BUILDINGS & CITIES

Uncertainty and equivocality in reuse-oriented deconstruction

SPECIAL COLLECTION: MAINSTREAMING BUILDING COMPONENT REUSE

RESEARCH

LI JIANG
HANS VOORDIJK
MARC VAN DEN BERG
ANDREAS HARTMANN

*Author affiliations can be found in the back matter of this article

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ABSTRACT

Deconstruction aimed at element reuse is recognised as a circular practice, yet it remains a particularly challenging alternative to conventional demolition. To better understand these challenges, this study adopts an information-processing perspective that frames reuse challenges as rooted in both uncertainty and equivocality. While uncertainty arises from missing or incomplete information, equivocality stems from multiple, sometimes conflicting, interpretations of the same information. Drawing on empirical data from four Dutch reuse-oriented projects, this study develops a conceptual framework mapping building, workflow, and environmental uncertainty and equivocality. The findings also suggest that some forms of project-level equivocality in deconstruction may be linked to unresolved uncertainties at the sector level. As these challenges extend beyond individual projects, addressing them may require institutional learning and sector-wide coordination. These findings extend existing information-processing theory by suggesting that sectoral uncertainty-reducing mechanisms, including standardised reusability guidelines, formalised responsibility structures and regulatory frameworks tailored to deconstruction, may also mitigate project-level equivocality by narrowing the space of plausible interpretations.

PRACTICE RELEVANCE

Actionable insights are provided for demolition contractors navigating the information-processing challenges of reuse-oriented deconstruction. By distinguishing uncertainty from equivocality, the findings clarify which challenges require the collection of new information and which require interpretive alignment among stakeholders—a distinction with direct implications for how contractors select and deploy coordination mechanisms. Both established and deconstruction-specific mechanisms are identified that practitioners can tailor to their project contexts. The limitations of organisational responses at the project level point to a further need for coordinated action from policymakers and industry bodies to develop shared standards and regulatory frameworks that support reuse. Without such sector-wide coordination, reuse may remain a coordination-intensive exception rather than a scalable practice.

CORRESPONDING AUTHOR:
Li Jiang
Department of Construction Management & Engineering, Faculty of Engineering Technology, University of Twente, PO Box 217, 7500 AE Enschede, NL
l.jiang@utwente.nl

KEYWORDS:
circularity; demolition; deconstruction; reuse; waste management; demolition contractors; circular economy

TO CITE THIS ARTICLE:
Jiang, L., van den Berg, M., Voordijk, H., & Hartmann, A. (2026). Uncertainty and equivocality in reuse-oriented deconstruction. *Buildings and Cities*, 7(1), pp. 1357–1374. DOI: https://doi.org/10.5334/bc.835

DOI: 10.5334/bc.835

1. INTRODUCTION

The construction industry urgently requires insights into circular practices to advance building element reuse. Deconstruction has gained growing attention, aiming to extract and recover building elements with reusability potential (Akbarieh *et al.* 2020). Van den Berg (2024) conceptualises deconstruction as the process of moving elements from the point of obsolete or 'donor' buildings to the location of 'target' projects. In contrast, demolition is conventionally practised by removing a structure without considering its future scenarios, resulting in waste that is either recycled or landfilled. Reuse is a preferred strategy for managing the end-of-life stage of elements (Uusikartano *et al.* 2026). It refers to building elements that can be used again, either for their original purpose or for a similar intent, with no or limited processing (Hosseini *et al.* 2015).

Intricate challenges nevertheless arise during the transition towards deconstruction practices and element reuse (Jiang *et al.* 2025). These challenges include the uncertainty of quantity and quality, the lack of rules and standards, and low demand for reusable elements (Godina *et al.* 2025). Prior research identifies uncertainty as a root cause (Chileshe *et al.* 2019), suggesting that stakeholders lack the information needed to plan and execute circular projects (Kanyilmaz *et al.* 2023). Project novelty further amplifies this, requiring project team members to obtain more information for unfamiliar activities (Sakka *et al.* 2016).

Despite its potential relevance to these challenges, equivocality has received comparatively little attention in deconstruction research, where challenges are predominantly attributed to uncertainty (Van den Berg *et al.* 2020). This is consequential, as uncertainty and equivocality are different problems requiring different responses (Julmi 2025). While uncertainty reflects a deficiency of information to make a decision, equivocality refers to the presence of multiple interpretations of the same information (Daft & Lengel 1986; Shurrab & Jonsson 2026). Providing more information does not necessarily resolve equivocality, as it may simply produce more data that actors interpret differently. In deconstruction, equivocality may arise when project parties hold different perceptions of roles and responsibilities (Ward & Chapman 2003) or when stakeholders have conflicting views regarding the reusability of a certain building element in the absence of standards (Lambec *et al.* 2025; Nicolas & Sébastien 2026). Without accounting for equivocality, proposed solutions risk addressing the wrong problem: prescribing more information where what is needed is interpretive alignment (Sloot *et al.* 2025).

An information-processing perspective offers a systematic lens through which to understand these challenges, framing reuse difficulties as rooted in both uncertainty and equivocality. In response, organisations adopt 'coordination mechanisms' to cope, including the gathering, interpreting, and synthesising of information to initiate and control (reusable) material flows in deconstruction projects (Van den Berg *et al.* 2020). Information is critical to both uncertainty and equivocality reduction, but the underlying information-processing activities differ markedly (Frishammar *et al.* 2011). Uncertainty reduction requires the acquisition of new information, *e.g.* through information systems, while equivocality reduction depends on the sharing and negotiation of interpretations among actors, such as through group meetings (Daft & Lengel 1986).

Prior work has begun to examine uncertainty in end-of-life strategies and the coordination mechanisms demolition companies adopt in response (Van den Berg *et al.* 2020). However, the transition towards deconstruction is constrained not only by technical unknowns (Huuhka 2023) but also by interpretive conflicts, such as contested responsibilities and disagreements over what constitutes acceptable reusability, which uncertainty-focused frameworks cannot fully capture (Van den Berg *et al.* 2020). Few studies have considered both uncertainty and equivocality faced by demolition contractors, obscuring why reuse challenges persist despite growing access to information.

