

Life Cycle Sustainability Assessment in the construction sector - actual application and future outlook

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Introduction & Objective

The construction sector is responsible for about 10% of global Gross Domestic Product (GDP) and employs 100 million people [1]. The sector, promoting economy and social wellbeing by shelters and employment, at the same time contributes significantly to resource depletion, energy consumption and CO₂-emissions [2]. The Life Cycle Sustainability Assessment (LCSA) framework extends the scope of the known Life Cycle Assessment (LCA) to cover all three dimensions of sustainability [3,4].

Challenge: LCSA is being applied in the construction sector, although to date only a small number of studies have considered all three pillars: only 11% of studies reviewed made use of LCSA in the construction sector [5].

The main **goal** of the study is to foster the partnership between LCSA and the construction sector - to get an understanding of backgrounds and options of LCSA application in this sector.

Methodology

A worldwide **survey** (winter 20/21) was conducted via anonymous online questionnaires to ask three target groups (TG) about their use, understanding and interpretation of LCSA (Table 1). Each individual target group was subject to individual hypotheses,

which in their own small sub-studies led to acceptance or rejection – nevertheless, one **main hypothesis** (H_{main}) was stated for all TG:
 H_{main} : *The LCSA framework in its current form is little known and too complex to base decision-making regarding sustainability, particularly in the construction sector.*

Target Group (TG)	1	2	3
	LCSA experts worldwide, independent of construction sector	students on environmental and construction engineering, mainly German (future decision maker (DM))	today's decision maker (DM) (planners, architects)
Contact via	mail and network; based on publications	social media and network	mail and network
Reason for TG	experts in LCSA, familiar with challenges and chances	future employees and decision maker	actual employees in construction sector and DM
Objective of survey	clarify whether and how the LCSA framework can be modified or simplified in order to reduce the application threshold and its complexity	clarify whether LCSA or individual parts of sustainability assessment (e.g. LCA) are known and taught and whether one can assume an increasing interest	clarify whether and to what extent practitioners are aware of LCSA and what challenges practitioners face
Nr. of questions	25	31	37
Nr. respondents	67	143	61

Tab. 1: Target group, reason and objective

Results



- **Implementation** of all three pillars (LCA, LCC, S-LCA) is **difficult** for 57% of respondents
- **Selection** and definition of appropriate **indicators** easy for only 3% of respondents
- **Combination** of LCSA and SDG is welcomed by 87% of experts

Should a set of predefined indicators be given for each pillar?

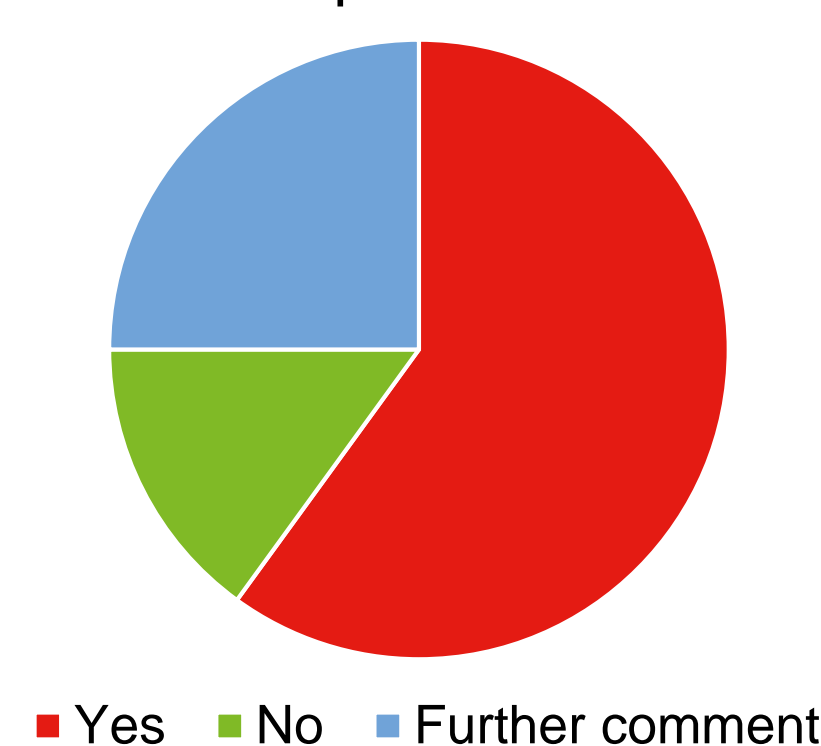


Fig. 1: Indicator set



- Study background of participants: 63% civil engineering, 37% environmental engineering
- 54% of all students have passed their 5th bachelor semester
- 62% of all students indicated that sustainability is a focus of their degree program
- 38% of all students ever heard of LCSA
- < 10% of all students have ever done a LCA

Is a visualization tool needed for DM support and interpretation?

