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REUSE CHALLENGES IN CIRCULAR DECONSTRUCTION: LESSONS FROM EXPLORATIVE CASE STUDIES

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ABSTRACT

Background and aim. There is a lack of empirical insights into the challenges faced in deconstruction processes aimed at building element reuse, particularly from the perspective of demolishers. This study aims to address this gap by identifying the challenges that hinder the recovery of building elements for reuse in deconstruction processes.

Methods and Data. Using a multiple case study design, we examined deconstruction practices in two projects, an outpatient clinic and a brick factory. Qualitative data were gathered through ten semi-structured interviews, project documentation, and field visits. A combination of deductive and inductive approaches was applied to data analysis.

Findings. Our findings reveal several challenges that hinder reuse practices in deconstruction projects. We have categorised these into four key system elements: technology, people, processes, and policy. These challenges collectively impede the transition towards a more circular practice in the demolition industry.

Theoretical/ Practical / Societal implications. This study provides a holistic understanding of the challenges that demolishers encounter when attempting to reuse building elements. It also extends existing research by providing empirical insights into deconstruction practices.

KEYWORDS: Construction industry, Circular practices, Deconstruction, Reuse, Reverse Logistics

1 INTRODUCTION

The construction industry urgently requires insights into reuse processes to facilitate more sustainable waste management. The industry generates about one-third of the total amount of waste in Europe (European Commission, 2022), which is often destined to be recycled or landfilled (Chileshe et al., 2019). Specifically, the construction and demolition waste (CDW) generated from the end-of-life (EoL) of an asset, so-called demolition waste (DW), is the largest contributor to the CDW (Jiang et al., 2017; Wijewickrama et al., 2020). Reverse logistics supply chain (RLSC) management has emerged as a crucial part of sustainable practices (Mallick et al., 2023). In the construction sector, this refers to the process of moving building elements and components from the point of salvaged buildings to the point of new construction (Hosseini et al., 2015). This mainly involves recovered elements resulting from the processes of selective demolition or deconstruction (Elghaish et al., 2023; Ghobakhloo et al., 2013; Wibowo et al., 2022), with the aim of salvaging and recovering (a portion of) elements with reuse capability (Akbarieh et al., 2020). In a deconstruction process, a sequence of preferred circular actions is established. Among others, reuse is one of the preferred options (Parto et al., 2007). It represents using a building element again, either for its original purpose or for a similar intent (Van den Berg et al., 2020a).

Several challenges are yet to be overcome before the widespread adoption of reuse practices. In this regard, many studies provide valuable knowledge on the challenges associated with reuse in circular demolition processes. For example, Purchase et al. (2021) highlighted some challenges hindering circular practices in the construction and demolition sectors. In particular, the authors used a literature review to summarise several main barriers, including, policy and governance, permits and specifications, technological limitations, quality and performance and implementation costs. Similarly, Ferriz-Papi et al. (2024) reviewed and categorised the challenges

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that prevent improved CDW management. These challenges range from political, economic, social, and technological to environmental aspects. Wijewickrama et al. (2020) outlined challenges and future opportunities regarding information sharing in the RLSC on demolition waste, with a systematic literature review. However, most existing studies are primarily theoretical or conceptual, and empirical insights into the challenges of the deconstruction process aimed at reuse are lacking. Furthermore, in terms of target groups, researchers have mainly focused on project actors such as designers and clients (Eikelenboom et al., 2024). Little is known about the challenges faced by demolishers. For reuse to occur, demolishers must shift their focus from demolishing building parts to recovering them (Van den Berg et al., 2020b). Fini and Forsythe (2020) also identified demolishers, along with building owners, as the primary influencers in determining the extent of waste reduction sent to landfills. They need to execute several (new) tasks, including advising, redistributing, storing and supplying elements in circular construction projects (Eikelenboom et al., 2024). Despite their key roles in the decision-making processes for EoL scenarios of building elements, relatively few studies focus on demolishers (Van den Berg et al., 2020a).

This study aims to address these gaps by identifying the challenges that hinder the reuse of building elements in deconstruction processes, especially from the perspective of demolishers. An element refers to any physical part of a building that can be handled separately, such as façade elements and ceiling tiles (Van den Berg et al., 2020b). The succeeding sections are structured as follows. We first present the literature review on circular demolition and embedded challenges. This is followed by an explanation of the multiple-case studies methodology adopted. We then present our findings on the challenges faced in deconstruction projects intended for element reuse. A discussion is followed regarding its contributions and future work. The paper ends with a conclusion.

2 LITERATURE REVIEW

Construction practitioners have traditionally focused on the materials flow from the point of extraction to their consumption, while an RLSC keeps materials in a loop by harvesting them from buildings (Hosseini et al., 2015). A RLSC starts with dismantling existing buildings (Wijewickrama et al., 2020). Various dismantling techniques are available, including demolition and deconstruction. Specifically, demolition represents the conventional practice of removing a building without considering potential reuse possibilities. In contrast, deconstruction is sometimes understood as construction in reverse, serving an important role in buildings' circularity (Bertino et al., 2021). Those dismantled elements are then subjected to recovery through reuse or other strategies (Wijewickrama et al., 2020). In this study, the terms "circular demolition" and "deconstruction" are used interchangeably, both referring to the process of recovering elements with reuse potential.

