



AFFORDABLE MULTI-FAMILY RESIDENTIAL HOUSING

Prioritizing DGNB Criteria for Evaluating Construction Methods in Affordable Multi-Family Residential Housing

Insights from Certified Practitioners

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AGENDA

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|----------|-------------------|----------|-------------|
| 1 | Introduction | 5 | Methodology |
| 2 | Background | 6 | Result |
| 3 | Literature Review | 7 | Discussion |
| 4 | Research Question | 8 | Conclusion |

Nanjing Green Towers in China

Are Vertical Gardens in Skyscrapers the Future of Sustainable Urban Living?, By: THURSD., 2025,
<https://thursd.com/articles/vertical-gardens-skyscrapers-sustainable-living>.

Photo: [@stefano boeri architetti](#)

Balancing Sustainability and Affordability

40%

of global material consumption
used by buildings (Mercader-
Moyano et al., 2022)

35%

of global waste produced by the
construction sector (Mercader-
Moyano et al., 2022)

29

DGNB criteria govern sustainability
(DGNB, 2023), but not construction-
method choice

Building certification: a scheme rates a building against a set of sustainability criteria, giving transparency on project quality, guidance for investors and attention to environmental performance.

UK · 1990

BREEAM

*Building Research Establishment Environmental Assessment
Method*

- First method focused on environmental performance
- Initially for office buildings; inspired other national schemes
- Does not capture environmental effects of the construction process

USA · 2000

LEED

Leadership in Energy and Environmental Design

- Voluntary; assesses diverse building types
- Covers life cycle, site, water and resources, indoor quality and design
- All criteria carry equal weight

GERMANY-2007

DGNB

German Sustainable Building Council

- One of the most common systems in Germany
- Reference framework of this study

25%

25%

25%

10%

10%

Six weighted qualities: environmental, economic, socio-cultural, technical, process, site (5%)

Sources: Mercader-Moyano et al. (2022); Ding (2008); Seo et al. (2005); Cole (1998); Ferreira et al. (2023); Markelj et al. (2013); Bragança et al. (2025); DGNB (2023, 2026)

