DETERMINANTS OF MATERIAL REUSE IN A RESTORATIVE CIRCULAR ECONOMY IN THE BUILDING SECTOR: INSIGHTS FROM STEEL AND PLASTERBOARD SUPPLY CHAINS

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The reuse of building materials provides a circular approach to managing building stock and supports the transition to regenerative cities. However, recycling remains the dominant end-of-life pathway of circularity, and building materials have varying potentials for reuse, e.g., steel and plasterboard. The determinants of their reusability are yet to be fully explored. Semi-structured interviews with thirty practitioners from steel and plasterboard supply chains were conducted to investigate the factors influencing their reusability. Findings revealed the disparity in the economic value and ease of deconstruction between steel and plasterboard is critical in determining their practical feasibility for reuse. A framework including twenty-one factors was proposed to support the evaluation of the reusability of building materials. While plasterboard is barely reused, potential pathways for improving its reuse include adaptive reuse, modular construction, standardisation, reversible fixings, servitisation, and community-based business models. The upscaling of steel reuse is constrained by insufficient supplies from demolition. Future research should expand the framework to include other materials and develop a weighted scoring system for practical use.

Keywords: circular economy; reuse; building materials; steel; plasterboard

INTRODUCTION

Cities have been experiencing increasing pressure on their building stock, driven by societal trends such as ageing populations, rising affluence, and climate change, all of which entail additional urban space (EEA, 2024). However, construction activities currently account for over 35% of total waste generation, 50% of annual raw material consumption, and 5%-12% of total greenhouse gas emissions in the EU (EEA, 2024). These alarming figures pinpoint the critical need to develop restorative cities by strengthening the technical loop of building materials, represented in the "butterfly" diagram of circular economy (CE) depicted by the Ellen MacArthur Foundation (2013). The restorative approach seeks to remove the "end-of-life" notion and replace it with material cycles featuring a "cradle-to-cradle" process (Abadi *et al.,* 2021). The "3R" framework (i.e., reduce, reuse and recycling) has been extensively recognised as the foundation of CE, but its implementation in construction remains largely confined

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to recycling (Abadi *et al.,* 2023), despite reuse offering substantially greater environmental benefits. Reuse in construction is still in its early stages of development, confronting various barriers to its application that entail top-down policy interventions (Fufa *et al.,* 2023).

Recent regulatory developments in the UK, particularly the Circular Economy Statement introduced by the Greater London Authority (GLA), have spurred bottom-up reuse initiatives in major London developments. Reuse potential varies across building materials (Fufa *et al.,* 2023), e.g., steel and plasterboard. Steel reuse has emerged as a prominent example, with numerous successful cases demonstrating significant embodied carbon savings for developers (Huang *et al.,* 2024). However, not all building materials are inherently suitable for reuse due to differences in quality, durability, function, lifetime, and so forth (Iacovidou and Purnell, 2016). Plasterboard sits at the opposite end of the reuse spectrum as opposed to steel, despite accounting for the largest share in fit-out waste streams reported by a major waste contractor in London (Casas-Arredondo *et al.,* 2018). Current research tends to focus on individual material or broadly investigate multiple materials. Hence, this study aims to develop a framework to support the evaluation of the reusability of building materials drawing upon the sharp contrast between steel and plasterboard. It also seeks to uncover the untapped opportunities for plasterboard reuse.

LITERATURE REVIEW

ISO 20887 defines reuse in building construction as repeated use of building products or components for their original intended purposes, potentially involving minor reprocessing (ISO, 2020). Its application is typically manifested in three main approaches: Adaptive reuse, relocation, and building component reuse (Gorgolewski, 2008). First, adaptive reuse refers to repurposing an existing building for a new function, such as heritage buildings due to their strong cultural significance (Mısırlısoy and Günçe, 2016). Second, relocation involves moving a building in whole or in part to a new site. For instance, Pichlmeier and Lindner (2024) investigated the reuse of building services in three prefabricated buildings which were dismantled and rebuilt at new locations. Third, building component reuse, a more prevalent topic in the literature, concerns salvaging individual components at the end-of-life stage of buildings. Gobbo *et al. (*2024) adapted Brand's six shearing layers framework to classify component reuse across structure, skin, space plan, services, and outdoor spaces. Concrete, brick and steel constitute most structural components embedded in building stocks, but most existing studies focus on steel and timber structures due to their ease of deconstruction compared to concrete and masonry structures (Cai and Waldmann, 2019). Beyond structural components, recent projects shed light on reusing interior components within the scope of space plan and services (Devènes *et al.,* 2024). For instance, ongoing initiatives led by the Finishes and Interior Sector (FIS, 2025) in the UK explore opportunities for reusing suspended ceilings, luminaires and raised access flooring in commercial office buildings.

