



RELISE

*ASSESSMENT OF THE SUITABILITY OF MCDA METHODS FOR
AGGREGATION IN S-LCA: A SYSTEMATIC REVIEW¹*

**AVALIAÇÃO DA ADEQUAÇÃO DOS MÉTODOS MCDA PARA A
AGREGAÇÃO EM ACV-SOCIAL: UMA REVISÃO SISTEMÁTICA**

José Eric da Silva Queiroz²

Breno Barros Telles do Carmo³

ABSTRACT

Considering that sustainability has encouraged organizations and governments to develop tools capable of supporting the decision-making process to achieve the Sustainable Development Goals (SDGs), Social Life Cycle Assessment (S-LCA), through research, has shown great capacity and promising potential. However, this tool, due to its subjective nature, lacks methodologies capable of tackling aggregation and weighting steps across multiple criteria. This research addresses one of the methodological gaps listed by the United Nations Environment Programme (UNEP), which is the consideration of S-LCA in decision-making. Based on this context, the objective of this systematic literature review is to identify, characterize, and analyze research that has applied Multicriteria Decision Analysis (MCDA) as a methodology to support decision-making in S-LCA studies. In this review, 284 articles were identified, of which 30 were considered relevant, mostly published in recent years, with the Analytic Hierarchy Process (AHP) method being the most used. In conclusion, the growing research on S-LCA still requires methodological improvement, as researchers often choose methods randomly, without adequate justification or criteria.

Keywords: S-LCA, decision-making, MCDA.

RESUMO

Considerando que a sustentabilidade tem estimulado organizações e governos a desenvolverem ferramentas capazes de subsidiar o processo de tomada de decisão para alcançar os Objetivos do Desenvolvimento Sustentável (ODS), a

¹ Received on 12/08/2025. Accepted on 18/09/2025. DOI: doi.org/10.5281/zenodo.21246085

² Universidade Federal Rural do Semi-Árido. j.ericqueiroz@gmail.com

³ Universidade Federal do Ceará. brenobarros@ufc.br



RELISE

Avaliação Social do Ciclo de Vida (ACV-Social), por meio de pesquisas, tem-se apresentado com grande capacidade e potencial promissor. Todavia, esta ferramenta por possuir característica subjetiva carece de metodologias capazes de desafiar etapas de agregação e ponderação em múltiplos critérios. Esta pesquisa aborda uma das lacunas metodológicas listada pela Organização das Nações Unidas (ONU), que é a consideração da ACV-Social nas tomadas de decisão. Baseado nesse contexto, o objetivo desta revisão sistemática da literatura é identificar, caracterizar e analisar pesquisas que aplicaram a Análise de Decisão Multicritério (MCDA) como metodologia de apoio a tomada de decisão em estudos da ACV-Social. Nesta revisão foram identificados 284 artigos, dos quais 30 foram considerados relevantes, em sua maioria publicados nos últimos anos, sendo o método *Analytic Hierarchy Process* (AHP) o mais utilizado. Como conclusão, tem-se que as crescentes pesquisas da ACV-Social ainda carecem de aprimoramento metodológico, pois pesquisadores escolhem métodos de forma aleatória, sem justificativa ou critério adequado.

Palavras-chave: ACV-Social, tomada de decisão, MCDA.

INTRODUCTION

The pursuit of sustainability, which balances environmental, social, and economic dimensions, has become a global imperative. In this context, governments, companies, and organizations seek effective tools to support strategic and operational decision-making. The United Nations (UN), through the Sustainable Development Goals (SDGs), has established a global agenda for planning sustainable actions, driving the need for robust methodologies to measure progress and impacts (UNEP, 2020). Among the various tools developed, Life Cycle Assessment (LCA) emerges as one of the main instruments for this purpose.

LCA is a comprehensive methodology based on the principles of Life Cycle Thinking, which enables the assessment of the impacts of a product, service, or process from “cradle to grave” — that is, from raw material extraction to final disposal (SHAHID, 2017). The objective is to identify critical points and opportunities for improvement throughout the entire value chain, aiming to create products that are simultaneously environmentally sound, socially just, and



RELISE

economically viable. The LCA methodology is rigorously structured into four phases, as established by ABNT (2014): (i) goal and scope definition; (ii) inventory analysis for data collection; (iii) impact assessment; and (iv) interpretation of results.

However, the social dimension of sustainability, addressed by Social Life Cycle Assessment (S-LCA), is the most recent and the least consolidated within the scientific community. The first guidelines were published in 2009 by UNEP, and the methodology remains under refinement. In its latest 2020 guidelines, UNEP identified ten priority gaps to be addressed by 2030, inviting researchers to contribute through the application and demonstration of methods. This systematic review aligns with gap number 8, which focuses on the application of S-LCA in decision-making processes, both in industry and in public policy.

Unlike environmental or economic assessments, S-LCA deals with an inherently more subjective dimension. Evaluation criteria are often based on the perceptions of different stakeholders regarding six impact categories: workers, consumers, local communities, value chain actors, society, and children (EKENER; HANSSON; GUSTAVSSON, 2018; GOMPF; TRAVERSO; HETTERICH, 2021).

UNEP (2020) established 42 subcategories to guide the assessment, but the task of identifying, aggregating, and weighting these indicators within a case study is complex. Weight definition, for example, is crucial for aggregated assessment and the development of decision-making frameworks (CARMO; MARGNI; BAPTISTE, 2017; YANG et al., 2017), yet it is a process that depends heavily on expert knowledge (SUREAU et al., 2019), which may be considered a methodological limitation. Furthermore, the proper identification and selection of stakeholders are of utmost importance for the validity of the assessment (SAJID; LYNCH, 2018).



Despite the recognized importance of S-LCA, the complexity of multiple criteria, the diversity of stakeholders, and cultural and contextual differences continue to be limiting factors. The scientific community still lacks robust methodologies capable of integrating the various social indicators to effectively support decision-making. However, Multi-Criteria Decision Analysis (MCDA) has proven to be a valuable tool for filling this gap (GOMPF; TRAVERSO; HETTERICH, 2021). MCDA offers a structured approach to decision-making that includes the identification of decision-makers, the selection of criteria and alternatives, sensitivity analysis, and transparent communication of results (DA SILVA et al., 2023; NETO, ALENCAR; VÁSQUEZ, 2023).

MCDA is a methodology that effectively addresses complex decision problems by enabling the evaluation of multiple alternatives based on several criteria, even when they are conflicting (TZENG; HUANG, 2011). Furthermore, it is capable of modeling human subjectivity in a transparent and structured manner (BELTON; STEWART, 2002), making it particularly suitable for S-LCA. Zanghelini, Cherubini, and Soares (2018) emphasize that MCDA can identify, weight, and aggregate impact categories, thereby supporting analysis and decision-making processes. Du, Dias, and Freire (2019) concluded that MCDA is particularly valuable during the aggregation and results analysis phases of S-LCA. Researchers have applied MCDA to a wide range of problems, from the development of new frameworks to the evaluation of case studies.

A recent systematic review by Neto, Alencar, and Vásquez (2023), focused on the built environment, reinforces the importance of MCDA in S-LCA but also highlights the need for careful method selection. The authors point to the fundamental distinction between compensatory and non-compensatory methods, warning against the risk of inappropriate trade-offs (for example, compensating for poor occupational safety with excellent thermal comfort for users). This observation highlights a persistent problem in the literature: the lack of



RELISE

182

justification and rationale for selecting MCDA methods. Many researchers appear to choose methods based on familiarity rather than their suitability for the problem at hand.

