Enabling Reuse in the Swedish Construction Sector

Development of Product Parameters

Master's thesis in Design and Construction Project Management

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Cover: A circle with five interconnected arrows displaying a water closet, washbasin, ceiling tiles, ventilation duct, and radiator. AI generated

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Abstract

The construction sector is one of the most resource intensive industries globally and contributes to massive waste generation, greenhouse gas emissions and the consumption of virgin materials. Reuse of building components has been identified as an important strategy to reduce the impact of the sector by extending products life cycle and preserving material value. Despite the growing interest in circular practices, implementation of reuse within the sector remains limited. Previous research on the subject has identified several barriers such as lack of standardized information, uncertainty and limited market structures for reused objects.

The purpose of this report was to investigate how a development of product parameters can support reuse in the Swedish construction sector. The study was conducted using a qualitative and abductive research approach, combining a literature review, an analysis of AMA and empirical interview results from professionals in the industry. Based on these findings parameter frameworks for selected building components were developed to illustrate which information is considered to be most essential to support reuse practices.

The results show that reuse is hindered by technical challenges but also things such as: uncertainty regarding component performance, lack of trustworthy information, logistical barriers, and the absence of standardized methods for describing reused components. The study also suggests that complex information systems might be too difficult to implement in practice. Instead a smaller and more focused parameter structure may provide a more realistic starting point for enabling reuse workflows. The proposed parameter framework therefore only contains the parameters considered most essential for reuse decision making rather than all available data of a component. The study concludes that standardized and structured information has the potential to increase reuse. However reuse should be understood as a socio technical transition requiring coordinated development of market structures, digital systems, regulations and industry practices.

Keywords: Reuse, Construction sector, Circular economy, Standardized information, Digital Product Passport, AMA, Enablers, Barriers.

Möjliggörande av återbruk inom den svenska byggsektorn
Utveckling av produktparametrar
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Sammanfattning

Byggsektorn är en av världens mest resursintensiva industrier och bidrar till stora mängder avfallsgenerering, utsläpp av växthusgaser samt konsumtion av material. Återbruk av byggkomponenter har identifierats som en viktig strategi för att minska sektorns miljöpåverkan genom att förlänga produkters livslängd och bevara materialvärde. Trots det ökande intresset för cirkulära arbetssätt är implementeringen av återbruk inom sektorn fortfarande begränsad. Tidigare forskning inom området har identifierat flera hinder, såsom brist på standardiserad information, osäkerhet samt begränsade marknadsstrukturer för återbrukade produkter.

Syftet med denna rapport var att undersöka hur utvecklingen av produktparametrar kan stödja återbruk inom den svenska byggsektorn. Studien genomfördes med en kvalitativ och abduktiv forskningsansats där litteraturstudier, analys av AMA samt empiriska intervjuer med yrkesverksamma inom branschen kombinerades. Baserat på dessa resultat utvecklades parameterstrukturer för utvalda byggkomponenter för att illustrera vilken information som anses mest väsentlig för att stödja återbruksprocesser.

Resultaten visar att återbruk försvåras av tekniska utmaningar men även av faktorer såsom osäkerhet kring komponenters prestanda, brist på tillförlitlig information, logistiska hinder samt avsaknaden av standardiserade metoder för att beskriva återbrukade komponenter. Studien indikerar även att komplexa informationssystem kan vara svåra att implementera i praktiken. Istället kan en mindre och mer fokuserad parameterstruktur utgöra en mer realistisk utgångspunkt för att möjliggöra återbruksprocesser. Det föreslagna parameterramverket innehåller därför endast de parametrar som bedöms vara mest centrala för beslutsfattande kring återbruk, snarare än all tillgänglig information om en komponent. Studien drar slutsatsen att standardiserad och strukturerad information har potential att öka återbruk inom byggsektorn. Samtidigt bör återbruk förstås som en socioteknisk omställning som kräver samordnad utveckling av marknadsstrukturer, digitala system, regelverk och branschpraxis.

Nyckelord: Återbruk, Byggsektorn, Cirkulär ekonomi, Standardiserad information, Digitalt Produktpass, AMA, Möjliggörare, Hinder.

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This thesis is the result of many contributions, and we hope it provides valuable insights for enabling reuse in the construction industry.

Felicia Ljungblad & Erik Lundgren - Gothenburg, June 2026

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

AMA	Allmän material- och arbetsbeskrivning
BFS	Boverkets författningssammling
BIM	Building Information Modeling
CPR	Construction Products Regulation
DfD	Design for Deconstruction
DPP	Digital Product Passport
ESPR	Ecodesign for Sustainable Products Regulation
EU	European Union
IFC	Industry Foundation Classes
ISO	International Organization for Standardization
PBL	Plan- och Bygglagen
RFID	Radio-Frequency Identification
SME	Small and Medium-sized Enterprises
TDPs	Technical Design Principles

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1 Introduction

The construction sector is one of the most resource intensive industries globally, accounting for over 30% of natural material extraction and around 33% of global waste generation, while also contributing to around one third of all global greenhouse gas emissions (United Nations Environment Programme [UNEP], 2025; Yu et al., 2024). Traditionally the sector has operated according to a linear model in which raw materials are extracted, processed into construction products, used throughout a building's life cycle and eventually discarded (Benachio et al., 2020).

In response, stricter environmental regulations and waste management requirements have accelerated interest in circular construction practices and have more specifically increased interest in reuse (Boverket, 2024a). Reuse has gained particular attention due to its potential to preserve both the material and the functional value of the building products while reducing the need for virgin material extraction (Yu et al., 2024). Studies have shown that reuse can significantly reduce the environmental impact associated with the manufacturing of construction products as the production phase generally represents one of the largest contributors to a building's life cycle emissions.

Despite the growing interest, the implementation of product reuse has not increased correspondingly, and large scale implementation of reuse practices within the construction sector still remains limited (Boverket, 2024a). Reuse is currently most commonly applied to refurbishment and rebuilding projects rather than in new construction. Furthermore, reuse initiatives are often limited to individual pilot projects instead of being implemented on a national or global scale across the industry (Ericsson et al., 2024). This indicates that reuse implementation is hindered by interconnected technical, economic, logistical, regulatory, and informational challenges rather than by a single isolated barrier.

Building regulations are currently designed around newly produced products where the documentation already is standardized (Boverket, 2024a). Reused products often lack equivalent standardized documentation, creating an uncertainty regarding responsibilities, warranties and regulatory compliance which has been identified as one of the key barriers limiting reuse practices (Ericsson et al., 2024; Gobbo et al., 2024). The current documentation of products is often incomplete, inaccessible or stored in incompatible formats. As a result stakeholders may perceive reused products as a high risk alternative compared to newly manufactured products (Gobbo et al., 2024). Furthermore the absence of standardized methods for documenting and transferring information between stakeholders limits interoperability and creates difficulties in scaling reuse practices within the construction sector.

Recent developments in digitalisation and circular economy policies have increased the focus on information management and traceability throughout the life cycle of construction products (European Union, 2024). Technologies and frameworks such as Digital Product Passports (DPPs), have been proposed as potential tools for improving the traceability and accessibility of building information. However despite ongoing developments there is currently no universally established framework defining which parameters and information are required to support reuse in practice (Ericsson et al., 2024). This creates a need to identify and structure the information necessary to describe building products throughout their life cycle in a standardized and interoperable way. By improving information management and reducing uncertainty reuse practices may become more feasible and economically viable. In this context, the built environment can increasingly be viewed not only as a consumer of resources but also as a material bank for future construction projects.

1.1 Definition of Reuse

Reuse refers to the act of using an item again for either a new or the same purpose, in contrast to discarding or demolishing it after its initial use (Dictionary, 2026b). Compared to recycling, reuse retains the object's initial value as much as possible and incorporates it in a new project (Dictionary, 2026a). Recycling, on the other hand, involves the deconstruction of an object in order to recover its material which is then reshaped into the same or a different product.

1.2 Aim

The purpose of this study is to investigate how standardized information structures and parameter frameworks can support reuse practices within the construction sector. This study aims to identify current barriers and enablers for reuse practices, and to examine which information is considered most essential when assessing reused construction products. Based on these findings parameter frameworks for selected construction products are developed to illustrate how structured and standardized information may support reuse workflows in practice. Finally the study aims to contribute to the ongoing transition towards a more circular and recourse efficient construction sector.

1.2.1 Research Questions

The main research question is therefore:

- How can standardized product parameters enable reuse in the construction sector?

To support this, these are the following sub-questions:

- What are the main barriers that currently limit the implementation of reuse within the construction sector?
- Which data are essential to describe specific construction objects to enable reuse?
- How can standardized information structures contribute to reducing uncertainty and enabling reuse practices?

1.3 Limitations

To ensure a manageable scope the study is limited to projects within the Swedish construction sector. The findings and conclusions are therefore influenced by Swedish regulations, industry practices, standards and market conditions which may limit the applicability of the results to other national contexts. Furthermore the study focuses on building products rather than construction materials, where a limited number of selected products were analyzed in greater detail. As a result the developed parameter frameworks should not be interpreted as universally applicable to all building components.

The research is based on an empirical study combined with a literature review. The empirical data were collected through interviews with professionals working within the Swedish construction sector. The findings are therefore influenced by the perspectives of the selected respondents. Finally the study does not include any experimental testing, technical verification, or real world implementation of the proposed parameter frameworks. The proposed frameworks should therefore be understood as an example of how structured information may support reuse practices, rather than a finalized industry standard.

1.4 Sustainability considerations

Since the construction industry is highly resource intensive and dependent on the extraction of virgin materials which are limited resources, the sector needs to utilize the products used in construction rather than solely relying on newly produced products. Reuse practices have the potential to reduce the consumption of virgin materials, decrease waste generation, and lower the environmental impact of the construction sector. By extending the lifespan of building components and preserving their functional value, reuse may contribute to a more circular and sustainable construction sector.

2

Theoretical Framework & Literature Review

This chapter presents the theoretical framework and the literature review used in the study. It includes concepts related to reuse in the construction sector, including identified enablers and barriers for reuse implementation. Furthermore relevant laws, regulations, and standards are reviewed, to understand the Swedish context. The purpose of this chapter is to provide an understanding of the current state of knowledge regarding reuse within the construction sector.