However, reuse in building construction remains a niche practice with limited types of materials considered and varying degrees of reuse potential. Iacovidou and Purnell (2016) consider reuse potential as the capacity of construction components to maintain the functionality beyond their initial use. Arora *et al. (*2020) calculated reuse potential based on recovery feasibility, retained functionality, and physical conditions, framing it as a key indicator for the availability of secondary resources in urban mining. Bellini *et al. (*2024) further added that a comprehensive evaluation of reuse potential involves environmental impacts, technical performance, lifespan, disassembly feasibility, logistics, storage, and both risk and cost implications. These evaluation criteria can also be shaped by common barriers to reuse, including inadequate design and demolition methods, design iterations due to variability in supply, complex supply chain logistics, lack of technical guidance, economic constraints, and additional performance assessment and certification (Devènes *et al.,* 2024). In a national survey of the Norwegian construction industry, Fufa *et al. (*2023) revealed the lack of documentation as the most challenging barrier to reuse.

Building materials exhibit distinct potentials for reuse. For example, steel has high potentials for reuse due to strength and durability, while 'plasterboard' is more associated with recycling. Huang *et al. (*2024) compiled a list of recent initiatives on steel reuse featured in online records, but its reuse rate remains low. In response, researchers have proposed various solutions to support steel reuse, such as smart technologies to support structural steel tracking (Smeets *et al.,* 2019) and demountable and reusable structural connection systems (Kitayama and Iuorio, 2023b). At the other extreme, plasterboard presents low economic value and limited structural strength. It constitutes a significant portion of fit-out waste, whilst it poses greater disposal challenges than steel. Its waste can contaminate other inert construction waste, and produce hydrogen sulphide gas, a highly toxic substance, when landfilled with organic waste (Erbs *et al.,* 2021). To date, only one known study has explored the possibility of reusing plasterboard and concluded that it holds high reuse potential via prefabricated construction (Kitayama and Iuorio, 2023a). Current research tends to focus on its recycling. For instance, Erbs *et al. (*2021) demonstrated the feasibility of producing new plasterboard sheets using only recycled plaster and recycled paper, both sourced from plasterboard waste.

The literature has explored numerous design interventions and new business models aimed at promoting the reuse of building materials. For instance, Piccardo and Hughes (2022) discussed design for disassembly to increase the reuse of wood in buildings. Another notable design strategy is design for manufacture and assembly that focuses on off-site production and on-site assembly to streamline construction and facilitate reuse (Iacovidou and Purnell, 2016). In parallel, new business model have been studied to support reuse practices. For example, Nußholz *et al. (*2020) investigated how material reuse in circular business models creates added value that extends beyond the financial gains of traditional business models and delivers broader benefits for stakeholders, society, and the environment. Ness *et al. (*2019) approached circular business models through the lens of product service system (PSS) and proposed an ICT-enabled model where suppliers retain ownership of reusable components and provide them as a service. These strategies provide valuable insights into how reuse can be upscaled in practice for high-performing materials like steel, while informing the untapped potential for reusing more challenging materials such as plasterboards.

Reviewing the literature raises three main questions that guide the development of the framework for assessing the reusability of building materials: (1) What are the circularity pathways for steel/plasterboard? (2) What are the determinant factors of reusing steel/plasterboard? (3) What strategies can be used to improve the reusability of steel/plasterboard? These questions also shaped the initial set of questions used in the semi-structured interviews conducted in this study.