DGNB framework

25% **Environmental**

official DGNB weight of total score

25% **Economic**

official DGNB weight of total score

25% **Socio-cultural**

official DGNB weight of total score

10% **Technical**

official DGNB weight of total score

10% **Process**

official DGNB weight of total score

5% **Site**

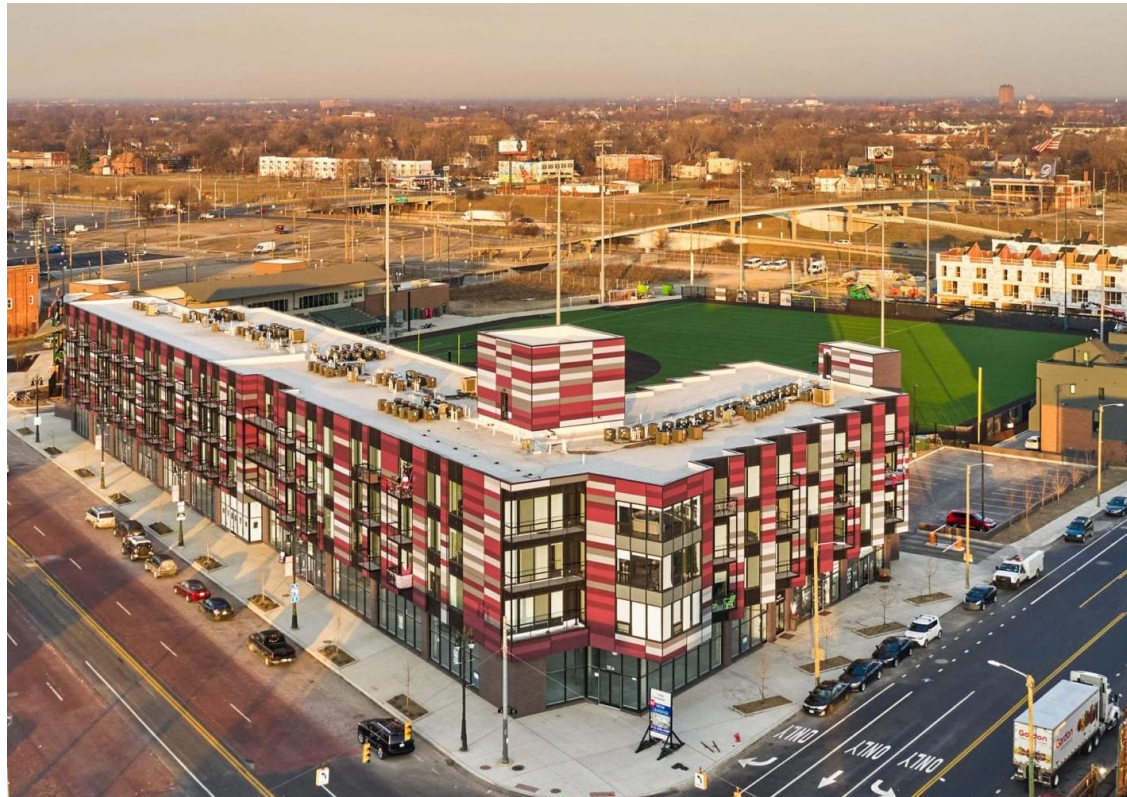
official DGNB weight of total score

29 criteria (DGNB, 2023)· v2023.2 replaces v2023 in October 2026 (removes PRO1.4)

Construction methods compared in prior research

Prefabrication/ Modular

- Reduced cost in mass production.
- Faster construction.
- Better quality.
- Energy efficiency.
- Reduction of water consumption.
- Low carbon emissions.
- Reduction of waste.
- Better acoustic and thermal insulation in comparison to SIP (Kim, 2025; Vargas et al., 2025).



The Corner
Larson Realty Group, 2024,
<https://www.larsonrg.com/>

Sources: Kim (2025); Vargas et al. (2025)

Construction methods compared in prior research

Precast reinforced concrete

- Lower initial cost
- Weaker environmental performance in GHG emissions
- Higher energy consumption (Mahecha et al., 2020)



Precast concrete modules for honeycomb house in Germany
BUILD OFFSITE, 2024,
<https://builtoffline.com.au/news/precast-concrete-modules-for-honeycomb-house-offer-alternative-vision-of-architectural-innovation/>

Steel Frame

- Balance between cost, environment, and performance in Peru (Castillo & Yepes, 2025).
- Better performance of LSF in comparison with structural concrete in Brazil (Gurgulino et al., 2017).
- In India, the reduction of material waste and consumption, carbon footprint, and energy efficiency (Minde & Kulkarni, 2025).



Vista at Brighton, cold-formed steel (CFS) framing.
BuildSteel, n.d., <https://buildsteel.org/projects/multi-family-residential/intellisteel-converts-wood-framed-project-to-steel/>

Sources: Castillo & Yepes (2025); Gurgulino et al. (2017); Mahecha et al. (2020); Minde & Kulkarni (2025)

Construction methods compared in prior research

Timber / CLT

- In the UK, the timber truss system reduces carbon emissions by 30%, reduces waste, and reduces costs (Victoria et al., 2023).
- In Germany & Australia, CLT reduces greenhouse gas emissions, waste, and global warming due to the reduction of the usage of concrete or steel (Lehmann, 2013).



The Rainbow Tree
THINKWOOD, n.d.,
<https://www.thinkwood.com/blog/outside-the-box-modular-multi-family-designs-are-turning-heads>

3D printing

- More negative environmental impact than conventional cast-in-place concrete due to cement (Han et al., 2021; Kul et al., 2024).
- Lower cost due to reduced labor (Han et al., 2021).
- In Africa, reduces construction duration and carbon footprint (Moghayedi et al., 2024).



