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In a Nutshell. . .

LIFE CYCLE ASSESSMENT

A multistakeholder participatory Life Cycle Sustainability Assessment framework for the options appraisal of social housing regeneration schemes, by Nava et al.

A proposed participatory Life Cycle Sustainability Assessment (LCSA) framework is presented for the assessment and analysis of the life cycle sustainability of regeneration schemes.

ENVIRONMENTAL RISK ASSESSMENT

Incorporating other world views such as Indigenous knowledge will strengthen environmental risk assessments, by Aberra et al.

Scientifically robust, technically advanced environmental risk assessments benefit from the inclusion of community participation and the harmonization of concepts and categories.

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A multistakeholder participatory Life Cycle Sustainability Assessment framework for the options appraisal of social housing regeneration schemes

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INTRODUCTION

To enable sustainable growth in housing provision, the socioeconomic impacts of social housing regeneration schemes alongside their life cycle environmental impacts should be assessed. Life Cycle Sustainability Assessment (LCSA) is a methodology used for assessing the overall sustainability of products and systems (Klopffer & Grahl, 2014) wherein goal and scope definition, inventory analysis, Life Cycle Impact Assessment (LCIA), and Interpretation are conducted for the environmental, social, and economic impacts of different scenarios (Hannouf & Assefa, 2018). Lack of stakeholders' involvement is one of the main limitations of LCSA methodologies (Souza et al., 2015; Zamagni et al., 2013). A comprehensive LCSA in the context of regeneration schemes should include the participation of different stakeholders, including the community, in all the stages. Our study aims to answer the question: "How can a participatory approach be integrated into the LCSA framework for options appraisal of social housing regeneration schemes?" We used a mixed-methods design for the assessment and analysis of LCSA. Data collection for this research consisted of a scoping review, surveys, co-design workshops, ethnographic observations, and semistructured interviews.

To reflect the priorities of an array of stakeholders in options appraisal and to promote informed decision-making, different stakeholders should be engaged at different stages of decision analysis. The inaccessibility of assessment methodologies and tools for laypeople has been noted as one of the limitations in developing a sustainable building assessment tool (Kang et al., 2016). Kang et al. (2016) have suggested engaging nonexpert stakeholders, especially users, throughout the framework-development process. The British Standard Institution BS ISO 21931-1:2022 Standard (BSI, 2022) identifies clients, designers, constructors, suppliers, and governmental agencies as possible stakeholders involved in the assessment methods for design development, and the owners, designers, building managers and operators, occupants, and governmental agencies as

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the potential list of stakeholders involved in the assessment of environmental impacts. However, the recommended level of participation of the identified stakeholders is limited.

A profound LCSA requires a justifiable selection of the indicators (Weidema et al., 2020) that respond to the contxt and priorities of the project. The approach for addressing sustainability indicators for LCSA of buildings has not been consistent. While the BS ISO 21931-1:2022 Standard (BSI, 2022) recommends a list of criteria to be applied Europewide, the core indicators do not take into account the contextual considerations for different building sectors. The selection of indicators has a direct influence on the assessment results. Identifying the scope of the LCSA is a step that should include all stakeholders. To enable informed decision-making, prior to the selection of indicators, the goals and objectives of the indicators should be communicated clearly with all the stakeholders. Knowledge-sharing and the selection of indicators can be accomplished through a combination of workshops, surveys, focus groups, interviews, and Multi-Criteria Decision Analysis (MCDA) approaches.

Multi-Criteria Decision Analysis is a decision-aid methodology that facilitates decision-making and is suitable for addressing complex problems by providing quantitative methods to incorporate the values and perspectives of different stakeholders across several criteria. Multi-Criteria Decision Analysis and LCSA can complement each other and compensate for the drawbacks of each methodology due to the objective characteristics of the latter methodology and the subjective characteristics of the former, such as stakeholders' values (Zanghelini et al., 2018).

A preference or value-based approach to develop weighting factors in LCSA is the panel-based model, in which the relative value of a criterion or a topic under study is derived from the stakeholders and/or experts (Sala et al., 2018). We propose a simple MCDA approach for a panel-based weight elicitation of selected indicators and evaluation of the results of the LCIA studies. The panel consists of stakeholder representatives of the regeneration scheme under study, including the community and residents; an architect; a mechanical, electrical, and structural engineer; the client team; a cost consultant; and a sustainability and/or LCSA specialist.