2.1 Reuse in the Construction Industry

Increasing reuse is not a goal in itself, but rather a means of reducing waste, climate impact, and resource extraction within the construction sector (Mjörnell, 2025). Reuse also contributes to improved resource efficiency and increase in resilience against supply chain disruptions by reducing dependence on newly manufactured and imported products. Consequently, reuse has the potential to strengthen both the environmental and economic sustainability of the construction industry. Implementing reuse requires a transition from traditional linear construction processes towards more circular approaches (Karlsson et al., 2022). Unlike newly manufactured products, reused products must be identified, assessed, recovered, and reintegrated into new projects. As a result, reuse introduces additional activities such as inventory, dismantling, reconditioning, transport, storage, resale, and reinstallation. These activities influence decision-making throughout the entire project life cycle and involve multiple stakeholders.

The needed processes vary depending on conditions and premises for the current situation where inventory constitutes a critical initial phase, to evaluate accessibility, quality and value of the product with the purpose to establish the foundation for later decision-making (Karlsson et al., 2022). It is a data gathering phase where dimensions, condition, material properties, and potential value of the product are collected to identify suitability for reuse. The possibility of successful reuse is also influenced by how easily a product can be dismantled without compromising its condition. The product needs to be carefully handled to ensure no further damages, and make reinstallation easier. Consequently, dismantling is preferably carried out by personnel with installation experience to minimize damage and preserve value. Following dismantling, products may be reconditioned to restore their condition and are then, depending on timing and location, either stored for future use or transported to a new site for reinstallation. Since these activities introduce additional costs and coordination requirements, they directly affect the economic feasibility of reuse and influence stakeholders' willingness to adopt reuse practices.

Legal frameworks today are increasingly supporting reuse with new requirements for reuse inventories to ensure materials are mapped before demolition or renovation and it exist several different approaches to incorporate reuse (Palats, 2026). They involve different stakeholders and vary depending on practical handling of the material or component, responsibility, quality assurance and business model (Mjörnell, 2025). The most suitable approach depends on the characteristics of the product as well as project-specific conditions. The identified reuse loops are following:

- Internal reuse within the company or project.
- Direct recycling between organizations without intermediaries.
- Reuse hubs that collect and resell products and materials.
- Suppliers and distributors that sell materials and products but are not the manufacturer for them.
- Manufacturers that retake and provide needed recondition of the product.

The suitability of each reuse loop depends on factors such as the quantity, quality, location, and condition of the available materials (Mjörnell, 2025). Products that requires refurbishment may be better suited for manufacturer-led take-back systems, while products that can be reused directly may be exchanged through reuse hubs or direct transactions between organizations. Emerging reuse hubs illustrate a type of business model for that has shown successful implementation (Palats, 2026). In Sweden actors such as Palats and Återbruket demonstrate structured processes for collection, inspection, digital registration, and redistribution of reusable products. It address challenges by connecting supply and demand while supporting traceability, quality assurance, and inventory management. A development of functioning reuse markets is therefore an important prerequisite for increasing reuse within the construction sector.

Effective inventory management and information sharing enables matching between available products and project requirements, as one way to face the challenge of economic viability (Palats, 2026). Contractors today are often reluctant to dismantle products without a known buyer due to the additional costs associated with dismantling, storage, and disposal. Therefore, it is important to improve the digitalization within reuse processes, as it allows for traceability, real-time inventory information, and structured documentation. This allows stakeholders to identify available products and assess their suitability for reuse. These capabilities become increasingly important as reuse markets grow and involve larger numbers of actors and products.

An example of a manufacturer-led reuse initiative is Ecophon's take-back system for ceiling tiles (ecophon, n.d). They buy used ceiling tiles from contractors, ensure quality requirements and provide needed guarantees before reintroducing the product to the market. Such initiatives demonstrate how manufacturers can contribute to reuse by providing quality assurance, traceability, and confidence in reused products. The example illustrates how products can extend their life cycle and support the wider implementation of reuse practices within the construction sector.

While market structures, logistics, and business models are important for enabling reuse, the characteristics of the product itself also influence its reuse potential (Forghani et al., 2023). A product that is difficult to dismantle, contains hazardous materials, or lacks durability may be unsuitable regardless of the surrounding market conditions. These principles are commonly referred to as Technical Design Principles (TDPs) and focus on product characteristics that improve recoverability, durability, maintainability, and adaptability throughout the life cycle of a component. To identify the most important design principles for reuse, architects, engineers, and demolition professionals were asked to evaluate a range of design principles based on their importance for enabling reuse. The ten highest-ranked principles identified in the study are presented in Table 2.1.

Table 2.1: Summary of factors with mean values and ranking

Ranking	Factors	Mean
1	Avoid hazardous substances	4.29
2	Use components with a long lifespan	4.25
3	Use components with low maintenance cost	4.15
4	Consider lifespan of components during design	4.14
5	Maintain information about structure and its details	4.13
6	Use durable joints and connectors	4.04
7	Use bolted connections instead of welded connections	4.02
8	Use components that need common equipment for assembly/disassembly	4.01
9	Allocate lifting points on the components for ease of handling	4.00
10	Use standard components	3.98

Note. Adapted from *Critical technical design principles for maximizing the reuse of building component*s R. Forghani 2023.

The results indicate that both physical and informational characteristics influence the potential for reuse (Forghani et al., 2023). Several of the highest-ranked principles are directly related to information management, such as maintaining information regarding the structure and characteristics of a product. Others emphasize durability, ease of handling, standardization, and the avoidance of hazardous materials, indicating the importance of consideration to component's properties and condition. The identified design principles therefore provide valuable insights into which types of information may be important to capture and maintain throughout their life cycle.

This is particularly relevant when developing information structures and parameter frameworks intended to support reuse decision-making.

2.2 Enablers for Reuse

To facilitate reuse in the construction industry, there exist several enablers which can ease the process of reusing materials and components for all stakeholders involved in a building's life cycle. One of the most important enablers is the introduction of reuse considerations at an early stage of the project process (Ericsson et al., 2024). When reuse is integrated during planning and design phases rather than treated as an add on, opportunities for material recovery increase substantially (Forghani et al., 2023).

To efficiently integrate reuse in the planning and design phases, new and improved project management methods are required that accommodate circular objectives alongside cost, time, and quality considerations.(Ericsson et al., 2024). This is due to reuse relying on collaboration between involved stakeholders, where improved communication is identified as a critical enabler (Forghani et al., 2023). To further discuss communication, the development of digital or physical marketplaces where actors can share information about availability, quality, and quantities of reusable components directly is one potential enabler that could enhance the use of reused materials in the construction sector.

Another important enabling factor is enhanced competence and learning, both within and across organizations (Ericsson et al., 2024; Meghrig & Sandra, 2023). Increased knowledge about reused components, material assessment methods, and circular business models can reduce perceived risks and strengthen confidence among stakeholders (Ericsson et al., 2024).

2.2.1 Designing for Deconstruction

Design for Deconstruction (DfD) also known as Design for Disassembly, is a design approach that is intended to facilitate the dismantling of buildings after the end of their service life (Ostapska et al., 2024). According to the international organization for standardization (ISO) standard ISO 20887:2020, DfD is defined as a standard design approach that enables components to be reused and recycled (International Organization for Standardization, 2020). DfD is also seen as one of the key enablers to circular economy where DfD changes the demolition from the final stage of a building's life cycle, to a material bank where components retain their technical and economic value (Ostapska et al., 2024).

A fundamental concept to DfD is the understanding of buildings as layered systems composed of elements or components with different functions and lifespans (Crowther, 2018). A typical framework consists of four different structural layers, the structural layer, the skin layer, a building service layer and finally a spatial layer. These layers have different lifespans some need to be refurbished or replaced more often than others. These layers are often permanently attached to each other through welding or other adhesive bonding (Crowther, 2018). DfD challenges this logic by promoting independence of each layer through the use of reversible connections. Leading to individual components becoming more accessible and can be removed, upgraded or replaced without damaging the surrounding elements.

The primary driver for implementing DfD lies in the preservation of embodied energy (Crowther, 2018). Embodied energy refers to the total energy required to construct a component, including the extraction of raw materials, manufacturing of the component, transportation and assembly. Research indicates that direct reuse of components can preserve up to 95% of the embodied energy in certain cases. In comparison with recycling which usually relies on energy intensive processes such as melting steel or crushing concrete. DfD facilitates reuse, by increasing the availability of materials that can be reused on the market (Rios et al., 2015). To fully utilize the potential of DfD and enable the built environment as a resource supply, clear guidelines on deconstruction and post deconstruction process are required to support efficient implementation (Allam & Nik-Bakht, 2024).

For a building to function as a recoverable asset, several technical principles must be integrated during the design and construction phase (Ostapska et al., 2024; Rios et al., 2015). Reversible connections such as the use of bolts and screws, are better for disassembly process over glue and welding for instance (Ostapska et al., 2024). Modularity and standardized connections increase the compatibility for components to future projects. Furthermore, the joints and connections must be easily accessible to ensure reversibility. Reliable information regarding material composition and installation method is also of crucial importance to reduce uncertainty regarding the properties of reused materials.

Despite the environmental benefit, DfD introduces some challenges in practice (Abuzied et al., 2020). It requires designers and project managers to consider and plan for end of life scenarios from the early stages of a project, where decision making processes are highly affected by time constraints and short term costs.

2.3 Barriers for Reuse

Organizational and knowledge related barriers are shown to be a huge issue to implementing reuse practices (Ericsson et al., 2024). Many people working in the construction industry report limited or non existent experience with reuse, contributing to uncertainty and a preference for conventional and well documented solutions which in this case is using virgin materials. The construction sector is frequently characterized as conservative and resistant to change, relying on established routines. This cultural dimension reinforces technical and market related barriers, as innovation requires both competence development and willingness to alter established workflows, meaning that a shift in the construction sector from using virgin materials to using reused ones might be met with resistance among construction workers.

2.3.1 Absence of a Market

Another frequently identified structural barrier is the absence of a well functioning professional reuse market (Ericsson et al., 2024). Research shows that stakeholders experience difficulties in finding large quantities of uniform and quality assured reused materials, particularly for new construction projects (Ericsson et al., 2024; Forghani et al., 2023; Meghrig & Sandra, 2023). This challenge is amplified in projects and buildings with specific requirements such as hospitals or healthcare facilities due to the potentially available components being more scarce, meaning that even if stakeholders want to use reused components the current market does not allow it on a large scale (Ericsson et al., 2024). The lack of an organized marketplace therefore limits predictability, scalability, and material credibility, reducing the implementation of reuse in larger or more complex projects (Ericsson et al., 2024; Meghrig & Sandra, 2023). The lack of a functioning market makes trading of reused materials highly dependent on personal networks rather than transparent market structures, limiting the development of things such as information and trading of reused materials on a national scale (Ericsson et al., 2024).