3D-printed residential building in Heidelberg
BFT, n.d., <https://www.bft-international.com/en/artikel/germanys-first-serially-produced-3d-printed-residential-building-celebrates-its-premiere-in-heidelberg-4309212.html>

Sources: Han et al. (2021); Kul et al. (2024); Lehmann (2013); Moghayedi et al. (2024); Victoria et al. (2023)

What we do not know

Prior studies compare construction methods on environmental, economic, or social grounds (Ganiya et al., 2015) or study DGNB, LEED, and BREEAM certification procedures in general.

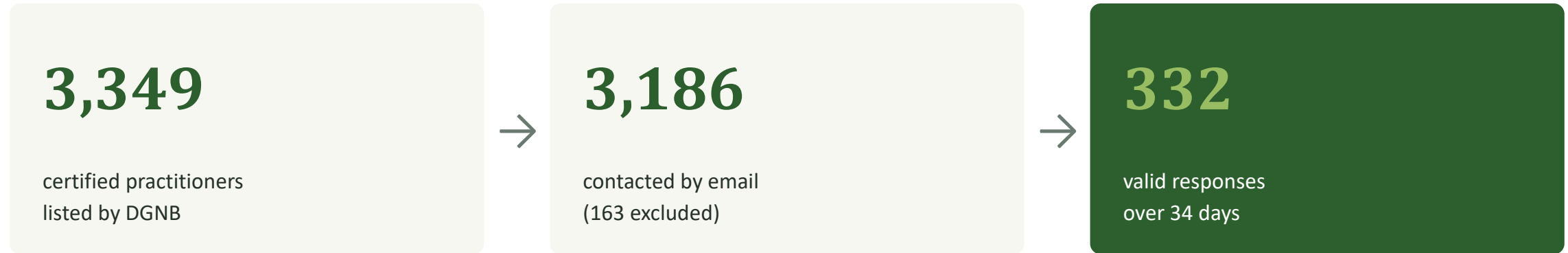
RESEARCH QUESTION

Main research question: How should DGNB be better adapted to reflect the construction-method realities of multi-family affordable residential housing?

- SQ1: How do DGNB-certified practitioners prioritize the 29 DGNB criteria when evaluating construction method compatibility in affordable multi-family residential housing?

No prior study has assessed criterion-level priorities specifically for construction-method compatibility.

From 3,349 practitioners to 332 valid responses



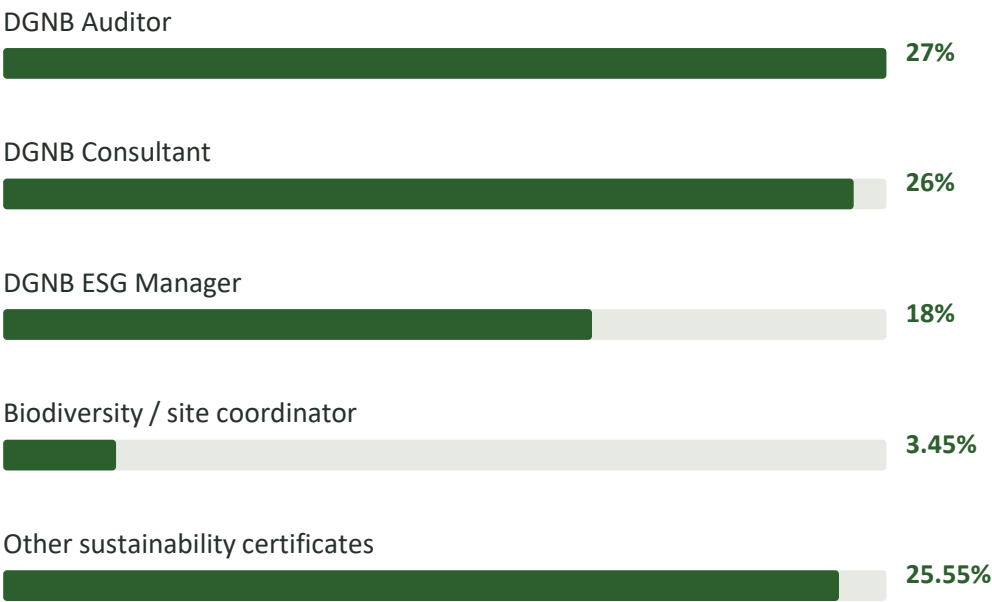
Required sample for 95% CI (population 2,674): ~337 — 332 considered acceptable.