The transition from demolition to deconstruction of buildings has gained traction. Allam and Nik-Bakht (2023) summarised three key areas of deconstruction-related research, each corresponding to a major phase of construction projects: (1) the design phase, with an emphasis on Design for Deconstruction; (2) the EoL phase, which focuses on deconstruction planning and waste management; and (3) the second-life phase, examining the performance of recovered construction elements. The authors further emphasised the need for EoL insights regarding the destination of the recovered elements and deconstruction processes. During the EoL phase, recycling – reprocessing components to produce new ones (Hosseini et al., 2015), has received significant attention. Several European Member States, such as the Netherlands, Germany and Finland, have already achieved a 70% recycling rate, meeting the target set by the European Commission in 2014 (Gálvez-Martos et al., 2018). To further improve resource efficiency, maximising reuse is regarded as one of the best practices in Europe (Gálvez-Martos et al., 2018). Compared to recycling, reuse minimises the consumption of additional materials, energy, and labour, making it a more circular option (Ellen MacArthur, 2013). Accordingly, the European Union has introduced the Waste Framework Directive, prioritising reuse over recycling (Huuhka et al., 2015). To support the reuse of building elements, a series of activities with a focus on reuse should be planned in circular demolition projects. Van den Berg (2024a) distinguished three main phases in a deconstruction process, namely, identifying, harvesting and distributing. Any deconstruction process is, accordingly, initialised by identifying building elements presenting a high reuse potential. The term "harvesting" represents the activity of reclaiming those valuable elements from the existing built environment, for further facilitating reuse in new projects (Jongert et al., 2011). Lastly, distributing presents the diverging movement of harvested elements away from a demolition site.

Wijewickrama et al. (2021) supposed that an integrated system of technology, people, process and policy is necessary in the RLSC of DW. Technology is required to provide reliable, accurate and sufficient information in digital form for building element reuse (Byers et al., 2023). Iyiola et al. (2024) showed that various digital technologies, such as Building Information Modelling (BIM) and blockchain, can support reuse practices. The second element, people, considers how demolishers and other stakeholders (e.g., contractors and clients) collaboratively work during buildings' EoL. For reuse to take place, the elements recovered by demolishers should be utilised in new projects by contractors and clients. In this context, Eikelenboom et al. (2024) studied the changing role of demolishers in circular construction projects, compared to their conventional roles regarding tasks, timing, position and image. Furthermore, the third

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element, process, refers to a set of interrelated activities designed to achieve a defined output (Cruz et al., 2015; Hammer & Champy, 2009; Ko, 2009). Information sharing among these processes is significant to ensure the effectiveness of demolition operations (Rameezdeen et al., 2016; Wu et al., 2022). The last element, policy, represents the rules, standards, and guidelines that provide demolishers with clear directions on what is expected of them (Wijewickrama et al., 2021). Wijewickrama et al. (2021) proposed that a RLSC, or a reuse process, should be achieved through the integration and coordination of technology, people, process and policy. The authors developed a conceptual integrated framework by integrating these four system elements while acknowledging the need for empirical validation and testing. Previous studies have explored the challenges associated with the deconstruction process but lack empirical insights into the challenges demolishers face when reusing building elements, particularly in relation to the interconnected system elements of technology, people, processes, and policy.

3 METHODS

This study employed a multiple-case study method to enhance theoretical knowledge by incorporating new empirical insights from real-life cases (Çetin et al., 2022). Two case studies were purposefully chosen: the deconstruction projects concerning an outpatient clinic and a brick factory (
Table 1). Both case projects were completely deconstructed at the moment of this study, providing the possibility of understanding the whole deconstruction process and enabling the observation of reuse practices in the target buildings. They are both located in the Netherlands, which is recognised as a global leader in the implementation of circularity (Marino & Pariso, 2020). Conducting the study in this context is ideal for generating valuable insights into the reuse-related challenges. These cases are also considered "unique" (Yin, 2014), since they share exceptional circularity ambitions: large quantities of old elements were planned to be reused. This circular approach is, also in Europe, rarely adopted in the demolition industry, where construction materials are often either disposed of or recycled (Gálvez-Martos et al., 2018).

Specifically, in the outpatient clinic project, a temporary outpatient clinic was dismantled in its entirety and rebuilt as a healthcare centre at a new location. The brick factory was composed of four halls. One obsolete hall was repurposed for use by a (local folklore) parade association, and many elements from some other halls were dismantled and planned to be sold through different channels. The project was awarded a Dutch certification for its circular approach. Both projects are considered circular projects with a high reuse percentage, supported by several favourable conditions. First, both projects were designed to be easy to disassemble. The outpatient clinic, a modular building with prefabricated components, was specifically designed for easy disassembly to support future reuse. Similarly, the brick factory employed a steel-based construction, which was notable because projects of that scale "were normally built by concrete (at that time) and then it is very difficult to demolish", introduced by the project manager. Second, both projects were driven by strong deconstruction ambitions. This focus ensured that stakeholders carefully considered the destinations of elements throughout the projects. These two similar deconstruction projects, hereby, offer an opportunity for an in-depth exploration of the common challenges faced by demolishers.