While building element reuse requires collaboration across the entire construction supply chain, demolition contractors play an important role in facilitating reuse (Fini & Forsythe 2020). In reuse-oriented deconstruction, these firms act not only as material brokers (Eikelenboom *et al.* 2024) but also as information brokers (Wijewickrama *et al.* 2021), facilitating the collection, interpretation, and exchange of information between end-of-life buildings and new construction

projects. The changing roles and responsibilities of demolition contractors at the forefront of the circularity transition introduce new information-processing challenges, highlighting the need for a deeper understanding of how they navigate these challenges in practice. In this paper, the terms 'demolition contractor' and 'demolition company' are used broadly to include firms and their practitioners involved in deconstruction and disassembly activities.

Against this background, this study aims to advance understanding of information-processing challenges in reuse-oriented deconstruction from the perspective of demolition contractors. Its objectives are (1) to identify the main sources of uncertainty and equivocality and (2) to examine the coordination mechanisms demolition contractors use to manage these challenges. Specifically, it asks: What are the main information-processing challenges in deconstruction projects, and how do demolition contractors manage these challenges? To answer this question, a qualitative multiple-case study of four reuse-oriented deconstruction projects in the Netherlands was adopted.

2. THEORETICAL BACKGROUND

Despite its considerable potential, reuse is still considered an immature and experimental practice and needs to progress from a trial-and-error approach towards more standardised solutions (Knoth *et al.* 2022). Prior studies have sought to support this transition by developing methods for end-of-life circularity assessment (Jiang *et al.* 2025), guiding waste management decisions (Van den Berg *et al.* 2023) and identifying reuse barriers (Nicolas & Sébastien 2026). Building on these contributions, an information-processing perspective offers a complementary lens through which to understand the nature of challenges encountered during deconstruction and how demolition contractors respond to them.

Accordingly, the following review draws on information-processing theory and its applications in construction and other organisational contexts, focusing on uncertainty, equivocality and the coordination mechanisms used to manage them.

2.1 UNCERTAINTY AND EQUIVOCALITY IN DECONSTRUCTION

Uncertainty refers to insufficient information or knowledge needed to answer known questions and make a decision. By contrast, equivocality arises when available information or situations are ambiguous, allowing multiple or conflicting interpretations (Daft & Lengel 1986; Shurrab & Jonsson 2026). This distinction allows deconstruction challenges to be analytically distinguished between those requiring more information and those requiring the alignment of different interpretations, even though uncertainty and equivocality may be interrelated in practice (Daft & Lengel 1986; Julmi 2025).

Many challenges related to reuse stem from uncertainty (Knoth *et al.* 2022). Van den Berg *et al.* (2020) identified three categories of uncertainty in demolition projects: building, workflow and environment. First, building uncertainty concerns incomplete, outdated or fragmented information about existing buildings, particularly where as-built documentation has not been updated (Nicolas & Sébastien 2026). This includes insufficient information about the condition of building elements, the types and quantities of materials, and whether elements can be dismantled without damage. Second, workflow uncertainty arises from limited task capabilities and interdependencies between tasks (Chang & Tien 2006), particularly as deconstruction requires demolition companies to perform unfamiliar activities such as disassembling, redistributing and storing building elements. Third, environmental uncertainty concerns difficulties in predicting the outcomes of decisions due to external conditions, such as unfavourable market conditions for salvaged building resources.

Equivocality can have detrimental consequences for project decision-making, as differing interpretations may persist even when information is available (Frishammar *et al.* 2011). For example, ambiguous requirements, unclear regulations and complex, interdependent tasks can lead to different understandings of expectations, responsibilities and possible solutions (Shurrab & Jonsson 2026). Such differences may result in inconsistent decisions and delays in project execution.

In construction, Levander *et al.* (2011) found that clients faced both uncertainty and equivocality, but their information-processing practices were insufficient to manage these challenges. Similarly, Sjödin *et al.* (2016) demonstrated that uncertainty and equivocality present distinct challenges in joint process development projects, requiring different responses. More recently, Sloot *et al.* (2025) identified equivocality concerning scope, needs and priorities that complicated the interoperability of information systems in public infrastructure asset management. Collectively, these studies highlight the need to address differing interpretations rather than relying solely on improving information availability. However, none of these studies specifically examined equivocality in the context of end-of-life building deconstruction, limiting the understanding of how ambiguous and different interpretations affect building element reuse and how they are addressed.

2.2 COORDINATION MECHANISMS

To effectively facilitate building element reuse, demolition companies may adopt different coordination mechanisms to manage both uncertainty and equivocality (Table 1). Early work by Galbraith (1974) conceptualised organisational responses into two broad strategies: reducing information-processing requirements through mechanisms such as self-contained tasks, or increasing information-processing capacity through investments in lateral relations. Daft & Lengel (1986) extended this by distinguishing between uncertainty and equivocality, arguing that each requires different responses: impersonal mechanisms such as rules and regulations for uncertainty reduction, and interaction-intensive mechanisms such as group meetings for equivocality mitigation.

CODE	COORDINATION MECHANISMS	REFERENCES
M1	Rules and regulations (*Setting standards, procedures or requirements*)	1–3
M2	Hierarchy (*Using formal decision authority, including the client's authority, to resolve issues*)	1, 3
M3	Slack resources (*Providing extra capacity and resources*)	1, 3, 7
M4	Self-contained tasks (*Designing work so that tasks can be completed independently*)	1, 3
M5	Information systems and digital technologies (*Using traditional or advanced information technologies*)	1–3, 6, 8, 10
M6	Collection of drawings (*Collecting construction drawings*)	3
M7	On-site inspections (*Physically examining the building or elements*)	3
M8	Special reports (*Conducting one-time studies and surveys about an issue*)	2, 3
M9	Planning (*Setting schedules, sequencing tasks and allocating resources in advance*)	2, 4
M10	Lateral relations (*Direct communication across actors, including direct contact and group meetings*)	1–5, 8, 10
M11	Prolongation of buyer and supplier collaboration (*Maintaining long-term relationships with buyers and suppliers*)	3
M12	Joint problem-solving (*Collaborative efforts among actors*)	4, 5, 9

Table 1: Coordination mechanisms for managing uncertainty and/or equivocality.

Sources: 1 = Galbraith (1974); 2 = Daft & Lengel (1986); 3 = Van den Berg *et al.* (2020); 4 = Trauernicht *et al.* (2025); 5 = Rönndahl *et al.* (2025); 6 = Belhadi *et al.* (2024); 7 = Conz *et al.* (2023); 8 = Berntzen *et al.* (2023); 9 = Sjödin *et al.* (2016); 10 = Sun *et al.* (2025).