Instrument & analysis

- 5-point Likert scale across 29 DGNB v2023 criteria
- Mean, median, SD, % high ratings (4–5), and a composite priority index
- Kendall's coefficient of concordance (W) for overall agreement

Who responded

Certification / role



4 yrs

median DGNB experience
(IQR 3–10 years)

0–28

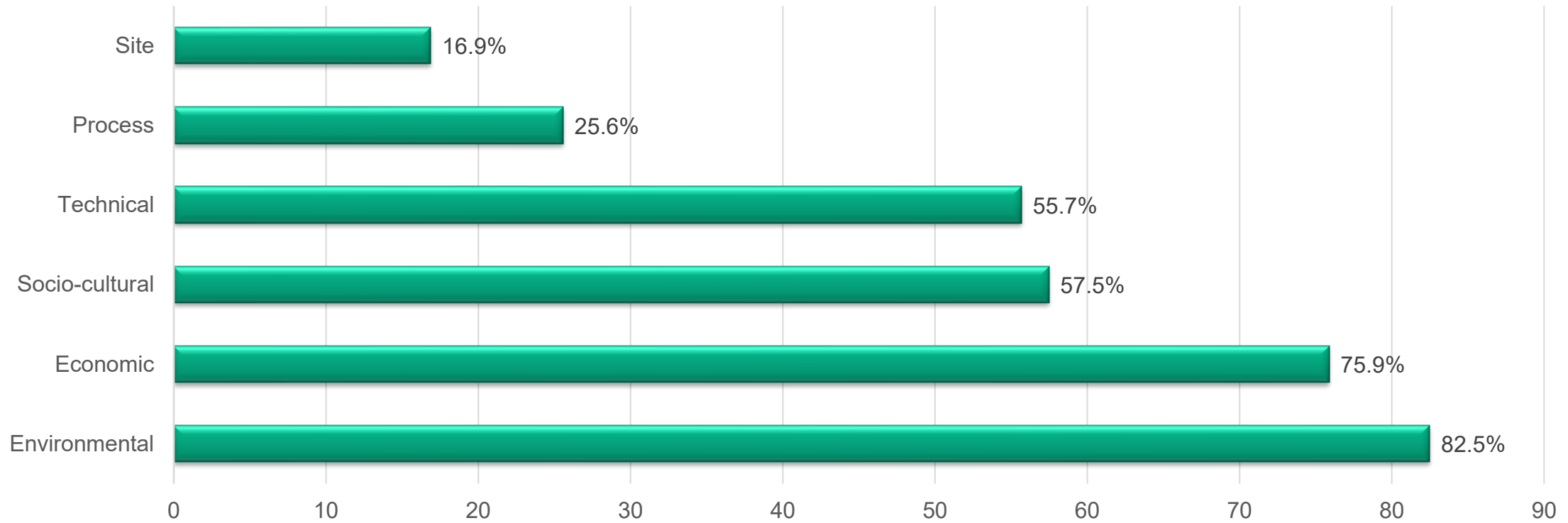
range of years reported
(one 28-year outlier)

49.7%

have direct affordable
housing project experience

Distribution of DGNB Qualities

82.5% of practitioners selected Environmental Quality



Respondents could select more than one category.

Construction Methods used in realities

Construction methods used in DGNB projects



Multiple methods could be reported per respondent.

68.7%

of practitioners say construction method
has a moderate-to-strong influence on
DGNB assessment outcomes

