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# Organising for Circularity in Construction

A Study of the Implementation of Reuse in Swedish Redevelopment Projects

Master's thesis in Design and Construction Project Management

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### SUMMARY

The construction industry is a significant contributor to both greenhouse gas emissions and waste, and it is facing increasing pressure to reduce its climate impact. As a result, interest in the circular economy (CE) within the construction sector is growing. However, the transition towards circular practices remains in its early stages, and new workflows have not yet been fully established. This thesis investigates how circular practices – particularly the reuse of building products and components – can be effectively integrated into building transformation and redevelopment projects. The study explores organisational approaches to reuse, aiming to identify success factors and provide practical examples of methods and solutions, with a focus on contract types, procurement strategies, adaptations to the design and construction process, and the management of reuse-related challenges. The research was conducted as a multiple case study with an abductive approach, combining a theoretical framework with empirical data from 11 semi-structured interviews across three case projects. The findings show that both partnering agreements with design-build contractors and divided contract structures with traditional construction contracts can support reuse, though roles and responsibilities differ. Traditional contracts require clearly defined reuse requirements, while design-build contracts rely more on contractor incentives. Reuse also introduces new activities – such as inventory, disassembly, and quality control – that increase coordination needs and challenge traditional workflows. Moreover, the study identifies three main types of barriers to reuse: cultural, regulatory, and financial. Cultural barriers can be mitigated by fostering shared commitment and individual engagement. Regulatory barriers remain resource-intensive to navigate, suggesting a need for simplified regulations and clearer standards. Financial barriers, often tied to added labour costs, may be reduced through more efficient reuse processes. Ultimately, the findings of this thesis provide guidance on how reuse can be organised in practice, supporting stakeholders involved in future transformation and redevelopment projects in planning and organising for reuse.

Keywords: building transformation, circular economy, contract types, design and construction process, organisation, procurement, reuse.



# Att organisera för cirkularitet i byggandet

## En studie av implementeringen av återbruk i svenska ombyggnadsprojekt

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### SAMMANFATTNING

Byggbranschen är en betydande källa till både växthusgasutsläpp och avfall, och står inför allt hårdare krav på att minska sitt klimatavtryck. Som en följd av detta ökar intresset för cirkulär ekonomi (CE) inom byggsektorn. Övergången till cirkulära arbetssätt befinner sig dock fortfarande i ett tidigt skede, och nya arbetsflöden har ännu inte etablerats fullt ut. Denna uppsats undersöker hur cirkulära arbetssätt – särskilt återbruk av byggprodukter och byggkomponenter – kan integreras på ett effektivt sätt i transformations- och ombyggnadsprojekt. Studien utforskar organisatoriska aspekter av återbruk i syfte att identifiera framgångsfaktorer och ge praktiska exempel på metoder och lösningar. Fokus ligger på entreprenadformer, upphandlingsstrategier, anpassningar i projekterings- och byggprocessen samt hantering av återbruksrelaterade utmaningar. Forskningen har genomförts som en flerfallstudie med en abduktiv ansats, där ett teoretiskt ramverk kombinerats med empiriska data från 11 semistrukturerade intervjuer med representanter från tre olika projekt. Resultaten visar att både samverkansavtal med totalentreprenörer och delad entreprenad med utförandeentreprenörer kan stödja återbruk, även om roller och ansvar fördelas olika. Utförandeentreprenader kräver tydligt definierade återbrukskrav, medan totalentreprenader i större utsträckning bygger på entreprenörens incitament. Återbruk introducerar också nya aktiviteter – såsom inventering, demontering och kvalitetskontroll – vilka ökar behovet av samordning och utmanar traditionella arbetsflöden. Vidare identifieras tre huvudsakliga typer av hinder för återbruk: kulturella, regulatoriska och ekonomiska. Kulturella hinder kan hanteras genom att skapa gemensamt engagemang och individuellt driv. Regulatoriska hinder är resurskrävande att hantera, vilket pekar på behovet av förenklade regler och tydligare standarder. Ekonomiska hinder, som ofta är kopplade till ökade arbetskostnader, kan minskas genom mer effektiva återbruksprocesser. Avslutningsvis bidrar uppsatsens resultat med vägledning i hur återbruk kan organiseras i praktiken, och kan därmed stödja aktörer i planering och organisering av återbruk i framtida transformations- och ombyggnadsprojekt.

Nyckelord: byggprocess, cirkulär ekonomi, entreprenadformer, projektering, ombyggnation, organisation, upphandling, återbruk.



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Gothenburg, June 2025

Clara Wetterqvist



# Glossary of Terms

## English

Contract type

Design-build contract

Traditional construction contract

Type of procurement

Divided contract

General contract

Partnering contract

Pre-study

Program phase

System design phase

Detailed design phase

Detailed development plan

## Svenska

Entreprenadform

Totalentreprenad

Utförandeentreprenad

Upphandlingsform

Delad entreprenad

Generalentreprenad

Samverkansentreprenad

Förstudie

Programskede

Systemhandlingsskede

Bygghandlingsskede

Detaljplan



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# 1. Introduction

This chapter first provides a brief background to the topic of circular economy in construction, leading to the aim of the thesis. It then presents the three research questions, followed by the delimitations of the study.

## 1.1 Background

The construction and real estate sector is currently facing a major transition, where the climate impact must be drastically reduced in the coming years to meet established climate goals (Boverket, 2024c). A key part of this transition is shifting from a traditional linear economy to a circular economy (CE). A CE aims to minimise waste and emissions by replacing the linear ‘make-use-dispose’ model with circular systems (Geissdoerfer et al., 2017). This shift is supported by strategies such as reuse, refurbishment, and recycling, which keep products, components, and materials circulating in the economy (Ellen MacArthur Foundation, 2015).

