

Review

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Review

Social Life-Cycle Assessment in the Construction Industry: A Review of Case Studies

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Abstract: Purpose—The paper aims to view how researchers have operationalized social impact assessment for construction projects over the last ten years. Design/methodology/approach—A systematic review was used to investigate case studies in the Social Life-Cycle Assessment (S-LCA) to analyze the application of the methodology. A qualitative study of 19 articles published between 2012 and 2022 was used to collect content on multiple categories impeding S-LCA through case studies in the construction industry. Findings—Our results showed the existence of limitations on the qualitative and quantitative aspects in measuring the social indicators. They were associated with the scoring method and the lack of data in some articles. Social implications—From this review, we understood that S-LCA has flaws in terms of the quality of the measurement, scoring method, and the lack of social data. Lack of social data means social impacts are being neglected and not assessed properly since there are several challenges pointed out throughout literature. Originality/value—The originality of this research is that it focuses on case studies in the construction industry. It studies the operationalization of the S-LCA in this specific industry showing the different characteristics and challenges in the last 10 years.

Keywords: social life-cycle assessment; S-LCA; social impacts; construction industry; literature review; case studies

1. Introduction

The construction industry is one of the major industries in any national economy regardless of its level of development (Ilhan, & Yobas, 2019). It is responsible for substantial material and resource consumption and its impact on climate change (Balasbaneh et al., 2018). In 2018, the building and construction sectors were responsible for 40% of global greenhouse gas emissions (Larsen et al., 2022), and 36% of final energy use contributed to climate change effects and negatively impacting health (UNEP, 2019). Mostly, with a lack of consideration for waste management and waste reduction in the early phases of projects, there tends to be waste generated by construction and demolition through the life cycle of buildings (Esa et al., 2017) with a remarkable impact of 50 % at the end of life of a project (Kibert, 2016). It has a reputation for its high consumption rate of natural resources, which generates between two and three billion tonnes of building waste per year (Jain, 2021).

Fortunately, the construction sector has started to adopt life-cycle assessments (LCA) to conduct environmental assessment. On the other hand, social life cycle assessment (S-LCA) has not gained as much popularity despite it is recognized as key in designing process and sustainable products (Vitorio, & Kripka, 2021). S-LCA is a methodology to assess the social impacts of products and services throughout their life cycle from raw resource extraction to their final disposal. It is based on the UNEP/SETAC guidelines (UNEP, 2020). While LCA will involve material, energy, and economic flows in production and consumption impacting stakeholders, S-LCA provide a systematic assessment framework combining quantitative and qualitative data to support social and socio-economic decision-making (UNEP, 2020). It comprises four phases: goal and scope definition, inventory analysis, impact assessment, and interpretation (Ramirez et al., 2014). The two strengths of the S-LCA are its focus on the product and (2) the definition of social impacts, that englobes both a company's behavior and its socioeconomic perspective (Zamagni et al., 2011).

However, little research focuses on S-LCA in the construction industry. Larsen et al. (2022) said that S-LCA is neither considered nor applied in the building industry to evaluate the impact of construction and refurbishing buildings on the social aspect. However, social value should be considered in the construction industry as social value tends to increase or improve their social image for stakeholders (Daniel and Pasquire, 2019). Considering current challenges, there is a need to enhance social indicators within the building sector. While certain solutions have been identified with commendable social characteristics, it is crucial to acknowledge that studies might overlook the social advantages inherent in these solutions (Ostermeyer et al., 2013). Most research focuses on technology and neglects social and human needs (Fan et al., 2018). Tokede et Traverso (2020) pointed out that the challenge with S-LCA is in the definition of wellbeing, which should provide a holistic understanding of the human condition and aspirations. It is worth noting that most studies in this field rely on qualitative and semi-qualitative data which can present challenges when attempting to draw definitive conclusions from the obtained results. (Huertas-Valdivia et al., 2020). On the other hand, concerns revolve around the methodological operationalization and measurability of social indicators, which pose limitations on data gathering and stakeholder identification (Tokede et Traverso, 2020). Though the social aspect is important, there are no existing standardized methodologies for S-LCA (Larsen et al., 2022). Given the impact of the construction industry, it would be a sector that would need a methodology that accesses the social impact properly.

In this sense, the focus in this paper will be on how literature presents the operationalization of S-LCA in the construction industry through case studies to highlight social impacts and their mutual interactions through their indicators. This study aims to assess to what extent the social life cycle assessment has been reported in case studies focused on the construction industry in the last ten years.