Subsequent studies have elaborated a broader set of coordination mechanisms for managing information-processing challenges. Examples include slack resources to buffer uncertainty (Conz *et al.* 2023), boundary-spanning roles to coordinate teams in complex and dynamic environments

(Berntzen *et al.* 2023), and prolonged collaboration with suppliers and buyers to reduce supply chain uncertainty (Van den Berg *et al.* 2020). Digital technologies and information systems further enhance organisations' ability to collect, process and share information: advanced digital tools such as blockchain and smart sensors improve information traceability in complex supply chains (Belhadi *et al.* 2024), while building information modelling (BIM) facilitates the integration and management of project information in construction (Sami Ur Rehman *et al.* 2022). In deconstruction projects, drawing collection and on-site inspections reduce uncertainty about existing structures (Van den Berg *et al.* 2020). Recent research in building project design further shows that digital information systems complement interpersonal communication and group meetings in managing information-processing and coordination challenges (Sun *et al.* 2025). Similarly, studies on interorganisational construction projects have further highlighted how relationship development and collaboration meetings facilitate mutual understanding, and joint problem-solving supports coordinated responses to emerging project challenges (Rönndahl *et al.* 2025; Trauernicht *et al.* 2025). Collectively, these studies suggest that effective coordination involves a combination of impersonal and interaction-oriented mechanisms.

Despite these advances, limited attention has been paid to how uncertainty and equivocality jointly shape coordination challenges in reuse-oriented deconstruction projects. This study addresses this gap by examining both constructs and identifying the mechanisms through which demolition contractors manage them.

3. METHODS

A qualitative multiple-case study method was adopted to investigate information-processing challenges. This approach is appropriate for examining complex phenomena within their real-world project contexts, while allowing existing theoretical concepts to guide the empirical investigation (Yin 2014).

Four deconstruction projects in the Netherlands were purposefully selected, including an outpatient clinic (C1), a brick factory (C2), an office building (C3) and a courthouse (C4). The individual deconstruction project served as the unit of analysis (Yin 2014), with projects drawn from two demolition companies to broaden the organisational settings represented. C1 and C2 were undertaken by company A, while C3 and C4 were undertaken by company B. Both demolition contractors were experienced in circular deconstruction practices and actively experimented with innovative approaches to building element reuse, such as interorganisational collaboration and circular business models. These advanced settings provided information-rich cases for examining both the coordination mechanisms used to manage information-processing challenges and the challenges that persisted despite rich experience with reuse-oriented deconstruction.

All four cases pursued ambitious circularity objectives centred on large-scale building element reuse (Table 2). Large quantities of old building elements from donor buildings were intended for reuse in target projects, ranging from the reconstruction of entire buildings or halls (C1, C2, C4) to large-scale one-to-one reuse of concrete slabs (C3). Such large-scale reuse remains relatively uncommon, even in the Netherlands, a frontrunner in reuse-oriented deconstruction (Marino & Pariso 2020).

Table 2: Characteristics of the four case projects.

	OUTPATIENT CLINIC (C1)	BRICK FACTORY (C2)	OFFICE BUILDING (C3)	COURTHOUSE (C4)
Reuse approach	Entire building dismantled and reconstructed at a nearby location	One hall dismantled for reuse and components from other halls resold through multiple channels	Large-scale element reuse, primarily through one-to-one reuse of concrete slabs	Entire building dismantled and reassembled in another city
Construction year	2016	1909	1984	2016
Main structural system	Steel-framed demountable building	Steel-framed industrial hall	Precast concrete structure	Demountable steel frame with precast concrete floors
Main elements targeted for reuse	Facade and floor elements	Steel frame and roof elements	Hollow-core slabs and facade elements	Steel frame and hollow-core slabs

While sharing these ambitious reuse objectives, the cases differed in typology, building age, structural system and whether the donor building had been designed for disassembly. C1 and C4 were relatively recent, demountable buildings in which future disassembly had been anticipated, whereas C2 and C3 were older buildings without such design considerations. Despite structural differences, structural elements were important reuse targets in all four cases. Thus, the cases shared a common focus on element reuse while representing different building and project conditions.

3.1 DATA COLLECTION: FOUR REUSE-ORIENTED PROJECTS

The same general data-collection approach was followed across the four cases, with semi-structured interviews serving as the primary data source and project documentation and other sources (*e.g.* field visits) providing supplementary evidence (Table 3). Data collection took place between June 2024 and December 2025. In total, 20 interviews were conducted with 13 participants involved in the demolition teams of the four cases. Consistent with the study's focus on the demolition-contractor perspective, these participants were purposively selected based on their direct involvement in the case projects and their responsibilities for planning, managing or coordinating reuse activities. Selection sought to cover the principal roles within the demolition teams, including project managers, planners and site managers where available. The roles represented reflected how reuse activities and responsibilities were organised within the respective projects. For example, digital specialists were involved in projects (C1, C3, C4) where BIM or scanning technologies were adopted, whereas a dedicated material harvester was involved in C2 in finding reuse destinations for different recovered components. Participants involved in multiple cases (*e.g.* I2) were interviewed separately about each project's activities and challenges. Additional follow-up interviews were conducted (*e.g.* with I8) where further clarification of emerging issues was required.

Table 3: Overview of the data sources.

	OUTPATIENT CLINIC (C1)	BRICK FACTORY (C2)	OFFICE BUILDING (C3)	COURTHOUSE (C4)
Semi-structured interviews	I1: Project manager (1×) I2: Project planner (2×) I3: Digital specialist (1×) I4: Site manager (1×)	I5: Project manager (1×) I2: Project planner (2×) I6: Harvester (1×) I7: Site manager (1×)	I8: Programme manager (2×) I9: Project manager (1×) I10: Digital specialist (1×) I11: Project coordinator (1×) I12: Research specialist (1×)	I8: Programme manager (1×) I9: Project manager (1×) I10: Digital specialist (1×) I13: Site manager (1×)
Project documents	Technical drawings, element labelling and project photos	Construction drawings and material inventory	Material inventory, disassembly and storage plan, and project photos	Building information modelling (BIM) models, storage and transportation plan
Other sources	One field visit to the target project, presentations, media and online sources	Media and online sources	Multiple field visits to the target project, academic papers, presentations, media and online sources	Multiple field visits to the target project, presentations, media and online sources

The empirical material for this study was collected as part of a broader qualitative investigation into information integration in reuse-oriented deconstruction. The present study provides a focused analysis of information-processing challenges, distinguishing between uncertainty and equivocality and examining the coordination mechanisms demolition contractors used in response. Specifically, the interviews followed the deconstruction process, ranging from the identification of reusable elements and their harvesting from donor buildings to their distribution to target projects or other destinations. Participants were asked about the information they used to undertake these activities, their exchanges with other actors, the information-processing challenges they encountered and how these challenges were managed throughout the process. For example, questions such as 'Did you observe situations where stakeholders interpreted the same situation or information differently?' were asked to elicit insights into equivocality. The interview protocol relevant to the present study is provided in Appendix A in the supplemental data online. Each interview lasted about 60–90 minutes and was recorded and transcribed verbatim.