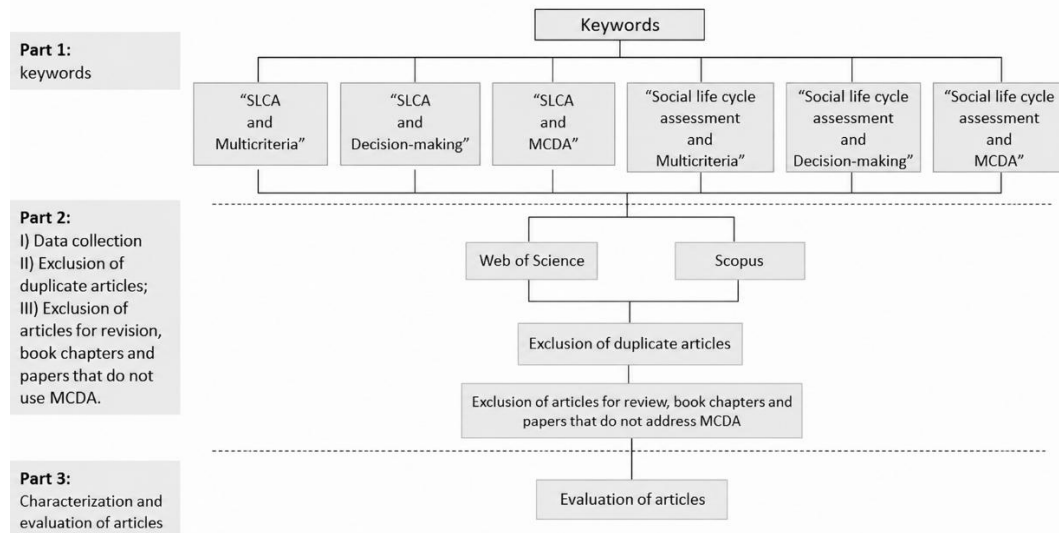
Given the identified gaps, the objective of this study is to conduct a systematic literature review to identify and analyze scientific research that employs MCDA as a decision-making tool in S-LCA. By characterizing these studies and the methods applied, it is expected to promote a discussion on the need for a more rigorous and well-founded selection of MCDA methods in S-LCA studies, thereby contributing to methodological advancement and addressing one of the priority gaps identified by UNEP.

METHOD

The systematic review conducted in this research is presented as an assessment of the current scientific landscape regarding the use of MCDA as a decision-making tool in S-LCA. To this end, the review methodology was developed in three stages: (i) definition of keywords for database searches; (ii) data collection (retrieved articles) and application of filters for study selection; and (iii) characterization and analysis of the selected articles. Figure 01 presents the workflow and steps applied for the selection of the articles.



Figure 1. Stages of the systematic review of selected articles addressing MCDA in S-LCA.



Stage 01 consisted of defining the keywords to be used in the Web of Science and Scopus databases to identify the articles. For the collection of articles, keywords related to S-LCA, MCDA, and decision-making studies were selected through the use of Boolean search logic operators. From this perspective, the following keywords were used for the literature review: i) “SLCA” AND “Multicriteria”; ii) “SLCA” AND “Decision-making”; iii) “SLCA” AND “MCDA”; iv) “Social Life Cycle Assessment” AND “Multicriteria”; v) “Social Life Cycle Assessment” AND “Decision-making”; vi) “Social Life Cycle Assessment” AND “MCDA”.

These keywords were defined with the aim of identifying all studies that used MCDA methods to weight and aggregate performance in S-LCA categories, considering that MCDA methods are also widely used in Environmental Life Cycle Assessment (E-LCA) and Economic Life Cycle Assessment (Ec-LCA). In addition, there are also studies that applied LCA across its three pillars consecutively, aiming at a sustainability assessment.

Subsequently, after identifying the number of articles, in the second stage, evaluation criteria were defined to filter and exclude articles from the



literature review that were not related to the theme of this study. Thus, the following criteria were applied for data collection filtering: i) exclusion of duplicate articles found in both the Web of Science and Scopus databases; ii) exclusion of book chapter articles; iii) exclusion of literature review articles; and iv) exclusion of articles published in journals without a defined impact factor.

The exclusion of literature review articles was established because this research focuses on the application of multicriteria methods in aggregation and/or weighting, which is associated with the practical application of case studies and also with the development of methodologies and frameworks for S-LCA. To this end, the articles were read to verify which studies actually used MCDA methods in the aggregation phase, thereby obtaining a selection of potential articles. In addition, studies published in journals without an impact factor were also excluded from this literature review.

The application of these filters was intended to obtain a net number of articles to be considered for identifying possible methodological gaps, limitations, findings, and considerations reported in S-LCA studies.

Stage 03 consisted of reading the articles to characterize the applied method, identifying the authors involved, the university and country of origin, and the year of publication. Subsequently, an analysis of the selected articles was conducted based on the following evaluation criteria: i) presence of numerical values; ii) compensation among criteria; iii) justification of the selected method; iv) sample size; v) decision-makers' profile; vi) whether the results satisfy decision-makers' understanding. Chart 1 below presents the predefined criteria and their respective descriptions.



Chart 1. Description of the evaluation subcriteria

Criteria	Description of criteria
Numerical values	Numerical values are used and considered in Social Life Cycle Assessment (S-LCA) for the presentation of results, and also as parameters in scales and scoring systems (UNEP, 2020).
Compensation among criteria	Compensation among criteria and the characteristics of the method that justified its selection should be considered. Compensation among criteria is neither accepted nor envisaged in S-LCA studies, which highlights the importance of selecting the MCDA method (UNEP, 2020).
Justification for the selected method	The choice of the MCDA method should be related to the type of decision problem, based on its main characteristics, advantages, and disadvantages (ROY; SŁOWIŃSKI, 2013).
Sample size	It produces data for obtaining a realistic local representation of perceptions regarding specific issues of the problem (UNEP, 2020).
Decision-makers' profile	The preferences and weights adopted in S-LCA studies are based on existing database information or on stakeholders' expressed preferences derived from decision-makers' profile values (UNEP, 2020).
Feedback on whether the results satisfy decision-makers' understanding	The presentation of results is fundamental in S-LCA studies, as it is related to the ability to present results, suggestions, and potential improvements. They support decision-making in accordance with the defined goal and scope (UNEP, 2020).

For the evaluation of the articles according to the aforementioned criteria, two objective evaluation descriptors were adopted: “Yes”, for studies that satisfy the criterion requirements, and “No”, for those that do not. These descriptors will be used to evaluate the selected articles and will assist in the comparative analysis, supporting the definition of the chosen MCDA method.

Finally, a discussion of the studies was carried out based on the defined criteria, with the aim of characterizing the current state of the art of S-LCA research that used MCDA approaches in the weighting/aggregation phase. In addition, this characterization will support the discussion of the main perceived gaps and limitations.

RESULTS AND DISCUSSION

The selected keywords were used in the Scopus and Web of Science databases with the aid of Boolean operators. In this initial data collection, a total of 284 articles were identified and tabulated in a spreadsheet. Subsequently,



RELISE

186

filters were applied to delimit the articles that were correlated with the objective of this research. Considering that different keywords retrieved duplicate studies, and that this duplication also occurred within each database, the first filter applied was the elimination of duplicate studies. After this step, a total of 122 articles remained.

Considering that the purpose of this study is to identify articles with methodological applications of S-LCA case studies in the aggregation and weighting phase of impact subcategories, additional filters were defined to eliminate literature review articles, since they do not address applied case studies, as well as book chapters and articles published in scientific journals without defined impact or relevance. Thus, from the total of 122 articles, a net result of 30 potential articles was obtained.

After this delimitation, the studies were read and the following characteristics were identified: i) authors; ii) year of publication; iii) MCDA method. Chart 2 below presents the results obtained from the data collection according to the established characterization.