2.3.2 Uncertainty

Uncertainty is highlighted as one of the main barriers to reuse within the construction sector (Ericsson et al., 2024; Meghrig & Sandra, 2023). Uncertainty is often related to limited knowledge regarding the technical performance, condition, durability, and remaining service life of reused components. Unlike newly manufactured products, reused components frequently lack standardized documentation, performance data, and product declarations, making it more difficult for stakeholders to assess their suitability for reuse. The uncertainty is further amplified by limited experience with reused materials and components within the construction sector. As a result, stakeholders often perceive reused products as a higher risk alternative compared to newly manufactured products, even when the technical performance may be sufficient for the intended application. This uncertainty may influence decision making throughout the project process and reduce the willingness to adopt reuse practices. In addition, insufficient documentation may make it more difficult to demonstrate compliance with existing requirements and standards (Ericsson et al., 2024). Consequently, uncertainty regarding reused products extends beyond technical performance and also affects responsibility, liability, and stakeholder confidence. Improved documentation, traceability, and standardized information have therefore been identified as important measures for reducing uncertainty and enabling wider implementation of reuse practices.

2.3.3 Logistical Barrier

To efficiently implement reuse of materials there is currently a need for dedicated facilities where recovered materials can be stored, processed and redistributed these facilities are often referred to as reuse hubs (Tsui et al., 2023). Recovered materials often require significant storage space due to their bulk and irregular form. Reuse hubs are important to minimize storage on construction sites and to reduce capital tied up in inventory. Leading to a need for a temporary storage to bridge the gap between deconstruction and construction (Mjörnell, 2025). The construction sector is optimized around a linear supply chain with just in time delivery systems where materials are transported directly to the construction site shortly before installation (Ericsson et al., 2024).

Transportation and handling of material introduce another challenge, salvaged components are often sensitive to damage both during dismantling and transportation (Ericsson et al., 2024). Moving materials between construction sites and reuse hubs increases the risk of damage which may reduce both their technical performance and economic value. Creating a need for professional material handlers who can ensure a safe handling and transportation of materials without damaging them. The placement of the reuse hubs affects transportation distance where reuse hubs in close proximity are preferred to remain environmentally and economically viable. Although allocating land for material banks can be perceived as generating lost rental income compared to development opportunities on the same space (Mjörnell, 2025). The introduction of reuse hubs is also closely linked to the absence of a market, since without a national market companies might be hesitant to construct such storage places or reuse hubs, due to stakeholders being hesitant to purchase material that cannot be inspected in advance. Leading to an uncertainty regarding the demand of reused products, meaning there is an uncertainty regarding how long materials will be stored in reuse hubs and if the reuse hubs will be able to sell or transport the materials they have acquired. Creating a financial risk for reuse hubs which is strengthened by planning uncertainty in construction projects (Mjörnell, 2025). Where construction projects often experience delays or long planning phases which makes it difficult to predict when material will move from design to actual execution. There are existing reuse hubs today but these face several limitations (Kifokeris et al., 2025). Many primarily serve individual consumers and focus on single item sales rather than supporting large scale construction, which hinders their ability to facilitate change in the sector.

2.3.4 Economical Barriers

There are also economical barriers to implementing reuse in the construction sector (Ericsson et al., 2024; Park & Tucker, 2017). Reusing material often leads to higher operational costs due to the process of obtaining reused materials being significantly more labor intensive and also time consuming than purchasing new products (Ericsson et al., 2024; Nicolas & Sébastien, 2026; Park & Tucker, 2017). Selective dismantling is also often costlier than traditional demolition because it requires careful handling to avoid damaging components in the process. Further additional expenses can arise after demolition because of transportation, storage, reconditioning and technical testing leading to the final price for reused materials being higher than new ones in some cases. In addition the mentioned uncertainty regarding reused material performance creating a hesitation for companies to purchase reused materials over freshly produced materials, leading to a lower demand for reused materials compared to virgin ones (Ericsson et al., 2024; Nicolas & Sébastien, 2026).

Suppliers and manufacturers within the industry frequently offer volume discounts on new products whereas the relatively small reuse market, lacks comparable economic incentives (Ericsson et al., 2024). This further increases the attractiveness of purchasing virgin materials. In addition, the landfill tipping fees are low which makes it cheaper for companies to dispose of their construction waste, rather than hiring people for the recovery of materials (Nicolas & Sébastien, 2026; Park & Tucker, 2017).

Additionally, there is a lack of standardized pricing models for reused components which makes it difficult for project managers to prove reliable cost estimates during the planning phase (Nicolas & Sébastien, 2026). The reason for this is because pricing of reused materials is often determined on a case by case basis. The heavy tax burden on labor makes labor intensive reuse processes more expensive than material intensive new construction which also increases the prices of reused materials. Finally, insurance companies currently often demand higher premiums on reused buildings due to the practice of using reused materials is deemed as something unconventional.

Several barriers and enablers appear to mirror each other (Forghani et al., 2023). Lack of documentation corresponds to the need for improved data systems for collaboration, absence of market structures corresponds to the development of communication platforms, insufficient knowledge corresponds to enhanced competence development, and regulatory uncertainty corresponds to clearer legislation. This indicates that the construction sector may be understood as being in a transitional phase. Rather than representing fixed obstacles many barriers can be interpreted as areas where structural development is currently underway (Ericsson et al., 2024).

From a theoretical perspective reuse in the construction sector can therefore be seen as a systemic transformation process (Forghani et al., 2023). Market mechanisms, regulatory frameworks, technical design principles, organizational learning, and cultural norms interact to either hinder or promote circular practices (Ericsson et al., 2024). Seeing reuse solely as a technical challenge is incorrect; it must instead be analyzed as a socio-technical transition requiring coordinated change across multiple levels of the industry.

2.4 Data Standardization in Construction

The construction industry is undergoing a digital transformation which demands well structured data management to handle the growing complexity (Sibaii et al., 2025). A highly impactful development is Building Information Modeling, BIM, that enables multidisciplinary collaboration and streamlines workflows. The increase in collaboration is a positive outcome as a result of information being able to be shared and collected cross-disciplinary (Andersson & Eidenskog, 2023). While BIM supports digital representation, an obstacle that hinders its effectiveness is the lack of reliable, standardized data procedures (Sibaii et al., 2025). This prevents various tools and stakeholders from collaborating productively through seamless data exchange.

Without structured standardizations and streamlined information exchange, organizations fail to utilize all information that could be used (Cusumano et al., 2025; Sibaii et al., 2025). Companies and organizations therefore work as individuals which limits the collaboration among the affected stakeholders. Further, BIM lacks embeddedness in governmental practices and regulation (Andersson & Eidenskog, 2023). This leads to marginalization of disciplines and hinders the process of changing complex knowledge practices.

To continue the development of the digital transformation in the construction industry, the development of a semantic understanding of data is important (Sibaii et al., 2025). Through the expansion of data dictionaries and standardization one is able to formally organize information. One important factor for this is the incorporation of blockchain-models (Zhang et al., 2026). Blockchain allows for semantic interoperability to ensure data immutability and decentralized consensus for BIM processes. By changing the ways of working with data management, the industry has the potential to enhance the traceability, accessibility and operational efficiency of data for all involved stakeholders.

There exist several standards from the Swedish Institute for standards that showcase how to deal with data management while working with BIM. ISO 1965 (the International Organization for Standardization) sets principles for the construction industry to support information management when using BIM throughout the life cycle of a product (Swedish Institute for Standards [SIS], 2019). This is done through standardization that aims to ensure reliable and sustainable exchange of information. The standard SS-EN ISO 19650-1:2019 aims to set principles for information handling to enhance collaboration through efficient information sharing by setting premises for communication and reuse of information between different stakeholders without the risk of misinterpretation and loss of data.

The standard SS-EN ISO 23386:2020 sets premises and rules for definitions of properties in the construction industry (SIS, 2020a). It further includes premises for authoring and maintaining data to ensure easy sharing among affected stakeholders in the BIM process. This requires representations that are both machine-readable and human-understandable, created by defining properties and property groups using attribute sets. Through exemplification, both mandatory and optional requirements are defined to illustrate data management practices that enhance data standardization. To support this, the standard SS-EN ISO 23387:2020 aims to standardize digital processes when using machine-readable formats through using principle data templates for construction objects (SIS, 2020b).

In recent years, open-source initiatives have risen within the industry, as a step towards improvement of data management and interoperability, and not with the focus of specific data standardization (Sibaii et al., 2025). The organization buildingSMART constitutes an improvement through the development of IFC, Industry Foundation Classes. IFC fosters interoperability through being based on formats focused on construction objects (buildingSMART International, n.d.). However, currently there doesn't exist a data dictionary that collectively defines all needed definitions throughout all BIM domains (SIS, 2020a). The various separated data dictionaries are the result of limited international collaboration to create a unanimous dictionary due to different legislation and culture. Development is needed to ensure that data dictionaries can be interoperable in different tools and applications. This would lead to the possibility to map properties between different dictionaries and therefore harmonization in the BIM-process.

Product Data Management, PDM, represents solutions for exchanging structured, consistent, detailed and product data through establishing a system for attributes and properties for the eternity of a product life cycle (Gu & London, 2010). To facilitate PDM, standardized Product Data Templates, PDTs, and Product Data Sheets, PDSs, would enhance the data sharing process, enhance traceability and consistency (Lucky et al., 2019; Sibaii et al., 2025). PDTs are structures for defining data content through listing the required attributes for describing objects geometrical and alphanumerical, which today more commonly are described separately (Lucky et al., 2019). PDTs are therefore an approach for manufacturers to have a coherent structure for managing data to define the product during design, construction, operation and management. Through a tabular format, comparison based on functional equivalence can be conducted. When a PDTs are filled with specific data, it becomes a PDS. The PDS allows for involvement of external stakeholders to ensure adaptation and interoperability with the product.

2.5 Regulatory Framework

Construction in Sweden is regulated through Plan- och bygglagen, PBL, and associated regulations issued by Boverket where Boverket has published their own code of statutes called Boverkets författningssamling, BFS, which relevant actors are required to follow, where BFS specify the requirements mentioned in PBL (Boverket, 2025). These regulations establish functional requirements to ensure that buildings meet essential technical performance criteria, including structural safety and durability.