DOI: 10.5334/bc.835

3.2 DATA ANALYSIS: A HYBRID APPROACH

This study used a thematic analysis to examine uncertainty and equivocality in deconstruction and the coordination mechanisms used by demolition contractors to manage these challenges. Thematic analysis involves generating codes and developing themes or analytical categories to make sense of patterns within empirical data (Braun & Clarke 2006).

The data analysis process followed the phases of thematic analysis guided by Braun & Clarke (2006). The transcribed interviews were first thoroughly read to familiarise the researchers with the content, followed by the generation of initial codes capturing information-processing challenges and coordination mechanisms. To distinguish between the two types of challenges, situations involving insufficient information or knowledge generated uncertainty-related codes, whereas those reflecting multiple or conflicting interpretations generated equivocality-related codes. Both codes were applied where the same situation involved uncertainty and equivocality. Related codes were subsequently compared and grouped into higher-level analytical themes. For example, reusability could involve either uncertainty or equivocality depending on the underlying information-processing challenge. When actors lacked the information needed to assess an element's reusability, the challenge represented uncertainty, while when actors applied different criteria to determine whether an element was reusable, the challenge represented equivocality.

Table 4 illustrates the development from empirical extracts to codes using examples from the building category. Appendix B in the supplemental data online provides further examples of code and theme development for uncertainty, equivocality and coordination mechanisms. ATLAS.ti was used to support the data analysis.

Table 4: Development of codes and themes.

REPRESENTATIVE QUOTATIONS	CODES	THEMES
'You need to check whether what was in the drawings actually corresponded to what they had built, because that's also not a guarantee that the drawings that you find are correct' (I10)	As-is conditions	Building uncertainty
'We made a list of what would be reused [...] there was a carpet. [...] We thought it was a screw or something loose, but it was again connected with a kind of glued wooden floor. So that we could not reuse it' (I2)	Element reusability	
'[The clients] said to reuse as much as possible, at least 80%. [The demolition contractors] asked, "80% of what, is it 80% of CO_2 or 80% of the volume or the mass?"' (I8)	Circularity goals	Building equivocality
'The communication was difficult. That's where thoughts and ideas are different; for instance, some people think, "We can use click bricks, as it's a brick that is not put together with cement." Well, there are some lines of thinking where you say, "Maybe it isn't as circular as you would expect, because a click brick is very labour-intensive to harvest."' (I2)	Reusability potential	

Codes and themes were developed through a hybrid inductive-deductive analysis (Proudfoot 2023). The deductive approach uses existing theoretical concepts to guide interpretation of the data, while the inductive approach uses the data to develop contextual understanding and theoretical insights:

- Uncertainty was coded and grouped deductively, guided by the framework of Van den Berg *et al.* (2020). This framework distinguishes uncertainty associated with the building, workflow and environment. This demolition-specific framework was selected because it directly addresses end-of-life uncertainty in the demolition context, providing a context-sensitive basis for coding and theme development.
- Equivocality codes were developed inductively, as prior studies offer limited guidance on the forms of divergent interpretation arising in deconstruction. These codes were subsequently grouped into building, workflow and environmental categories.

- Coordination mechanisms were coded primarily deductively, guided by relevant studies (Table 1). Where observed practices could not be fully explained by existing studies, new codes were developed inductively and later synthesised as deconstruction-specific mechanisms.

4. FINDINGS

The findings reveal that demolition contractors encountered uncertainty and equivocality across building, workflow and environmental categories, although their specific manifestations varied across cases (Table 5). The following sections examine the sources of these challenges and the coordination mechanisms that helped actors manage them.

Table 5: Summary of empirical patterns across cases.

Note: M1–M12 refer to the coordination mechanisms presented in Table 1. An asterisk (*) indicates an additional one identified through the empirical analysis: M13 for tacit knowledge and M14 for learning-by-doing.

	DESCRIPTION	EMPIRICAL MANIFESTATIONS	COORDINATION MECHANISMS
Building uncertainty	*As-is conditions*: incomplete information on existing conditions *Element reusability*: insufficient information/ knowledge to determine element reusability	C3: Uncertain feasibility of cutting and recovering concrete elements C4: Unexpected dismantling and reuse difficulties despite design for disassembly	M5–M8, M10, M13*
Building equivocality	*Circularity goals*: different interpretations of project circularity targets *Reusability potential*: different judgements about whether an element is reusable	C1: Contrasting judgements about gypsum-board reuse C3: Ambiguous 80% reuse target	M2, M10
Workflow uncertainty	*Task capacity*: limited knowledge in performing unfamiliar reuse activities *Task interdependence*: insufficient information for coordinating interconnected activities	C1: Unexpected variations in facade connections requiring revised labelling C1: Insufficient information about the location of elements after transportation	M1, M4, M5, M9, M11, M14*
Workflow equivocality	*Task responsibility*: different interpretations of responsibilities	C1: Different expectations about disassembly and labelling efforts C3: Divergent understandings of design responsibilities	M12
Environmental uncertainty	*Building regulations*: uncertainty about regulatory compliance of recovered elements *Weather conditions*: unpredictable weather-related effects on elements and information *Market demand*: uncertainty about finding buyers or reuse destinations	C2: Uncertain demand for recovered elements C3: Doors found not to meet applicable standards	M3, M5, M9, M11
Environmental equivocality	*Standards*: ambiguity in applying existing regulations/standards to building reuse *Terminology*: different interpretations of circularity-related concepts	C2: Ambiguity between high-quality reuse and recycling C4: Ambiguous application of existing regulations to reuse	M10, M12

4.1 BUILDING UNCERTAINTY AND EQUIVOCALITY

4.1.1 Uncertainty on the as-is conditions and element reusability

Building uncertainty concerned two interrelated aspects: as-is conditions and element reusability. Their manifestations varied across cases depending on building characteristics, design intentions and available information. For example, although C4 was designed for disassembly, courthouse security requirements made dismantling more complicated than anticipated. In C3, which was not designed for disassembly, uncertainty concerned the feasibility of cutting and recovering concrete elements for reuse.