This paper focus on the following questions:

- RQ1–What is the scope of the S-LCA case studies?
- RQ2–What is the functional units measure studied in the case studies?
- RQ3–What is the nature of the S-LCA indicators used in the selected case studies?
- RQ4–What are the main challenges of social life cycle assessment in the literature in case studies presented in the construction industry?

The structure of the paper will be as follows. Section 2 is the methodological section which will describe the data selection and the research protocol overview. Contained in Section 2 is also the classification framework and four research questions. In Section 3 we propose the result of our literature review, each research question is followed by a table to separate their analytical categories. Section 4 will have our discussion and in section 5 will be the conclusion.

2. Methodology

This paper seeks to understand to what extent the operationalization of S-LCA has been reported by researchers in the literature. To do so, this research assessed articles published during the last ten years (2012-2023), focusing on case studies in the construction industry.

The research methodology in this literature review includes (1) the data collection protocol and (2) the classification of selected papers. Each part is described in detail in the following subsections.

2.1. Data Collection and Research Screening Overview

The search was based on bibliographic databases and electronic libraries of Web of Science and Google Scholar. Web of Science was used as it has a selective, balanced, and complete coverage of World's leading research covering around 34000 journals (Birkle et al., 2020). On the other hand, Google Scholar was used as well as it provides an instant method to build on a digital snowball to retrieve literature (Zientek et al., 2018). A systematic literature protocol was used to evaluate our findings. From these, four research questions were defined to pursue our research. To analyze the S-LCA literature, the inclusion criteria were as follows: (a) the time span was set between 2012 and 2023, inclusive and focuses on literature written in English, (b) documents were limited to journal

articles, and (c) early access articles that have a focus on case studies, S-LCA in the construction industry were also included. Additional articles were added to build our article.

Table 1. Inclusion criteria.

Inclusion criteria
Studies published between 2012 to 2023
Articles addressing social impacts
Articles presenting case studies
Articles focusing on the construction industry

The following search strings and keywords combinations of terminologies and abbreviations were used: ("SLCIA" OR "Social life cycle impact assessment" OR "SLCA" OR "S-LCA" OR "Social life-cycle assessment" OR "Social LCA" (Topic) AND ("construction" OR "building" OR "AEC") (Topic) AND ("case studies" OR "case study" OR "use case") (Topic) AND between 2012-2023 (Publication Years) AND Article (Document Types) and Article (Document Types) AND Article or Early Access (Document Types) AND English (Languages).

The first screening of databases resulted in 32 publications and contained scientific publications (peer-reviewed journal articles). To ensure that the articles mentioned both case studies and S-LCA and construction industry for the literature portfolio, all abstracts were screened through Endnote 20 and 19 were proven irrelevant based on the inclusion and exclusion criteria. Finally, 19 were kept.

After we screened out the articles, 19 relevant articles were kept.

Figure 1 summarizes the research screening and shows the criteria for classifying the articles. The following section describes the classification framework used to analyze the selected papers.

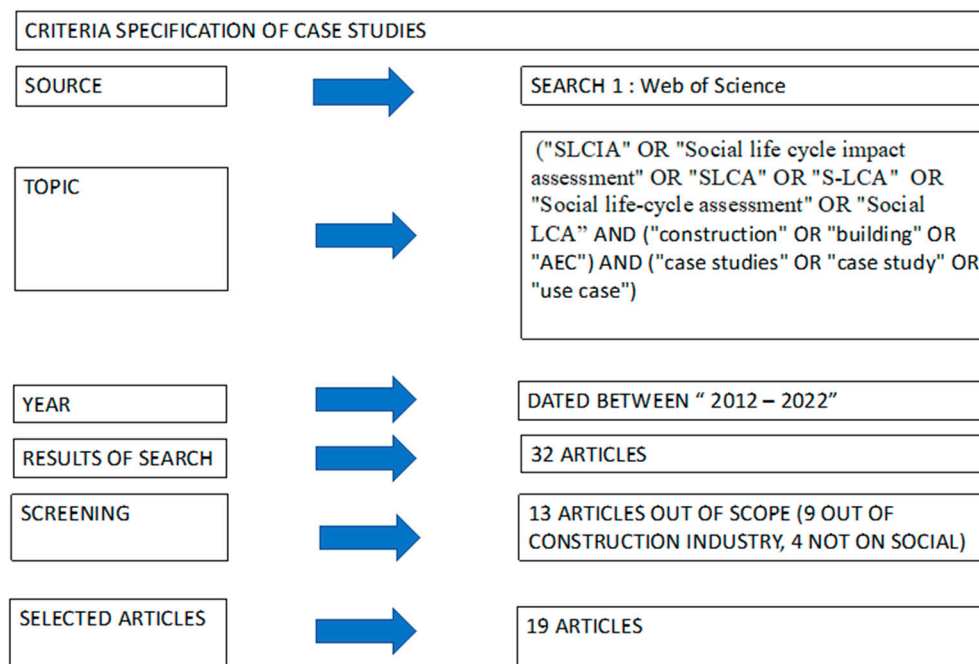


Figure 1. Research Screening.