According to BFS, building products and materials must have known and documented properties relevant to the building's ability to fulfill required technical requirements (Boverket, 2024b). Products with pre-assessed or certified properties are considered to have verified performance within the scope of that assessment.

For products without pre-assessed properties such as reused building products, verification must be carried out through testing or other recognized methods. Where applicable methods recognized within the European Union need to be used (Boverket, 2024b). Materials used in load bearing structures, including soil and rock, must demonstrate appropriate and documented mechanical and durability properties relevant to their intended structural function. The developer is responsible for ensuring that materials and building products used in a construction project possess the required properties. This responsibility includes performing reception control when materials and products are delivered to the construction site.

Reception control involves verifying that the delivered products correspond to their specified and documented properties (Boverket, 2024b). If a product has pre-assessed properties, the control may be limited to identification, marking verification, and review of the declaration of performance. If such documentation is lacking, additional verification through testing or other recognized methods is required to establish suitability.

2.5.1 AMA

AMA, (Allmän material och arbetsbeskrivning) is a reference system developed by Svensk Byggtjänst (Byggtjänst, n.d). The primary purpose of AMA is to serve as a standard to enhance the clarity regarding requirements within the construction sector and as well as serving as a tool for quality assurance throughout the entire construction process (Alliance, n.d). AMA is divided into five compendiums which are AMA building construction (AMA Hus), Groundworks and civil engineering (AMA Anläggning), Electrical installations (AMA EL), HVAC systems (AMA VVS & Kyla), and Contractual administrative provisions (AMA AF). AMA is regularly updated with new editions with the purpose to specify requirements for materials and workmanship in a systematic and standardized manner. By referring to AMA, requirements for materials and execution can be clearly defined in a way that is understood by all stakeholders and ensured during construction (Byggtjänst, n.d). This highly reduces the risk of misunderstanding which is a main factor why the system is used in most construction projects throughout Sweden.

Although there are several benefits to using AMA it is not a legal requirement, instead it is applied by being referenced in contracts and technical documentations (Byggtjänst, n.d). The system is structured using codes and headings which facilitates clear and precise references to specific requirements. Further, AMA is supported by publications called RA (Råd och Anvisningar) and MER (Mät- och ersättningsregler) with the purpose to complement and state application rules to make project adaptation more efficient.

2.5.2 EU Regulation

Regulation 2024/3110, Construction Product Regulation, aims to harmonize conditions for the marketing of construction products and to reduce barriers for trading between member states (Regulation (EU) 2024/3110, 2024). The regulation demands manufacturers to provide required information about the product, such as Performance Declaration and Conformity. The purpose for this is to ensure improvement of the product with regards to sustainability digitization, and safety with the updated publication, it now applies to reused and remanufactured products. Further, the CPR is adapted to fit several organizations, i.e SMEs, to strengthen market surveillance and ensure that only compliant construction products reach users within the EU.

The Construction Product Regulation, CPR, aligns with the European Green Deal, to support the transition into a circular economy (Regulation (EU) 2024/3110, 2024). Through new environmental obligations, it will be easier to assess sustainability throughout the entire life cycle, which can be shown through CE markings that declare a successful Declaration of Performance and Conformity. In the CPR, it furthermore states that such information about the product shall be accessible through data carriers and available in a digital product passport aligning with the Regulation (EU) 2024/1781.

The European Green Deal presents Europe´s sustainable growth strategy with the aim to become the first climate neutral continent by 2050 (Regulation (EU) 2024/1781, 2024). Through the Ecodesign for Sustainable Product Regulation, ESPR, the urgent need to transition to circular economy models is emphasized and the regulation establishes a comprehensive framework for ecodesign requirements with focus on the entire life cycle of a product. Today, energy and resources are being wasted as a result of frequent replacing and disposing which is a consequence of sustainable choices being too difficult. This is mainly because sufficient information is lacking and efficient business models to make sustainable products affordable are inadequate. Further, in the absence of a Union law, diverging national approaches limits the possibility to expand the sustainability work on the internationally traded products.

ESPR sets a framework to enhance the opportunities for sustainable value-retaining operation through new eco-design requirements (Regulation (EU) 2024/1781, 2024). These requirements ensure improvement in product durability, repairability, reusability and furthermore, with the aim to reduce environmental impact and enhance performance and the quality. The reasons for improving the eco-design requirements are many, and is one step towards becoming more sustainable. Through setting a regulation in the European Union, members collectively contribute to sustainability progressively becoming the norm.

Information requirements are one part of the new regulation that states that relevant product parameters need to be available (Regulation (EU) 2024/1781, 2024). This demands the manufacturer to provide information for all needing parties that handle the product throughout the entire value-chain. The information is required to be easily accessible and end-to-end traceable to ensure possibility to take well informed decisions. Therefore the ESPR includes regulation in DPP, Digital Product Passport, as a structured way for information management that is product type adapted.

2.6 Digital Product Passport

Digital Product Passport, DPP, is a standardized framework and requirements to enhance information management for products (Sibaii et al., 2025). The purpose of DPPs is to enhance circularity through providing accessible and traceable information about product's origin, material composition, environmental impact, safety instructions and end of life handling (European Union, 2024; Zhang et al., 2026).

The construction sector has substantial potential benefits from introducing DPPs, where insufficient and fragmented product information remains one of the main barriers to reuse in the sector (Debacker & Manshoven, 2016; Munaro & Tavares, 2021). Essential data regarding building components such as, chemical composition, structural properties, previous usage and material content are often unavailable or stored in incompatible formats across different stakeholders. This hinders information flow between actors in the sector, as a result components that potentially could be reused are instead being discarded or demolished contributing to massive waste generation. Although being introduced in 2024, stakeholders have no legal obligations to use them until 2028 where the implementation timeline is shown in Figure 12.1 (Oneclicklca, 2026). The implementation will require digital records to support decision makers to make informed choices and evaluate the impact of the product.

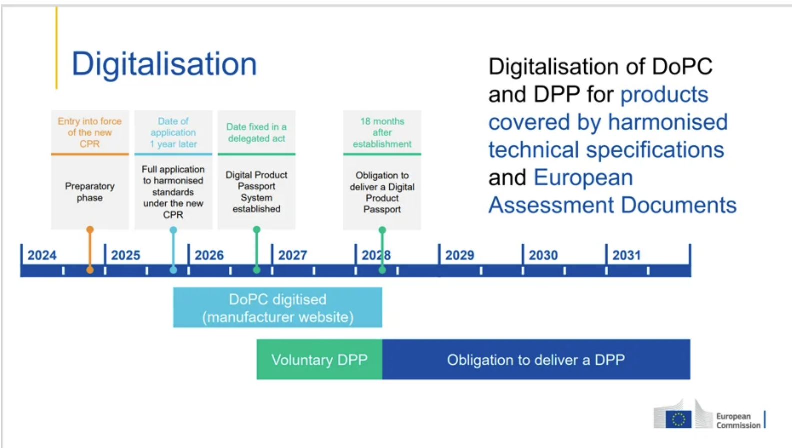

Figure 2.1: Timeline for DPP Implementation

To efficiently introduce reuse in the construction sector, there is a need to establish standardized formats and document structures containing the necessary and relevant information such as DPPs (Munaro & Tavares, 2021). These standards must then be accepted and applied across the sector to ensure interoperability. However, it is currently unclear what constitutes necessary information regarding reuse to use in practice. While some examples exist there is still not a universally agreed upon framework stating the information needed to implement reuse (Debacker & Manshoven, 2016; Munaro & Tavares, 2021). DPPs have been shown to be a promising approach to addressing this information gap. In addition to supporting both reuse and recycling, material passports promote the implementation of DfD principles (Benachio et al., 2020). By providing detailed information about material composition and fastening methods which facilitates easier restoration, renovation as well as disassembly (Benachio et al., 2020; Munaro & Tavares, 2021). Increasing the reuse potential, as well as better maintaining the value of products. Despite their potential benefits, Digital Product Passports face several implementation challenges.

2.6.1 Data Carriers

The ESPR regulation specifies that accessible product information shall be provided through data carriers placed on the product (Regulation (EU) 2024/1781, 2024). A data carrier could be a linear barcode, a two-dimensional symbol or other automatic identification that is scannable by a device. With having a unique identification for each product, and a data carrier linked through an open and interoperable format, product specific data are accessible throughout their entire life cycle. This allows for reduced uncertainties when using reused products (Valero et al., 2015). This is a result of decision-makers being able to make well-informed decisions about each individual product, as it carries information including material specifications and maintenance records.

One type of data carrier is Radio Frequency Identification, RFID, which is a wireless technology that enables the identification and tracking of objects through electromagnetic signals (Valero & Adán, 2016). In the construction sector, RFID has increasingly shown great success with DPPs as well as BIM and CAD models (Khan et al., 2024). Within the digital environment, RFID functions as the physical link between a building component and its associated digital information such as a DPP. A key advantage of RFID technology is that it does not require a line of sight for identification, meaning that the information about a tagged object can be accessed even if the object is embedded in walls or otherwise concealed. Further RFID tags have a passive reading range of up to 15 meters, which is particularity particularly relevant in construction where components can become inaccessible after installation (Valero & Adán, 2016).

Another type of data carrier is QR-codes which is a scannable and accessible data carrier for consumers (Rey Gaido, 2024). It is a low cost and viable solution for providing information about products. QR-codes are a feasible and accessible data carrier, although there are some disadvantages (Zhang et al., 2026). The codes are possible to copy which lowers security, and the code can easily be damaged during the use of the product. Further, there is a need to continue the technical development to ensure that the QR-code consistently presents the latest information about the product.

3
Product parameters

This chapter presents selected construction products and identifies key parameters relevant for their design and construction in accordance with AMA. The selection of products is based on their practical reuse potential and applicability within the construction sector. For each product, key parameters are defined and structured to illustrate how standardized information can support consistent and efficient decision-making in construction processes. The chapter aims to present AMA requirements into concrete, product-specific data structures.

3.1 The Selection of Products

There are numerous building products that show potential for reuse in construction projects with different environmental and economic impacts. In this study, the selected products are intended to illustrate how reuse can be facilitated through structured and standardized information of relevant parameters as well as providing examples of suitable products for reuse.