Our proposed framework, presented in Figure 1, consists of five stages: 1—Goal and Scope Definition; 2—Scenario Development; 3—Assessment; 4—Aggregation; and 5—Interpretation. The first stage involves consensus goal and objective setting and the selection and weighting of sustainability goals/indicators by the stakeholder representatives. The iterative nature of any life cycle-based assessment framework and its use for options' comparison means that a participatory LCSA should be tied to a participatory approach for the design scenario development. Hence, stage 2 of the framework involves the collaborative development of design proposals by the participants. LCIA for each design scenario is prepared by the researcher and the design team in stage 3. At stage 4, the LCIA results are scored by the stakeholder representatives and aggregated through the previous weighting of each criterion using simple MCDA approaches. For the aggregation of the assessment results at stage 4, the study proposes a meta-model for calculating the weighted mean of each indicator by applying the weightings of the selected indicators (computed at stage 1) to the mean score that the participants have given to each of the LCIA results for each scenario. The aggregated result for each scenario is the sum of the weighted mean scores of all the selected indicators. At the interpretation stage, completeness and consistency checks are conducted, together with uncertainty and sensitivity analyses. The results of the assessment and analyses are to be communicated with the stakeholders at a workshop, during which the indicators that have had a considerable contribution to the aggregated results will also be identified. These stages can be repeated until consensus is achieved between the stakeholders at different stages of the project.

CONCLUSION

The contextual nature of social housing regeneration schemes is often neglected in the sustainability assessment of those schemes. The collaborative methods of our research have assisted in developing a participatory framework for the assessment and analysis of the LCSA of regeneration schemes. The participatory approaches used in this framework allow for the priorities of different regeneration scheme stakeholder groups to be considered through collaborative goal-setting, selection and weighting of indicators, and aggregation of the assessment results for each option. The proposed framework can be incorporated into conducting a contextual and holistic options appraisal of regeneration schemes, where the priorities of different stakeholders are collaboratively identified for conducting and interpreting LCSA studies.

AUTHOR CONTRIBUTION

Sahar Nava: Conceptualization; formal analysis; investigation; methodology; visualization; writing—original draft; writing—review and editing. **Zaid Chalabi:** Supervision; writing—review and editing. **Sarah Bell:** Supervision; writing—review and editing. **Esfandiar Burman:** Supervision; writing—review and editing.

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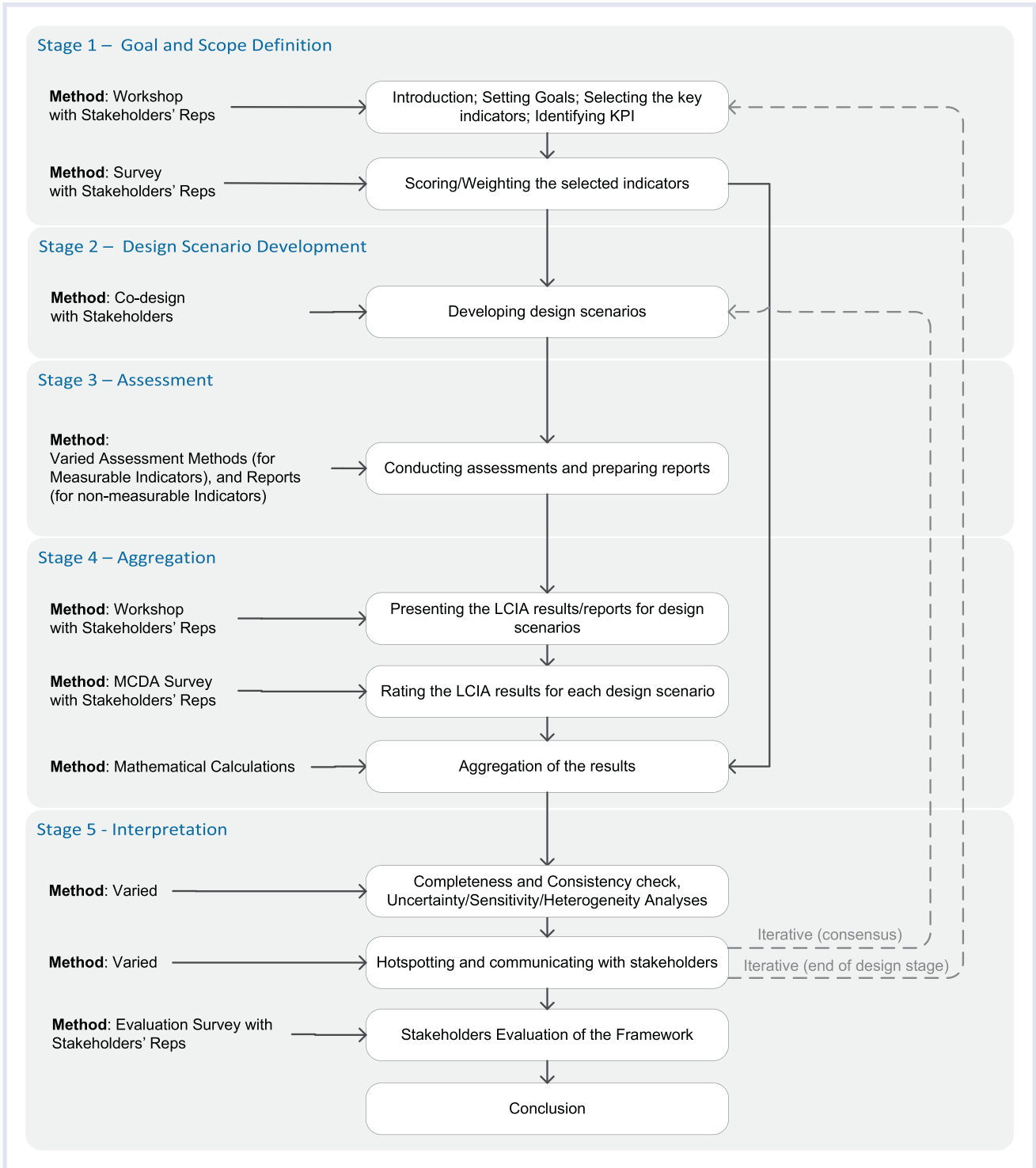