METHOD

This study employed a multiple-case study design to explore the determinants of material reuse, focusing on two widely used building materials, steel and plasterboard, each with distinct reuse potential. A case study is an empirical method used to investigate a contemporary phenomenon within its real-world context (Yin, 2018). The "case" can be any subject or topic that allows for close, in-depth, and detailed investigation (Yin, 2018). This study conceptualised the "case" as the material itself, an approach also seen in Nasir *et al. (*2017) who analysed two types of insulation materials to compare linear and circular supply chains. Following Yin's (2018) “two-tail” design that involves the deliberate selection of cases from both extremes, this study compared steel as an exemplar of successful reuse with plasterboard that faces significant challenges. Philosophically, the study is grounded in an interpretivist stance, which acknowledges that knowledge is socially constructed and best understood through the perspectives and experiences of those directly involved. An inductive approach was employed that allows themes and insights derived from the qualitative data. Data was collected through semi-structured interviews as part of a broader study. Participants were selected through purposive sampling based on inclusion criteria reflecting their involvement in circular construction supply chains. Participants engaged in either the steel or plasterboard supply chain were identified via LinkedIn, with additional participants recruited through snowball sampling. This process yielded a total of thirty interviewees, whose roles spanned building design (nine), construction (nine), material supply (five), demolition (three), and waste management (four). Most participants (twenty-three) had more than fifteen years of working experience. The interviews were conducted on MS Teams with live transcription enabled. The discussions were guided by the three key questions previously proposed. The initial exported transcript was refined against the audio recording and subsequently imported into NVivo 12 for thematic coding that involves organising interview data into themes relevant to each material case. From this inductive process, a structured reusability framework was developed that synthesizes the identified factors to evaluate the reuse potential of building materials.

FINDINGS

Circularity Pathways of Steel and Plasterboard

Thirteen interviewees had experience with steel reuse. While recycling via electric arc furnace remains the dominant end-of-life pathway for steel, whereby scrap from building demolition is sent to metal recyclers for re-melting or export, its reuse is gaining traction in recent years due to regulatory development. This process typically is preceded by a pre-demolition audit to assess reclaimable steel components. Two main reuse routes were identified: First, donor-recipient model, where the client has both the demolition and new construction projects, allowing steel to be transferred directly from the ‘donor’ to the ‘recipient’ building; and second, stockholder route, where demolition contractors sell reclaimed steel to stockists who undertake initial processing or reconditioning, coordinate with testing bodies for certification, and supply the steel for fabrication and on-site assembly.

In contrast, none of the interviewees reported any experience with plasterboard reuse. Different from steel, which is reclaimed during demolition, plasterboard is typically removed during the soft strip stage involving the removal of non-structural elements prior to demolition or refurbishment. Although some manufacturers offer take-back schemes, these are limited to waste from new products and exclude end-of-life waste from refurbishment or demolition. While plasterboard reuse is hardly seen in practice, recycling is the main circular pathway for plasterboard. The process begins with on-site collection, which may include segregation or pre-treatment to meet acceptance criteria of recycling facilities. Subsequently, plasterboard waste is shredded and separated into gypsum and paper. The recovered gypsum is then either reintegrated into new plasterboard production or downcycled for use as filler, soil conditioner in agriculture, cement additive, or road base material.

Key Factors Influencing Steel Reuse

Discussions with the interviewees revealed four key factors that contribute to the success of reusing steel beyond its inherent properties: Embodied carbon benefits, technical feasibility, availability of reused steel, and supply chain engagement.

Steel reuse tends to be driven by high-profile clients with strong carbon agenda, motivated by the significant embodied carbon savings. The client support allows greater flexibility to plan, coordinate, and implement steel reuse. However, interviewees raised concerns over the current distribution of carbon benefits which are credited only to clients reusing the steel. This prompts questions about whether demolition contractors or the original property owners should also receive recognition. While demolition contractors do not gain carbon credits, they often leverage their involvement in reuse as a marketing tool to secure new contracts. Few interviewees also noted that encouraging buy-in from end-users or property owners is crucial but often overlooked, as many pay attention to EPC ratings rather than embodied carbon, potentially influencing client decisions to pursue reuse.