Chart 2. Identification of potential articles that applied MCDA in S-LCA

Authors	MCDA Method	Titleo
Nieder-Heitmann; Haigh; Görgens, 2019	AHP	Life cycle assessment and multi-criteria analysis of sugarcane biorefinery scenarios: Finding a sustainable solution for the South African sugar industry
Gompf; Traverso; Hetterich, 2021	AHP	Using analytical hierarchy process (AHP) to introduce weights to social life cycle assessment of mobility services
Kolotzek et al., 2018	AHP	A company-oriented model for the assessment of raw material supply risks, environmental impact and social implications
Wilken et al., 2020	PROMETHEE II	Multidimensional assessment of passenger cars: Comparison of electric vehicles with internal combustion engine vehicles
Rafiaani et al., 2020	TOPSIS	Identifying Social Indicators for Sustainability Assessment of CCU Technologies: A Modified Multi-criteria Decision Making
Cardoso et al., 2018	PROMETHEE II	Economic, environmental, and social impacts of different sugarcane production systems
Do Carmo et al., 2021	PROMSORT	Participatory approach for pertinent impact subcategory identification: Local community
Wang et al., 2019	TOPSIS	Comprehensive Evaluation of the Sustainable Development of Battery Electric Vehicles in China
Xu et al., 2017	AHP	Life Cycle Sustainability Assessment of Chemical Processes: A Vector-Based Three-Dimensional Algorithm Coupled with AHP
Zheng et al., 2019	AHP + VIKOR	Life-cycle sustainability assessment of pavement maintenance alternatives: Methodology and case study
Zhou et al., 2019	AHP	Model development of sustainability assessment from a life cycle perspective: A case study on waste management systems in China
Eagan; Weinberg, 1999	AHP	Application of analytic hierarchy process techniques to streamlined life-cycle analysis of two anodizing processes
Halog; Manik, 2011	AHP	Advancing Integrated Systems Modelling Framework for Life Cycle Sustainability Assessment
Tavakoli; Barkdoll, 2020	BLISS METHOD	Blended Lifecycle Integrated Social System Method
Mattila et al., 2018	AHP	Evaluating social sustainability of bioeconomy value chains through integrated use of local and global methods
Féon et al., 2021	DEX METHOD	DEXiAqua, a Model to Assess the Sustainability of Aquaculture Systems: Methodological Development and Application to a French Salmon Farm
Alidoosti et al., 2021	BEST WORST METHOD (BWM)	Social sustainability of treatment technologies for bioenergy generation from the municipal solid waste using best worst method

continues



Chart 2. Identification of potential articles that applied MCDA in S-LCA - continuation

Authors	MCDA Method	Titleo
Opher; Shapira; Friedler, 2018	AHP	A comparative social life cycle assessment of urban domestic water reuse alternatives
De Luca et al., 2015	AHP	Social life cycle assessment and participatory approaches: A methodological proposal applied to citrus farming in Southern Italy
De Luca et al., 2018	AHP	Evaluation of sustainable innovations in olive growing systems: A Life Cycle Sustainability Assessment case study in southern Italy
Ren et al., 2015	AHP + VIKOR	Prioritization of bioethanol production pathways in China based on life cycle sustainability assessment and multicriteria decision-making
Subramanian et al., 2018	MAVT	Assessing the social impacts of nano-enabled products through the life cycle: the case of nano-enabled biocidal paint
Balasbaneh; Marsono, 2020	AHP + COOPRAS	Applying multi-criteria decision-making on alternatives for earth-retaining walls: LCA, LCC, and S-LCA
Balasbaneh; Yeoh; Zainal Abidin, 2020	TOPSIS + AHP	Life cycle sustainability assessment of window renovations in schools against noise pollution in tropical climates
Balasbaneh et al., 2021	AHP + COPRAS technique	Applying three pillar indicator assessments on alternative floor systems: life cycle study
Du; Dias; Freire, 2019	VIP Analisis (tipo II)	Robust multi-criteria weighting in comparative LCA and S-LCA: A case study of sugarcane production in Brazil
Kouloumpis; Azapagic, 2018	FUZZY + FELICITA	Integrated life cycle sustainability assessment using fuzzy inference: A novel FELICITA model
Liu; Qian, 2019	AHP + ELECTRE	Towards sustainability-oriented decision making: Model development and its validation via a comparative case study on building construction methods
Muhammad Anwar; Alvarado; Hsu, 2021	AHP	A socio-eco-efficiency analysis of water and wastewater treatment processes for refugee communities in Jordan
Zira et al., 2020	AHP	Social life cycle assessment of Swedish organic and conventional pork production

As can be observed, the collected studies are recent, since 25 out of the 30 studies were published within the last five years, corresponding to the period 2018–2022. This reinforces the fact that S-LCA is still a fertile research topic that demands further research efforts, with methodological approaches still under discussion and little methodological consolidation.



RELISE

Another point that can be observed is the correlation between the MCDA method applied and its geographical location. The approaches applied in a given country do not show great variability, concentrating most efforts on specific methods, probably due to researchers' familiarity with them. This can also be observed in countries with a higher number of publications, such as China, Germany, the USA, Italy, and Malaysia. In addition, most publications were concentrated in the European and Asian continents.

The AHP method, despite its popularity, which was also evidenced in the present study by the concentration of the highest number of publications, has been widely criticized in the literature due to negative aspects of the method, such as its compensatory characteristic among criteria (BANA E COSTA; VANSNICK, 2008). Brazil, as the only representative from South America, was the country with the highest concentration of MCDA methods from the French school, with two articles applying methods from the PROMETHEE family. The study by Cardoso et al. (2018) applied the PROMETHEE method for ranking alternatives, while Carmo et al. (2021) used PROMSORT for the classification and selection of impact subcategories.

The article data collection phase yielded the following concentration of applied methods: AHP – 13 articles (43.33%); TOPSIS – 2 articles (6.67%); PROMETHEE – 2 articles (6.67%); PROMSORT – 1 article (3.33%); BLISS METHOD – 1 article (3.33%); DEX METHOD – 1 article (3.33%); VIP ANALYSIS – 1 article (3.33%); BEST WORST METHOD – 1 article (3.33%); MAVT – 1 article (3.33%). Other articles were developed through combinations of methods: AHP and VIKOR – 2 articles (6.67%); AHP and COPRAS – 2 articles (6.67%); AHP and ELECTRE – 1 article (3.33%); AHP and TOPSIS – 1 article (3.33%); and FUZZY and FELICITA – 1 article (3.33%).

Overall, as can be observed, the AHP method accounted for 19 records (63.33%), with 13 standalone applications and 6 combined with other methods.



RELISE

It is worth highlighting that AHP, due to its own weighting system, has greater flexibility and can be combined with other methods, as was done with COPRAS, VIKOR, ELECTRE, and TOPSIS. Most studies that used these methods did not adequately justify their application, with the choice being made randomly or based on the authors' greater familiarity with the selected method.

The PROMETHEE family had three applications (2 PROMETHEE II and 1 PROMSORT), applied in Brazil and Germany. Most of the remaining methods appeared in only one application. It is worth noting that some methods were developed in these studies as alternative MCDA approaches for S-LCA, as in the case of the DEX METHOD.

The journals from which this systematic review retrieved publications showed the highest concentration in three journals: i) 7 publications in The International Journal of Life Cycle Assessment; ii) 7 publications in Journal of Cleaner Production; and iii) 4 publications in Sustainability. These journals, considered high-impact journals, account for 60% of the studies that applied MCDA in S-LCA, highlighting the relevance of these studies to the scientific community.

Based on the literature analysis, the selected studies demonstrate a diversity of MCDA approaches and applications in S-LCA. The context and decision-making problem addressed in each of the articles selected in this systematic review are briefly presented below, illustrating how different methods were employed for impact assessment.

Nieder-Heitman, Haigh, and Gorgens (2019) used the AHP method to support sustainability assessment. The parameters were normalized and weighted using AHP to support sustainable decision-making (integrating the pillars of Environmental LCA, Life Cycle Costing, and Social LCA) in a South African sugar industry. Environmental parameters included carbon footprint and water scarcity; cost parameters included profitability, total capital investment,



RELISE

total production cost, and technology readiness level; and the social dimension considered only job creation.

Gompf, Traverso, and Hetterich (2021) conducted an assessment of the social sustainability of mobility services. This research used the AHP method for the participatory weighting of 27 subcriteria across five evaluation categories (consumers, local community, value chain actors, workers, and society). Forty-eight experts from different groups participated in the study, which, despite disagreements in value judgments, resulted in clear guidance such as the need to improve air quality and user safety.