FIGURE 1 Proposed participatory Life Cycle Sustainability Assessment framework. KPI, key performance indicators; LCIA, Life Cycle Impact Assessment; MCDA, Multi-Criteria Decision Analysis

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Incorporating other worldviews such as Indigenous knowledge will strengthen environmental risk assessments

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As part of an introductory class on environmental risk assessment, we reviewed papers on Indigenous knowledge, ecological risk assessment guidance documents, and case studies. One of the authors, Bruce Duncan, has had key involvement with the role of the International Board of Environmental Risk Assessment (IBERA) to promote the field of environmental risk assessment through the development of a rigorous international certification program. We added readings germane to several topics that IBERA has indicated are critical to conducting environmental risk assessments at an advanced level (https://ibera-certification.org/exams/). Students were challenged to answer the question: "What do you think would help improve environmental risk assessments the most?" In our review, we identified two emerging areas that could broaden and strengthen environmental risk assessments: (1) harmonizing risk-related definitions and (2) incorporating knowledge from all peoples, with particular emphasis on Indigenous nations.

We discuss our findings on the need for clear definitions related to environmental risk assessment. Definitions are the foundations of any field and refining opaque terminology benefits all. Having multiple or unclear definitions of concepts central to environmental risk assessment discourse can lead to confusion or conflation of issues. Definitions of terms such as "jeopardy/adverse modification," "adaptation," and "recovery" have yet to be fully and accurately refined; the resulting ambiguity that arises from this opaqueness should be overcome. Encouraging efforts to harmonize such terminology across related ontologies would provide necessary clarity and precision to assessment goals and endpoints. For example, when addressing cohesion among concept definitions relating to the human health component of environmental risk assessments, the term "resilience" warrants further clarification.

Based on our review of papers on Indigenous knowledge and resilience, we observed that there is a lack of community involvement when defining "resilience." For example, the number of times that resilience is mentioned in research articles related to climate change has increased. Given this fact, it seems odd that very few papers include definitions of resilience that are vetted by populations disproportionately impacted by climate change. The Intergovernmental Panel on Climate Change (IPCC, 2007) defines resilience as "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for selforganization and the capacity to adapt to stress and change." While this is a good general definition, it can be strengthened by involving affected groups in determining what resilience means to them. For example, Donatuto et al. (2016) define resilience in Indigenous peoples as containing three subcategories: self-esteem, identity, and sustainability (Table 1). This definition emerged from multiple workshops with community members organized to develop measures that resonated with participants. This workshop is an example of how disproportionately affected groups who have been marginalized are given agency to define the state of their communities.

Montgomery's (2022) book on Indigenous ecological consciousness examines the relationships among communities, their lands, and the other species that comprise the ecological framework. Montgomery (2022) further notes that humans do not only belong to a human community, but to a community of all living things within nature. Montgomery (2022) emphasizes that Indigenous knowledge represents worldviews that can lead to regenerative solutions, encompassing a collection of knowledge, identities, and lived experiences crucial to understanding environmental impacts.

Indigenous community knowledge of risk perception has some similarities, but also some differences, in comparison with western-based science. Stakeholders face challenges

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