Technical feasibility plays a critical role in enabling steel reuse. Standards such as SCI P427 and P440, developed by the Steel Construction Institute, provide essential technical guidance and confidence in incorporating reused steel in structural design. However, several interviewees noted that some safety indicators within the guidance are conservative, suggesting room for refinement to encourage wider reuse. Additionally, digital stock-matching tools have been developed to support alignment between reclaimed steel availability and design specifications, allowing designers to adjust specifications based on available stock. Demolition contractors reported that recovering steel for reuse involves largely the same processes and equipment as preparing it for recycling. The key difference is additional time and careful planning, such as using cranes to lower intact steel sections rather than cutting them into scrap.

Stockholding is another critical factor that provides the availability of processed and quality-assured reclaimed steel. Stockholders purchase reusable steel from demolition and conduct initial processing and reconditioning and often prepare it to be indistinguishable from new steel, but with significantly lower embodied carbon. These reclaimed materials are tested and certified with CE/UKCA markings, meet quality assurance standards. A pre-demolition audit is vital to assess steel reuse potential early on to help demolition contractors identify salvageable components and direct them to stockholders. However, the lack of financial incentives persists to be a significant barrier for demolition contractors. One interviewee stated: "we get paid well for recycling. Actually, for the amount of additional time, cost and effort, is it worth it?".

Effective steel reuse relies on early and continuous engagement across the supply chain. The intention to use reclaimed materials should be embedded from the outset, ideally during RIBA stage 0 or 1, when the project brief is being developed. Early engagement helps ensure reused steel is technically feasible, logistically viable, and commercially practical. Designers develop efficient structural systems with high utilisation and low weight, which can later be adapted to accommodate reused steel. Close and timely communication with stockholders is essential to align design decisions with available stock and avoid tying up reusable steel that could otherwise serve other projects. Stockholders, in turn, coordinate with demolition contractors to improve pre-demolition audits and boost the supply of reusable steel.

Key Factors Influencing Plasterboard Reuse

Interview findings indicate that plasterboard reuse is primarily constrained by its low economic value and the complexity of deconstruction. Unlike steel, which is durable and retains structural integrity, plasterboard is fragile, prone to damage, and difficult to extract in a reusable condition. While other factors, such as design standards, quality assurance protocols, and stockholding infrastructure, also impede reuse but are secondary concerns that become relevant only once the fundamental feasibility of reuse is established. At present, plasterboard reuse remains largely impractical.

The low economic value of plasterboard is the primary impeding factor to its reuse. Many interviewees claimed that plasterboard reuse is not considered due to its brittleness. However, "nobody complains that their iPhone is too fragile", an analogy made by one interviewee. Other fragile materials, such as windows, glazed partitions, and lighting fixtures, are handled more carefully because of their higher material value. Plasterboard, by contrast, is inexpensive and mass-produced. Manufacturers typically operate near gypsum sources and run highly efficient production lines, making the production of new boards fast, cheap, and convenient. Consequently, contractors tend to over-order plasterboard to prevent delays with insufficient consideration of its wastage. Interestingly, one interviewee suggested that the economic value of gypsum mining is not limited to the extraction of gypsum itself but also tied to the use of hollowed-out mines as profitable landfill sites.

The technical complexity of deconstructing plasterboard further undermines the business case with substantial labour and cost involved. Plasterboard is typically fixed to metal or timber studs or bonded directly to walls using the dot-and-dab method, both of which make removal without damage highly challenging. Screws used to secure plasterboard to framing are often concealed beneath skimmed finishes, making them nearly impossible to locate or access without damaging the board. In addition, there is no standardised screw pattern, and each sheet may be fastened with dozens of screws placed irregularly. Even if plasterboard could be deconstructed intact, handling intact plasterboard sheets requires careful lifting with mechanical aids that are often unavailable during soft-strip operations. Further logistical challenges include protecting the board from moisture and damages during transport and storage. As one interviewee commented that “even if you did get it off the wall, you’ve got to protect it, store it, and eventually cut it again on the next site”.