Kolotzek et al. (2018) proposed a decision-support sustainability assessment model in a corporate context, including the social dimension in the analysis. The AHP method was applied to weight indicators suggested by experts from academia and industry. To validate the model, a case study was conducted for capacitor technology selection.

Wilken et al. (2020) proposed a sustainability assessment of conventional vehicle drive systems (internal combustion engine vehicles) and electric vehicles. Although studies evaluating environmental impacts already exist, the authors considered an integrated assessment including social and economic aspects necessary for a global and transparent perspective. To achieve this, the PROMETHEE method was applied. Based on preference evaluations and threshold values, the study concluded that battery electric vehicles achieved more satisfactory results compared to internal combustion and hybrid vehicles.

Rafiaani et al. (2020) highlighted the absence of social impact studies on carbon capture and utilization (CCU) technologies, which are used to capture CO₂ waste for the development of new products and materials. The research proposed identifying social indicators using the TOPSIS method to empirically determine relevant indicators for assessing the social impacts of European



RELISE

companies operating with CCU technologies. Through questionnaires, 33 experts evaluated impact subcategories proposed by UNEP for three stakeholder groups: workers, consumers, and the local community. The authors argued that the selected subcategories would support future research on social impact assessment and help producers identify potential risks in their production activities, thereby promoting process improvements.

Cardoso et al. (2018) proposed an integrated assessment of sugarcane production considering technological advances and process mechanization. Thus, evaluating the advantages and disadvantages of equipment use in planting, pre-harvest, harvesting, and recovery processes becomes necessary, taking into account not only environmental aspects but also social and economic ones. The assessment showed that manual scenarios were associated with greater job creation and lower rates of return but higher production costs, while mechanized scenarios presented lower biomass production costs and higher ethanol return rates. Using the PROMETHEE II method, the authors concluded that mechanized scenarios achieved better sustainability performance.

Do Carmo et al. (2021) presented a framework capable of modeling the subjectivity associated with the selection of S-LCA impact subcategories through a participatory approach involving stakeholders from the Local Community category. The study was conducted in a fruit pulp production company in northeastern Brazil. Using PROMSORT, the framework classified relevant subcategories in both individual perception and consensus contexts.

Wang et al. (2019) also conducted an integrated sustainability assessment study of electric vehicles, a growing trend in China due to increasing vehicle numbers and the resulting energy consumption and environmental pollution. After separately assessing the environmental, social, and cost dimensions using Environmental LCA, Social LCA, and Life Cycle Costing, the TOPSIS method was applied to support decision-making through dimension



RELISE

integration. Surprisingly, the study indicated that conventional internal combustion vehicles outperformed battery electric vehicles, mainly due to higher energy consumption during the operation phase of electric vehicles and the high cost of batteries.

Xu et al. (2017) also proposed an integrated vector-based methodology for assessing the sustainability of chemical processes. Decision alternatives were prioritized through a combination of performance evaluation and weighting assignment across sustainability pillars using the AHP method. To validate the proposed methodology, a case study was conducted to classify and identify the most sustainable choice among three alternative ammonia production processes.

Zheng et al. (2019) developed an integrated sustainability assessment methodology (environmental, social, and economic) for appropriate pavement selection through the combination of the AHP-VIKOR method. The proposed methodology applied the LCA stages, defined the goal and scope, and identified pavement alternatives. Subsequently, inventory data related to pavements were collected, impact assessment models were proposed, and a sustainable pavement alternative was selected. The VIKOR method was applied to aggregate the performance of alternatives, while AHP was used for weighting criteria across the three dimensions. Finally, during the interpretation stage, the results were discussed and a sensitivity analysis was performed for 21 cases, which identified the economic pillar as the most sensitive.

Zhou et al. (2019) established a new environment-energy-economy-society (3E + S) model for sustainability assessment in municipal solid waste (MSW) management, considering urbanization and city expansion. This study proposed four treatment alternatives within an MSW management system and used the AHP method for weighting in order to support integrated decision-making. Higher weights were assigned to criteria that ensure living conditions and access to material resources, thereby reducing potential human-caused impacts.



RELISE

The proposed method proved effective due to its robustness, as identified through sensitivity analysis.

Eagan and Weinberg (1999) applied the AHP method to decision-making in a manufacturing process context. In the study, the method was used to weight matrix rationales through expert evaluation to add value to an S-LCA approach comparing two manufacturing processes: chromic acid anodizing and boric/sulfuric acid anodizing.

Halog and Manik (2011) proposed a computational, systemic, and integrated framework for sustainability assessment in bioenergy systems. The authors emphasized the need to integrate social sciences with engineering and technology in governmental and corporate decision-making contexts. The research aggregated results using the AHP method, based on stakeholder value judgments, and proved effective for modeling and simulation to support intelligent decision-making regarding climate-related impacts and mitigation strategies.

Tavakoli and Barkdoll (2020) presented a robust S-LCA framework combining social aspects to support decision-making processes aimed at minimizing social impacts on industry and society. The “Blended Lifecycle Integrated Social System” (BLISS) is a new method validated through a case study on algae biofuel production. Integration was achieved through criteria weighting and stakeholder perceptions in a complex multicriteria decision problem.

Mattila et al. (2018) proposed comparing and integrating local and global bioeconomy priorities using data from the Social Hotspots Database (SHDB) to assess social sustainability in the context of Finnish wood products. The results enabled comparisons between local and global data (outside Finland), revealing divergences. For example, social inequality received a high ranking in SHDB results but a low ranking from the perspective of local stakeholders.



RELISE

Feon et al. (2021) addressed decision-making in aquaculture systems. The authors developed a multi-attribute model called DEXiAqua, based on DEXi software, to assess sustainability through technical indicators and the use of Environmental, Social, and Economic LCA tools. The method allowed the use of qualitative and quantitative indicators, thresholds, and reference scales for measurement at the end of each branch of the decision tree, based on stakeholder input data. The model was validated through a case study and its robustness verified through sensitivity analysis. However, the authors emphasized the need for studies in other contexts and geographical areas.

Alidoosti et al. (2021) highlighted concerns regarding the neglect of social assessment in scientific research and emphasized the importance of the social dimension within the bioindustry for sustainable practices. Accordingly, the study proposed a systemic model for assessing the social sustainability of solid waste treatment technologies using the Best Worst Method, which was applied to define optimal weights and rank alternatives based on performance scores. The research was validated through a case study in Tehran, Iran, where fermentation technology achieved the highest ranking, while pyrolysis received the lowest classification.

Opher, Shapira, and Friedler (2018) compared the social benefits and impacts of four alternatives for non-potable domestic water reuse across three stakeholder categories: consumers, local community, and society. The AHP method was used, and based on the value judgments of 20 experts, preference elicitation was performed to assign weights to 13 subcriteria. The results showed that water reuse was socially beneficial, particularly regarding increased community participation and the promotion of public commitment to water conservation and urban landscape improvement.

De Luca et al. (2015) highlighted the lack of standardization in S-LCA compared to other dimensions such as Environmental LCA. Therefore, the study



RELISE

aimed to develop a methodology based on a multicriteria approach using the AHP method. The proposed methodology was then applied to three production areas belonging to three different citrus production systems in Calabria, southern Italy, a region of significant social interest due to the presence of immigrant workers. Based on the value judgments of six decision-makers, strategies could be prioritized for adequate territorial planning according to the local context.

De Luca et al. (2018) presented a participatory multicriteria methodology integrating Economic LCA and Social LCA in olive cultivation in Calabria, southern Italy. The study adopted a cradle-to-farm-gate system boundary, one hectare as the functional unit, and involved 15 experts from three groups: i) researchers, ii) technicians, and iii) producers. Through the application of the AHP method and semi-structured questionnaires, the results indicated greater attention to environmental and social aspects, especially worker health and toxicity issues. Consequently, the reduction or elimination of chemical products for pest control was recommended due to their potential to cause fatal diseases.

