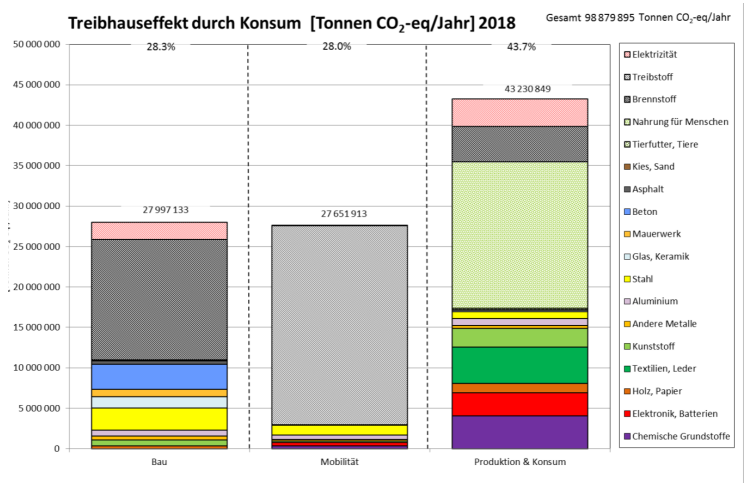
University of Applied Sciences and Arts Northwestern Switzerland
School of Architecture, Construction and Geomatics

Beyond Measuring Resource-Flow

A Holistic Approach for a Framework to Assess Circularity in the Built Environment through all Life Cycle Stages

Circularity in the Built Environment 2025 ¦ Tampere, Finland
Prof. Dr. Margarete Olender
17.09.2025

Drivers for circularity in Swiss Construction



~ 28 Mio. t CO_2-eq/year
~ 29% greenhouse gases

~ 1/3 embodied energy
~ 2/3 operational energy

source: EMPA (2019) Projekt MatCH – Synthese Material- und Energieflüsse der schweizerischen Volkswirtschaft – Mit Bewertung der Umweltbelastungen

75 Mio.t = 84% of all waste

25 Mio.t = 28% of all landfill waste

source:
https://www.bafu.admin.ch/bafu/de/home/themen/abfall/inkuerze.html

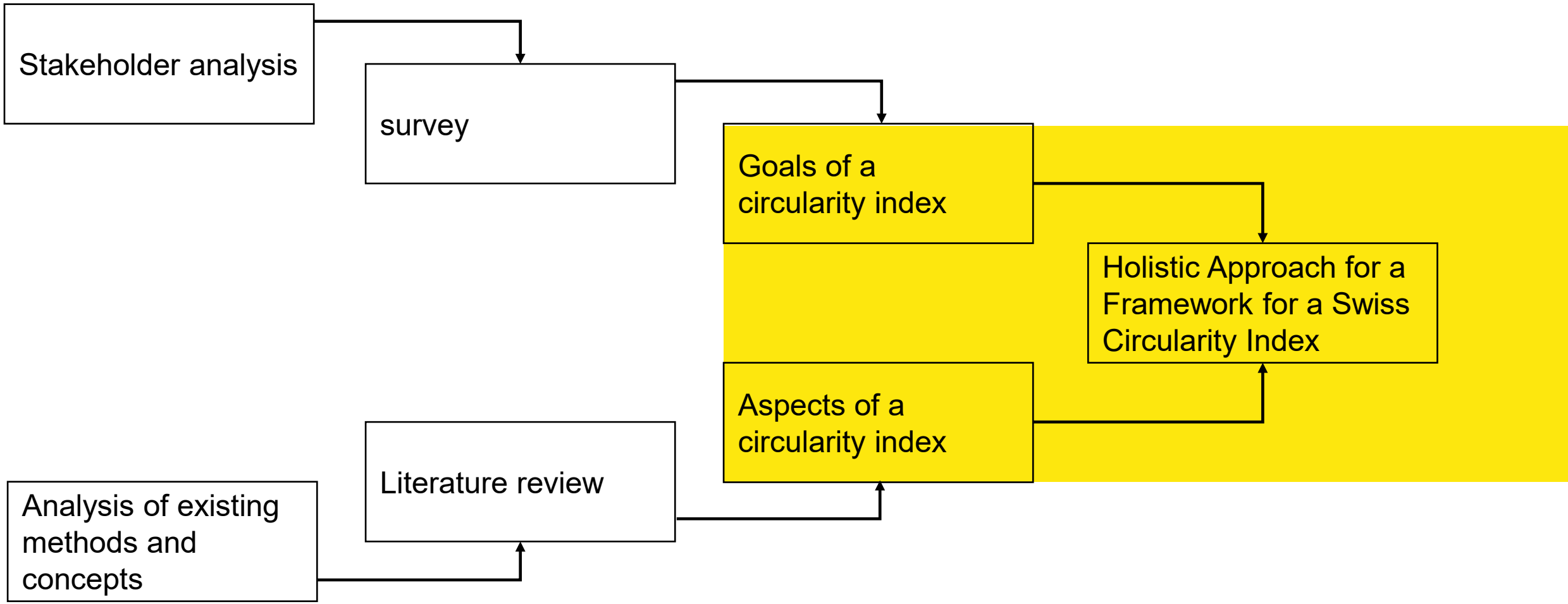
Federal Climate and Innovation Act
since 30.09.2022