Table 1. Case studies overview

	Outpatient clinic	Brick factory
Characteristic	Rebuilding a modular building for a healthy purpose	Reusing elements from a steel-based construction
Gross floor area	1100 m2	3240 m2
Construction year	2016	1909
Demolition year	2023	2023
Exemplary element reuse	Facade elements, floor plates	Steel, roof plates

3.1 DATA COLLECTION

In line with the triangulation principle (Eisenhardt, 1989), multiple sources of evidence were used, including documents, field visits, and in-depth semi-structured interviews (see Table 2). Those information sources are intended to offer insight into the embedded challenges in hindering element reuse in deconstruction processes. Data was collected from June 2024 to November 2024. Ten semi-structured interviews were conducted with key informants in demolition teams from both projects, including two project managers, one project planner, one digital expert, one material harvester and two site managers. Incorporating the perspectives of diverse stakeholders can enhance the understanding of a complex problem or phenomenon being studied (Van de Ven, 2007). Semi-open questions were designed to understand challenges in the deconstruction process, from identifying, harvesting and distributing reusable elements from "donor" to "target" buildings (Van den Berg, 2024b). Each interview lasted between 60 and 90 minutes and was audio-/video-recorded and transcribed. The case studies were also informed by project documents, including, among others, construction drawings, materials inventory and demolition plans (see Table 2).

Table 2. Data collection

	Outpatient clinic	Brick factory
Semi-structured interviews	Project manager (1x) Project planner (2x) Digital expert (1x) Site manager (1x)	Project manager (1x) Project planner (2x) Harvester (1x) Site manager (1x)

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Project documentation	Construction drawings, Demolition plans, Project Contracts, etc.	Construction drawings, Materials inventory, Project photos, etc.
Site visits	Visits to both the demolition site and the rebuilt location	-

3.2 DATA ANALYSIS

For analysing associated challenges in the process, this study used thematic analysis as a qualitative method, incorporating both deductive and inductive approaches.

Table 3. Data analysis example

.Example quotes	Inductive analysis	Deductive analysis
"There is not, something like QR code <in the sticker> that you can scan and know the information of the component…you could not track the component."	Limited digital technologies	Technology
"My colleagues said, we can, for instance, use a tablet on a construction site to number the elements. But I knew 100% that the construction workers outside could not use it on the right"	Lack of expertise and experience	People

The thematic analysis consists of generating emerging themes or analytical categories as a description of the phenomena within the data (Fereday & Muir-Cochrane, 2006). The deductive approach uses an organising framework derived from extant literature to perform the analysis. The inductive approach, on the other hand, involves working exclusively from raw data (Azungah, 2018). This technique is widely used in various studies (see Wijewickrama et al., 2021).

Specifically, all collected data, including transcribed interviews and project documents, were first thoroughly read to familiarise the researchers with the content. Next, Table 3 provides examples of how the data was analysed in a deductive and inductive manner. Altas.ti was used to conduct the analysis, which is software for structuring, retrieving and analysing qualitative data in a continuous and cyclical way (Ronzani et al., 2020). It also supports the analysis of "theme intensity", which represents the number of statements referring to a particular challenge across a total number of statements (Wao et al., 2011). Complementing the qualitative method, this quantitative analysis provided insights into the relative importance of different themes/codes (see Figure 1).

4 FINDINGS

This study identifies several challenges hindering the recovery of building elements for reuse in circular demolition projects, which are grouped into four key elements: technology, people, process, and policy.

4.1 TECHNOLOGY

The use of digital technology was limited in both case projects (Table 4), which is one of the biggest challenges (with a theme intensity of about 24%, see Figure 1). In the case of the brick factory, a company inventory application was used to take photos and record relevant information on reusable elements. The application integrates with two

an inductive approach was applied to identify initial codes representing data features relevant to the research questions centred on reuse-related challenges. Those codes were then collated into four themes or elements deductively: technology-, people-, process- and policy-related challenges, building on Wijewickrama et al. (2020). The final step involved refining each theme by reviewing it in relation to the extracted codes and the entire dataset. This process aligns with the phases of thematic analysis proposed by Braun and Clarke (2006). It offered a basis to start understanding challenges in deconstruction processes.

other digital technologies, Insert and an online marketplace, to facilitate information sharing between buildings slated for demolition and new projects. Specifically, Insert is an initiative founded by several demolition companies in the Netherlands. One important function is to collect and store reusable elements for potential future reuse among its partnering firms. It was used in the case of the brick factory to disseminate information of reusable elements. An online marketplace was used in both projects for selling recovered products in the Netherlands. Moreover, Lidar (Light Detection and Ranging technology) was utilised in the case of the outpatient clinic with the potential of developing a digitalised representation of the to-be-demolished building.