19.9% slight influence

5.7% uncertain

5.7% little / no influence



All 29 DGNB criteria at a glance

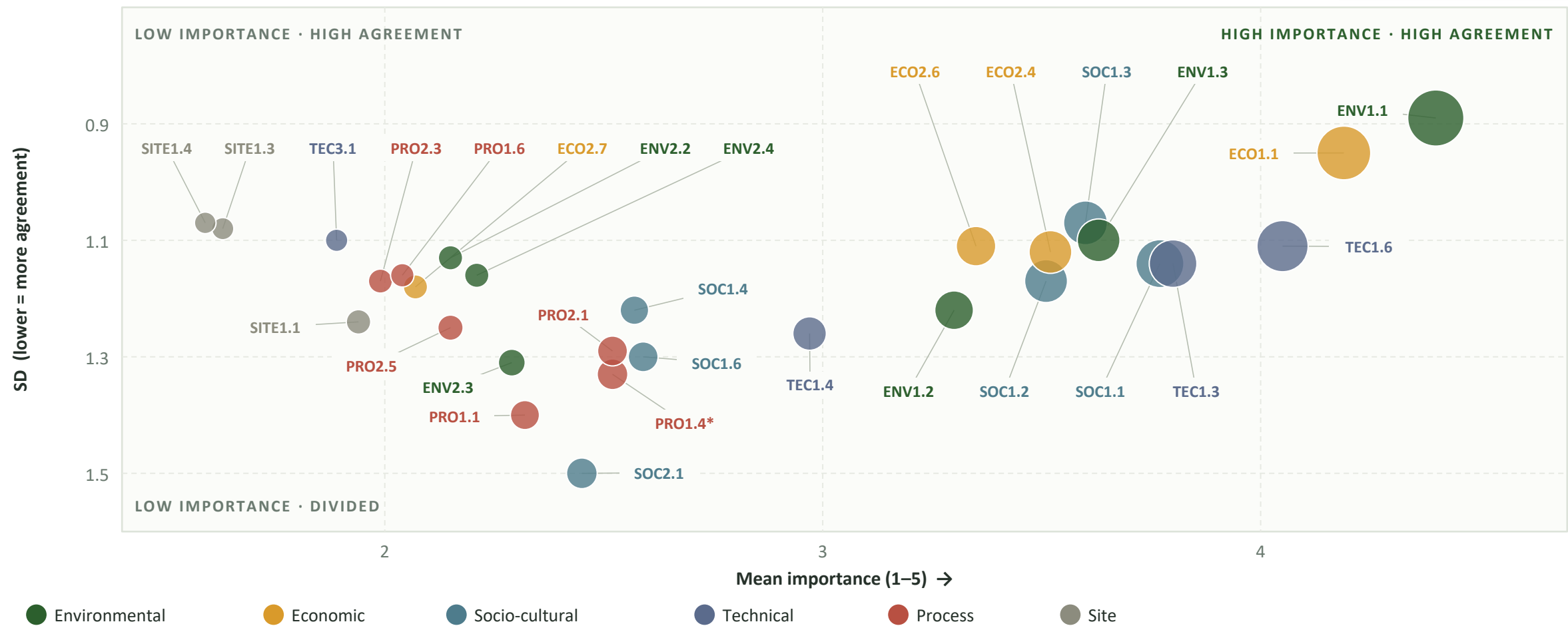
Rank	Criterion	Mean	SD	Median	% High	Priority
1	ENV1.1	4.40	0.89	5.0	84.9%	5.43
2	ECO1.1	4.19	0.95	4.0	79.5%	5.17
3	TEC1.6	4.05	1.11	4.0	73.8%	5.01
4	TEC1.3	3.80	1.14	4.0	66.0%	4.69
5	SOC1.1	3.77	1.14	4.0	66.6%	4.65
6	ENV1.3	3.63	1.10	4.0	55.1%	4.48
7	SOC1.3	3.60	1.07	4.0	57.5%	4.44
8	ECO2.4	3.52	1.12	4.0	55.1%	4.35
9	SOC1.2	3.51	1.17	4.0	55.4%	4.34
10	ECO2.6	3.35	1.11	3.0	47.9%	4.14
11	ENV1.2	3.30	1.22	3.0	46.1%	4.07
12	TEC1.4	2.97	1.26	3.0	34.6%	3.67
13	SOC1.6	2.59	1.30	2.0	26.5%	3.19
14	SOC1.4	2.57	1.22	2.5	23.5%	3.18
15	PRO1.4*	2.52	1.33	2.0	28.3%	3.11