Net-zero until 2050

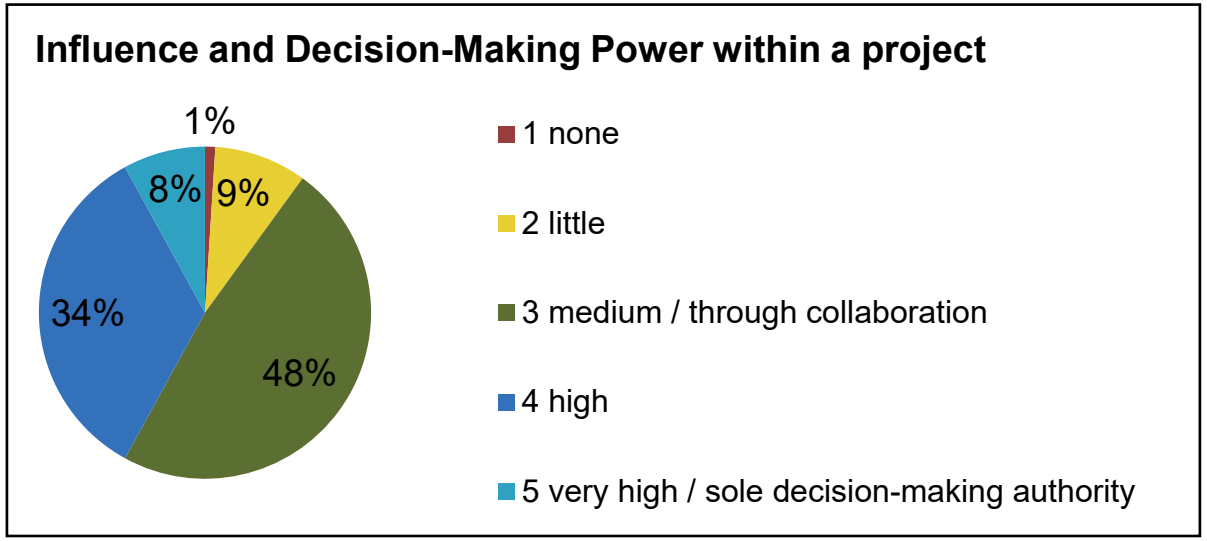
Federal Act on the Protection of the Environment
Art. 35j, since 1.1.2025