2.2. Classification Framework

To classify our paper, we first categorized our articles as per their location, type of infrastructure, model, and the stakeholders involved. The location is the country where the research has been done and studied. It is prescriptive and helps to understand if the results are biased and influenced because of their location in a certain part of the world. Type of infrastructure to understand if it is a building,

a part of the building, or a specific model. The actors involved help to identify the type of stakeholders/individuals involved.

A specific classification scheme was then developed to answer each research question, as described in the following subsections.

2.2.1. Scope

The objective of a scope is to identify and “define the object of the study and to delimit the assessment” (Jørgensen et al.,2008). According to the UNEP (2020) Guidelines, some elements are included or excluded depending on the goal of the study. In those, we shall find (1) the definition of the object of the study (product, function, or service), the number of materials needed to produce the product or output, and the steps, activities, and organizations to comply with the functional unit ; (2) the identification of parts of the production system in the assessment (the system boundaries) ; (3) the variable(s) to determine the importance of different activities in the product system; the stakeholders included and affected (workers, value chain actors, society, consumers, government, construction enterprises, real estate developments, community); the type of impact assessment method, and impact categories and/or subcategories included; the data collection strategies (inventory indicators, data type, and data collection) and data quality requirements.

To answer this question, we looked at the scope of the study presented by each article. Then four elements' criteria were used: (a) the type of construction (building, route, etc.), (b) the scope of infrastructure studied (full building or parts of buildings), (c) the type of case studies (single or multiple case studies), (d) organizational type (public or private) and (e) the type of stakeholders involved (workers, local community, society, consumers, value chain actors)

2.2.2. Functional Unit and System Boundary

Functional units are the “quantified performance of a product system for use as a reference unit in a life cycle assessment study” (UNEP, 2009). Its purpose is to provide a reference to the relationship between inputs and outputs (Tokede et Traverso,2020). It is a critical issue in S-LCA as it is difficult to identify (Fan et al.,2018). However, it needs to be consistent with the Goal and Scope of the study (UNEP,2020) in which it is involved.

The system boundary “determine parts of the product system that will be included in the system assessed” (UNEP,2020). They are defined according to the life cycle stages from upstream processes (i.e., resource use, purchase of goods, and services) to downstream processes (i.e., distribution use and end-of-life products). According to the guidelines (UNEP,2020), it is defined as (a) the Full Life cycle of products and services (cradle-to-grave; from resource extraction to end-of-life); (b) the Supply chain of the product (cradle-to-gate; exclude use phase and end-of-life) ; (c) Parts of the Life Cycle (gate-to-gate or gate-to-grave).

To answer this question, we separated the functional units for S-LCA, the boundary (cradle to grave or cradle to gate), and the functional units used for LCA.

2.2.3. S-LCA indicators

Social indicators can be described as “evidence, subjective or objective, qualitative, quantitative, or semi-quantitative being collected to facilitate concise, comprehensive, and balanced judgments about the condition of specific social aspects with respect to a set of values and goals.” (UNEP,2020). It includes: (a) approaches such as impact pathway (mentioned in Question 3); (b) social topic as stakeholders and impact categories; (c) characterization model and type of impact pathway used for assessment, and (d) the weighting approach (UNEP,2020).

