the SOLCA results.

Due to the specificities of social dimension, it seems more difficult, than for OLCA, that site-specific social data is collected every year. This is mainly due to the fact that SOLCA and SLCA are still new approaches; thus, it would take some time to obtain the social data needed and it will be done probably in a step-wise approach. Indeed, even for the environmental dimension, currently most of the organizations are only able to yearly report life cycle data for climate change but not for other indicators.

As it is probably not practicable to yearly perform interviews with all stakeholders, for direct and indirect activities, the organization can collect activity data (including activity variables and other data related to the level of activity, as kilowatt-hour of electricity consumed) and adjust the results for different years. For SOLCA, we think that it is neither necessary to update all indicators nor to do it every year. In this way, only activity data may be annually updated, or the organization may decide to (annually) update data merely for certain activities, sectors, or countries, based on the hotspots identified in the previous SOLCA results. Furthermore, although the inventory and impacts refer to 1 year of operation, the organization can opt to update the results over a longer period of time. This could be also reasonable, as longer time frames may be needed to make results from improvement measures visible. A compromise solution may be to annually update only certain hotspots or activity data and prepare overall updates every 3 or 5 years, for instance.

Apart from further methodological development of the proposed SOLCA framework, which should particularly explore the questions raised in this section, it is recommended to test it in practice, meaning to apply the concept of SOLCA to case studies. One good way to start could be to adapt the scope of existing product SLCA case studies and to receive first feedback on the applicability of SOLCA and first answers on the questions raised.

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