The demolition companies employed several coordination mechanisms to manage these uncertainties. Construction drawings were used across all cases, while in C3, the demolition company also relied on lateral relations, such as contacting workers involved in the original construction to clarify how the buildings had been assembled. On-site inspections and information technologies further supported the acquisition of reliable building information. For example,

scanning technologies in C3 produced accurate digital models of the to-be-demolished structures, enabling 'sawing concrete slabs based on the exact location of rebar' (I10) and supporting one-to-one concrete reuse. Demolition contractors also drew on tacit knowledge when assessing element reusability. As a project planner (I2) noted:

> We know that from other projects, the metal stud profiles can be reused when you disassemble them the right way. [...] It's not our first project.

Such accumulated knowledge helped demolition contractors identify reuse opportunities despite incomplete information. Where additional verification was necessary, special reports were commissioned. In C1, for example, the clients requested a report to verify that the walls did not contain hexavalent chromium (chromium 6), a known human carcinogen.

4.1.2 Equivocality on circularity goals and reusability potential

Building equivocality concerned different interpretations of project circularity goals and the reusability potential of building elements. In C3, the client expressed strong circularity ambitions, but translating these ambitions into project requirements was open to interpretation. With no comparable circularity tenders available, the client established a team to explore 'how they can do the tender for circularity' (I12). The interpretive challenge became evident when, according to the programme manager (I8), the client expressed an ambition to reuse as much as possible, with a target of at least 80%. However, the basis for measuring this target was equivocal, prompting the demolition contractor to question: 'Is it 80% CO_2 (reduction), 80% of volume, or 80% of mass?' To address this equivocality, the demolition company relied on lateral relations, engaging directly with the client to clarify the interpretation of the circularity target.

Equivocality also arose when actors held different perspectives on how to assess element reusability. For example, click bricks could be considered reusable because of their reversible, cement-free design. However, their labour-intensive production and recovery raised questions about whether reuse was worthwhile. As one interviewee (I8) noted, 'there are many ways to look at it, and none of them is optimal'. Similarly, in C1, the demolition company considered gypsum boards reusable based on their previous project experience, whereas construction contractors preferred to discard them based on their construction experience. These examples illustrate how different professional experiences and assessment criteria could lead to contrasting judgements about element reusability. In practice, actors sometimes relied on hierarchy to manage unresolved equivocality, with clients exercising decision-making authority over which elements would be reused.

Despite variation across cases, these findings illustrate how reuse decisions can be complicated by both incomplete knowledge of existing buildings and differing interpretations of circularity goals and element reusability. This suggests that addressing information gaps alone may be insufficient, as differences in interpretation and professional judgement can also affect reuse decisions.

4.2 WORKFLOW UNCERTAINTY AND EQUIVOCALITY

4.2.1 Uncertainty on task capacity and interdependence

Workflow uncertainty stemmed from task capacity and task interdependencies. Regarding task capacity, uncertainty became apparent when demolition contractors encountered requirements of unfamiliar reuse-related activities. For example, in C1, facade elements were initially assumed to be standardised and interchangeable. During disassembly, the company's workers on-site discovered variations in their screw connections and fittings, requiring precise labelling to ensure each element could be reinstalled in its original position. These unexpected differences complicated the labelling task and required adjustments to the planned workflow.

Uncertainty also arose from task interdependencies, particularly the need to coordinate disassembly, transportation and subsequent reassembly. As one interviewee (I10) explained:

> One goal of labelling is to ensure you know the order, so you don't end up with the element you need first at the back.

DOI: 10.5334/bc.835

In C1, insufficient information about the location of elements after transportation created difficulties for the receiving contractor. As the planner (I2) acknowledged:

> It's worth knowing where the elements are at the new location [...] that is also something that we did not do, and the new contractor has problems with that.

To manage these workflow uncertainties, demolition companies deployed several mechanisms across the cases. Planning supported the coordination of deconstruction activities, including the transportation and storage of concrete slabs in C4. Rules and regulations provided procedural guidance through information-update requirements associated with circular deconstruction certification in C2. Digital technologies, including BIM simulations, supported disassembly sequencing and safety arrangements in C3. Self-contained tasks reduced reliance on external parties for critical activities. In C3, the demolition company even bought a company to bring scanning capabilities in-house. As one interviewee (I8) explained, 'It's too complicated to have a third-party scan for you.' Prolongation of supplier collaboration also helped manage unexpected challenges, as illustrated by the use of established transport partners in C1. The deconstruction workers on-site additionally adopted a learning-by-doing approach, refining procedures through practical experience. In C1, the planner initially suggested labelling elements according to construction drawings, while site workers adjusted the sequence to accommodate hidden connections and practical disassembly constraints. The resulting approach combined drawing-based planning with on-site adjustments, illustrating how learning-by-doing complemented formal planning when actual conditions differed from expectations.

4.2.2 Equivocality on task responsibility

Workflow equivocality was relatively limited, as most routine deconstruction tasks were well-understood. As one project manager (I5) noted, 'Everyone on the construction site knows what to do.' Joint problem-solving was further used to align expectations. In C1, contractors responsible for rebuilding were also involved in the disassembly process. Early coordination meetings helped align expectations about element handling during both disassembly and reassembly.

However, equivocality emerged when actors interpreted task responsibilities differently during interorganisational collaboration. In C1, the division of effort for disassembly and labelling was not clearly agreed upon. As one project planner (I2) reflected:

> The mistake is, partly our mistake [...] but [the contractors] also had to invest (more) hours during the disassembly of the building.

This suggested differing expectations about how the additional work should be shared. Similar challenges arose in C3, where the demolition company (also acting as the construction contractor), designers and construction engineers collaborated from the beginning of the project. Because this was one of the first collaborations of this kind, their respective responsibilities were not fully delineated. For example, actors held different interpretations of what 'design for reuse' entailed. Designers initially developed conceptual designs following conventional practices, whereas demolition contractors expected the designs to account for the practical constraints of salvaged elements. This divergence in expectations resulted in additional design work. Trust helped sustain collaboration despite the underlying equivocality, while joint problem-solving during the project helped actors gradually develop a clearer understanding of each other's expectations and identify lessons for future projects.