Reuse Opportunities for Plasterboard

Interview findings revealed three broad categories of reuse opportunities for plasterboard with each addressing different stages of intervention. First, one route to improving reuse is by eliminating the need for removal. This can be achieved through adaptive reuse, where materials are reused in situ without incurring the damage, labour, or cost associated with removal and reinstallation. Another strategy in this category involves integrating plasterboard into modular or prefabricated components (Kitayama and Iuorio, 2023a), allowing entire wall panels to be relocated as a unit. Second, when removal is necessary, designing for disassembly can significantly enhance reuse potential. Traditional screw-fixed plasterboard is difficult to recover intact due to concealed fixings and its fragile composition. This challenge can be addressed through innovations in reversible mechanical fixings, such as sliding tracks, magnetic attachments, or click-together panel systems. Additionally, standardisation of panel sizes and fixing methods would further improve efficiency in deconstruction and make it easier to match reclaimed boards with new applications. Third, alternative business models offer new ways of enabling plasterboard reuse. For instance, servitisation models, where manufacturers retain product ownership and provide them as a service, have the potential to shift incentives toward designing for multiple lifecycles by introducing more durable and modular plasterboard systems. Moreover, community-based reuse models (Ward, 2024), where surplus plasterboard from construction sites is diverted to local hubs for use in community projects. These projects typically have lower performance thresholds and offer added social value.

Reusability framework for Building Materials

Table 1: The Proposed Framework of Determinant Factors for Building Materials Reusability

No	Group	Reusability Factor	Steel	Plasterboard
1	Material Attributes	Durability and strength	High	Relatively low
2		Economic value	High	Relatively low
3		Carbon saving	Significantly greater than their recycling	
4		Function in buildings	Structural; hidden	Non-structural; finishes
5	Design	Reuse specified in brief	Reuse tends to be a target and voluntary practice	
6		Design for deconstruction	Most buildings design not suitable for reuse	
7		Reuse standards and guide	SCI P427, P440	Not available
8		Regulatory incentive	GLA CE statement	Not applied to fit-out
9		Supply chain engagement	Reuse-oriented design entails early engagement	
10	Construction	Fixings and connections	Bolted/welded	Screwed/glued
11		Use of modular elements	Both can be integrated into modular systems	
12		Records and traceability	Both requires traceable provenance for reuse	
13	Operation	Adverse conditions	Both cannot be exposed to fire and moisture	
14		Functional degradation	High durability	Relative low durability
15	Deconstruction	Ease of deconstruction	Feasible with care	Technically difficult
16		Damage of removal	Low	Highly possible
17		Lifting machinery	Cranes	Unavailable in soft strip
18		Market demand	Mature recycling market but niche for reuse	
19	Post-deconstruction	Transport distance	Carbon impact influences transport distance	
20		Stockholding	Stockists available	Not available
21		Test and certification	Supported by norms	Not available

Iacovidou and Purnell (2016) posit that the most fundamental factors of a component's end-of-life potential are its embodied carbon value and its technical feasibility for deconstruction. Similarly, the survey by Fufa *et al. (*2023) revealed emission reduction and supply chain coordination as the most influential factors in driving construction products rese. These factors align well with the case of steel. In contrast, plasterboard reuse remains impractical due to its low value and difficulty in deconstruction. Therefore, this study proposes that technical feasibility and product value are the primary factors of reuse. When these are addressed, secondary factors, such as standards, stakeholder coordination, or stockholding infrastructure, become relevant and influence the ease and scale of reuse.

Drawing on the interview coding, Table 1 presents twenty-one factors that influence the reusability of building materials classified into two dimensions: Material attributes, which establish the baseline inherent suitability for a second life; and building lifecycle stages, with each enhancing or undermining the baseline reuse potential. Mapping the framework against the two materials illuminates why steel is successfully reused in practice while plasterboard struggles. It is important to note that as more materials are considered, the factor list will likely expand. For instance, in the case of mechanical and electrical components, designing for access and maintenance can be a critical factor that determines future reuse potential.