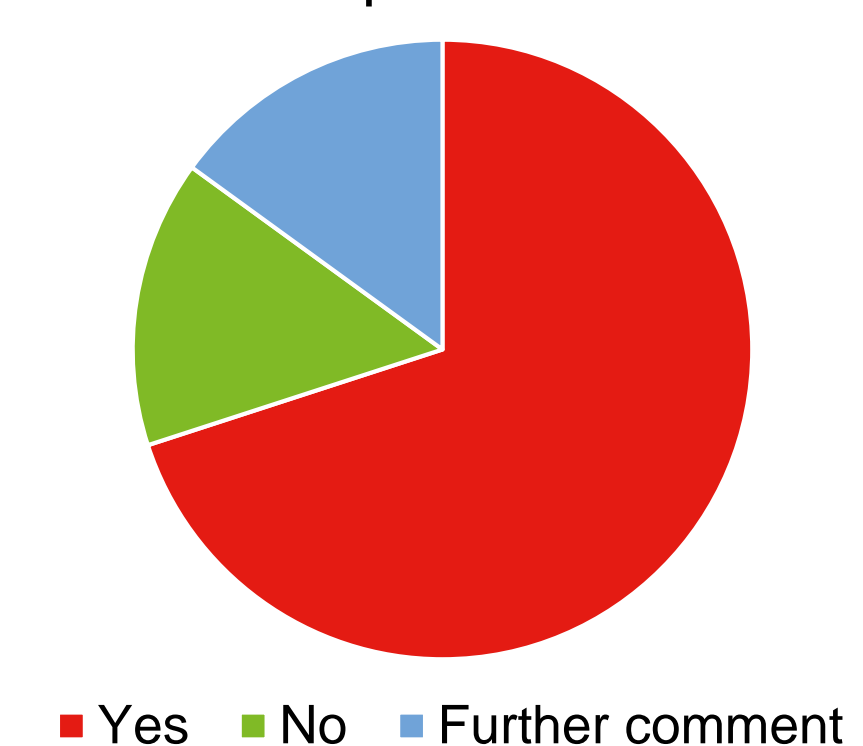


Fig. 2: Visualization tool

Future need:

- 100% ask for **more seminars and lectures**
- More **practical LCA and LCSA exercises** are questioned
- Cross-thematic and **interdisciplinary** events are required



- 94% of today's DM name **LCA** as important and **relevant** for construction sector
- LCA was carried out as it was **required** by **client**
- No application of LCSA in construction practice
- DM ignore equality of the three pillars: rate the economic pillar as most important: economic > environmental > social (pillar)
- Use-phase of entire life cycle was rated as most important

Future need:

- For DM **consensus term** on sustainable building is missing
- **Educate** DM with compulsory seminars – especially as they are service providers to clients
- **Combine disciplines** and add sustainability expert in construction project team

Conclusion

As a first interim result of this research, it can be summarized that H_{main} (LCSA framework in its current form is little known and too complex to base decision-making regarding sustainability, particularly in the construction sector) has to be **proven true**. LCSA is hardly known among actual and future decision-makers in the construction sector. More and intense education concerning sustainability and its assessments in the construction sector is needed. Further, standardization of LCSA and a set of predefined indicators, as well as an adequate visualization tool could support the implementation.

References:
[1] Y. H. Dong and S. T. Ng, "A modeling framework to evaluate sustainability of building construction based on LCSA," *Int. J. Life Cycle Assess.*, vol. 21, no. 4, 2016, pp. 555–568.; [2] S. Y. Janjua, P. K. Sarker, and W. K. Biswas, "A Review of Residential Buildings' Sustainability Performance Using a Life Cycle Assessment Approach," *J. Sustain. Res.*, vol. 1, no. 1, 2019.; [3] W. Kloepffer, "Life cycle sustainability assessment of products (with Comments by Helias A. Udo de Haes, p. 95)," *Int. J. Life Cycle Assess.*, vol. 13, no. 2, 2008, pp. 89–95.; [4] M. Finkbeiner, E. M. Schau, A. Lehmann, and M. Traverso, "Towards life cycle sustainability assessment," *Sustainability*, vol. 2, no. 10, 2010, pp. 3309–3322.; [5] J.G. Backes, M. Traverso, "Application of Life Cycle Sustainability Assessment in the Construction Sector: A Systematic Literature Review," *Processes* (7), 1248 (2021).