Across the cases, workflow uncertainty concerned task capacity and interdependencies, while equivocality emerged from differing interpretations of responsibility boundaries. These findings suggest that reuse-oriented deconstruction may require not only adjustments to existing workflows but also greater alignment of expectations when activities extend across organisational boundaries.

DOI: 10.5334/bc.835

4.3 ENVIRONMENTAL UNCERTAINTY AND EQUIVOCALITY

4.3.1 Uncertainty on weather, regulations and market demand

Environmental uncertainty stemmed from three main sources: building regulations, weather conditions and market demand. Regulatory uncertainty concerned whether salvaged building elements could meet applicable requirements. For example, doors in C3 were found to no longer meet the minimum height requirements introduced by the revised Dutch Building Decree. Weather conditions added another layer of unpredictability in both element preservation and information transfer. In C3, identification labels attached to stored elements quickly degraded due to weather exposure, 'so the data could not be added to the BIM model (as planned)', as one expert (I9) explained. Market uncertainty, meanwhile, concerned whether buyers could be found for recovered elements. In C2, one harvester (I6) explained that salvaged elements could be sold because the demolition company already knew potential buyers, but such opportunities were uncommon, as many companies remained reluctant to use reclaimed elements. Market uncertainty also influenced whether technically reusable elements would actually be recovered. For example, a site manager (I7) described a boiler that was considered reusable but would be disposed of if no buyer could be found before the end of the project.

To manage market-related uncertainty, demolition companies primarily relied on prolongation of buyer collaboration, with digital technologies used only as a fallback. As one participant (I2) noted:

> We always try to sell things to our clients who have been with us for years. If not possible, the last thing we want to do is put it on a digital marketplace.

Established buyer networks helped identify demand for specific elements. As another participant (I6) explained:

> When we dismantle a building, we immediately notify potential buyers about available materials [...] I know that [company X] is always looking for corrugated iron and [company Y] can always use roller doors.

Slack resources provided additional flexibility when immediate demand was uncertain. Both demolition companies used warehouses to store valuable elements such as wooden beams when immediate buyers could not be found. Early planning offered another way to manage market uncertainty. One participant (I8) described a proactive approach in which material inventory lists could be shared with partners and internal project leaders years in advance, allowing more time to identify reuse opportunities in future projects aligned with deconstruction schedules.

4.3.2 Equivocality on standards and terminology

Alongside these uncertainties, environmental equivocality emerged mainly around ambiguities in the interpretation and application of existing standards and circularity-related terminology. In C4, the permit application process illustrated the coexistence of uncertainty and equivocality. The lack of reuse-specific guidance created uncertainty about how to proceed, while existing requirements, developed primarily for new construction, were open to interpretation. As one participant (I8) explained:

> Applying for the permit took quite some time. [Reusing elements] was also new for the municipality.

Beyond obtaining information, demolition contractors and municipal authorities engaged in joint problem-solving to develop a shared understanding of how to interpret and apply these requirements to the reuse project. The coexistence of multiple circularity-related assessment frameworks, including the Building Circularity Index (BCI Gebouw), Platform CB'23 and Building Research Establishment Environmental Assessment Method (BREEAM), introduced further interpretive complexity in how circularity performance should be evaluated. As these frameworks adopt different assessment criteria and approaches, they may lead to different evaluations of a project's circularity performance, raising questions about which framework should guide decision-making.

Equivocality was also evident in the interpretation of circularity-related terminology. In C2, circular certification distinguished between different circular strategies, yet terminology was not consistently understood. As a project planner (I2) noted:

> They use the term high-quality reuse (which we do not have), and I think it is the same meaning as high-quality recycling.

This illustrated different understandings of how recovered materials should be categorised and reported. Similar issues emerged in C3. Although the client requested to 'reuse concrete', demolition companies understood this requirement differently during the tender procedure. One company interpreted reuse as processing recovered concrete into new concrete, whereas the selected company understood it as direct reuse of harvested concrete elements. As the programme manager (I8) explained, there was no shared interpretation of what reuse meant. Lateral relations helped clarify these alternatives for the client by communicating their implications for circularity performance.

Environmental challenges manifested differently across cases, but consistently highlighted the influence of external conditions and actors beyond demolition contractors' direct control. In particular, ambiguities in applying existing regulations to building element reuse and interpreting circularity terminology suggest that some challenges may extend beyond individual projects and require broader institutional clarification.

5. DISCUSSION

This study develops a better understanding of deconstruction challenges through an information-processing view, applying a dual lens of uncertainty and equivocality to explain the challenges faced in reuse-oriented projects and the coordination mechanisms demolition contractors deploy in response. Prior studies have largely framed uncertainty as the main barrier to element reuse (Chileshe *et al.* 2019; Van den Berg *et al.* 2020), while equivocality, though it has been shown to account for a significant share of challenges in construction projects (Chang & Tien 2006; Levander *et al.* 2011), has received comparatively little attention in deconstruction. The findings confirm that both constructs are present in deconstruction, while also suggesting that some forms of project-level equivocality may be linked to sector-level uncertainty.

5.1 THE DUAL LENS OF UNCERTAINTY AND EQUIVOCALITY IN DECONSTRUCTION

Drawing on empirical data from four deconstruction projects, this study develops a conceptual framework (Figure 1) that systematically maps information-processing challenges in deconstruction across three categories: building, workflow and environment. The framework confirms that demolition projects are shaped by significant sources of uncertainty across the building (as-is conditions and element reusability), workflow (task capacity and interdependence) and environment (weather, regulations and market demand), which reinforces the findings of earlier exploratory work (Van den Berg *et al.* 2020).

More importantly, this study reveals that deconstruction projects are also characterised by equivocality, a dimension that has received limited attention in this context. This study addresses this gap by identifying deconstruction-specific forms of equivocality. Specifically, building equivocality arises when actors have different interpretations of circularity goals and of what qualifies as reusable. Workflow equivocality emerges when task responsibility boundaries are interpreted differently across actors, while environmental equivocality appears when external standards and circularity-related terminology applied to existing buildings are open to multiple interpretations. These forms of challenges are often overlooked or misattributed to uncertainty in existing studies (Chang & Tien 2006), while framing them as uncertainty problems risks prescribing the wrong solutions (Sloot *et al.* 2025).