The character of assessment for social indicators is divided into three types of indicators: (a) qualitative, which are nominative and will use words (description); (b) quantitative, which will use a numerical description of the issue (physical units), and (c) semi-qualitative will have results expressed into a yes/no form or a scale (scoring system) (UNEP,2020)

UNEP (2009) defines the Impact pathways as “social LCI results and/or social impact categories” and Impact categories as “logical groupings of S-LCA results related to social issues of interest to stakeholders and decision makers.” The impact pathway is an important part as it will bring a framework, and with the identification of indicators, it will give a better of the social impact assessment and its impacts throughout the life cycle (Tokede et Traverso, 2020). It can be qualitative, which will cover social topics and categories, and quantitative, which will have a focus on measurable numbers and targets (UNEP,2020). It is referred to as a cause-effect relationship between the midpoint and endpoint (Jørgensen et al.,2008). The midpoint is the parameters in the social mechanism network (UNEP,2020; De Bare et al., 2000; JRC,2010). The endpoint is the determined damage levels (UNEP,2020; De Jolliet et al.,2004). The impact affects mostly links with the midpoint and endpoint impact pathways. The impact categories cover certain social issues of interest to stakeholders and decision makers. And can be grouped as subcategories results (UNEP,2020). It is separated between additive and descriptive according to the criteria of their functional units in the case studies.

To answer this question, we looked at the stakeholder categories and their impact categories linked to their activities, the social indicators, the character of the assessment process through impact pathways, impact effects, and impact and stakeholder categories. The impact categories are linked to an indicator, and the indicator is a way to relate to the identified impact (Mathe, 2014). Indicators are direct measurements of social issues, and they act as a bridge to link the data with subcategories and impact categories to guide the data collection process (Wu et Chen, 2014).

2.2.4. Challenges

Jørgensen et al. (2008) described the impact assessment as the phase where the inventory information is translated into impacts. Characterization considers the inventory results within the same impact category (Jørgensen et al.,2008). It is required to translate results into value for an impact indicator at the midpoint or endpoint (UNEP,2020). This is the final stage of the S-LCA, where the results are checked and discussed. They are broken down into levels of life cycle phases, impact categories, impact subcategories, and stakeholder categories (UNEP,2020).

This section comprises data for stakeholders and impact categories. Three approaches are used to prioritize data collection: (a) make a literature review to highlight key potential social impacts to identify specific unit processes for which data should be collected; (b) explore the intensity of different unit processes in a product’s life cycle and determined a variable; (c) identify hotspots in the product’s life cycle (UNEP,2020). The approach to prioritize data is by identifying the hotspot. It highlighted that hotspots are linked to social issues, and impact subcategories cover these. In general, hotspots can be evaluated at the country’s level, but for case-specific S-LCA, more precise geographic information is needed (Hosseiniyou et al.,2014). Benoit et al. (2010) claimed that the impact assessment is underdeveloped as the guidelines provide a general structure with a set of categories and subcategories.

To answer this question, we observed the process mentioned in each article via data collection and availability, impact assessment, and the interpretation of the results. We look at data collection and availability (literature, intensity of units, hotspots), impact assessment (midpoint or endpoint), and the interpretations of the results (level of life cycle phases, impact categories, and subcategories). This analysis made it possible to identify the challenges presented in the 19 articles.

In our next section, we discussed our results and findings through respective tables associated with each question.

3. Results

Based on our research, our findings brought 19 articles (Table 2). A numerical value is attributed to each article and will be used in the remaining tables and figures.

Table 2. Selected papers.

Paper	Authors	Papers and their Objectives
1	Dong et Ng, 2015	Develop a S-LCA model for building construction projects
2	Fan et al, 2018	Evaluate the social impact of a green building district within its designed service life
3	Balasbaneh et al., 2018	Analyze the stakeholder toward contribution to economic development
4	Dong et Ng,2016	Develop a LCSA framework and a case study of LCSA
5	Hosseinjou et al., 2014	Assess and compare socio-economic impacts of materials in their life cycle.
6	Fauzi et al., 2022	Propose a method and case study based on the S-LCA framework and guidelines.
7	Santos et al.,2019	Collect and analyze information to assist the decision-making process
8	Balasbaneh et al., 2021	Assess three different construction techniques
9	Zheng et al.,2020	Evaluate the social impacts on pavement
10	Hossain et al.,2018	Assess the social implications and sustainability of construction materials with a comparative rating model
11	Bezama et al.,2021	Compare two different demonstrator systems for lightweight wood-based concrete elements
12	Liu et Qian, 2019 (Towards)	Propose an integrated building-specific sustainability assessment model
13	Liu et Qian., 2019 (Evaluation...)	Develop a methodological framework for social life cycle assessment
14	Zheng et al., 2019	Compare LCSA
15	Vitorio et Kripka, 2021	Verify the evolution of social indicators in the sectors
16	Balasbaneh et al., 2020	Evaluate carbon dioxide (CO ₂) emissions and the cost and social impacts
17	Ostermeyer et al., 2013	Address the potential of LCSA in the built environment
18	Balasbaneh et al., 2021	Evaluate the sustainability performance of different flooring systems
19	Osorio-Tejada et al., 2022	Analyze the social performance of companies involved in the supply chain of road transport