Rank	Criterion	Mean	SD	Median	% High	Priority
16	PRO2.1	2.52	1.29	2.0	26.5%	3.11
17	SOC2.1	2.45	1.50	2.0	28.3%	3.03
18	PRO1.1	2.32	1.40	2.0	24.7%	2.86
19	ENV2.3	2.29	1.31	2.0	19.9%	2.83
20	ENV2.4	2.21	1.16	2.0	14.2%	2.73
21	ENV2.2	2.15	1.13	2.0	14.2%	2.65
22	PRO2.5	2.15	1.25	2.0	16.3%	2.65
23	ECO2.7	2.07	1.18	2.0	13.9%	2.56
24	PRO1.6	2.04	1.16	2.0	12.3%	2.51
25	PRO2.3	1.99	1.17	2.0	13.6%	2.46
26	SITE1.1	1.94	1.24	1.0	14.5%	2.39
27	TEC3.1	1.89	1.10	1.5	9.9%	2.34
28	SITE1.3	1.63	1.08	1.0	9.3%	2.01
29	SITE1.4	1.59	1.07	1.0	8.1%	1.96

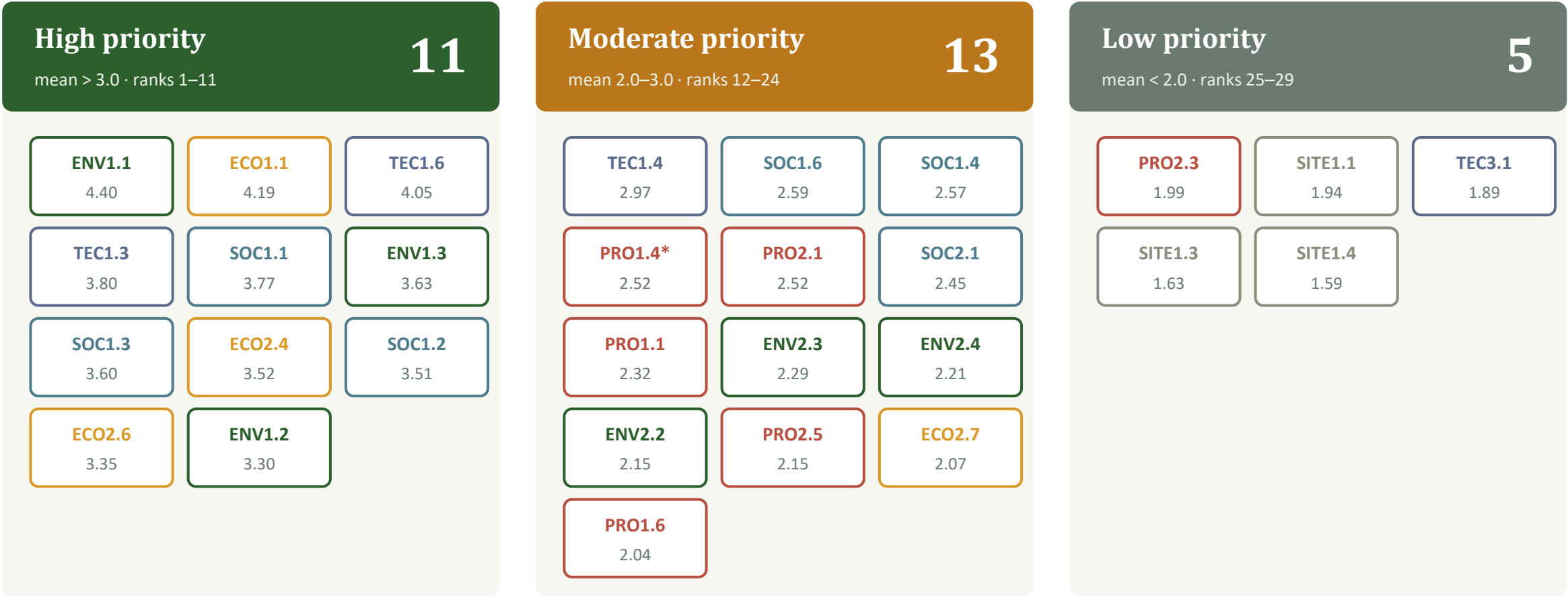
● Environmental
 ● Economic
 ● Socio-cultural
 ● Technical
 ● Process
 ● Site

Cell shading = higher value. Amber SD = SD ≥ 1.30 (more divided opinion). * PRO1.4 exists only in DGNB v2023 (removed in v2023.2).