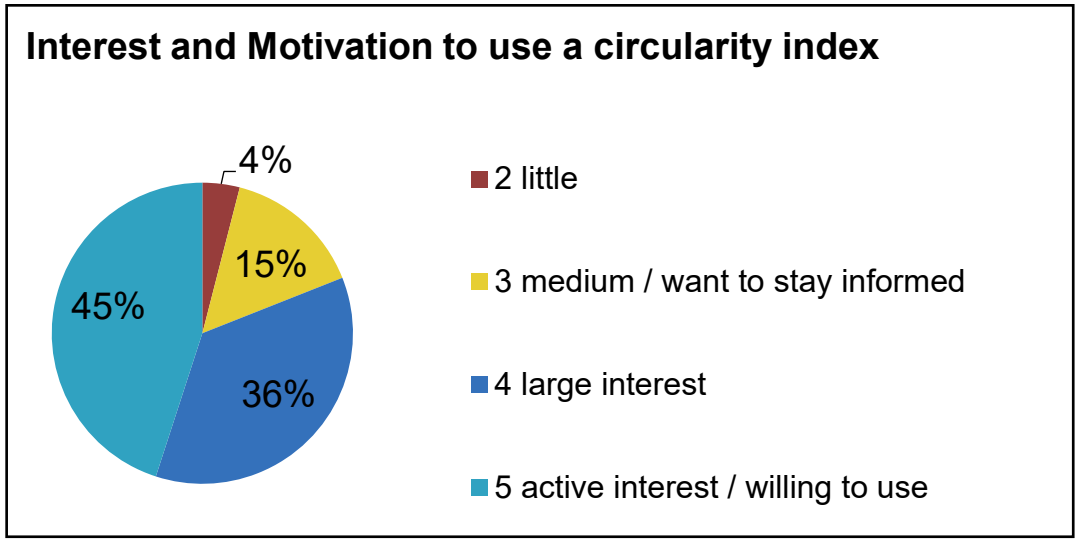
Resource-conserving Construction

Materials and Methods

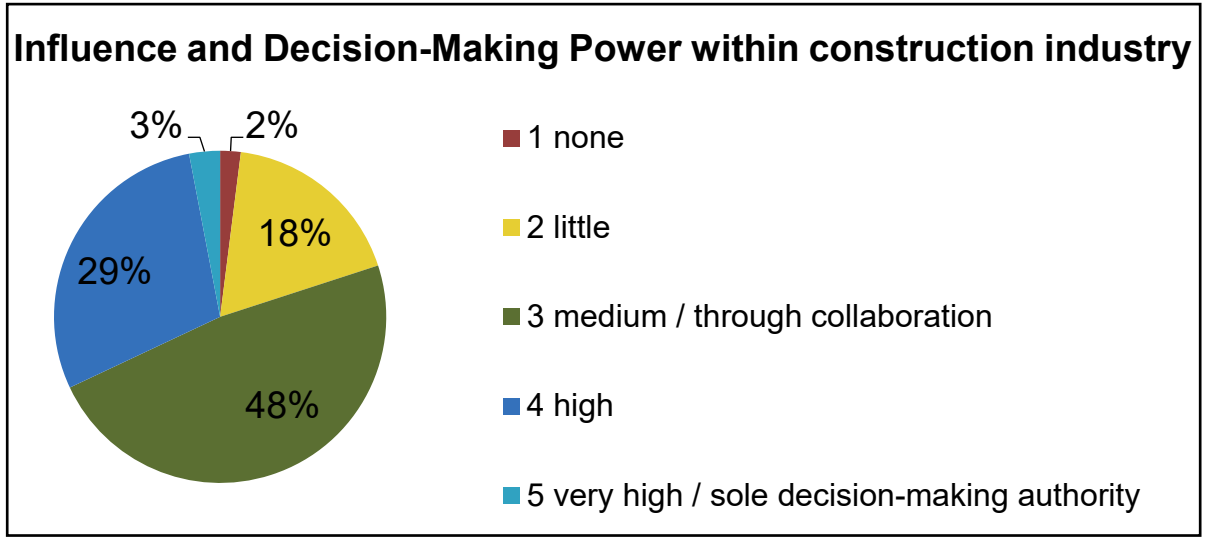


Interest and influence by Stakeholders regarding Circularity





158 participants / total population of sector 514'700
confidence level 95% / margin error 8%