3.1. Scope of the S-LCA case studies?

For the scope, we classified the articles as per their contribution to research. Table 2 showed that out of the 19 articles, three had scope to develop and assess, four were to evaluate, one was to collect, compare, and verify S-LCA, and two were to propose and analyze S-LCA. In Table 3, for the type of construction, 19 articles study mostly parts of the built-in environment, leaving four studying buildings. The type of case studies was mostly single case studies rather than multiple. The organizational type was three private and sixteen public. For the type of stakeholders, the focus was on workers, value chain actors, consumers, and the community.

In our study, authors were focused on (1) developing a model and methodological or LCSA framework; (2) assessing social impacts and sustainability of building materials; (3) evaluating the social cost of carbon dioxide emissions in green buildings and its material; (4) comparing LCSA and system of construction materials; (5) verifying evolution of social indicators and (6) analyzing stakeholder's contribution and the social performance of companies.

Table 3. Type of construction, case studies, organization, and stakeholders.

Paper	Type of construction	Type of case studies		Organization Type		Type of stakeholders involved:			
		Single	Multiple	Public	Private	Workers	Value Chain actors	Consumers	Community
1	Precast façade, semi precast slab, and precast staircase	X		X		X			X
2	Green building	X			X			X	X
3	Timber and concrete structure		X	X		X			
4	Building	X		X	X	X			X
5	Material (steel and iron)	X		X		X	X	X	X
6	Wood, concrete, steel, gravel, aluminum, gypsum, and brick	X		X		X	X	X	X
7	Construction and Demolition waste	x		X		X	X	X	X
8	Materials (concrete) and Single-story residential building		X	X		X	X	X	X
9	Hot-mix asphalt pavement	X		X		X		X	X
10	Recycled materials	X		X		X	X	X	X
11	Wood-based concrete elements	X		X		X			
12	PPVC project semi-prefab	X		X		X		X	X
13	Social sustainability projects	X		X		X		X	X
14	Pavement	X		X		X		X	X
15	Single-family residences	X			X	X	X	X	X
16	Flooring systems	X		X		X		X	X
17	Refurbishment of building	X			X			X	
18	School building		X	X		X		X	X
19	Road freight service		X	X		X		X	X

Mathe (2014) highlighted the need to consider the range of actors and indicators chosen as well as the individuals concerned. As such, one category in Table 3 is the type of stakeholders involved. Stakeholders should be present during the development of the S-LCA analysis and are considered from the impact analysis's point of view (Arcese et al,2013). However, it seems that although the purpose of S-LCA is to get as valid an assessment and its consequences, some factors are personal. Therefore, it is impractical as some changes cannot be related to which person is affected (Jorgensen et al., 2010).

3.2. Functional Units and system boundary in case studies

Out of the 19 articles, the functional unit in the S-LCA showed that evaluation would be done: from worst to best (two), on %, on m2 (three), scoring from unconcerned to very strong priority (one), linked with national law and international with scoring from strongly positive to strongly negative (one), number, category, yes and no, hour (one), weight as specification (one), cost evaluation (three), level of risk (one) and finally two articles showed no identification of functional units. For the functional unit in relation to LCA: two were in relation to cost, three with weight specification, one with cm, one with kg, m3, one with T, m2, one with worst and best criteria, and seven were not identified. Finally, the system boundary showed that eight articles were on the cradle to the gate and eleven from cradle to grave. This would be explained as out of the 19 articles, four only studied the building itself, and the rest were projects or materials.

We can see in Table 4 that the unit processes to fulfill the functional unit is set up for both S-LCA and LCA. However, even if it is so, this approach is not feasible in S-LCA as the measures are mostly on the socioeconomic impacts, which are related to the company's behavior instead of the product's function unit (Jørgensen, 2013). As such, if S-LCA is applied to assess a product by focusing on the product system itself, the behavior will not be caught because the supplier be held responsible for only the part of production included in the product system (Zamagni et al., 2011). Thus, the impacts cannot be expressed through the functional unit. Also, S-LCA works with data on attributes and characteristics of processes that cannot be expressed per unit (Hosseinijou et al., 2014). Lagarde & Macombe, (2013) mentioned that the concepts used to describe the systems and the boundaries are unclear in the literature since authors do not clearly explain their models and criteria on which their choice was made. It has been pointed out that to support management decisions, it is sufficient to include only parts of the life cycle that are directly influenced by companies (Hosseinijou et al., 2014). In our study, the articles are from cradle to gate or cradle to grave, meaning that all life cycle stages were involved.