Consensus map: how important, and how agreed?



Three tiers of practitioner priority



High tier contains no process or site criteria; every site criterion falls in the low tier. * PRO1.4 exists only in DGNB v2023.

Where practitioners agree, and where they split

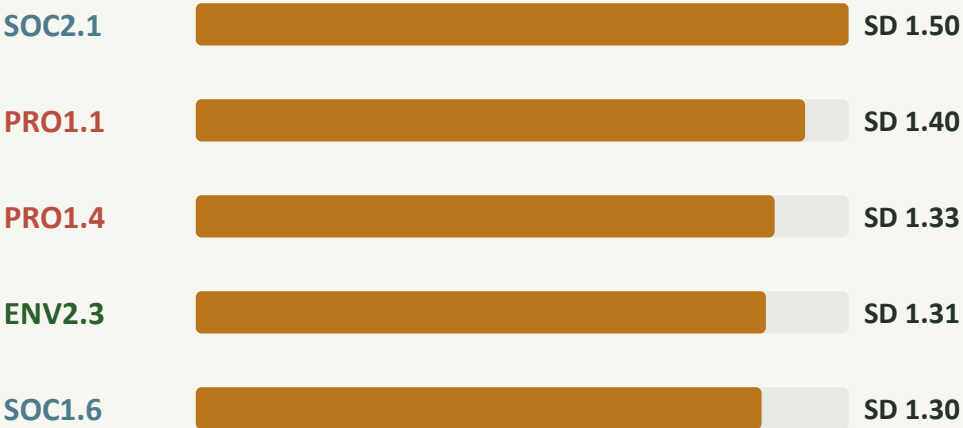
Most agreed upon

Lowest standard deviation



Most divided

Highest standard deviation



5.0

ENV1.1 is the only criterion with a median of 5

28.3%

rated SOC2.1 high (4–5) despite its low mean of 2.45: polarised

W = 0.339

Kendall's W: moderate agreement, strongest for top-ranked criteria



Practitioners rank technical quality above what the official DGNB weighting suggests

Official DGNB weighting (residential)

top 4 criteria by weight (% of total score)

1	ENV1.1 Climate action & energy	10% <i>practitioners: 5.43%</i>
2	ECO1.1 Life Cycle Cost	9.1% <i>practitioners: 5.17%</i>
3	ECO2.4 Value stability & adaptability	6.8% <i>practitioners: 4.35% (8th)</i>
4	ECO2.6 Climate resilience	6.8% <i>practitioners: 4.14% (10th)</i>

Practitioner survey ranking

top 4 criteria by priority index (% of total, Table 1)

1	ENV1.1 Climate action & energy	5.43% <i>mean 4.40</i>
2	ECO1.1 Life Cycle Cost	5.17% <i>mean 4.19</i>
3	TEC1.6 Circular construction	5.01% <i>mean 4.05</i>
4	TEC1.3 Quality of the building envelope	4.69% <i>mean 3.80</i>

Practitioners place TEC1.6 and TEC1.3 in their top four, ahead of ECO2.4 and ECO2.6, which take 3rd and 4th place in the official weighting. For construction-method compatibility, technical performance matters more than the general framework implies.

Official weights: DGNB (2026), residential, v2023.2. Practitioner priority index: Table 1 (each mean as a share of all 29 means, summing to 100%). Compare the order of criteria rather than the absolute levels.

Why environmental and economic criteria lead

ENV1.1

Climate action and energy

4.40

mean score

84.9% rated 4–5

Highest official weight: 10%

ECO1.1

Life Cycle Cost

4.19

mean score

79.5% rated 4–5

Second-highest official weight: 9.1%

Consistent with previous research

1

LCA and environmental performance

Duan et al. (2022); Zhang et al. (2025): life cycle assessment is essential for evaluating building energy performance and environmental efficiency.