Ren et al. (2015) developed a generic integrated sustainability decision-making methodology combining MCDA with LCA pillars through a bioethanol production case study in China. For integration, the AHP and VIKOR techniques were combined, with AHP used for weight determination and VIKOR for ranking sustainable alternatives. In addition, a Fuzzy approach was applied to reduce uncertainty, and sensitivity analysis was conducted to evaluate the robustness of the obtained data. The results indicated cassava-based bioethanol production as more sustainable than corn- and wheat-based alternatives.

Subramanian et al. (2018) presented a framework capable of integrating social performance and assessing the impacts of nano-enabled products. Through the MAVT method, normalization, weighting, aggregation, and ranking of scores were performed for 15 social indicators within the local community and workers categories. The main case study result showed that n-CuO paint



RELISE

presented more favorable outcomes for workers, with high benefits. Furthermore, the author emphasized the importance of S-LCA for corporate benchmarking and social footprint assessment of manufactured products.

Balasbaneh and Marsono (2020) addressed sustainability-oriented decision-making by considering the environmental, social, and economic aspects of different concrete wall systems used in residential buildings in Malaysia. Regarding the social dimension, the authors considered the stakeholder categories of local community, society, and workers. Through the combination of the AHP and COPRAS methods, prioritization was performed using a decision matrix composed of three concrete wall alternatives and two stone wall alternatives, which were evaluated across sustainability criteria by 45 experts. Within the social dimension, the RMW wall achieved the most favorable results, presenting the lowest aggregated scores across all evaluation categories. Finally, the authors concluded that the methodology was efficient and comprehensive and could be applied in other countries and contexts with climatic conditions similar to those of Malaysia.

Balasbaneh, Yeoh, and Zainal Abidin (2020) also conducted an impact assessment study in the construction sector in a Malaysian city, focusing on the sustainability assessment of school windows and their implications for noise pollution and carbon emissions. The case study addressed a school context in which noise pollution exceeded the acceptable limit of 55 dB and considered three alternative window systems. After applying LCA in the social, economic, and environmental dimensions, conflicting results were observed. To support decision-making, a combined AHP-TOPSIS approach was applied for integrated sustainability assessment. The results identified double-glazed windows as the most sustainable option, which coincided with the best Social LCA performance. The authors concluded that the proposed methodology could support designers,



RELISE

policymakers, and property owners in sustainable decision-making related to acoustic barrier solutions.

Balashbani et al. (2021) proposed a comprehensive sustainability assessment of different flooring systems using a multicriteria approach. The decision matrix included ceramic tile, laminate, concrete, and wood flooring alternatives. In the social dimension, the study assessed the stakeholder categories of workers, local community, society, and consumers with the participation of 45 experts. The integrated sustainability assessment identified wood flooring as the most sustainable option. However, sensitivity analysis showed that other alternatives achieved higher rankings under different weighting scenarios, indicating that changes in weighting priorities can significantly influence final results. The authors concluded by recommending the application of the methodology in countries with climatic and cultural contexts similar to those of Malaysia.

Du, Dias, and Freire (2019) conducted research assessing environmental and social impacts in Brazilian sugarcane production. To support decision-making, the VIP Analysis method was applied to rank the best alternative between manual and mechanized harvesting. The analysis was based on the value judgments of seven experts, including researchers and experienced professionals from the Brazilian sugarcane sector. After stochastic aggregation and weighting of criteria, mechanized harvesting proved more advantageous than manual harvesting. The study suggested accelerated mechanization in regions such as Northern and Northeastern Brazil, where mechanization levels remain lower, due to its lower environmental impacts and positive social outcomes, including increased income, reduced social inequality, and fair wages. The authors concluded by emphasizing the methodological relevance of the study for comparative environmental and social impact assessment in LCA



RELISE

studies, even in situations where decision-makers have diverse judgments and weighting vectors.

Kouloumpis and Azapagic (2018) developed a sustainability assessment model based on the FELICITA method (Fuzzy Evaluation for Life Cycle Integrated Sustainability Assessment), using Fuzzy logic. The proposed methodology was applied to a case study involving electricity generation alternatives, including coal, natural gas, nuclear power, offshore wind, and photovoltaic solar energy. To collect value judgments, a five-point Likert scale ranging from “very poor” to “very good” was employed. Through the FELICITA method, nuclear energy was ranked as the best option due to its strong performance in environmental and social aspects. The proposed methodology enabled the resolution of complex sustainability indicator problems, with Fuzzy logic helping to reduce uncertainty and human subjectivity in the decision-making process.

Liu and Qian (2019) developed a study to support sustainable decision-making in the construction industry by integrating environmental and socioeconomic impacts. The research proposed an MCDA-based methodology to select the most sustainable alternative among three structural project options: volumetric prefabricated and prefinished construction, semi-prefabricated construction, and conventional construction. The AHP method was used to establish weights, while Fuzzy ELECTRE III was applied to rank the alternatives. Based on the value judgments of 103 experts across eight evaluation criteria, the semi-prefabricated project achieved the highest ranking. The authors concluded by demonstrating the feasibility of the proposed methodology for complex decision problems involving multiple criteria and alternatives.

Muhammad Anwar, Alvarado, and Hsu (2021) presented an MCDA-based framework for water and wastewater treatment through a case study involving three scenarios in Jordan. Based on the judgments of eight experts regarding environmental, social (limited to local community and consumers), and



economic criteria, and after weighting using the AHP method, Scenario 3—which incorporates the long-term reuse of non-potable wastewater—was identified as the most sustainable alternative. This result differed from those obtained using other approaches, reinforcing the need to include the social dimension in decision-making processes.

Zira et al. (2020) applied S-LCA to analyze the risks of negative social impacts in Swedish pork production systems. The study included workers, farmers, local communities, pigs, consumers, and society as stakeholders in the assessment of two production systems: organic and conventional production. The inclusion of farmers and pigs as stakeholders was justified by their central role in pork production. With the participation of ten experts and weighting performed using the AHP method, the results indicated that the workers and society categories presented higher risks of negative social impacts in organic production systems, whereas the remaining categories showed higher risks in conventional systems. Furthermore, the study concluded that both Swedish organic and conventional production systems exhibited lower risks of negative impacts than the European average.

Characterization of the studies

To characterize the studies obtained from the data collection, the evaluation criteria presented in Chart 1 were applied based on a detailed reading of the articles, and objective descriptors were established. The symbol “x” was adopted to indicate studies that satisfy and comply with the established criteria. A summary table of the obtained results is presented below, based on the following criteria definitions: S1 – numerical values; S2 – compensation among criteria; S3 – method justification; S4 – sample size; S5 – decision-makers’ profile; S6 – feedback on results.



RELISE

Chart 3. Characterization of the studies according to the established criteria

Authors	S1	S2	S3	S4	S5	S6
NIEDER-HEITMANN; HAIGH; GÖRGENS, 2019	x				x	
GOMPF; TRAVERSO; HETTERICH, 2021	x			x	x	
KOLOTZEK et al., 2018	x			x	x	
WILKEN et al., 2020	x	x				
RAFIAANI et al., 2020	x		x	x	x	
CARDOSO et al., 2018	x	x				
DO CARMO et al., 2021	x	x	x		x	
WANG et al., 2019	x				x	
XU et al., 2017	x					
ZHENG et al., 2019	x			x	x	
ZHOU et al., 2019	x					
EAGAN; WEINBERG, 1999	x					
HALOG; MANIK, 2011	x					
TAVAKOLI; BARKDOLL, 2020	x				x	
MATTILA et al., 2018	x		x			
FÉON et al., 2021	x	x		x	x	
ALIDOOSTI et al., 2021	x			x	x	
OPHER; SHAPIRA; FRIEDLER, 2018	x			x	x	
DE LUCA et al., 2015	x			x	x	
DE LUCA et al., 2018	x			x	x	
REN et al., 2015	x					
SUBRAMANIAN et al., 2018	x					
BALASBANEH; MARSONO, 2020	x			x	x	
BALASBANEH; YEOH; ZAINAL ABIDIN, 2020	x			x	x	
BALASBANEH et al., 2021	x			x	x	
DU; DIAS; FREIRE, 2019	x			x	x	
KOULOUMPIS; AZAPAGIC, 2018	x					
LIU; QIAN, 2019	x			x	x	
MUHAMMAD ANWAR; ALVARADO; HSU, 2021	x			x	x	
ZIRA et al., 2020	x			x	x	

S1 – numerical values; S2 – compensation among criteria; S3 – method justification; S4 – sample size; S5 – decision-makers' profile; S6 – feedback on results.