Table 4. Functional units S-LCA, boundary, and functional units LCA.

#	FU-S-LCA	Boundary	FU-LCA
1	Scale of -1 to 1, and -1 is the worst and 1 is the best social	Cradle to grave	Scale of 1 to -1
2	None	Cradle to gate	None
3	%	Cradle to grave	Cost per MYR
4	-1 to 1, with 1 being the best social performance; the score ranges from -5 to 5, with 5 being the best social performance	Cradle to grave	Kg
5	T, m ²	Cradle to grave	None
6	M ²	Cradle to grave	None
7	None	Cradle to grave	None
8	9 is unconcerned, 7 is moderate priority, 5 is strong priority, 3 is solid priority, and 1 is very strong priority	Cradle to grave	M ²
9	%	Cradle to gate	None
10	1.00 Strongly positive, fully agreed, very highly related, highly compatible 0.75 Mostly positive, moderately agreed, highly related, moderately compatible 0.50 Neutrally affected, agreed, neutrally related, compatible 0.25 Mostly negative, partially disagreed, moderately negative, negatively compatible 0.00 Strongly negative, fully disagreed, highly unrelated, incompatible	Cradle to grave	None
11	Number, category, percent, yes and no, hour	Cradle to gate	Kg, mm
12	Weights	Cradle to gate	none
13	Weights	Cradle to gate	Weight
14	HHCP, milli-DALYS eq, S, nox eq)	Cradle to gate	T, m ³
15	R\$/month	Cradle to grave	Kg, m ²
16	Weight	Cradle to grave	US \$
17	Cost	Cradle to gate	Investment cost
18	Cost	Cradle to grave	Cm
19	Low, medium, high, very high risk	Cradle to gate	None

3.3. Nature of the S-LCA indicators used in the selected case studies

For the social indicators (Figure 2), we regrouped five stakeholders' categories and their respective impact categories highlighted by the UNEP guidelines. As Chan & Oppong (2017) discussed, a stakeholder has different attributes (power, legitimacy, and urgency) and it is important to understand their effect on construction projects. For workers, the categories associated were fair salary, working hours, forced labor, equal opportunities, health and safety, and discrimination. For value chain actors, the subcategories were capacity for job creation and local employment. For consumers, it was consumer privacy that was one of their concerns. The community was linked to local job creation and respect for indigenous rights, land use, cultural heritage, safe living conditions,

community engagement, human health, public commitment, and technology development. In our 19 articles, it is noticed that some data were not obtained as it was difficult to identify the stakeholders. This is surprising as the UNEP (2020) guidelines state that the first starting point of the analysis is identifying the stakeholders. We noticed a repeating trend associated with the stakeholders' categories to these specific impact categories (Figure 2).