Table 4. Digital technologies use cases in case projects

	Identifying	Harvesting	Distributing
Brick factory	An inventory application, Insert, an online marketplace	-	-
Outpatient clinic	Lidar Scanner, an	-	-

	online marketplace

Those digital technologies were primarily used during the identifying phase, with limited application in subsequent activities (Table 4). The deconstruction process was perceived as labour-intensive and characterised by a lack of technologies. New technologies are hereby required to support the process, especially during the harvesting and distributing phases. For example, one project planner expected the application of Quick Response (QR) codes for tracking recovered elements in the harvesting and distributing phase. "You can know, for instance, that container A contains all the wall insulation when you scan the QR codes", he explained. However, "There is not something like QR code (in the project)…you could not track the component", he further added. Furthermore, existing technologies face limited implementation due to their inability to effectively support deconstruction activities. For example, although a scanned model of the outpatient clinic was generated using Lidar, the

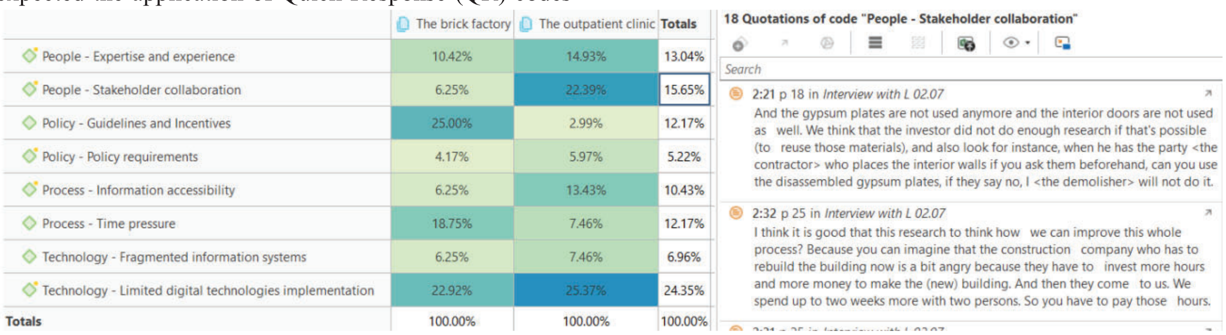

Figure 1. Theme density analysed by Atlas.ti

demolishers did not use it in practice. This is because "it doesn't provide the functionality we need... it is not user-friendly", as one digital specialist noted. The participant further explained several challenges with this technique. First, the scanning technology lacks visual context: "You want a nice picture (of building components), rather than (only) a point cloud…if we want to sell them". The technique also encounters problems in incorporating additional information into the scanned models and connecting with other platforms like Insert. Moreover, "(for Lidar technology), that's one million points to get one door…we want one BIM of the door, including the picture of that specific door", the participant said. It can be potentially improved with automatic recognition of standardised objects (e.g., windows and doors) with technology like artificial intelligence. Another example is the Insert, which is still implemented on a limited scale and is primarily viewed as a "promotional initiative". No elements were actually sold through the Insert in the brick factory case, and it ultimately served only for demonstration purposes. "It <Insert> is a nice platform and also a good initiative, but if you want to sell something, you must use other platforms", one project planner added.

The use of different, disconnected information sources led to fragmented information management across the entire process. In the case projects, a common practice involves recording and exchanging information through documentation formats such as photos, digital spreadsheets, Portable Document Format (PDF) files, or other alternatives. The entire deconstruction process of case projects relied on these information sources, including annotated drawings detailing element dimensions and material inventory in spreadsheets. Furthermore, information was also available in the form of scanned models or within the inventory application. Those isolated and disconnected information sources led to information fragmentation across the deconstruction process. For instance, in the case of the brick factory, the inventory application was utilised during the identifying phase. However, as new information emerged during the harvesting phase (e.g., damaged products), updates were recorded in a separate Excel file due to its simplicity. "It is a bit difficult to add something here (in the application)", one project planner mentioned. During the phase of distributing, a purchase confirmation was manually prepared for each buyer, detailing the specific elements they purchased. However, this process was entirely paper-based, with no connection to the previous material inventory or other information sources.

Overall, digital technologies are used only to a limited extent in deconstruction projects, given some challenges. Furthermore, information is used in isolation, lacking an integrated information system.

4.2 PEOPLE

The extent of stakeholder collaboration—one of the most influential factors (with a theme intensity of about 15%) — can significantly impact the effectiveness of reuse practices in deconstruction projects. This was evident in the case of outpatient clinic, where demolishers were asked to label some building elements so that the (new) contractors could trace the origin of these components and reconstruct the structure in a nearby city. Two contractors were involved in both the deconstruction and reconstruction processes. During this process,

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demolishers have discussed unexpected situations and new plans with contractors. For example, during the harvesting phase, actual labelling went differently from what was planned. The façade elements had been regarded as standard components, which could be repositioned on the façade of the new building rather than needing to be installed in their original locations. However, each façade element was found to have slight differences in its connection methods. The new plan was then discussed among demolishers and contractors, and those elements were labelled accordingly during the harvesting process. At the same time, the demolishers shared the 2D drawings with labelling and other documents (e.g., photos of containers) with the contractors. The early involvement of contractors facilitated the seamless information flow between the donor and the target building. However, their collaboration also faced some difficulties. For example, incorrect labelling was observed. The project planner explained that the construction company should "help us <demolishers>, but they did not spend enough hours during disassembly…now they have to spend more time (to rebuild due to wrong labelling done by the demolishers)". Moreover, the requirements of new contractors play a key role in determining the destination of elements. In the outpatient clinic, four containers of lamps, insulations and other loose elements were identified as reusables but were not installed in the new building as the new contractor "did not want to use them". The project planner also exemplified the gypsum plates, which were initially intended for reuse but ended up being disposed of. "If they <the new contractors> say no (to using those plates beforehand), I <demolishers> will not disassemble them…", he explained. Early involvement and information exchange are hereby important to make joint decisions in identifying, harvesting, and distributing reusable elements.