It should be noted that other products with either greater environmental or economical benefits or components that are easier to reuse might exist. However the selections made in this study, are based on the criteria of being practical and having scalable reuse potential. This resulted in less technical advanced products being chosen. The selected products are characterized by the following attributes:

- They are easy to access.
- They can be disassembled and reinstalled with limited effort.
- They are not technically complex, and therefore do not require a higher level of specialized expertise for handling.
- They have a sufficiently long lifespan to remain functional beyond their initial use phase.
- Potential to gather large volumes of the product.
- Low risk of need for reconditioning.

3.1.1 Radiators

Radiators vary in design based on several different parameters but are commonly consisting of panels and convection slats, which determines the possible heating output. An increase in the number of panels and fins leads to a higher heating capacity. There is also a difference in efficiency depending on if the radiator is a panel radiator or an electric radiator. During designing of radiators, the industry standard in Sweden is to follow AMA VSS & Kyla with support from the advice and instruction collection, RA VSS & Kyla (Svensk Byggtjänst, 2025a, 2025b). In section PTB.1 in AMA it states that radiators shall be manufactured in accordance with SS-EN 422-1 and tested in accordance with SS-EN 442-2. Table 3.1 presents key parameters for radiators.

Table 3.1: Key parameters for radiators

Parameter	**Description**
Type	Describes the radiator type (e.g water or electric) and the radiator configuration (e.g. single, double, or triple panel with or without convector fins).
Dimensions	Refers to the physical size of the radiator, including height, width and depth.
Configuration	Ensure factory-installed air vent and bottom plug. Furthermore, it should be specified whether the radiator is to be equipped with a factory-installed radiator valve and connection set and, if so, whether the valve and connection set are intended for a one-pipe or two-pipe system.
Heat Output	The thermal power emitted by the radiator.
Connections	Specify the location and size of the connections. This determines compatibility with existing piping systems and installation requirements.
Material	Indicates the primary construction material, such as steel or aluminum. The material influences durability, weight, and thermal characteristics.
Pressure Rating	The maximum operating pressure the radiator is designed to withstand, and pressure class higher than PN 6 .
Temperature Range	The range of operating temperatures for which the radiator is designed.
Manufacturer	Present who the manufacturer is and year of production. This can be used to assess expected lifespan, standards compliance, and potential degradation.
Surface Finish	Refers to the external coating or treatment and its color.

In the new AMA VSS & Kyla 25, it states actions to ensure good premises for reuse (Svensk Byggtjänst, 2025a). For example, storage should ensure that radiators are protected from freezing and internal corrosion. In RA VSS & Kyla 25, generic controls that shall be considered are stated to ensure its function (Svensk Byggtjänst, 2025b). For example, the radiators heating output shall be controlled to ensure its quality and potential reconditioning to improve the usage of the product. Further, there are recommendations for assembly (Svensk Byggtjänst, 2025a). The purpose is to ensure proper air circulation around or through the radiator, for instance, so that it functions efficiently.

3.1.2 Ceiling Tiles

AMA Hus 24 and RA Hus 25 express recommendation to consider while design the suspended ceiling where the ceiling tiles are a large impacting factor (Svensk Byggtjänst, 2024a, 2024b). For a building or a room, the recommendation is done to ensure compliance to standard SS-EN 13964, the standard for suspended ceilings where the different components of the ceiling influence each other. Depending on the purpose of the current studied room or building, the suspended ceiling and therefore also the ceiling tiles needs to be adapted. One adaptation could be for instance if installations needs to pass through. Key parameters to consider for ceiling tiles are presented in Table 3.2.

Table 3.2: Key parameters for ceiling tiles

Parameter	**Description**
Dimensions	Refers to the size of the tile, typically length, width, and thickness.
Material	Indicates the material of the tile.
Surface Finish	Refers to the surface treatment and the color of the tile.
Acoustic Rating	Defines the sound absorption performance, and should fulfill the requirement for absorption class according to SS-EN ISO 11654.
Fire Resistance	Indicates the reaction-to-fire classification to ensures compliance with fire safety requirements in buildings.
Moisture Resistance	Describes the tile's ability to withstand humidity and moisture without deformation.
Manufacturer	Present who the manufacturer is and year of production. This can be used to assess expected lifespan, standards compliance, and potential degradation.

3.1.3 Ventilation Ducts

Ventilation ducts are components of air distribution systems and in AMA VVS & Kyla 25 and RA VVS & Kyla 25, parameters are expressed to support the designing of ventilation system to ensure good indoor climate (Svensk Byggtjänst, 2025a, 2025b). The routing of the ducts influence its performance and the volume of air that are able to be transported. For the ventilation ducts, key parameters are presented in Table 3.3.

Table 3.3: Key parameters for ventilation ducts

Parameter	Description
Dimensions	Refers to the size of the duct, including diameter for circular ducts, width and height for rectangular ducts, and material thickness.
Shape	Indicates whether the duct is circular or rectangular.
Material	Specifies the construction material, typically galvanized steel, aluminum, or plastic.
Insulation	Describes whether the duct is insulated and the type of insulation used. This affects thermal performance and condensation control.
Airflow Capacity	Refers to the volume of air the duct can transport.
Pressure Class	Indicates the maximum pressure the duct is designed to withstand.
Connection Types	Describes how duct sections are joined, such as flanged or slip connections.
Air tightness	Defines the allowable air leakage according to standards.
Manufacturer	Present who the manufacturer is and year of production. This can be used to assess expected lifespan, standards compliance, and potential degradation.
Surface Finish	Refers to the surface treatment and the color of the pipe to describe appearance.

AMA VVS & KYLA 25 states that ventilation ducts can be stored in an unheated space but shall be protected from humidity and moisture (Svensk Byggtjänst, 2025a). This is important to take into consideration to enable an increase in reuse. Further measures that shall be taken into account are stated in RA VVS & KYLA 25 and include primarily different quality controls (Svensk Byggtjänst, 2025b). Air leakages, damages and possibilities for adjustment capabilities are examples of such controls. Used ventilation ducts could be better suited for exhaust ducts as the requirements for supply air ducts are higher.

3.1.4 Sanitary Ware

Section PU Sanitetsenheter och Sanitetsutrustningar in AMA VVS & Kyla 25, includes recommendations related to sanitary ware (Svensk Byggtjänst, 2025a). Several parameters are directly related to the manufactured documents, for instance how to install. Further there exist several standards that related to material and configuration, for example washbasin shall be manufactured with dimensions in accordance with standard SS 822026 and have hole dimensions in accordance with standard SS-EN 31. Key parameters from AMA VVS & Kyla 25 and RA VVS & Kyla 25 for water closet are shown in Table 3.4, and for washbasins are shown in Table 3.5 (Svensk Byggtjänst, 2025a, 2025b).

Table 3.4: Key parameters for water closets

Parameter	**Description**
Dimensions	Refers to the size of the water closet, including height, width and depth.
Type	Indicates the type of sanitary ware, for example as wall-mounted, floor-standing or accessible toilet.
Flush Volume	Specifies the amount of water used per flush, to determine water consumption.
Connection Types	Specifies how water is supplied to the cistern (e.g. bottom or back inlet), and how the water closet is connected to the drainage system, such as horizontal or vertical outlet.
Material	Specifies the construction material, typically sanitary porcelain in accordance with SS 822012.
Components and functions	Information regarding shut-off valve, water saving fixtures, taps, faucets and water trap, to ensure proper water flow and drainage.
Manufacturer	Present who the manufacturer is and year of production. This can be used to assess expected lifespan, standards compliance, and potential degradation.
Surface Finish	Refers to the glaze or coating of the ceramic surface, and its color.

Table 3.5: Key parameters for washbasins

Parameter	**Description**
Dimensions	Refers to the size of the washbasin, including height, width and depth.
Type	Indicates the type of washbasin, for example wall-mounted or floor-standing.
Connection Types	Specifies how water is supplied, and how the washbasin is connected to the drainage system, such as horizontal or vertical outlet.
Material	Specifies the construction material, typically sanitary porcelain in accordance with SS 822012.
Components and functions	Information regarding faucet and drain valve to ensure proper water flow and drainage.
Manufacturer	Present who the manufacturer is and year of production. This can be used to assess expected lifespan, standards compliance, and potential degradation.
Surface Finish	Refers to the glaze or coating of the ceramic surface, and its color.

Controls expressed in AMA VSS & Kyla 25, related to reuse, includes checks for cracks in the porcelain and to check the gaskets (Svensk Byggtjänst, 2025a). Most of these expressed check points are easier to repair or replace to ensure long-lasting installation even though the actual component itself not is new. Further, it states that sanitary ware can be stored in an unheated space but shall be protected against dirt and damage.

4
Methods

This chapter describes the research methodologies applied in the study. It explains the overall research approach including the literature review and the empirical study based on interviews. Furthermore, the process of developing component parameters is explained alongside ethical considerations. The purpose of this chapter is to ensure transparency and reliability by clearly presenting how data has been collected, analyzed and interpreted.

4.1 Theoretical Framework & Literature Review

The study was conducted using an abductive research approach, enabling an iterative process between empirical data and theoretical frameworks (Inceoglu, 2022). This involved moving back and forth between the collected interview data and relevant literature throughout several iterations. Several perspectives have been studied to gain a holistic understanding of the researched subject. This forms the basis of the theoretical framework and literature review. An abductive approach was chosen to deepen the theory with additional information to supplement the new insights and information gathered during the interviews.

The majority of the information gathered in the study was collected from databases Scopus, Science Direct, Google Scholar and Chalmers Library. The most common search words for collecting theoretical information were for instance a combination of the following: "Reuse in Construction ", " Enablers", "barriers" "Design for Disassembly", "Material Passports", " Digital Product Passport", "Challenges with reuse", "Data Standardization", "Circularity Construction". Recently published articles were used to ensure that the collected information is relevant and reflects current industry conditions. The selection of literature was also conducted through a structured screening process. Articles were identified through database searches using the relevant keywords. The titles and abstracts were then reviewed to assess relevance to the research topic. Articles that were deemed irrelevant or lacking sufficient academic quality were then excluded. Further, the findings from the literature review and theoretical framework served as the foundation for the interview questionnaire.

4.2 Empirical Study

Eleven semi-structured interviews were conducted with professionals from different fields within the construction industry. Templates with questions were created before the interviews and tailored to the specific person and role, with a selection of questions presented in Appendix A. The purpose was to ensure relevant interview questions and improve the efficiency of each interview. Furthermore, the questions varied in character, included both factual and experience based perspectives to enhance the comprehensive understanding of the subject. The semi-structured way of interviewing allowed for greater flexibility for follow-up questions on interesting and emerging insights raised by the interviewees (Library, 2026).