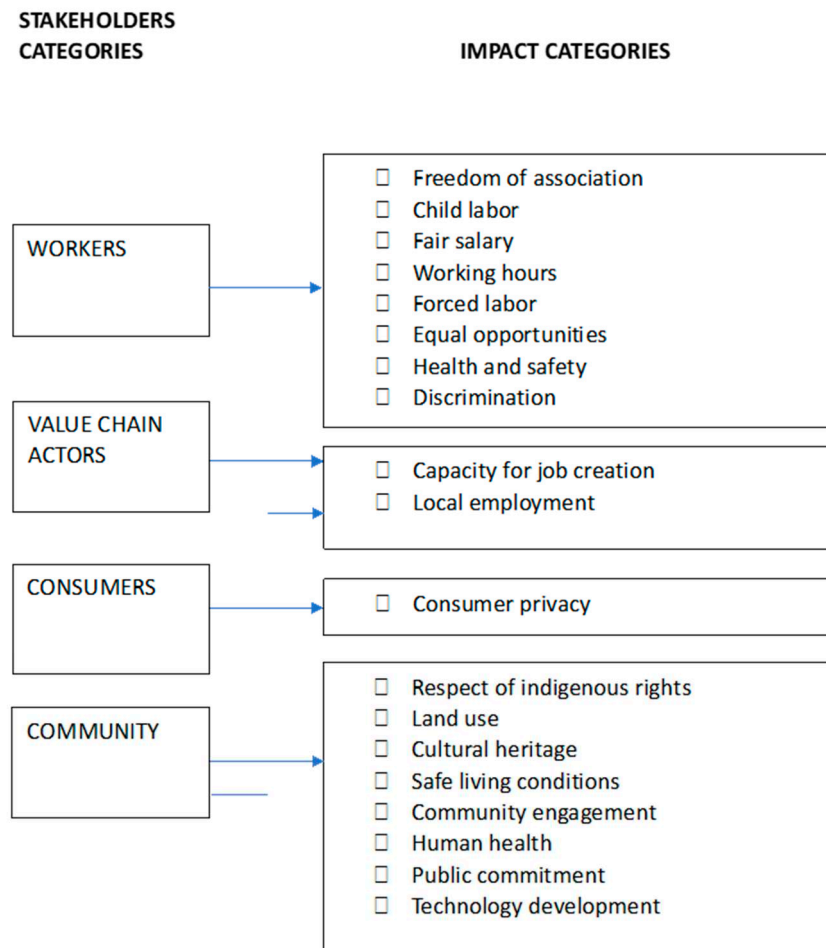


Figure 2. Stakeholder's categories and subcategories from UNEP guidelines.

For Table 5, our results showed that out of the 19 articles, the character of assessment was 9 quantitative, five qualitative, and five semi-quantitative. Only three articles considered exclusively midpoint (two) and endpoint (one), whereas the other sixteen took both midpoint and endpoint criteria into consideration. Seven articles showed the direct impact and eleven indirect impacts. Fifteen articles were descriptive, and four articles were additive. We observed that very few of the articles assessed the impact through semi-quantitative processes. The impact pathway is the link to indicators to show the cause-effect relationship between the midpoint and endpoint (Paragahawewa et al., 2009). In fact, the articles had linked mostly between fair wages (midpoint) and human health (endpoint). As mentioned by Hosseinijou et al. (2014), it is still not clear how to measure this process. We concluded that, as Neugebauer et al. (2014) mentioned, the impact indicators and inventory indicators are not clearly distinctive.

Table 5. Character of assessment, impact pathways, effects, and categories.

Paper	Assessment process			Impact pathways		Impact effects		Impact categories	
	Quatitative	Qualitative	Semi-Quantitative	Midpoint	Endpopoint	Direct	Indirect	Additive	Descriptive
1			X	X	X	X		X	
2	X			X	X	X		X	
3			X	X	X		X		X
4				X	X		X	X	
5		X	X	X	X		X	X	
6	X	X		X	X	X			X
7		X		X	X	X			X
8	X			X	X	X			X
9	X	X		X	X	X			X
10		X		X	X		X		X
11	X	X		X	X		X		X
12	X	X		X	X		X		X
13		X	X	X	X		X		X
14	X		X	X	X		X		X
15	X			X	X	X			X
16	X	X		X	X		X		X
17	X	X		X	X		X		X
18	X			X	X		X		X
19		X		X	X		X		X

3.4. Main challenges of social life cycle assessment

In this analysis, we identified that the main challenge is methodological. To answer research question 4: the challenges were separated into four types: data quality, data uncertainties, data measurement, and missing data. We noticed that six were done through surveys, five via interviews, two via literature review, two via models, three via multi-criteria decision-making, and five via stats and matrix. In the category of data quality, Dong & Ng. (2015) pointed out that the quality of data is mostly an issue as some indicators cannot be measured. Therefore, it becomes impossible to estimate the score. On the other hand, the scoring method is problematic as there is a lack of and well-accepted scoring system (Fan et al., 2018). For data uncertainties, though the information is obtained from questionnaires, it may exhibit some uncertainties. Not only that, Balasbaneh et al (2020) said that it is difficult to identify some stakeholders, mostly in governance rendering it difficult to collect data from them. Concerning the data measurement, overall, quantification of the social impact is difficult. Regarding sustainability, it is highlighted in Article 5 that it is undeveloped. Plus, Vitorio & Kripka. (2021) mention that the construction industry still lacks satisfactory social data inventories. As for the missing data, it was pointed out that some stakeholders were left out because of missing data (Balasbaneh et al., 2018), especially with value chain actors and governance, it was difficult to obtain information (Balasbaneh et al., 2020). We could see a possible link between our articles in Table 4. Eight articles were on the cradle to the gate, and eleven were from cradle to grave. The life cycle analysis is influenced by missing data.

Table 6. Feedback on Data collection from the authors in our 19 articles.