However, the distinction between uncertainty and equivocality is not always clear-cut in practice. This echoes Levander *et al.* (2011), who found that empirical situations could contain characteristics of both constructs even though uncertainty and equivocality represent different

information-processing challenges. The present study reinforces this point in deconstruction. For example, assessing element reusability may involve both uncertainty about an element's actual condition and equivocality arising from different interpretations of its reuse potential, illustrating how the two challenges can coexist in practice.

The study also identifies coordination mechanisms that demolition companies can use to respond to these challenges (Figure 1). While many of these mechanisms correspond to responses identified in other contexts (Table 1), the findings provide new insights into how they operate in the deconstruction context, both within and across organisational boundaries. Within demolition companies, mechanisms such as rules and regulations are complemented by newly identified mechanisms, including learning-by-doing and tacit knowledge, through which actors develop task capacity and draw on accumulated experience when established information or workflows are lacking. At the same time, some mechanisms extend beyond the individual organisation. For example, lateral relations enable demolition contractors to coordinate directly with other project actors (*e.g.* downstream contractors), while prolonged collaboration with suppliers and buyers facilitates information exchange and coordination across the wider circular value chain. These findings draw attention to the classic organisational focus of Galbraith's (1974) information-processing framework, which takes the organisation as its primary unit. In deconstruction, managing project-level information-processing challenges from the perspective of demolition contractors depends not only on mechanisms within the focal organisation, but also on coordination across organisational boundaries.

5.2 SECTOR-LEVEL UNCERTAINTY AS A SOURCE OF PROJECT-LEVEL EQUIVOCALITY

The findings also suggest a relationship between uncertainty and equivocality in deconstruction that organisational responses alone may not fully resolve. Some forms of project-level equivocality may be linked to unresolved uncertainty at the sector level. Here, sector-level uncertainty refers to information deficiencies arising from the absence of established sector-wide frameworks or standards, as experienced by demolition contractors in their project-level decision-making.

Building equivocality, for example, arises during reusability assessment when competing evaluation criteria produce divergent judgements among stakeholders. Previous studies have also highlighted the lack of standardised methods for assessing residual value (Jiang *et al.* 2022; Nicolas & Sébastien 2026). Without a common basis for assessing reusability (Lambec *et al.* 2025), project actors may rely on different criteria and frames of reference, contributing to divergent interpretations of the same elements. In such situations, project-level and organisational coordination mechanisms are constrained, and decisions are often resolved through hierarchy, typically exercised by clients who hold contractual authority over reuse decisions. Developing standardised reusability assessment methods that incorporate criteria such as technical condition and remaining service life (Jiang *et al.* 2022) could provide a more consistent, evidence-based foundation for such decisions.

A similar dynamic emerges around responsibility structures. The absence of formalised accountability arrangements creates uncertainty about expected roles and responsibilities, which can contribute to different interpretations of responsibility boundaries. While joint problem-solving can help stakeholders gradually clarify expectations and negotiate responsibilities, trust may sustain collaboration despite unresolved equivocality (Zanini & Migueles 2013). However, persistent equivocality may, over time, challenge the development and maintenance of trust at both the individual and team levels (Sannes & Kim 2018). At the broader environmental level, the absence of regulatory guidance for deconstruction and reuse creates a regulatory vacuum (Condotta & Zatta 2021). Existing regulations, largely developed for conventional new construction, provide limited guidance on their application to reuse, leaving multiple plausible interpretations at the project level and resulting in inconsistencies across projects.

These challenges may not be fully resolved by individual demolition companies or through organisational- and project-level coordination mechanisms. Rather, they point to the need for broader institutional learning and sector-level responses. Information-processing theory

traditionally treats uncertainty and equivocality as distinct problems requiring different solutions: uncertainty calls for relatively impersonal mechanisms such as rules and regulations, while equivocality demands rich communication. However, these two constructs may be interrelated (Daft & Lengel 1986; Julmi 2025). Levander *et al.* (2011), for example, highlight a sequential relationship in which equivocality needs to be reduced by defining relevant questions and variables before the information needed to address uncertainty can be sought. The present study suggests a complementary relationship across levels: sector-level uncertainty could contribute to project-level equivocality. Where the absence of shared guidelines, formalised responsibility structures or deconstruction-specific regulatory frameworks (Corsini 2025; Lambec *et al.* 2025) leaves project actors without common reference points for interpretation, mechanisms traditionally associated with uncertainty reduction, including rules and regulations (Daft & Lengel 1986), may also help mitigate equivocality by establishing a shared basis for interpretation. This suggests that uncertainty and equivocality, while analytically distinct, need not operate independently.

5.3 PRACTICAL IMPLICATIONS

This study also carries several practical implications. The findings offer demolition contractors a clearer understanding of how deconstruction challenges manifest and how organisational responses can be tailored accordingly. To enhance reuse potential, demolition contractors should not only focus on capturing additional information but also on fostering shared interpretation among stakeholders. In particular, involving designers, contractors, and other key actors early in the project and clearly defining responsibilities across actor groups are essential steps for managing challenges. Beyond the project level, the findings highlight the limitations of organisational responses and point to the need for industry-wide standards, guidelines and regulatory frameworks tailored to deconstruction. Policymakers and industry bodies should direct greater attention to the deconstruction context, which has distinct information-processing demands that frameworks developed for new construction or renovation do not adequately address.