The interviews were conducted either in person or digitally, depending on the interviewees' location and preferences. All interviews were conducted in Swedish and lasted 45 to 60 minutes. Each session was recorded and transcribed, with the consent of all participants. Transcriptions of each interview were generated using AI based tools such as Microsoft Teams and Klang.ai, which were reviewed manually to ensure correct and accurate information by re-listening to the recording. However, the results may be influenced by the subjective perspectives of the participants. Since the interviews were conducted in Swedish, the transcriptions were translated by the authors and intended to reflect the original responses as accurately as possible. The information gathered from the interviews was then analyzed using a thematic analysis approach, where the transcriptions were reviewed and grouped based on different categories such as uncertainty, economic barriers and information needs. These categories were compared across interviews to identify recurring patterns to enhance the credibility of the findings.

4.2.1 Respondents

Table 4.1 presents the conducted interviews arranged in chronological order. The table illustrates the different roles and companies of the interviewees. Interviewees from several different professional backgrounds were selected to provide a broader understanding of reuse practices within the construction sector. Since reuse affects multiple stages of the construction process, the inclusion of respondents with different responsibilities contributed to a more holistic perspective on the subject.
Furthermore, all interviewees had previous or ongoing experience working with reuse-related processes in different capacities. Their professional experience therefore provided relevant insights regarding current barriers, information requirements, and future possibilities connected to reuse implementation. The variation in professional roles and experiences contributed to a broader empirical foundation and supported the identification of recurring themes and patterns across the interviews.

Table 4.1: Lists of respondents, their role and company.

Role	Company	Reference in text
Product Designer	Palats	PD1
Project Manager	Chalmers Industriteknik	PM1
Head of Public Affairs	GS1	HPA
Sustainability Manager	Sweco	SM
Architect	Liljewall	ARC
Business Manager	Vestia	BM
Project Manager	Svenskt Trä	PM2
Project Director	Vasakronan	PD2
Guest Researcher	Chalmers	RE1
Sustainability Coordinator	Akuro	SC
Researcher	Ragn-Sells	RE2

Product Designer, PD1, is employed at a company that provides an online marketplace for reused components, enabling the sale of such components and supporting companies in managing their inventory.

Project Manager, PM1, focuses on circularity and sustainability through traceability across product life cycles. Furthermore, the interviewee is involved in the development of Digital Product Passports for the European Union.

Head of Public Affairs, HPA, works for a standards organization that provides a solution to support the traceability of components through barcodes that contain encoded information.

Sustainability Manager, SM, responsible for sustainability work within the division of digital services, with interoperability and open data as two main focus areas.

Architect, ARC, responsible architect for a project where reuse of building components was required by the main client. Involved throughout the process, from identifying suitable reused components to preparing construction documentation.

Business Manager, BM, works with sustainability management in a project where reuse was required by the main client. Has experience with sustainable construction practices in both renovation and new construction projects.

Project Manager, PM2, digitalization project manager in a company focusing on wood. Involved in the development of the company's own digital product passport to meet requirements on standardized ways of working with data.

Project Director, PD2, representative and responsible for a project where reuse practices were successfully integrated. The project involved renovation and reconstruction where new methods were applied to reduce climate impact while maintaining project quality and functionality.

Guest Researcher, RE1, focuses on reuse within the construction sector and is involved in the innovation program Shift Sweden, which aims to reduce raw material extraction and climate impact through circular processes.

Sustainability Coordinator, SC, representative for the main client and is responsible for the sustainability work in a project where reused components are a focus area. Involved in the process through identifying potential and ensuring stated demands are met in the project.

Researcher, RE2, works with strategy and research and development related to digitalization. Involved in issues concerning data accessibility, quality-assured information, and interoperability between digital systems.

4.3 Development of Product Parameters

The parameter templates for reusable construction components presented in Chapter 3 were developed using AMA as a foundation to identify relevant information and technical properties for selected construction products. All AMA terminology and descriptions have been translated from Swedish to English by the authors. As no official English version exists, the translations are intended to reflect the original meaning as accurately as possible.

With insights from AMA, the interviews, and the literature & theoretical framework , the component parameters developed in Chapter 3 have been refined to better reflect the information considered essential for supporting reuse practices and increasing stakeholder trust in reused components. The updated parameters were created with the intention to have enough information to enable reuse but also without overwhelming the system with unnecessary complexity, to balance information completeness with practical usability. The level of detail included in the templates were also adapted to fit the complexity of the component.

4.4 Discussion

The discussion chapter was developed through an iterative analytical process combining findings from the empirical study, the literature review and the developed parameter frameworks. The analysis was conducted using an abductive approach where theoretical and empirical findings were compared and interpreted throughout the study. The analytical process focused on identifying broader systemic relationships connected to reuse practices. As a result the discussion includes both technical and organizational perspectives related to reuse implementation.

4.5 Ethical Considerations

Each interview began with obtaining the interviewees' consent to be recorded and transcribed. The participants were also informed about the purpose of the study and asked for permission to use the collected information within the research, with the option to remain anonymous if requested. These measures were taken to ensure that the participants felt comfortable participating openly in the interviews. All collected data were handled confidentially and used solely for research purposes.

4.6 Validity and Reliability

To ensure validity and reliability throughout the study, several considerations were made. The literature and theoretical framework were primarily based on recently published academic sources considered reliable and relevant to the research topic. Particular consideration was also given to the Swedish construction context to ensure that national regulations, standards and industry conditions were taken into account. The empirical study included interviews with respondents from different professional backgrounds connected to reuse practices within the construction sector, which enabled comparison between different perspectives. This supported a more holistic analysis and strengthened the credibility of the findings. Although the authors' own perspectives may influence certain aspects of the analysis, efforts were made to maintain an objective approach to minimize bias.

AI-based tools such as ChatGPT and Claude were used during the writing process to support grammar correction, academic phrasing, text structuring, and readability improvements. The tools were also used during brainstorming processes and for organizational suggestions related to different sections of the report. However, all scientific reasoning, interpretations, analyses, and conclusions were developed independently by the authors. Furthermore, AI-based transcription services from Klang.ai and Microsoft Teams were used to transcribe the conducted interviews. This made it possible to focus more actively on the interview discussions and ask more detailed follow-up questions during the interviews. All transcriptions were subsequently reviewed and compared with the original audio recordings to ensure transcription accuracy.

5

Result & Analysis

This chapter presents the results from the interviews conducted during the study, where the findings have been grouped into four different thematic categories. Furthermore, the chapter presents updated parameter frameworks for selected construction components, developed to better reflect the current conditions and information needs related to reuse within the construction sector. An analysis of the proposed parameters is also included to illustrate the relevance and purpose of each parameter in supporting reuse practices.

5.1 Interview Results

This chapter summarizes interviews conducted with professionals involved in the construction sector with a focus on current practices related to reuse associated with current challenges and potential strategies to improve reuse implementation in the built environment.

5.1.1 Economy

The economic aspect was identified by the interviewees as one of the most significant barriers to implementing reuse practices within the construction sector. Several interviewees highlighted that reuse often costs more compared to using newly produced materials and components, primarily due to reuse introducing additional processes such as dismantling, transportation, storage and reconditioning. Unlike new materials which are typically delivered directly to the construction site through established supply chains, reused products require handling in multiple stages making reuse processes both more time consuming and labor intensive. Transportation of reused products was also identified as a major cost driver where the costs for dismantling a product and transportation were described as significantly higher compared to purchasing newly manufactured components. Furthermore, the lack of established material banks and available inventories forces projects to develop sourcing processes for reused materials on a case-by-case basis which further increases both costs and uncertainty. Which have been shown to also increase the costs of reuse, where it is often treated as an additional activity which requires extra time and coordination, resulting in increased costs within already time pressured production environments. Several interviewees emphasized the importance of integrating reuse into early project stages and existing workflows to avoid disruptions later in the process to minimize the extra time required to integrate reuse.

Storage and timing were also identified as economic challenges since construction projects often operate under tight schedules and budgets. There is limited capacity to purchase and store reused materials in advance, due to the lack of material banks and the limited market. This creates a risk of investing in materials that may not be used, increasing the uncertainty regarding reused materials and whether it is a worthwhile investment.

Despite these challenges multiple economic incentives were discussed, one example is the use of contractual models where higher profit margins are allowed for reused materials while limiting margins on new projects. Such approaches were described as effective in making reuse financially attractive for contractors. Other suggested incentives include changes in taxation such as lowering taxes on labor and increasing them on new materials, as well as introducing stricter climate related requirements. If reuse is associated with lower or even negative carbon impact, this could shift economic conditions in its favor. Additionally increasing prices of new materials could further improve the competitiveness of reused components.

However several interviewees stressed that reuse must be economically viable to be implemented on a larger scale. Without a clear business case, reuse initiatives risk remaining limited to pilot projects or other niche applications. Overall the findings suggest that while reuse currently faces significant economic barriers there are clear opportunities to improve its viability through better integration into project processes, development of market structures and the introduction of targeted economic incentives.

5.1.2 Information and Standardization

The need for reliable and structured information was highlighted as a critical factor for enabling reuse. Interviewees emphasized that the type and level of information required vary depending on the product, but certain parameters were consistently identified as essential, such as condition, technical specifications and visual documentation.

Images and information about the condition of a product were often described as the most important factors in the initial decision making. In addition technical data such as dimensions, performance requirements and classifications are necessary to ensure that reused components meet project requirements. The level of required detail increases with the complexity of the component. Simpler products may only require basic information while more complex products, such as doors, require detailed specifications to assess their suitability for reuse. Furthermore the responsibility for ensuring complete and accurate information was highlighted as a key issue. Incomplete datasets reduce usability and may prevent components from being reused altogether. Therefore defining required parameters in advance and ensuring data quality throughout the process is essential.

Beyond stating what information is necessary several interviewees also emphasized the importance of how this information is structured and handled. The ability to standardize and structure data was described as a key factor in enabling reuse practices. Several interviewees also stressed the importance of standardized and machine readable data, current practices such as storing information in PDFs are considered insufficient for enabling efficient data exchange. Instead structured data formats and shared standards are needed to allow information to be transferred between systems without manual intervention.