The lack of expertise and experience further hinders the technology implementation and circular practices. For example, although a scanned model of the outpatient clinic was generated, the project planner did not use it in practice. Instead of digital models, he relied on the physical drawings to label elements, "supposing you have 25 constructive façade elements, then I label them 1, 2, 3, 4, 5 to 25 and then I printed it out and came to the construction site to say (to frontman), that number 1 is left above". Except for the technological limitation of the scanned model, the project planner also discussed the challenges of conveying instructions to workers using the digital model. "My colleagues said we can, for instance, use a tablet on a construction site to number the elements. But yeah, I knew 100% that the construction workers outside could not use it on the right <way>, I know surely that when we did <use the tablets>, that we had more problems than not", the project planner explained. Despite the demolition company being one of the largest in the Netherlands, the project planner admitted, "This was the first time we've done a project like this (a circular rebuilt project)" and they lacked experience in tasks such as labelling building components and coordinating with different stakeholders.

In sum, the collaboration between demolishers and contractors affects the deconstruction processes. Additionally, demolishers lack the expertise and experience necessary for circular demolition practices.

4.3 PROCESS

The deconstruction process is guided through some standard procedures. Although there is no clear separation between identifying, harvesting and distributing building elements, the deconstruction process basically follows these three phases. It consists of an interconnected series of tasks, where the effectiveness of each step influences the others. In other words, (some) information generated from the early stages is needed for subsequent stages. For example, information on as-is building conditions gathered from previous owners/builders supports demolishers in identifying elements' reusability. With the information from identifying, demolition and separation plans can then be drawn up in the harvesting phase. "Based on what you want to do with the elements, you determine how you disassemble them", one project planner introduced. The deconstruction plan also supports subsequent transporting and storing in the distributing phase:" so you don't end up with elements you need first lying at the back", a project manager introduced. For certain common materials, demolishers have developed standardised recycling procedures based on established partnerships. "We have a partnership with a door manufacturer", one digital specialist mentioned. However, "very high-quality reuse is sometimes difficult", he added.

Information accessibility in deconstruction processes was one concern (with about a 10% theme intensity). It often stems from a reluctance to share data among stakeholders involved in different projects. In the case of the outpatient clinic, demolishers only received the basic drawings, which lacked technical details from previous contractors due to concerns over intellectual property. Despite this, demolishers were requested to label big building components (e.g., ceiling systems, floor elements, and façade plates). The project planner exemplified: "I had drawings for the façade (but without details of façade elements), then I made a red rectangle (to represent each façade element)". As acknowledged by the participant, this manual drawing process is prone to errors. Furthermore, to facilitate reuse, a key task in the identifying phase is to align the demand from target projects with the supply of reusable elements from donor projects. However, in the process, information of reusable elements is normally missing, given the information mismatch between demand and supply. Demolition companies largely depend on their own networks or past partnerships to find potential buyers. The manager of a brick factory explained that about 70% of the building elements were sold to their clients. Similarly, in the project outpatient clinic, the project planner shared his concerns: “For this project, we had the opportunity to sell materials somewhere since we knew the clients, but that wasn’t always this way”. This implies that the potential for reusing elements is heavily influenced by the demolishers’ ambition and network. Consequently, smaller demolition companies may face further limitations in this process due to their more restricted networks. Although two digital technologies were applied in case projects, their limited implementation hindered the information exchange between the supply and demand of reusable elements in the phase of identifying. As one project manager mentioned, “At first, most materials have a second life (from the identifying phase), but some materials didn’t survive”. The material inventory from the brick factory also documented some materials such as steel and boilers, which were considered to be reusable, while ultimately sent for recycling since “there was no demand”. As a result, the reusable elements could not be collected and distributed in the subsequent phases due to the limited information available from the earlier phase.

Time pressure also affects the information flow appropriately in deconstruction processes. In the outpatient clinic, the phase of identifying was largely limited, while many unexpected situations and emerging information only appeared during the sequential activities (harvesting and distributing). The carpet was an example: “We thought it was something loose, but during the execution phase, we found it was glued to the wooden floor.” When the first leading researcher asked if this information could be figured out during the identifying phase, with some pre-audit reclamations. The project manager introduced that this project suffered from a tight project schedule, “we have to start from week 40 and finish it before Christmas…but only in week 39, the building was empty (for demolition)…(because of this), sometimes you meet something which is not the same as planned”. Similarly, several participants of the brick factory project highlighted the challenge of short timelines. The harvester explained that finding potential clients normally takes a lot of time, while demolition projects must be completed within strict deadlines. “We want to sell the recovered materials, but we have to move forward with the process”, he noted. The site manager also explained that if some potentially reusable elements could not find destinations within the project timeframe, they would end up being recycled or disposed of. “That is why finding buyers quickly is crucial”, he added.

Reuse practices in circular demolition projects are hindered by limited access to information during the deconstruction process. This is caused by the information mismatch between supply and demand and the unwillingness of information sharing among projects. Furthermore, reuse practices are also constrained by time pressure.