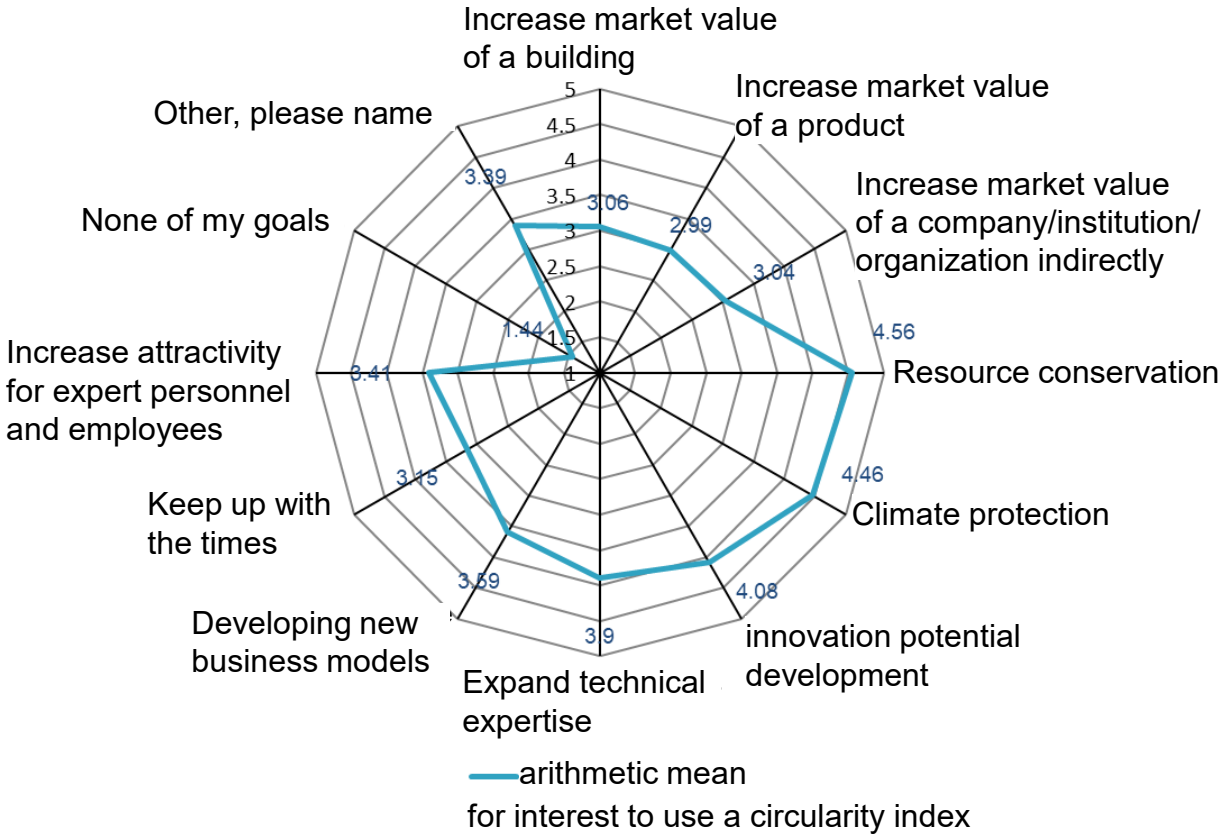
79% open to collaborate with professionals in other areas

Stakeholders' Goals to use a Circularity Index

Percentage of participants with

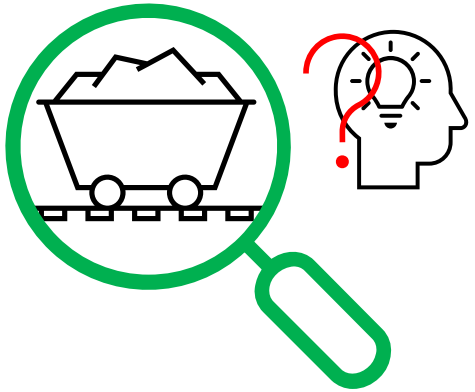
high or **very high motivation** for the following goals:

- resource conservation (89%)
- climate protection (88%)
- innovation potential development (78%)
- Expand Technical expertise (69%)
- Developing new business models (56%)
- Increase attractivity for expert personnel and employees (56%)

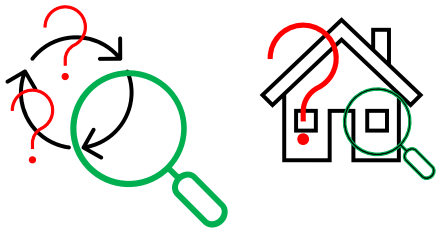


Literature review - Comparative academic analyses

recurring limitations of circularity indicators

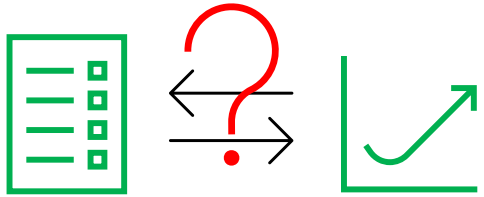


predominant focus on material flows, while neglecting early-phase strategies



Weak representation of **spatial and temporal dynamics**, limiting adaptability across building types and life cycle stages

Minimal coverage of **societal dimensions**



Lack of integration between **material tracking** and **performance indicators**

Literature review – methods and concepts

- **R-Framework** (Kirchherr)
- **Circular Ecosystem Innovation** (Konietzko)
- **Cradle-to-Cradle** (McDonough und Braungart)
- **ISO 59020 Circular economy**
- Material Circularity Indicator by Ellen MacArthur Foundation
- European proposition for indicators for the built environment
- Quality standard for a circularity index by German Sustainable Building Council (DGNB)