The use of standardized approaches was therefore highlighted as important for enabling collaboration between different actors in the sector. By describing data in a consistent and structured way both humans and digital systems can interpret and use the information effectively. This reduces the need for manual handling and eases communication across projects and organizations. Standardized information structures are necessary to enable efficient information sharing and comparison between stakeholders, as current practices often involve different ways of describing and categorizing component data. Overall the results show that clear standardized and accessible information is a prerequisite for enabling reuse, and that inefficient data management acts as a significant barrier.

5.1.3 Availability

Another challenge emphasized by the interviewees was the scarce availability of reused materials which is particularly relevant in larger construction projects where sufficient quantities are required. The interviewees' emphasized that the issue is not the willingness to reuse materials but rather the difficulty in obtaining a sufficient quantity of suitable components. A recurring concern is the lack of predictability in the market. Unlike new materials which can be ordered in exact quantities and delivered at a specified time, reused components are dependent on what is currently available. This makes it difficult to plan projects especially in early design stages when decisions regarding materials are made. Interviewees also highlighted challenges related to consistency and quality, even when reused components are available, they may differ in appearance dimensions or condition making it difficult to achieve a uniform result in a project with high aesthetic or functional requirements. The timing mismatch between supply and demand further complicates the issue, since the future availability of reused materials is often uncertain during the early design stages of construction projects. Where storing materials in advance is rarely feasible due to high costs and associated risks.

Another key barrier is the absence of a well-functioning marketplace for reused components. Several interviewees pointed out the need for a large scale digital platform where available materials can be found, compared and purchased. Such a system would improve transparency and enable coordination across projects and locations. Overall the findings indicate that limited availability, lack of predictability and insufficient market structures significantly hinder the large scale implementation of reuse in the construction sector.

5.1.4 Uncertainties

Uncertainties about reused material performance was identified as an underlying factor where interviewees expressed concerns regarding the reliability of reused components, particularly in terms of quality, performance and remaining lifespan. This uncertainty is closely linked to information quality. Incomplete or unclear data makes it difficult to assess whether a component meets project requirements, increasing the perceived risk of reuse. As a result, stakeholders may avoid reused materials even when materials are available. Overall, the findings indicate that reducing uncertainty through improved availability, better information, and standardized processes is essential for increasing confidence in reuse practices.

5.2 Updated Product Parameters

The selected parameters were influenced by the identified barriers connected to reuse, identified in both the interviews and the literature review. Several interviewees emphasized that lack of structured and reliable information increases uncertainty and manual work, which in turn contributes to higher costs and reduced willingness to reuse components. The proposed parameter structures therefore aim to standardize the information considered most essential for enabling more efficient reuse workflows. The templates are also intended to be implemented within existing digital systems where desired parameter values can be assigned to facilitate the identification of suitable reused components. The selected parameters can be directly linked to the barriers identified in the interviews and the theory. Parameters such as condition, manufacturer, material, and technical specifications address uncertainty related to performance and suitability, while dimensions support compatibility with project requirements. Parameters such as weight and availability date contribute to logistical planning, and hazardous materials address regulatory and safety concerns. By aligning parameter selection with identified barriers the proposed structure supports more efficient and reliable reuse decision making.

Parameters commonly found in DPP systems, such as detailed environmental data, were excluded as they were not deemed necessary for initial reuse decision-making. This does not imply that additional information lacks value and different processes might need more or less data than others. However the findings suggest that a smaller and focused parameter structure may provide a more realistic starting point. While a minimal parameter set improves usability, it may also limit the level of detail available for more complex decision making processes.

Several interviewees also emphasized the importance of visual documentation when assessing reused products. However visual information was not included within the proposed templates due to limitations regarding how this type of information can be and structured within parameter based systems. Additional parameters identified as relevant through the interviews and literature review & theoretical framework are presented separately in Chapter 5.2.1.

Table 5.1: Key parameters for reuse of radiators

Parameter	**Description**
Type	Describes the radiator type and its configuration.
Manufacturer	Present who the manufacturer is and year of production.
Dimensions	Refers to the physical size of the radiator.
Weight	Refers to the heaviness of the radiator.
Material	Specifies the construction material.
Hazardous substances	Indicates whether the product contains hazardous substances
Connection	Specifies the location and size of connections.
Heat Output	The thermal power emitted by the radiator.
Pressure Rating	The maximum operating pressure the radiator is designed to withstand.
Surface Finish	Refers to the surface treatment of the radiator, and its color.
Condition scale	Describes the current condition of the radiator using a standardized rating from A to F, where A represents excellent condition and F represents poor condition.
Availability Date	Specifies the point in time at which the radiator is available for collection or reuse.

Table 5.2: Key parameters for reuse of ceiling tiles

Parameter	**Description**
Dimensions	Refers to the size of the tile.
Material	Specifies the construction material.
Hazardous substances	Indicates whether the product contains hazardous substances.
Surface Finish	Refers to the surface treatment of the tile, and its color
Acoustic Rating	Defines the sound absorption performance.
Fire Resistance	Indicates the reaction-to-fire classification.
Manufacturer	Present who the manufacturer is and year of production.
Condition scale	Describes the current condition of the tile using a standardized rating from A to F, where A represents excellent condition and F represents poor condition.

Parameter	Description
Availability Date	Specifies the point in time at which the tile is available for collection or reuse.

Table 5.3: Key parameters for reuse of ventilation ducts

Parameter	Description
Dimensions	Refers to the size of the duct, including diameter for circular ducts or width and height for rectangular ducts, and its length.
Weight	Refers to the heaviness of the duct.
Material	Specifies the construction material.
Hazardous substances	Indicates whether the product contains hazardous substances
Connection Type	Describes how duct sections are joined.
Manufacturer	Present who the manufacturer is and year of production.
Surface Finish	Refers to the surface treatment of the duct, and its color.
Condition scale	Describes the current condition of the duct using a standardized rating from A to F, where A represents excellent condition and F represents poor condition.
Availability Date	Specifies the point in time at which the duct is available for collection or reuse.

Table 5.4: Key parameters for reuse of water closets

Parameter	Description
Type	Indicates the type of water closet.
Dimensions	Refers to the size of the water closets.
Weight	Refers to the heaviness of the WC.
Flush Volume	Specifies the amount of water used per flush, typically in liters.
Connection Type	Describes how the water closet connects to the drainage system, and to the water supply.
Material	Specifies the construction material.
Hazardous substances	Indicates whether the product contains hazardous substances
Manufacturer	Present who the manufacturer is and year of production.
Surface Finish	Refers to the surface treatment of the WC, and its color.

Parameter	Description
Condition scale	Describes the current condition of the WC using a standardized rating from A to F, where A represents excellent condition and F represents poor condition.
Availability Date	Specifies the point in time at which the WC is available for collection or reuse.

Table 5.5: Key parameters for reuse of washbasins

Parameter	Description
Type	Indicates the type of washbasin.
Dimensions	Refers to the size of the washbasin.
Weight	Refers to the heaviness of the washbasin.
Connection Type	Describes how the washbasin connects to the drainage system, and to the water supply.
Material	Specifies the construction material.
Hazardous substances	Indicates whether the product contains hazardous substances
Manufacturer	Present who the manufacturer is and year of production.
Surface Finish	Refers to the surface treatment of the washbasin, and its color.
Condition scale	Describes the current condition of the washbasin using a standardized rating from A to F, where A represents excellent condition and F represents poor condition.
Availability Date	Specifies the point in time at which the washbasin is available for collection or reuse.

5.2.1 Additional Important Parameters

This chapter presents additional parameters and information types that were identified as important for reuse through the empirical study and the theoretical findings, but for different reasons were excluded from the proposed parameter framework.

One important aspect highlighted by several interviewees was the importance of a visual representation such as a picture of the reusable component. A picture might help stakeholders to assess aesthetics, condition and overall suitability of a component. However such information is hard to include in the proposed framework since the framework and was therefore excluded from the framework is intended for use inside digital models as a requirement on reused components.

Another important factor identified in the research was the potential environmental benefit associated with reuse for a specific product. Several interviewees emphasized

that viable environmental impact indicators such as CO_2eq savings per component may positively influence the willingness to adopt reuse materials. Where visible climate benefits may strengthen both the motivation and environmental justification for selecting reused components. However, environmental calculations often depend on project specific assumptions and system boundaries making it difficult to define standardized values which are applicable across all reuse scenarios.
Recondition guidelines were also identified as something important particularity for limited physical damage with easy reconditioning possibilities. Such information may support stakeholders to understand how damaged reused components can be restored for additional use instead of being discarded. In addition disassembly guidelines were also identified as important to facilitate the extraction of reusable components. Where information regarding fastening methods, component accessibility and disassembly procedures may simplify future reuse processes and reduce the risk of damaging components during deconstruction.

Traceability information was also identified as important for supporting reuse practices. Where information regarding a component's origin, previous usage and maintenance history would be stated. Several interviewees emphasized that lack of historical information reduces trust in reused products particularly for more technically complex products. However, traceability information may be difficult to fully standardize due to differences in documentation quality and life cycle and usage of construction products.

6

Discussion

This chapter provides a deeper analysis based on insights and perspectives gained during the study. The analysis is based on interpretations from the literature review and the interview study meaning that it is subjective viewpoints from the authors.

6.1 Market for Reused Products

The findings indicate that the reuse market is still immature, characterized by low availability, predictability and fragmented information sharing. This creates significant challenges for stakeholders that attempt to find relevant and useful reused building products. Unlike virgin materials and new products which already are integrated into established and optimized supply chains. As a result, the process of using reused products becomes both more time consuming and costly because of the additional work. This creates a negative feedback loop where limited availability leads to higher costs and an increase in manual work, which in return reduces the demand for reused materials which weakens the development of a reuse market. This suggests that the main challenge is not necessarily the lack of reusable products themselves but rather the absence of an efficient system which identifies and finds available and fitting reused materials to reduce the extra work linked to reuse.

In the empirical study interviewees expressed the need for a centralized market platform closely connected to BIM models used during the design phase of construction projects. Such system could drastically reduce the manual effort currently required to identify suitable reused products. It would allow project managers to automatically identify matching reused materials based on project requirements. This highlights the importance of structured and standardized information as proposed in this study. For such a system to function efficiently, reused products must be described using a consistent set of parameters that can be interpreted both by humans and digital systems. The parameter framework developed in this study could therefore serve as a foundation for enabling more efficient information exchange and interoperability between reuse platforms and stakeholders within the construction industry sector.