4.4 POLICY

Policy guidelines and incentives are key factors of element reuse in deconstruction processes (with about a 12% theme intensity). In the case of the brick factory, policy guidelines and incentives played a role, which received a certification for circular demolition. This certification encouraged demolishers to prepare an extensive material inventory including pictures of elements, material characteristics, optimal circular strategies (e.g., reuse and recycling), sale channels, appropriate demolition techniques, etc. As the harvester and project planner noted, “They <the certification organisation> are going to track what happens to every material we inventory”, and “We have to sell these materials for the certification”. It showed how policies encourage demolishers to choose the optimal destinations for salvaged elements. However, one harvester also mentioned that policy guidelines and incentives are still in the early stages and insufficient, “the government has to do something about it, to make it <using reused products> easier…the government have to stimulate the use of products getting free from the project”.

Policy requirements also hinder reuse possibilities. “The construction company must provide a guarantee for the roof of the (new) building, and they could not use the old one”, the project manager of the brick factory mentioned. Moreover, in the case of outpatient clinic, a project planner explained that old doors are often difficult to reuse because their height and fire safety features do not meet current regulations. As a result, these doors must undergo a remanufacturing process rather than reuse, such as being repurposed into a new door to meet the required height. However, the case of the outpatient clinic is an exception, where the new building was constructed with old doors, thanks to a special permit for temporary structures. In this regard, a site manager noted that building codes need to become more flexible to accommodate sustainable construction methods.

In sum, the policy can, on the one hand, facilitate the reuse of building elements by providing motivation and guidance; on the other hand, it can hinder reuse practices due to the policy requirements of building elements.

5 DISCUSSIONS

This study makes contributions to the understanding of circular practices in the demolition phase, an area that has been largely underexplored in existing literature. While much of the current research on reuse focuses on project actors such as designers and clients (Eikelenboom et al., 2024), it leaves the challenges faced by demolishers largely unaddressed. Given their critical role in decision-making processes regarding the fate of building elements at EoL, this study provides new empirical insights into the challenges to reuse, specifically from the perspective of demolishers. The study categorises these challenges into four key system elements—technology, people, process

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and policy—offering a more holistic theoretical understanding of the challenges to reuse practices in demolition. This segmentation provides a comprehensive view of the multi-dimensional obstacles faced by demolishers, highlighting that the obstacles to circular demolition are not confined to any one dimension but are multi-faceted and interconnected (Wijewickrama et al., 2021).

Furthermore, this study extends existing research by providing empirical evidence that sheds light on these challenges. Specifically, technology-related challenges were frequently mentioned by the participants. The study reveals that the technologies currently applied in construction and demolition waste management are still in their early stages of development, consistent with the findings of Li et al. (2020). Additionally, deconstruction processes were constrained by fragmented information systems. To address this, the study recommends that future research focus on integrating emerging technologies (see Iyiola et al., 2024) and enhancing digital tools to enable seamless information exchange across the entire reuse-centric process, as an example provided by Kuzminykh et al. (2024). Regarding the element of people, the study highlights a key issue: limited stakeholder collaboration. As also highlighted by Küpfer et al. (2023), demolishers and contractors are typically responsible for separate tasks—deconstructing and reassembling reclaimed components, which disrupts the information flow in the process. In response, it is proposed that a new demolition process is needed, one that fosters stronger relationships and earlier collaboration among stakeholders, particularly between demolishers and contractors (Eikelenboom et al., 2024). This could involve the development of cross-disciplinary teams or closer working relationships to facilitate better knowledge sharing and information flow regarding both reclaimed elements and future construction projects. Additionally, the study underscores the need for demolishers to gain specialised expertise and experience in circular demolition practices, contributing empirical evidence to the existing research (see Wijewickrama et al., 2021). This implies that demolition companies should invest in training programs designed to upskill their workforce in resource efficiency (Sharma et al., 2022). Regarding process-related challenges, the study demonstrates that critical information is often not accessible throughout the deconstruction activities. This is partly due to mismatches between the supply and demand for reusable elements during the identifying phase, which is also highlighted in the study of Rakhshan et al. (2020). Because of this, demolition companies commonly rely on informal networks to find potential buyers, as demonstrated in the case studies. Instead, the development and implementation of digital platforms will be a potential solution (Köhler et al., 2024). Furthermore, limited reuse practices can also result from factors such as time pressure and a reluctance among stakeholders to share information. These gaps highlight the need for not only technological innovation but also cultural change within the demolition industry. Regarding the policy-related challenges, the study provides empirical insights into how regulations can influence element reuse in demolition. It suggests that policymakers should develop guidelines and incentives that encourage the reuse of building elements during demolition, such as establishing certification programs for element recovery (Wijewickrama et al., 2021). Furthermore, by supporting research on the regulation of reused element requirements, policymakers can further promote circular practices in construction projects.

However, this study acknowledges certain limitations, including its scope, which is restricted to two case studies. Further research incorporating additional case studies is recommended to strengthen and generalise the findings. Additionally, the focus on the demolishers' perspective may introduce bias, potentially overlooking the viewpoints of other stakeholders, such as contractors and clients. Similarly, the study primarily examines on-site demolition activities, without addressing upstream design decisions or downstream processes at new projects that influence reuse and circularity. Therefore, further studies are suggested to comprehensively understand the challenges in RLSC that influence reuse. Lastly, while this study offers valuable insights into deconstruction processes, there remains a limited understanding of how they differ from traditional demolition processes. Future studies are required to offer deeper insights into, for example, the specific tools, safety protocols, and workflows employed in deconstruction practices compared to demolition ones.