ASPECTS

Materials: biogenic, fossil, mineral, metallic, water, energy

End-of-Use Scenarios: Reuse, Repair, Refurbish, Remanufacture, Repurpose

End-of-Life Scenarios: Recycle, Compost, Recover, Incineration, landfill

Life Cycle Stages: Valorization, Design, Construction, Use

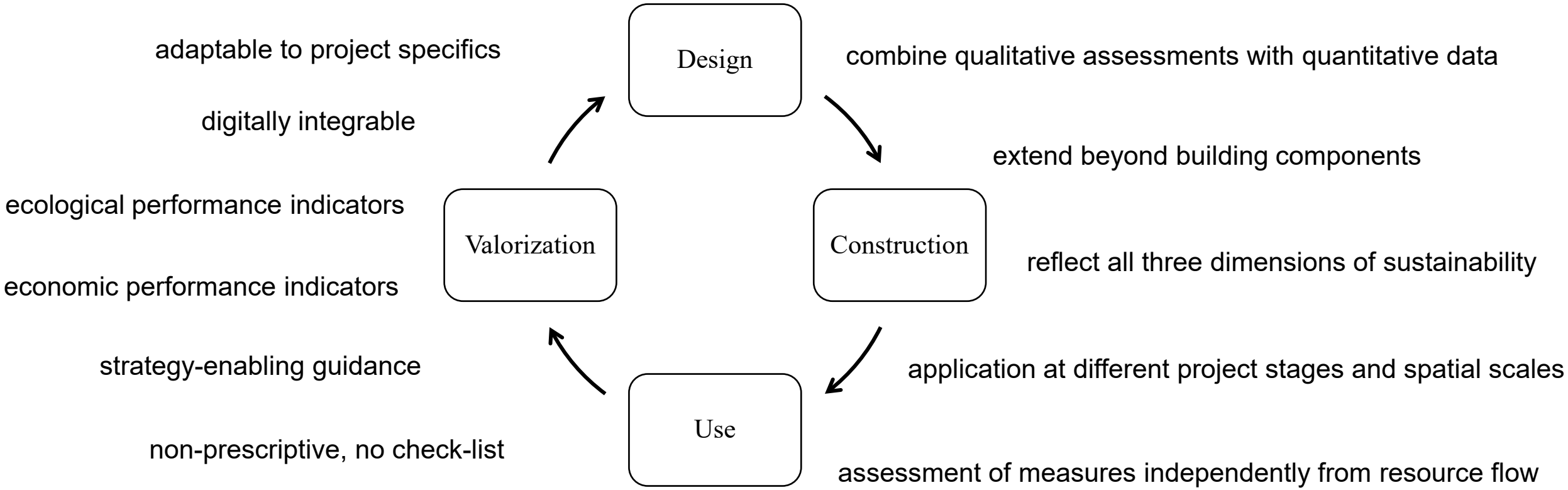
System boundaries: **timely** - full lifecycle with valorization at beginning and end, **spatial** – adaptable to measure of a project

Scales: building material, building elements or products, building components, building structure