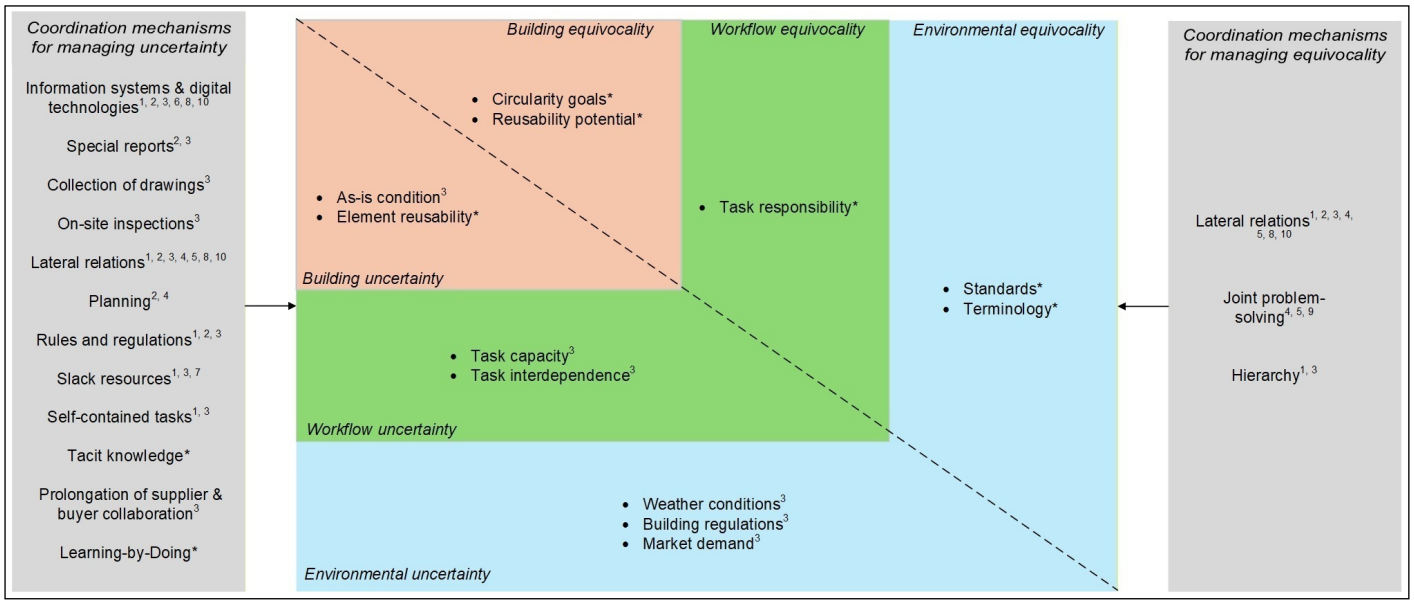


Figure 1: Information-processing challenges and coordination mechanisms in reuse-oriented deconstruction.

Note: Pink = building challenges; green = workflow challenges; blue = environmental challenges. Superscript numbers indicate supporting references, as listed in Table 1. An asterisk (*) = findings that extend beyond those identified in the reviewed literature.

5.4 LIMITATIONS AND FUTURE WORK

This study has several limitations. First, it does not provide a quantitative assessment of the relative magnitude of uncertainty and equivocality in deconstruction, treating both dimensions as analytically significant. Moreover, while this study identifies how demolition companies respond to different challenges, it provides limited insight into the causal relationships between challenges and coordination mechanisms. Future studies could examine the extent to which specific mechanisms reduce uncertainty and equivocality.

Second, this study focused primarily on how demolition contractors experience and manage information-processing challenges and did not directly examine the perspectives of other actors involved in deconstruction. The findings therefore should not be assumed to represent how other actors interpret the same situations. Furthermore, although experienced participants from advanced deconstruction projects were selected, differences in judgements reported by participants could reflect uncertainty (insufficient knowledge), equivocality (competing interpretations), or both. While the study sought to distinguish these explanations, their coexistence in practice makes such distinctions inherently challenging. The analysis also did not systematically compare how actors defined the same information-processing challenges, judged their importance or prioritised them. Future research could adopt a multi-actor perspective to develop a more comprehensive understanding of how uncertainty and equivocality manifest and interact in deconstruction projects.

Third, this study primarily examined uncertainty and equivocality as information-processing challenges. This does not imply that these conditions are inherently detrimental. Eriksson *et al.* (2016), for example, characterise equivocality as a 'double-edged sword', because it can also encourage the exploration of alternative interpretations and, when appropriately managed, support the development of novel solutions. These potentially productive effects were not examined in this study and warrant further research in deconstruction.

6. CONCLUSIONS

Drawing on four Dutch deconstruction projects, this study shows that information-processing challenges in reuse-oriented deconstruction extend beyond information deficiencies (uncertainty) to include multiple, sometimes conflicting, interpretations of available information (equivocality) across building, workflow and environmental categories. Addressing these challenges requires demolition contractors not only to acquire additional information but also to adopt coordination mechanisms that support shared understanding and decision-making among project actors.

Importantly, the findings suggest that uncertainty and equivocality, although analytically distinct, need not operate independently in deconstruction. Some forms of project-level equivocality may be linked to unresolved uncertainty at the sector level, where the absence of shared guidelines, formalised responsibility structures and regulatory frameworks tailored to deconstruction leaves actors without common reference points for interpretation. This suggests that managing underlying sector-level uncertainty may also help mitigate equivocality at the project level. Ultimately, advancing building element reuse requires not only project-level coordination but also institutional learning and the development of shared benchmarks and governance arrangements across the circular construction value chain.

ACKNOWLEDGEMENTS

The authors thank the participating demolition companies and interviewees for their valuable contributions to this research. They also thank the editor and reviewers for their constructive feedback, which helped improve the quality of this article.

AI DECLARATION

The authors used ChatGPT to assist with language editing and polishing of the manuscript. All content was subsequently reviewed and edited by the authors, who take full responsibility for the final published work.

AUTHOR AFFILIATIONS


Li Jiang orcid.org/0009-0009-7959-4019
Department of Construction Management & Engineering, Faculty of Engineering Technology, University of Twente, Enschede, NL

Marc van den Berg orcid.org/0000-0002-2357-8548
Department of Construction Management & Engineering, Faculty of Engineering Technology, University of Twente, Enschede, NL

Hans Voordijk orcid.org/0000-0002-1259-9407
Department of Construction Management & Engineering, Faculty of Engineering Technology, University of Twente, Enschede, NL

Andreas Hartmann orcid.org/0000-0003-3753-5378
Department of Construction Management & Engineering, Faculty of Engineering Technology, University of Twente, Enschede, NL

COMPETING INTERESTS

The authors have no competing interests to declare.

DATA ACCESSIBILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICAL APPROVAL

Informed consent was obtained from all interview participants before their involvement in the study.

FUNDING

This work was supported by the Dutch Research Council (NWO) (grant ID: https://doi.org/10.61686/BBOHH63815).

SUPPLEMENTAL DATA

Supplemental data for this article can be accessed at: https://doi.org/10.5334/bc.835.s1

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TO CITE THIS ARTICLE:
Jiang, L., van den Berg, M., Voordijk, H., & Hartmann, A. (2026). Uncertainty and equivocality in reuse-oriented deconstruction. *Buildings and Cities*, 7(1), pp. 1357–1374. DOI: https://doi.org/10.5334/bc.835

Submitted: 11 April 2026
Accepted: 01 November 2026
Published: 26 November 2026

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