6 CONCLUSIONS

This study offers empirical insights into the challenges associated with deconstruction processes aimed at building element reuse, with a particular focus on the perspective of demolishers. Two case studies were selected to represent circular demolition practices. Qualitative data were gathered through ten semi-structured interviews, project documentation, and field visits. The study identifies and categorises the challenges into four key elements: technology, people, process and policy. In doing so, it provides valuable empirical evidence regarding the barriers demolishers encounter when attempting to divert waste from demolition sites for reuse. Based on these findings, the study suggests avenues for future research and practical strategies aimed at improving circular practices in demolition projects. Future research is needed to generalise these findings by incorporating additional case studies. Moreover, future studies should also explore upstream and downstream processes in RLSC that influence element reuse, from the perspective of different stakeholders.

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REFERENCES

Akbarieh, A., Jayasinghe, L. B., Waldmann, D., & Teferle, F. N. (2020). BIM-based end-of-lifecycle decision making and digital deconstruction: Literature review. *Sustainability*, *12*(7), 2670.

Allam, A. S., & Nik-Bakht, M. (2023). From demolition to deconstruction of the built environment: A synthesis of the literature. *Journal of Building Engineering*, *64*, 105679.

Azungah, T. (2018). Qualitative research: deductive and inductive approaches to data analysis. *Qualitative research journal*, *18*(4), 383-400.

Bertino, G., Kisser, J., Zeilinger, J., Langergraber, G., Fischer, T., & Österreicher, D. (2021). Fundamentals of building deconstruction as a circular economy strategy for the reuse of construction materials. *Applied Sciences*, *11*(3), 939.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Byers, B. S., Raghu, D., Olumo, A., De Wolf, C., & Haas, C. (2023). From research to practice: A review on technologies for addressing the information gap for building material reuse in circular construction. *Sustainable Production and Consumption*.

Çetin, S., Gruis, V., & Straub, A. (2022). Digitalization for a circular economy in the building industry: Multiple-case study of Dutch social housing organizations. *Resources, Conservation & Recycling Advances*, *15*, 200110.

Chileshe, N., Jayasinghe, R. S., & Rameezdeen, R. (2019). Information flow-centric approach for reverse logistics supply chains. *Automation in Construction*, *106*, 102858.

Cruz, E. F., Machado, R. J., & Santos, M. Y. (2015). Deriving a data model from a set of interrelated business process models. International Conference on Enterprise Information Systems,

Eikelenboom, M., Oosterlee, M., & van Marrewijk, A. (2024). Demolishers or 'material experts'? Project actors negotiating changing roles in sustainable projects. *International Journal of Project Management*, 102605.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, *14*(4), 532-550.

Elghaish, F., Hosseini, M. R., Kocaturk, T., Arashpour, M., & Ledari, M. B. (2023). Digitalised circular construction supply chain: An integrated BIM-Blockchain solution. *Automation in construction*, *148*, 104746.

Ellen MacArthur, F. (2013). *Towards The Circular Economy: Economic and business rationale for an accelerated transition*. https://www.ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an

European Commission. (2022). *Buildings and construction*. Retrieved 6/14 from https://ec-europa-eu.ezproxy2.utwente.nl/growth/industry/sustainability/buildings-and-construction_en

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International journal of qualitative methods*, *5*(1), 80-92.

Ferriz-Papi, J. A., Lee, A., & Alhawamdeh, M. (2024). Examining the Challenges for Circular Economy Implementation in Construction and Demolition Waste Management: A Comprehensive Review Using Systematic Methods. *Buildings*, *14*(5), 1237.

Fini, A. A. F., & Forsythe, P. (2020). Barriers to reusing and recycling office fit-out: An exploratory analysis of demolition processes and product features. *Construction Economics and Building*, *20*(4), 42-62.

Gálvez-Martos, J.-L., Styles, D., Schoenberger, H., & Zeschmar-Lahl, B. (2018). Construction and demolition waste best management practice in Europe. *Resources, Conservation and Recycling*, *136*, 166-178.

Ghobakhloo, M., Tang, S. H., Zulkifli, N., & Ariffin, M. (2013). An integrated framework of green supply chain management implementation. *International Journal of Innovation, Management and Technology*, *4*(1), 86.

Hammer, M., & Champy, J. (2009). *Reengineering the corporation: Manifesto for business revolution, a*. Zondervan.

Hosseini, M. R., Rameezdeen, R., Chileshe, N., & Lehmann, S. (2015). Reverse logistics in the construction industry. *Waste Management & Research*, *33*(6), 499-514.

Huuhka, S., Kaasalainen, T., Hakanen, J., & Lahdensivu, J. (2015). Reusing concrete panels from buildings for building: Potential in Finnish 1970s mass housing. *Resources, Conservation and Recycling*, *101*, 105-121.

Iyiola, C. O., Shakantu, W., & Daniel, E. I. (2024). Digital Technologies for Promoting Construction and Demolition Waste Management: A Systematic Review. *Buildings*, *14*(10), 3234.