Summary of Implications for Framework Development

Stakeholder analysis

Literature review

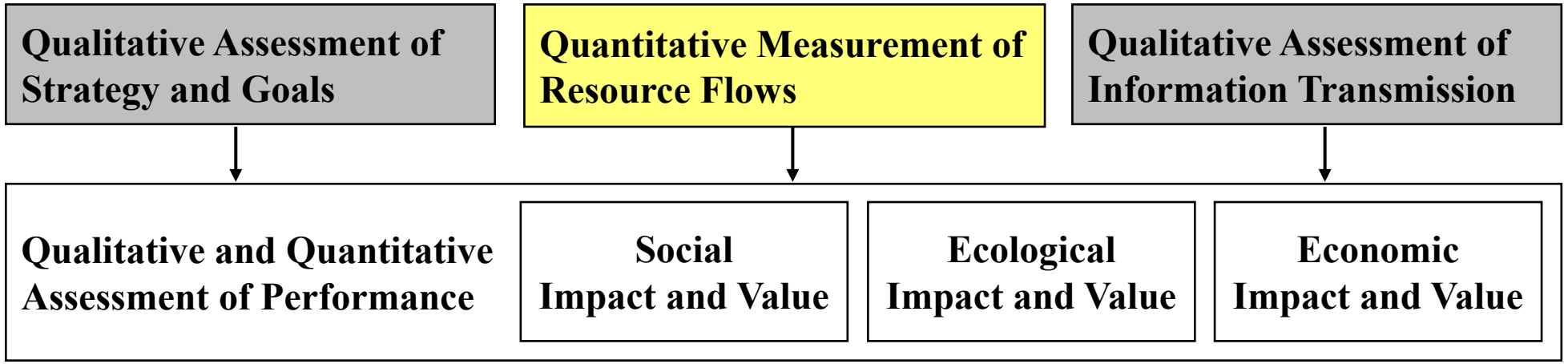


Framework – Group 1: assessing circular approaches

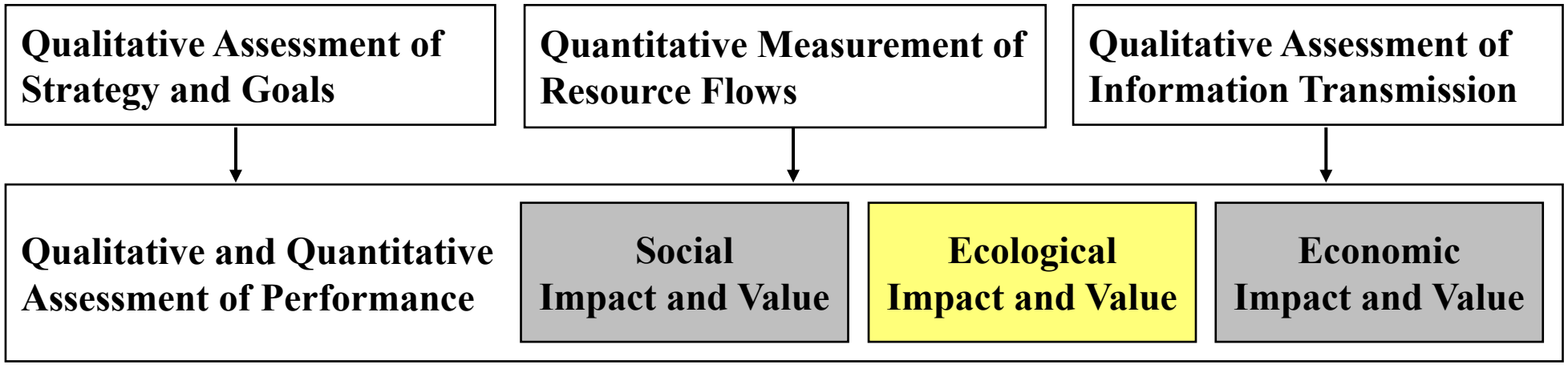
- circular thinking in early-phase decisions and project goals
- avoidance-based approaches
- extending the use of existing structures
- reducing material demand through spatial efficiency and sufficiency

- pre-use materials
- potential for post-use
- end-of-use strategies
- end-of-life scenarios
- material types: biogenic, fossil, mineral, metallic

- availability, quality, and accessibility of information
- resource passports
- material and building cadasters
- Building Information Modelling
- information transition to the next loop



Framework – Group 2: systemic effects of circular approaches



- user health and comfort
- neighborhood quality and participation,
- social inclusion
- identification with the built environment
- job creation
- skill development
- workplace safety including physical and mental health

- remediation of harmful substances
- biodiversity preservation (flora and fauna)
- water efficiency
- avoidance of ecosystem degradation (soil)
- impact on climate

- local economic development
- life cycle costing
- adaptability to future needs
- exposure to price volatility
- economic evaluation of scenarios: comparative assessment of interventions **– including the option not to build**

Limitations and Discussion

Holistic Foundation for assessing circularity:

– Shift focus from material flow to impact and performance.
– Include all dimensions of sustainability equally.
– Integrate information transition for a multiple life cycle perspective to widen temporal and spatial system boundaries.

Future work:

– Development of functional assessment tool with clear criteria, data structures, and evaluation methods
– Ensuring digital integration with tools such as BIM and material passports.
– Testing and validating the approach through pilot projects.

Note:
Ensure **alignment with national systems** to **avoid duplication**, to **reduce complexity**, and to **increase acceptance** of circularity assessment methods across the construction industry.