2

Priorities in affordable housing

Silva et al. (2024); Chan & Adabre (2019): construction, cost and environmental performance dominate; operational cost, construction time and quality are critical.

3

Life cycle costing

Geng et al. (2017): life cycle costing is expected to remain a key focus of built-environment research.

4

Open methodological need

Fnaïs et al. (2022); Negishi et al. (2018): LCA still needs temporal evaluation, real-time data and neighbourhood-level guidance.

Practitioners associate construction method choice mainly with life-cycle environmental performance and economic efficiency.

Sources: Chan & Adabre (2019); Duan et al. (2022); Fnaïs et al. (2022); Geng et al. (2017); Negishi et al. (2018); Silva et al. (2024); Zhang et al. (2025)

Linking the priorities to the construction method literature

ENV1.1

Climate action and energy · mean 4.40

Practice has not yet caught up with the evidence on climate

Reinforced concrete is the most used method, yet LCA studies find lower global warming potential for timber (Duan et al., 2022; Heeren et al., 2015) and weaker GHG results for precast panels than for masonry (Mahecha et al., 2020). For 3D printing the outcome depends on the mix and context (Han et al., 2021; Kul et al., 2024; Moghayedi et al., 2024).

ECO1.1

Life Cycle Cost · mean 4.19

Cost evidence is mostly about the build, not the life cycle

Reviewed studies mainly report construction-stage cost: prefabrication (Kim, 2025; Vargas et al., 2025), steel framing (Castillo & Yepes, 2025) and precast panels (Mahecha et al., 2020). Practitioners rank life cycle cost second, so these findings transfer only partly to ECO1.1.

TEC1.6

Circular construction · mean 4.05

TEC1.3

Building envelope · mean 3.80

Technical criteria reward less waste and a well-built envelope

Modular construction with BIM (Vargas et al., 2025), steel framing (Minde & Kulkarni, 2025) and timber trusses (Victoria et al., 2023) reduce waste and material use, matching TEC1.6. Envelope performance depends on the system: timber is thermally efficient (Lehmann, 2013), but CLT results vary with location, layers and insulation (Nunes et al., 2020). This may explain why technical criteria rank above ECO2.4 and ECO2.6.

Sources: Castillo & Yepes (2025); Duan et al. (2022); Han et al. (2021); Heeren et al. (2015); Kim (2025); Kul et al. (2024); Lehmann (2013); Mahecha et al. (2020); Minde & Kulkarni (2025); Moghayedi et al. (2024); Nunes et al. (2020); Vargas et al. (2025); Victoria et al. (2023)

Answering the research question and its limits

Research question: How do DGNB-certified practitioners prioritise the 29 DGNB criteria when evaluating construction method compatibility in affordable multi-family residential housing?

ANSWER

Practitioners rank environmental and economic criteria highest, led by ENV1.1 Climate action and energy and ECO1.1 Life Cycle Cost, followed by the technical criteria TEC1.6 Circular construction and TEC1.3 Quality of the building envelope. Process and site criteria rank lowest. This order differs from the general DGNB weighting, which places technical criteria lower.

Top criterion	ENV1.1 · 4.40
Second	ECO1.1 · 4.19
Agreement	W = 0.339

What the survey shows

- Environmental (82.5%) and economic (75.9%) qualities are chosen most often; process (25.6%) and site (16.9%) least
- Moderate agreement among respondents (Kendall's W = 0.339)
- 68.7% see a moderate-to-strong influence of the construction method on DGNB outcomes

Limitations

- Questionnaire used DGNB v2023; v2023.2 removes PRO1.4 (28 criteria remain)
- Perceptions of DGNB-certified practitioners, not measured performance
- 332 responses vs. about 337 required; 49.7% have affordable housing experience

The prioritisation complements, rather than replaces, the DGNB weighting, and is a first step towards adapting DGNB to construction method compatibility in affordable multi-family housing.

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Architektur & Wohnen, 2023,
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