Paper	Challenges of Data Collection				Types
	Data Quality	Data uncertainties	Data measurement	Missing data	
1	X	X	X		Questionnaires-surveys on social performance of environmental friendly practices
2	X	X	X	X	Questionnaires for green residential districts
3			X	X	Interviews and research assessment on contribution to economic development for numbers of job creation
4	X		X	X	Interviews on material stages
5		X			MFA (tool) to identify hotspots :communities, companies and employment
6		X	X	X	Multi-level Analysis on unit, company,sector and country
7				X	Model identifies stakeholders perspectives, experiences in waste management
8	X				Multi-criteria decision making on sustainable Flooring (type of flooring)
9				X	Framework on raw materials, production,construction, use and maintenance
10	X		X		Interviews - challenges - recycled materials
11		X		X	RESPONSA model- indicators and organisational learning
12	X	X	X	X	Model on structural design - well being of stakeholders
13	X		X	X	Interviews- Indicators on cause-effect relationships (soundproof issue)
14		X	X		Interviews and questionnaires -social impacts for pavement
15		X	X		WFWP method-raw materials and workers's wages
16		X	X		Multi-criteria decision making on user satisfaction and indoor noise and parameters
17			X	X	A multidimensional Pareto optimization methodology on Building materials, Workers and job conditions
18	X	X		X	Interview and Multi-criteria decision making on judgement of stakeholders on types of construction
19	X				Interviews on labor rights

As Fauzi et al., (2022) mentioned, there is a need to include a full life cycle because the impact throughout the product's life cycle phase is frequently overlooked because of missing data. Ostermeyer et al., (2013) explained that the missing data are solid data that need to be generated in future research. To sum up, Zanchi et al. (2018) listed some main elements that could affect S-LCA applications. They are perspective, S-LCA as a stand-alone method, the selection and prioritization of indicators, the functional unit, system boundaries, background and foreground unit processes and data sources, quality, and geographic level. Many of the challenges in our articles are affected and impacted by these, causing missing data, difficulty to measure, uncertainties, and unreliable data quality.

4. Discussion

Authors reported that challenges were mostly on the quality and uncertainties of the data. There is a link between the scope and measures which renders it difficult to assess on a methodological aspect. There is a lack of comparability and transparency in S-LCA (Pollok et al.,2021). In fact, assessing the same item made from different places could have different impacts influencing the indicators (Zamagni et al., 2013). Connecting the inventory results of the social dimension to functional units is another challenge (Zheng et al.,2019). Our findings showed several problems with the S-LCA assessment. In our study, the challenges were separated into four types: data quality, data uncertainties, data measurement, and missing data. However, we noticed that the quality of data is mostly an issue as some indicators cannot be measured. Therefore, it becomes impossible to estimate the score (Dong & Ng, 2015). On the other hand, the scoring method is problematic as there is a lack of a well-accepted scoring system (Fan et al.,2018). For data uncertainties, though the information is obtained from questionnaires, it may exhibit some uncertainties. It is, therefore, difficult to identify some stakeholders, mostly in governance, rendering it difficult to collect data from them (Balasbaneh et al.,2020). For data measurement, quantifying the social impact is difficult, and it is undeveloped regarding sustainability (Hosseinijou et al., 2014). For the missing data, it was pointed out that some stakeholders were left out because of missing data (Balasbaneh et al., 2018), especially with value chain actors and governance, as it was difficult to obtain information (Balasbaneh et al.,2020). Overall, the construction industry still lacks satisfactory social data inventories (Vitorio & Kripka, 2021).

5. Conclusions

This paper conducted a scoping review of publications over the last ten years to identify the current trend in the S-LCA in this industry. Despite the significant impact of the construction industry on the environment and society, there is very little research on the aspects of construction activities. Our paper's contribution is to point out the necessity to generate more research in this sector. From this review, we understood that S-LCA has flaws in terms of the quality of the measurement, scoring method, and the lack of social data. That not only in the construction sector but in general with other sector. Still, when it comes to the construction industry, authors such as Haugbølle et al. (2019), underlines the need to develop more appropriate measurements for construction output. As well, Koseoglu et al., (2018) highlighted that in state-of-the-art construction practice is confusing when it comes to assess the impacts. In our study, the limit of this research has been mostly on the number of articles that were obtained after filtering through the "construction sector" and "case studies". We focused on scientific articles and ignored grey literature, which may overlook case studies from non-academics in the construction industry. Future research could conduct an additional review of grey literature in the construction industry by interviewing actors in the construction industry.

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