Based on the presentation of Chart 3 and the evaluation behavior of the articles according to the established criteria, the main perceptions and inferences regarding the obtained data are described below.

Numerical values

Numerical values in S-LCA studies quantify the perception and value judgments of participating decision-makers through numbers to represent



realistic results, mostly through scale-based methodologies and criteria weighting systems. In this literature review, it was observed that all studies presented value judgment data from decision-makers.

There are several scoring systems that can be used to represent expert value judgments and measure performance in impact subcategories. Carmo et al. (2017) present ordinal classification systems based on qualitative levels (A, B, C, and D) and cardinal scales, which may also include negative score levels (for example [-10; 10]). In addition, their research clarifies that some scoring systems may use customized scoring functions, with non-linear distances between numbers and potentially exhibiting concave and convex characteristics.

Various scoring systems are used in S-LCA, including the use of colors to simplify evaluation: green for positive, red for negative, and gray for neutral. However, the most consolidated system for Type 1 studies is the five-point reference scale (1 to 5) used to represent the social performance of impact subcriteria. Type 2 studies also employ numerical values in cause-and-effect relationships, quantifying social consequences through midpoints and endpoints (NEUGEBAUER, 2016).

Considering the complexity of social problems and phenomena, numerical values may also be used for weighting and aggregating results across subcategories in Social Life Cycle Impact Assessment (S-LCIA), Phase 3 of impact assessment, as well as in sensitivity analyses, uncertainty reduction, and other explorations that may be adopted throughout the study (UNEP, 2020).

Halog and Manik (2011) present a dynamic model outlining numerical values for a combined assessment of the environmental, economic, and social pillars, representing the ranking of importance across a series of criteria as well as the consensus obtained from the evaluation. Zheng et al. (2019), in addition to ranking alternatives based on numerical results, present graphical representations of the results and a sensitivity analysis to investigate the



influence of decision subcriteria weights on result consistency and to identify the most sensitive subcriteria and dimensions according to decision-makers' value judgments.

Compensation among criteria

According to the UNEP guidelines (2020), compensation among criteria is neither accepted nor envisaged due to the negative impacts that compensation may cause through the incorrect prioritization of alternatives in decision-making processes. The compensatory characteristic present in some MCDA methods is strongly criticized by specialists because it may soften the negative impacts of alternatives that perform poorly in specific aspects.

As can be observed in Chart 3, only four studies applied methods that are explicitly classified as non-compensatory: Wilken et al. (2020), Cardoso et al. (2018), Do Carmo et al. (2021), and Féon et al. (2021). This highlights the need for the appropriate use of methods in S-LCA studies, since compensation among criteria is a methodological characteristic explicitly rejected by UNEP guidelines.

Based on the mathematical and methodological characteristics of MCDA methods and with the support of the MCDA Methods Selection Software (MCDA-MSS) developed by Cinelli et al. (2018) — a free software tool designed to assist analysts in selecting relevant methods for decision problems through a set of interactive questions that identify a subset of suitable methods — it was possible to identify studies that applied non-compensatory methods.

As previously mentioned, most studies used the AHP method, which has compensation among criteria as one of its main disadvantages, making its selection inconsistent with the recommendations of UNEP guidelines. The studies by Wilken et al. (2020), Cardoso et al. (2018), and Do Carmo et al. (2021) applied methods from the PROMETHEE family, which are recognized by MCDA specialists as non-compensatory. In addition to these three studies, Féon et al.



(2021) used the DEX Method, which is characterized by MCDA-MSS as null with respect to compensation among criteria. As observed, most studies contradict the very guidelines of S-LCA by randomly applying methods without evaluating their suitability for the decision problem and the context in which they are applied.

Justification for the selected method

According to Roy and Słowiński (2013), randomness should not guide the selection of an MCDA method, since the decision context, preference scales, compensation, advantages, disadvantages, and other characteristics are crucial for an appropriate method choice.

As can be observed, only three studies justified their choice through comparisons among methods. Rafiaani et al. (2020) justified their choice by presenting the main advantages of the TOPSIS method; however, a deeper theoretical discussion comparing the advantages and disadvantages of TOPSIS relative to other methods applied in S-LCA studies would have been necessary. Mattila et al. (2018) presented the advantages of AHP and MAUT for supporting decision-making processes through scenario examples, highlighting characteristics such as the use of scales and the quantification of social impacts, as well as the possibility of including criteria beyond social aspects in sustainability assessments of value chains.

Carmo et al. (2021), although not comparing MCDA methods directly, provided the strongest justification among the studies reviewed for selecting the PROMSORT method, presenting five reasons: i) non-compensatory method; ii) intuitive parameters for decision-makers; iii) allowance for decision-maker hesitation; iv) support for numerical and verbal scales; and v) use of preference thresholds and reference alternatives. Furthermore, considering that the purpose of the research was the classification and selection of impact subcategories, the



article established a simplified graphical and visual classification approach, facilitating result interpretation.

Because S-LCA involves the participation of society and stakeholders, does not permit compensation among criteria, and is associated with complex and subjective decision problems, decision-support tools should be selected carefully and should be capable of modeling subjectivity. Therefore, justifying the choice of the MCDA method that best fits the decision problem in S-LCA studies is essential to meet UNEP requirements and ensure research effectiveness.

Sample size

As previously discussed, S-LCA data are collected through value judgments, particularly when global databases are unavailable for the decision problem. In such situations, reliable decision-making requires realistic data to guide the process, especially when conflicting stakeholder interests exist.

Although S-LCA guidelines do not specify a response rate or an appropriate number of respondents, a representative sample size contributes to realistic results for decision support. This review identified that 16 studies reported sample size information: Gompf, Traverso, and Hetterich (2021); Kolotzek et al. (2018); Rafiaani et al. (2020); Zheng et al. (2019); Féon et al. (2021); Alidoosti et al. (2021); Opher, Shapira, and Friedler (2018); De Luca et al. (2015); De Luca et al. (2018); Balasbaneh and Marsono (2020); Balasbaneh, Yeoh, and Zainal Abidin (2020); Balasbaneh et al. (2021); Du, Dias, and Freire (2019); Liu and Qian (2019); Muhammad Anwar, Alvarado, and Hsu (2021); and Zira et al. (2020).

Therefore, it can be observed that a considerable portion of the studies did not report the number of participants, which is fundamental for data reliability and for the methodological replication of research in other social contexts and



locations. Furthermore, most studies did not report the statistical criteria used to define sample size for data collection.

Zhou et al. (2019) identified the categories of interviewed decision-makers — local community, society, and workers — but did not report the number of participants involved. Although this is not explicitly required by S-LCA guidelines, the statistical definition of representative samples contributes to robust and reliable studies.

The following chart presents the articles that report the number of interviewees included in the sample.

Chart 4. Quantity of interviewees in selected researches.

Research Authors	Sample	Research Authors	Sample
Gompf; Traverso; Hetterich, 2021	48	De Luca et al., 2018	15
Kolotzek et al., 2018	25	Balasbaneh; Marsono, 2020	45
Rafiaani et al., 2020	300	Balasbaneh; Yeoh; Zainal Abidin, 2020	45
Zheng et al., 2019	8	Balasbaneh et al., 2021	45
Féon et al., 2021	60	Du; Dias; Freire, 2019	7
Alidoosti et al., 2021	20	Liu; Qian, 2019	103
Opher; Shapira; Friedler, 2018	20	Muhammad Anwar; Alvarado; Hsu, 2021	8
De Luca et al., 2015	10	Zira et al., 2020	10

Of the 16 studies, as presented in the chart above, 3 studies used fewer than 10 respondents, 11 ranged from 10 to 60 respondents, and 2 studies exceeded 100 respondents. Although some studies collected data from a limited number of participants, this does not necessarily indicate insufficiency, since it must be associated with the population and circumstances of the decision problem.