Jiang, H., Feng, W., & Ouyang, W. (2017). Suggestions on Implementation of Reverse Logistics for Construction Waste of Sustainable

https://doi.org/10.52202/080684-0002

Development. *Journal of Residuals Science & Technology*, *14*(3).
Jongert, J., Nelson, N., & Goosens, F. (2011). Recyclicity: A Toolbox for Resource-Based Design. *Architectural design*, *81*(6), 54-61.
Ko, R. K. (2009). A computer scientist's introductory guide to business process management (BPM). *XRDS: Crossroads, The ACM Magazine for Students*, *15*(4), 11-18.
Köhler, J., Nielsen, F. F., Verstermark, J., & Thuesen, C. (2024). Recirculation of construction and demolition Waste: A case study of Danish producers and demolishers. *Cleaner Materials*, *14*, 100276.
Küpfer, C., Bastien-Masse, M., & Fivet, C. (2023). Reuse of concrete components in new construction projects: Critical review of 77 circular precedents. *Journal of Cleaner Production*, *383*, 135235.
Kuzminykh, A., Granja, J., Parente, M., & Azenha, M. (2024). Promoting circularity of construction materials through demolition digitalisation at the preparation stage: Information requirements and openBIM-based technological implementation. *Advanced Engineering Informatics*, *62*, 102755.
Li, C. Z., Zhao, Y., Xiao, B., Yu, B., Tam, V. W., Chen, Z., & Ya, Y. (2020). Research trend of the application of information technologies in construction and demolition waste management. *Journal of Cleaner Production*, *263*, 121458.
Mallick, P. K., Salling, K. B., Pigosso, D. C., & McAloone, T. C. (2023). Closing the loop: Establishing reverse logistics for a circular economy, a systematic review. *Journal of environmental management*, *328*, 117017.
Marino, A., & Pariso, P. (2020). Comparing European countries' performances in the transition towards the Circular Economy. *Science of the Total Environment*, *729*, 138142.
Parto, S., Loorbach, D., Lansink, A., & Kemp, R. (2007). Transitions and Institutional Change: the case of the Dutch waste system. *Industrial innovation and environmental regulation*, 233-258.
Purchase, C. K., Al Zulayq, D. M., O'Brien, B. T., Kowalewski, M. J., Berenjian, A., Tarighaleslami, A. H., & Seifan, M. (2021). Circular economy of construction and demolition waste: A literature review on lessons, challenges, and benefits. *Materials*, *15*(1), 76.
Rakhshan, K., Morel, J.-C., Alaka, H., & Charef, R. (2020). Components reuse in the building sector–A systematic review. *Waste Management & Research*, *38*(4), 347-370.
Rameezdeen, R., Chileshe, N., Hosseini, M. R., & Lehmann, S. (2016). A qualitative examination of major barriers in implementation of reverse logistics within the South Australian construction sector. *International Journal of Construction Management*, *16*(3), 185-196.
Ronzani, C. M., da Costa, P. R., da Silva, L. F., Pigola, A., & de Paiva, E. M. (2020). Qualitative methods of analysis: an example of Atlas. TI™ Software usage. *Revista Gestão & Tecnologia*, *20*(4), 284-311.
Sharma, N., Kalbar, P. P., & Salman, M. (2022). Global review of circular economy and life cycle thinking in building Demolition Waste Management: A way ahead for India. *Building and Environment*, *222*, 109413.
Van de Ven, A. H. (2007). *Engaged scholarship: A guide for organizational and social research*. Oxford University Press, USA.
Van den Berg, M. (2024a). Digital Technology Use Cases for Deconstruction and Reverse Logistics. In *A Circular Built Environment in the Digital Age* (pp. 197-212). Springer International Publishing Cham.
Van den Berg, M. (2024b). An Ethnographic Account of Circular Demolition Practices: Realising reuse potentials. In *Embracing Ethnography* (pp. 267-280). Routledge.
Van den Berg, M., Voordijk, H., & Adriaanse, A. (2020a). Information processing for end-of-life coordination: a multiple-case study. *Construction Innovation*, *20*(4), 647-671.
Van den Berg, M., Voordijk, H., & Adriaanse, A. (2020b). Recovering building elements for reuse (or not)–ethnographic insights into selective demolition practices. *Journal of Cleaner Production*, *256*, 120332.
Wao, H. O., Dedrick, R. F., & Ferron, J. M. (2011). Quantitizing text: using theme frequency and theme intensity to describe factors influencing time-to-doctorate. *Quality & Quantity*, *45*, 923-934.
Wibowo, M. A., Handayani, N. U., Mustikasari, A., Wardani, S. A., & Tjahjono, B. (2022). Reverse logistics performance indicators for the construction sector: a building project case. *Sustainability*, *14*(2), 963.
Wijewickrama, M., Chileshe, N., Rameezdeen, R., & Ochoa, J. J. (2020). Information Sharing in Reverse Logistics Supply Chain of Demolition Waste: A Systematic Literature Review. *Journal of Cleaner Production*, 124359.
Wijewickrama, M., Chileshe, N., Rameezdeen, R., & Ochoa, J. J. (2021). Quality assurance in reverse logistics supply chain of demolition waste: A systematic literature review. *Waste Management & Research*, *39*(1), 3-24.
Wu, Z., Yang, K., Xue, H., Zuo, J., & Li, S. (2022). Major barriers to information sharing in reverse logistics of construction and demolition waste. *Journal of Cleaner Production*, *350*, 131331.
Yin, R. K. (2014). *Case study research: design and methods*.