The proposed framework deepens the insights into reuse factors and extends those identified in prior studies (Arora *et al.,* 2020; Bellini *et al.,* 2024; Iacovidou and Purnell, 2016) by contextualising them through case studies of steel and plasterboard and providing a structured checklist for practitioners to assess material reusability. Following the two-dimension classification, decision-makers can see whether a material's baseline characterises merit further investigation, whilst actors involved at each building stage can pinpoint targeted interventions to improve material reuse potential. This framework also reveals opportunities for industry innovation, such as researching alternative materials with strong inherent reuse properties or designing connection systems that facilitate straightforward deconstruction.

CONCLUSIONS

This paper proposed a framework including twenty-one factors to support the evaluation of building materials reusability based on the insights from thirty semi-structured interviews with steel and plasterboard supply chain stakeholders. Findings revealed that embodied carbon benefits, technical feasibility, availability of reused steel, and early supply chain engagement are the key enablers of steel reuse. In contrast, low economic value and the complexity of deconstruction emerged as primary barriers to plasterboard reuse. Despite these barriers, potential pathways for enhancing plasterboard reuse were identified, including adaptive reuse, modular construction, standardisation, reversible fixings, servitisation, and community-based business models. The upscaling of steel reuse is constrained by limited supplies of salvaged steel from demolition, primarily due to lack of incentives for demolition contractors. The comparison between steel and plasterboard revealed that technical feasibility and product value form the foundational prerequisites for reuse. When these are met, other factors, such as standards, stakeholder coordination, and stockholding, become increasingly relevant, shaping the ease and scale of implementation.

This study contributes to the body of knowledge by providing deeper insights into material reusability using case studies of steel and plasterboard. For practitioners, the framework provides a structured checklist to assess material reusability and pinpoints targeted interventions to improve material reuse potential. It also helps identify where industry innovation can better support material reuse. However, this study does not exmaine specific projects where steel/plasterboard have been reused and may have overlooked some complexities of real-world reuse processes. In addition, the scope of this study is limited to steel and plasterboard. Future research will expand the framework by exploring a wider spectrum of building materials and based on real-world project contexts. Moreover, weighting each factor to develop a scoring system would improve the framework's practicality and decision-support value.

REFERENCES

Abadi, M, Huang, J, Yeow, J, Mohandes, S R and Zhang, L (2023) Towards a complex push-to-pull dynamics in circular construction supply chains: A systematic literature review, *Engineering, Construction and Architectural Management*, **32**(2).

Abadi, M, Moore, D R and Sammuneh, M A (2021) A framework of indicators to measure project circularity in construction circular economy, *Proceedings of the Institution of Civil Engineers - Management, Procurement and Law*, **175**(2), 54-66.

Arora, M, Raspall, F, Cheah, L and Silva, A (2020) Buildings and the circular economy: Estimating urban mining, recovery and reuse potential of building components, *Resources, Conservation and Recycling*, **154**, 104581.

Bellini, A andersen, B, Klungseth, N J and Tadayon, A (2024) Achieving a circular economy through the effective reuse of construction products: A case study of a residential building, *Journal of Cleaner Production*, **450**, 141753.

Cai, G and Waldmann, D (2019) A material and component bank to facilitate material recycling and component reuse for a sustainable construction: Concept and preliminary study, *Clean Technologies and Environmental Policy*, **21**(10), 2015-2032.

Casas-Arredondo, M, Croxford, B and Domenech, T (2018) Material and decision flows in non-domestic building fit-outs, *Journal of Cleaner Production*, **204**, 916-925.

Devènes, J, Bastien-Masse, M and Fivet, C (2024) Reusability assessment of reinforced concrete components prior to deconstruction from obsolete buildings, *Journal of Building Engineering*, **84**, 108584.

EMF (Ellen MacArthur Foundation) (2013) *Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition*, Available from: https://www.werktrends.nl/app/uploads/2015/06/Rapport_McKinsey-Towards_A_Circular_Economy.pdf [Accessed 28 July].

Erbs, A, Nagalli, A, Carvalho, K Q D, Mazer, W, Moraes Erbs, M D, Paz, D H F and Lafayette, K P V (2021) Development of plasterboard sheets exclusively from waste, *Journal of Building Engineering*, **44**, 102524.