Most studies used purposive sampling to establish specific criteria, as presented in the work of De Luca et al. (2015). This type of sample has the advantage of being faster and useful in quantitative studies; however, it may produce generic data and entail greater risk. In both sampling methods, approaches that incorporate associated uncertainty may be used, which will be discussed in the following section.

Decision-makers' profile

The description of the decision-makers' profile is of utmost importance for the methodological reproducibility of the method, as well as for ensuring the characterization and reliability that the obtained data faithfully represent the social context of the problem in which stakeholders are involved. The decision-makers' profile reflects the thinking of the categories through their value judgments, addressing existing consistencies and divergences through the presentation of value judgments. The UNEP guidelines (2020) highlight six impact assessment stakeholder categories (workers, consumers, local community, value chain actors, society, and children), which may, in certain situations, present convergent or divergent results.

The decision-makers' profile criterion was identified in 20 studies. This criterion is particularly relevant because the categories that should be included in S-LCA studies are specified in the guidelines. Unlike most studies in this review, which only indicate the categories that participated in data collection, the study by Zira et al. (2020), which categorized workers, farmers, consumers, local community, and society, described the selection of participants in much greater detail. For example, farmers were defined as owners of pig production enterprises and were distinguished from workers; the local community was defined as individuals living within a 3 km radius of the farms; consumers were defined as



RELISE

people who consume pork in Sweden; and society was defined as individuals living within a 2,000 km² area surrounding agricultural production regions.

In S-LCA studies, stakeholder categories should ideally encompass all six categories. However, several studies do not include all of them because certain contexts may not involve the presence of every category, as the product system boundaries may not encompass all stakeholder groups. Another important aspect is the adequate description of decision-makers' profiles, which provides greater reliability for data reproduction by describing in more detail the categorization process of participating decision-makers.

Results feedback

None of the studies included in this literature review reported providing feedback of the results to decision-makers and/or stakeholders. The importance of results feedback lies in promoting data transparency and, above all, facilitating the understanding and interpretation of data to support decision-making processes that generate benefits for local communities.

Interpretation (Phase 4), which may include results feedback, is an iterative phase of S-LCA in which the outcomes of this phase may lead to revisions of the goal and scope of the study (Phase 1), data collection (Phase 2), and impact assessment (Phase 3). Furthermore, the interpretation of results should: i) verify completeness; ii) check consistency; iii) verify data sensitivity and quality; iv) assess materiality; and v) present conclusions, limitations, and recommendations (UNEP, 2020).

Although none of the studies included in this systematic review presented feedback from specialists regarding the results, the study by Féon et al. (2021) showed that discussions occurred among experts during the data collection process, particularly due to differences in opinions, and concluded that future feedback would be useful for improving and developing the model. In addition,



RELISE

209

the authors believe that the discussions held during workshops should also take place with the community, reinforcing the need for feedback processes to be incorporated into S-LCA studies.

CONCLUSIONS

Despite advances and the growing number of studies, S-LCA still requires significant improvement and remains scientifically far behind Environmental LCA and Economic LCA. In its most recent guidelines, UNEP calls upon researchers in the field to address existing gaps and highlights the need for methodological advances. Some of the articles selected in this review focused primarily on sustainability assessment (the three pillars), with S-LCA serving as a secondary component of the research. This further contributes to the scarcity of in-depth studies given the limited number of publications in the field, reinforcing the need for additional research aimed at developing impact assessment methodologies capable of supporting decision-making for socially just products.

The decision-making process in S-LCA for public policies and industrial sectors is one of the main scientific gaps that must be addressed by 2030 (UNEP, 2020). In this context, MCDA approaches have become one of the principal tools supporting decision-making processes in S-LCA, particularly in the weighting and aggregation of criteria for social impact assessment. However, researchers have often selected methods arbitrarily, and when methods are chosen inappropriately, they may lead to misguided decision-making.

As observed in the data collection of this literature review, the most widely used method was AHP, which has compensation among criteria as one of its main characteristics. This feature should not be present in S-LCA studies, according to UNEP guidelines. Furthermore, shortcomings were identified in the application of S-LCA itself. Although its guidelines emphasize the importance of the interpretation and communication of results phase, this review found that



studies generally do not provide feedback to participants after data collection to facilitate stakeholders' understanding of the decision-making process. Instead, this phase is largely limited to scientific dissemination through journal publications.

Due to the limited number of studies available, S-LCA is still undergoing extensive refinement and the development of effective methodologies capable of meeting guideline requirements. Therefore, this literature review will provide researchers with an overview of the current state of the art regarding the use of MCDA in S-LCA.

The main limitations of this research include the time spent reading articles that were not related to the topic and were not filtered out during the data collection phase, as well as the difficulty in identifying relevant information, since some data were contained in supplementary materials and in figures and tables rather than being explicitly described in the main text.

Although the defined criteria are not exhaustive, the present study enabled a global assessment of the selected works and identified discussions and characteristics relevant to good practices in the use of MCDA within S-LCA. As a recommendation for future research, studies focused on the systematic selection of criteria and the development of weighted assessment models are suggested.

REFERENCES

ALIDOOSTI, Z. et al. Social sustainability of treatment technologies for bioenergy generation from the municipal solid waste using best worst method. **Journal of Cleaner Production**, v. 288, 15 mar. 2021.



RELISE

211

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS - ABNT. ABNT NBR ISO 14040 Gestão ambiental - Avaliação do ciclo de vida - Princípios e estrutura. **Associação Brasileira de Normas Técnicas**, p. 1–22, 2014.

BALASBANEH, A. T. et al. Applying three pillar indicator assessments on alternative floor systems: life cycle study. **International Journal of Life Cycle Assessment**, v. 26, n. 7, p. 1439–1455, 1 jul. 2021.

BALASBANEH, A. T.; MARSONO, A. K. BIN. Applying multi-criteria decision-making on alternatives for earth-retaining walls: LCA, LCC, and S-LCA. **International Journal of Life Cycle Assessment**, v. 25, n. 11, p. 2140–2153, 1 nov. 2020.

BALASBANEH, A. T.; YEOH, D.; ZAINAL ABIDIN, A. R. Life cycle sustainability assessment of window renovations in schools against noise pollution in tropical climates. **Journal of Building Engineering**, v. 32, 1 nov. 2020.

BANA E COSTA, C. A.; VANSNICK, J. C. A critical analysis of the eigenvalue method used to derive priorities in AHP. **European Journal of Operational Research**, v. 187, n. 3, p. 1422–1428, 16 jun. 2008.

BELTON, V.; STEWART, T. **Multiple Criteria Decision Analysis: An Integrated Approach**. Boston: Springer, 2002. CARDOSO, T. F. et al. Economic, environmental, and social impacts of different sugarcane production systems. **Biofuels, Bioproducts and Biorefining**, v. 12, n. 1, p. 68–82, 1 jan. 2018.

CARMO, B. B. T.; MARGNI, M.; BAPTISTE, P. Customized scoring and weighting approaches for quantifying and aggregating results in social life cycle



RELISE

impact assessment. **International Journal of Life Cycle Assessment**, v. 22, n. 12, 2017.

CINELLI, M. et al. **MCDA Methods Selection Software (MCDA-MSS)**. 2018. Disponível em: <https://mcda.cs.put.poznan.pl/>. Acesso em: 4 fev. 2025.

DA SILVA, L. B. L. et al. Paradigmas, Métodos e Ferramentas para Modelos de Decisão Multicritério em Sistemas de Manufatura Orientados para a Indústria Sustentável 4.0. **Sustentabilidade**, v. 15, n. 8869, 2023.

DE LUCA, A. I. et al. Social life cycle assessment and participatory approaches: A methodological proposal applied to citrus farming in Southern Italy. **Integrated Environmental Assessment and Management**, v. 11, n. 3, p. 383–396, 1 jul. 2015.