The findings further indicate that economic and logistical barriers are closely linked to current market conditions. The additional work required to identify, verify and manage reused materials contributes to higher costs and increased uncertainty. This reduces the economic incentives to adopt to reuse practices. If an efficient digital system for matching material and information sharing were implemented the effort required to work with reused materials could potentially be significantly reduced, improving both accessibility and the economic viability. However, the implementation of such systems remains challenging. Effective reuse platforms require coordination between multiple stakeholders, standardized methods for structuring information and an agreement regarding which parameters are essential for decision making within reuse. In addition the current reuse market is currently too small and fragmented which makes it difficult to justify the development of large-scale national search systems. These findings indicate that the challenges related to reuse are not only technical but systematic, requiring coordinated development of a market structure, digital systems and information management across the construction sector.

6.1.1 Availability

Currently, there is a significant challenge for larger construction projects to acquire sufficient quantities of reused materials. In many cases companies are only able to source a portion of the components needed for a project, limiting the ability to fully implement reuse practices. This creates challenges related to consistency, as many buildings are designed to maintain a consistent visual materiality across the project. Compared to reused materials, this process is currently significantly easier when using virgin materials, where exact quantities and specifications can be ordered directly from several suppliers. This problem can be addressed by adapting a more flexible and creative design approach, where for example reused carpets in different colors have been combined to create an illustrative pattern rather than attempting to achieve complete visual unity. This suggests that limitations associated with reuse may create new architectural and aesthetic opportunities with the right mindset. However, such adaptations would require additional designing and manual work which have been identified as major contributors to the increased costs for reused materials. As a result these approaches may not be economically suitable for all projects, which highlights the conflict between architectural flexibility and economic efficiency with reuse practices.

6.1.2 Logistic

Logistical challenges have also been identified as a major barrier to reuse practices. Unlike virgin materials which are integrated into optimized supply chains, reused products require logistical processes such as recovery, inspection, storage, transportation and redistribution. This introduces additional complexity with using reused products. A major identified issue is the lack of available material banks and storage faculties. At the same time the availability of reused products depends heavily on ongoing deconstruction activities creating a fluctuating supply, making it difficult for stakeholders to predict material availability. This results in construction companies often requiring a high degree of certainty regarding material availability before construction begins, limiting the willingness to rely on reused products.

Additional challenges are also associated with handling and transportation of reused products, materials often need to be carefully handled after deconstruction to ensure that they retain their qualities and performance. Products may then require transportation to temporary storage facilities or reuse hubs before eventually being transported again to the construction site. This creates additional challenges related to the geographical location of reuse hubs and construction projects, if the transportation distance becomes too extensive the environmental and economic benefits of reuse may decrease or be nullified due to increased emissions and transportation costs. This indicates that logistical challenges are not an isolated issue but systemic barriers which affect multiple stages of the reuse process from deconstruction to reinstallation. Improved access to structured information regarding the products location, availability and condition could support more efficient logistical planning and reduce uncertainty within reuse practices.

6.2 Uncertainties

The construction sector currently experiences significant uncertainty regarding the performance and reliability of reused products. One major reason for this uncertainty is the absence of large scale reference projects which demonstrates successful implementation of reuse practices in more complex construction projects. As a result stakeholders may be hesitant to incorporate reused products since uncertainty regarding durability, technical performance, maintenance requirements and regulatory compliance increases the perceived risk compared to using virgin materials.

This uncertainty is further strengthened by the lack of standardized documentation and traceable information connected to reused components. Unlike newly manufactured products, reused material often lack accessible information regarding service history, previous loading conditions, maintenance records and technical verification. Consequently stakeholders may perceive reused materials as unreliable alternatives despite the components potentially maintaining adequate technical performance. Suggesting that the hesitation towards reuse may not only reflect actual technical limitations but also limited access to reliable information and insufficient industry experience regarding large scale reuse implementation. The findings therefore indicate that uncertainty within reuse practices is not only technical but also institutional, lacking established workflows, standardized verification methods and successful reference projects. Large scale pilot projects may offer a solution to this challenge where if done right might help to normalize reuse practices within the industry. Demonstrating successful implementation of reused materials could reduce the perceived risks and provide practical examples for future projects.

The parameter framework proposed in this study may contribute to reducing some of this uncertainty by improving traceability comparability and accessibility of information regarding reused products. By structuring essential products data in a standardized way stakeholders may gain improved conditions for evaluating the suitability of reused materials. This further suggests that reuse implementation should be understood as a socio-technical transition requiring not only technical solutions, but also institutional trust, industry experience and standardized information management.

6.2.1 Quality Testing of Reused Products

Quality testing and verification of reused materials are needed to fully understand the capabilities of reused products. Unlike virgin materials, reused products may have been exposed to varying environmental conditions, loading histories or previous modifications making it more difficult to guarantee consistent technical performance. However, such testing processes can become both time consuming and costly further reducing the economic feasibility of reuse practices. As a result stakeholders may instead rely on representative testing or generalized assumptions regarding materials originating from the same source or batch. While this may reduce cost and manual work it also introduces uncertainty regarding the actual performance of individual products. This highlights a significant trade off between technical verification and economic efficiency within reuse practices, increasing the level of testing may improve safety and confidence in reuse materials but simultaneously increases project complexity, time requirements and costs. Improved traceability and documentation regarding previous use, maintenance history and technical performance may help simplify future verification processes and reduce the need for repeated testing. This further highlight the importance of structured information management within reuse practices.

6.2.2 Warranties

Warranties for reused materials and products may play and important role in reducing uncertainty for reused materials. By providing guarantees regarding the expected lifespan and technical performance of reused products stakeholders may gain increased confidence in reused materials. In this context warranties can function as a form of risk reduction where part of the technical and financial responsibility is transferred from the buyer to the supplier or reuse actor. However, to provide warranties, suppliers require accurate information regarding a product's previous use, maintenance history, testing results, and technical condition. This further highlights the importance of traceability and structured information management within reuse practices.

6.3 Implementation of Parameter Framework

Even though our suggested framework has been shown both by the theory and the interview study to foster and promote reuse in the construction sector. Different reuse projects might have different requirements to be able to reuse material efficiently, there is no real one solution fits all. Our parameter list is also defined for simple products where more technically advanced ones need more information and parameters to be able to reuse.

The findings are based on a limited number of interviews and may therefore not represent the entire construction sector meaning that the parameters needed to implement reuse might differ between different construction projects. As mentioned before the construction sector is hindered by workers being traditional meaning that they might be resistant to change and the work with reuse is highly dependent on information sharing meaning that for our proposed template to work as efficiently as intended it relies on stakeholders adapting to working with reuse, and be willing to improve their ways of work. The implementation also relies on the ability to acquire reused products easier alongside with strengthening the supply of reused products.

7 Conclusion

This study investigated how standardized information structures and product parameters can support reuse within the Swedish construction sector. The findings indicate that the current implementation of reuse is hindered not only by technical challenges, but also by fragmented information management, uncertainty regarding product performance, logistical barriers, and the absence of standardized methods for describing products. The study further demonstrates that the lack of trustworthy information affects stakeholders willingness to use reused products. Uncertainty regarding technical performance, regulatory compliance, quality assurance and long term durability was identified as one of the main barriers limiting reuse.

To address these challenges this study developed a parameter framework for selected products based on AMA, literature findings and empirical interviews with industry professionals. The findings suggest that a smaller and more focused parameter structure may provide a more realistic and implementable starting point for reuse practices compared to more complex systems containing large amounts of product data. The proposed framework therefore focuses on the information considered most essential for enabling reuse, rather than attempting to capture all available information related to a product.

The findings also indicate that standardized information alone is not sufficient to fully promote reuse practices. Economic conditions, market maturity, logistics, testing procedures, warranties and industry wide collaboration were also identified as significant barriers to reuse in the industry. Reuse should therefore be understood as a socio-technical transition requiring coordinated development across digital systems, regulations and market structures.

Despite these barriers the proposed parameter framework may contribute to improving traceability, reducing uncertainty and supporting more efficient information exchange between stakeholders. The study therefore contributes to the ongoing development of a more circular construction sector by illustrating how standardized product information can support reuse implementation. However, the study is limited to the Swedish construction sector and does not include experimental validation or practical implementation of the proposed parameter framework within real construction projects.

7.1 Suggestions for Further Research

Several aspects related to large scale adoption of the proposed parameter framework remain unexplored and would benefit from further investigation. One important area is the practical implementation of the parameter framework within existing BIM and CAD systems in combination with existing reuse platforms. This can be combined with advanced technical systems such as AI to automatically match the demand for reused materials to available reuse materials directly from the CAD or BIM model to make it easier to identify available and suitable components for specific construction projects. Further studies could expand the framework by investigating additional building components and identifying the most essential parameters required to support reuse across a broader range of products. Research could also examine how standardized parameter structures can be adapted to different regulatory environments and support international implementation beyond the Swedish context. Finally, further research is needed to investigate how the proposed parameter framework can interact with emerging Digital Product Passport (DPP) systems and other circular economy regulations introduced by the European Union. As these systems are still under development, their future relationship with reuse-oriented parameter frameworks remains uncertain.

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Appendix

A selection of questions that was adapted before the interviews depending on the role of the interviewee:

Construction Industry

- How does the fragmentation in the construction industry affect the ability to work with standardization of processes?
- How does collaboration between different stakeholders and actors impact the ways of working? With reuse?
- What do you believe needs to change within the construction industry for more companies to adopt reuse practices?

Data Management

- How is the industry currently working to improve data standardization?
- Which standardization is relevant? What works efficiently and what needs improvement?
- How can information management become streamlined and processes be implemented throughout the sector?
- How do you think the implementation of DPP will impact the construction industry?

Product Information

- How detailed information is required to describe a component efficiently?
- How is data quality and verification managed?
- How can data be ensured to follow the product throughout its entire lifecycle?
- What documentation is required for you to feel confident using reused components?

Design Management

- How do you think the implementation of DfD change the ways of working with reused products?
- Do you experience that BIM models contain sufficient information to enable reuse? What needs to be added?
- How early in the planning phase do you see that reuse considerations need to be integrated in order for material reuse to be economically viable?

- Do you experience uncertainty regarding responsibility when designing with reused components?

Reuse

- What are your experiences with working with reuse?
- How does the Swedish construction industry work with reuse today?
- Which incentives are there today to choose a reused product over a new one?
- How does the premise of a project change the way of working?
- Which parameters have contributed to certain projects successfully implementing reuse, and which parameters prevent companies from working with reuse?
- What would be required for you to choose a reused component over a new one?
- In your view, which factors have hindered and which have facilitated the implementation of reuse?

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