European Environment Agency (EEA) (2024) *Addressing the Environmental and Climate Footprint of Buildings*, Available from: https://www.eea.europa.eu/en/analysis/publications/addressing-the-environmental-and-climate-footprint-of-buildings [Accessed 28 July].

Finishes and Interior Sector (FIS) (2025) *Fis Project Reuse*, Available from: https://www.thefis.org/knowledge-hub/sustainablility/reuse/ [Accessed 28 July].

Fufa, S M, Brown, M K, Hauge, Å L, Johnsen, S Å and Fjellheim, K (2023) User perspectives on reuse of construction products in Norway: Results of a national survey, *Journal of Cleaner Production*, **408**, 137067.

Gobbo, É, Nia, E M, Straub, A and Stephan, A (2024) Exploring the effective reuse rate of materials and elements in the construction sector, *Journal of Building Engineering*, **98**, 111344.

Gorgolewski, M (2008) Designing with reused building components: Some challenges, *Building Research and Information*, **36**(2), 175-188.

Huang, J, Abadi, M and Yeow, J (2024) Policy Implications for Factors of Steel Reuse in Circular Construction Supply Chains: A System Thinking Perspective. *In:* Thomson, C (Ed.) and Neilson, C J (Ed.), *Proceedings 40th Annual ARCOM Conference*, 2-4 September 2024, London South Bank University, UK. Association of Researchers in Construction Management, 799-808.

Iacovidou, E and Purnell, P (2016) Mining the physical infrastructure: Opportunities, barriers and interventions in promoting structural components reuse, *Science of the Total Environment*, **557-558**, 791-807.

ISO (2020) ISO 20887:2020 Sustainability in buildings and civil engineering works—Design for disassembly and adaptability—Principles, requirements and guidance, Available from: https://www.iso.org/obp/ui/en/#iso:std:iso:20887:ed-1:v1:en [Accessed 28 July].

Kitayama, S and Iuorio, O (2023a) Can we reuse plasterboards? *In*: F Biondini and D M Frangopol (Eds) *Lifecycle of Structures and Infrastructure Systems 1st Edition*, London: CRC Press, 127-134

Kitayama, S and Iuorio, O (2023b) Disassembly and reuse of structural members in steel-framed buildings: State-of-the-art review of connection systems and future research trends, *Journal of Architectural Engineering*, **29**(4), 03123006.

Mısırlısoy, D and Günçe, K (2016) Adaptive reuse strategies for heritage buildings: A holistic approach, *Sustainable Cities and Society*, **26**, 91-98.

Nasir, M H A, Genovese, A, Acquaye, A A, Koh, S C L and Yamoah, F (2017) Comparing linear and circular supply chains: A case study from the construction industry, *International Journal of Production Economics*, **183**, 443-457.

Ness, D, Xing, K, Kim, K and Jenkins, A (2019) An ICT-enabled product service system for reuse of building components, *IFAC-Papersonline*, **52**(13), 761-766.

Nußholz, J L K, Rasmussen, F N, Whalen, K and Plepys, A (2020) Material reuse in buildings: Implications of a circular business model for sustainable value creation, *Journal of Cleaner Production*, **245**, 118546.

Piccardo, C and Hughes, M (2022) Design strategies to increase the reuse of wood materials in buildings: Lessons from architectural practice, *Journal of Cleaner Production*, **368**, 133083.

Pichlmeier, F and Lindner, S (2024) Reuse potential of building services in building relocation, *IOP Conference Series: Earth and Environmental Science*, **1363**(1), 012050.

Smeets, A, Wang, K and Drewniok, M P (2019) Can Material Passports lower financial barriers for structural steel re-use? *IOP Conference Series: Earth and Environmental Science*, **225**, 012006.

Ward, D (2024) *Construction Materials Reuse Hubs*, Available from: https://asbp.org.uk/wp-content/uploads/2024/12/16-Debbie_Rebuild_The-Reuse-Hub_ASBP_14Nov.pdf [Accessed 28 July].

Yin, R K (2018) *Case Study Research and Applications: Design and Methods Sixth Edition*, London: SAGE Publications.