DE LUCA, A. I. et al. Evaluation of sustainable innovations in olive growing systems: A Life Cycle Sustainability Assessment case study in southern Italy. **Journal of Cleaner Production**, v. 171, p. 1187–1202, 10 jan. 2018.

DO CARMO, B. B. T. et al. Participatory approach for pertinent impact subcategory identification: Local community. **International Journal of Life Cycle Assessment**, v. 26, n. 5, p. 950–962, 1 maio 2021.

DU, C.; DIAS, L. C.; FREIRE, F. Robust multi-criteria weighting in comparative LCA and S-LCA: A case study of sugarcane production in Brazil. **Journal of Cleaner Production**, v. 218, p. 708–717, 1 maio 2019.



RELISE

213

EAGAN, P.; WEINBERG, L. Application of analytic hierarchy process techniques to streamlined life-cycle analysis of two anodizing processes. **Environmental Science and Technology**, v. 33, n. 9, p. 1495–1500, 1 maio 1999.

EKENER, E.; HANSSON, J.; GUSTAVSSON, M. Addressing positive impacts in social LCA — discussing current and new approaches exemplified by the case of vehicle fuels. p. 556–568, 2018.

FÉON, S. LE et al. Dexiaqua, a model to assess the sustainability of aquaculture systems: Methodological development and application to a french salmon farm. **Sustainability (Switzerland)**, v. 13, n. 14, 2 jul. 2021.

GOMPF, K.; TRAVERSO, M.; HETTERICH, J. Using analytical hierarchy process (AHP) to introduce weights to social life cycle assessment of mobility services. **Sustainability (Switzerland)**, v. 13, n. 3, p. 1–10, 1 fev. 2021.

HALOG, A.; MANIK, Y. Advancing integrated systems modelling framework for life cycle sustainability assessment. **Sustainability**, v. 3, n. 2, p. 469–499, 2011.

KOLOTZEK, C. et al. A company-oriented model for the assessment of raw material supply risks, environmental impact and social implications. **Journal of Cleaner Production**, v. 176, p. 566–580, 1 mar. 2018.

KOULOUMPIS, V.; AZAPAGIC, A. Integrated life cycle sustainability assessment using fuzzy inference: A novel FELICITA model. **Sustainable Production and Consumption**, v. 15, p. 25–34, 1 jul. 2018.



RELISE

LIU, S.; QIAN, S. Towards sustainability-oriented decision making: Model development and its validation via a comparative case study on building construction methods. **Sustainable Development**, v. 27, n. 5, p. 860–872, 1 set. 2019.

MATTILA, T. J. et al. Evaluating social sustainability of bioeconomy value chains through integrated use of local and global methods. **Biomass and Bioenergy**, v. 109, p. 276–283, 1 fev. 2018.

MUHAMMAD ANWAR, S. N. B.; ALVARADO, V.; HSU, S. C. A socio-eco-efficiency analysis of water and wastewater treatment processes for refugee communities in Jordan. **Resources, Conservation and Recycling**, v. 164, 1 jan. 2021.

NETO, G. M. P.; ALENCAR, L. H.; VÁSQUEZ, R. V. Multiple-Criteria Methods for Assessing Social Sustainability in the Built Environment: A Systematic Review. **Sustainability**, v. 15, 23 nov. 2023.

NEUGEBAUER, S. **Enhancing Life Cycle Sustainability Assessment Tiered Approach and new Characterization Models for Social Life Cycle Assessment and Life Cycle Costing**. 2016. Tese (Doutorado) - Technische Universität Berlin, Berlin, 2016. Disponível em: <https://doi.org/http://dx.doi.org/10.14279/depositonce-5644>. Acesso em: 4 jan. 2025.

NIEDER-HEITMANN, M.; HAIGH, K. F.; GÖRGENS, J. F. Life cycle assessment and multi-criteria analysis of sugarcane biorefinery scenarios: Finding a



RELISE

215

sustainable solution for the South African sugar industry. **Journal of Cleaner Production**, v. 239, 1 dez. 2019.

OPHER, T.; SHAPIRA, A.; FRIEDLER, E. A comparative social life cycle assessment of urban domestic water reuse alternatives. **International Journal of Life Cycle Assessment**, v. 23, n. 6, p. 1315–1330, 1 jun. 2018.

RAFIAANI, P. et al. Identifying Social Indicators for Sustainability Assessment of CCU Technologies: A Modified Multi-criteria Decision Making. **Social Indicators Research**, v. 147, n. 1, p. 15–44, 1 jan. 2020.

REN, J. et al. Prioritization of bioethanol production pathways in China based on life cycle sustainability assessment and multicriteria decision-making. **International Journal of Life Cycle Assessment**, v. 20, n. 6, p. 842–853, 26 jun. 2015.

ROY, B.; SŁOWIŃSKI, R. Questions guiding the choice of a multicriteria decision aiding method. **EURO Journal on Decision Processes**, v. 1, n. 1–2, p. 69–97, 2013.

SAJID, Z.; LYNCH, N. Financial modelling strategies for social life cycle assessment: A project appraisal of biodiesel production and sustainability in Newfoundland and Labrador, Canada. **Sustainability (Switzerland)**, v. 10, n. 9, p. 8–10, 2018.

SHAHID, M. N. Developing and Applying a Social Life Cycle Assessment Framework to Assess the Social Sustainability of Cheese Supply Chains in the UK. n. January, 2017.



RELISE

SUBRAMANIAN, V. et al. Assessing the social impacts of nano-enabled products through the life cycle: the case of nano-enabled biocidal paint. **International Journal of Life Cycle Assessment**, v. 23, n. 2, p. 348–356, 1 fev. 2018.

SUREAU, S. et al. Participation in S-LCA: A methodological proposal applied to belgian alternative food chains (Part 1). **Resources**, v. 8, n. 4, p. 1–24, 2019.

TAVAKOLI, H.; BARKDOLL, B. D. Blended Lifecycle Integrated Social System Method. **International Journal of Environmental Research**, v. 14, n. 6, p. 727–749, 1 dez. 2020.

TZENG, G. H.; HUANG, J. J. **Multiple Attribute Decision Making: Methods and Applications**. 1. ed. Nova York: CRC Press, 2011.

UNEP. Guidelines for SOCIAL LIFE CYCLE ASSESSMENT OF PRODUCTS AND ORGANIZATIONS 2020. **United Nations Environment Programme (UNEP)**, 2020.

WANG, Y. et al. Comprehensive evaluation of the sustainable development of battery electric vehicles in China. **Sustainability (Switzerland)**, v. 11, n. 20, 1 out. 2019.

WILKEN, D. et al. **Multidimensional assessment of passenger cars: Comparison of electric vehicles with internal combustion engine vehicles**. Procedia CIRP. **Anais...Elsevier B.V.**, 2020.



RELISE

217

XU, D. et al. Supporting Information Life Cycle Sustainability Assessment of Chemical Processes: A Vector-based Three-dimensional Algorithm Coupled with AHP. **Industrial & Engineering Chemistry Research**, v. 56, 2017.

YANG, G. LIANG et al. A three-stage hybrid approach for weight assignment in MADM. **Omega (United Kingdom)**, v. 71, p. 93–105, 2017.

ZANGHELINI, G. M.; CHERUBINI, E.; SOARES, S. R. SC. **Journal of Cleaner Production**, v. 172, p. 609–622, 2018.

ZHENG, X. et al. Life-cycle sustainability assessment of pavement maintenance alternatives: Methodology and case study. **Journal of Cleaner Production**, v. 213, p. 659–672, 10 mar. 2019.

ZHOU, Z. et al. Model development of sustainability assessment from a life cycle perspective: A case study on waste management systems in China. **Journal of Cleaner Production**, v. 210, p. 1005–1014, 10 fev. 2019.

ZIRA, S. et al. Social life cycle assessment of Swedish organic and conventional pork production. **International Journal of Life Cycle Assessment**, v. 25, n. 10, p. 1957–1975, 1 out. 2020.