In construction, waste reduction primarily involves extending the lifespan of buildings and components, as well as minimising non-recyclable waste during demolition and renovation (Göteborgs Stad, 2020). This is increasingly urgent, as the built environment accounts for nearly 50% of the materials extracted globally each year and contributes significantly to greenhouse gas emissions (Ellen MacArthur Foundation, 2022).

In Sweden, the construction and real estate sector is responsible for over 20% of domestic greenhouse gas emissions, along with further emissions generated abroad through imported goods (Boverket, 2024d). A large share of these emissions comes from the production of building materials. At the same time, the construction industry produces substantial amounts of waste (Boverket, 2024c). In 2020, the sector generated 14.2 million tons of waste, which accounted for about 40% of the national total (Boverket, 2024a). During the construction phase alone, 15–20% of the materials used can end up as waste, and most materials from demolished buildings are either landfilled or burned (Material Economics, 2017).

The EU plays a leading role in advancing the CE, as it is a central component of the European Green Deal (European Commission, n.d.). For example, a new CE Action Plan adopted in 2020

aims to accelerate the transition and specifically highlights the construction and building sector as a priority area (European Commission, 2020).

Although interest in CE within the construction sector is growing, Boverket (2024c) notes that the shift towards more circular practices is still in its early stages. The transition has begun through gradual processes, often via pilot projects, but new workflows and solutions have yet to be fully established. As a result, many stakeholders request practical examples and guidance on how to structure work processes. Such knowledge can help shift attitudes and accelerate the transition to a CE.

While earlier studies (e.g. Hart et al., 2019; Gerhardsson et al., 2020; Ericsson et al., 2024) have focused on identifying barriers and enablers for circularity in construction, this thesis contributes by providing in-depth insights on how the implementation of reuse can be organised in practice. Although a bottom-up approach, with a focus on addressing barriers to circularity at the micro-level (i.e., individual projects or firms), has been recommended as the most suitable strategy for CE implementation in construction, this level remains the least studied (Ababio & Lu, 2023). Further research at this level is therefore essential to support the integration of CE principles into the design and construction process.

## 1.2 Aim

This thesis aims to investigate how circular practices can be effectively integrated into building transformation and redevelopment projects, with a particular focus on the reuse of building products and components. To achieve this, the thesis describes and compares different approaches to organising reuse within such projects, with the goal of identifying success factors and providing practical examples of methods and solutions. This includes examining the type of contracts and procurement strategies used, how the design and construction process is structured and adapted for reuse, and how challenges related to reuse implementation are addressed. Ultimately, the thesis seeks to provide guidance and practical examples on how reuse can be effectively organised in redevelopment projects. In doing so, it aims to support stakeholders involved in the early stages of such project in planning and organising for reuse.

## 1.3 Research Questions

To guide the research towards this aim, the following research questions have been formulated:

**RQ1:** *How have building transformation and redevelopment projects involving the reuse of building products and components been organised in terms of contract types and procurement strategies?*

**RQ2:** *How does the reuse of building products and components influence the design and construction process in building transformation and redevelopment projects?*

**RQ3:** *How can the barriers associated with reuse be addressed in future transformation and redevelopment projects?*

## 1.4 Delimitations

This thesis is limited to a Swedish context and is based on three case projects. To enable conclusions to be drawn about project outcomes, ongoing projects are excluded. At the same time, the selected projects must have been completed recently to ensure they reflect current practices.

The focus is on large-scale transformation and redevelopment of commercial buildings – primarily office buildings – as these properties are likely to undergo regular renovations and modifications, for example, due to tenant adaptations. The scope is limited to the top two levels of the EU waste hierarchy: prevention and reuse. Consequently, recycling of building materials is excluded. However, the study does not differentiate between direct reuse (for the same function) and repurposing (for a new function). Furthermore, it focuses solely on the reuse of building products and components, excluding the reuse of furniture.

Since the process of internal reuse within redevelopment projects can differ significantly from incorporating external reuse in new construction, the findings of this thesis are not intended to be generalised beyond this specific context. Additionally, as the study concentrates on processes and organisation during the design and construction phases, it does not consider aspects related to maintenance and facilities management – despite their potential relevance for reuse.



## 2. Theoretical Framework

The theoretical framework is divided into three main sections. The first section defines the concept of circular economy (CE) and situates it within the context of the construction industry, with a particular focus on the reuse of building products. The second section addresses organisation and contract relationships in construction, concentrating on contract types, procurement strategies, and the concept of partnering. The final section outlines the design and construction process – initially described in general terms and subsequently discussed in relation to reuse and circularity.

### 2.1 Circularity and Reuse in the Construction Industry

The construction industry accounts for a large share of global resource consumption and waste generation, making it a key sector for the implementation of circular strategies (European Commission, 2020). This section introduces the concepts of circularity and reuse in construction, reviews definitions of a circular economy, and outlines the barriers and enablers associated with reuse in the building sector.

#### 2.1.1 Definition of a Circular Economy

According to the Ellen MacArthur Foundation (2015), a circular economy (CE) is an economic system that is “*restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times*” (p. 2). In their definition, a distinction is made between technical and biological cycles. This thesis considers only the technical cycle, which involves the management of stocks of finite materials. In this cycle, technical components and materials are reused, refurbished, and recycled to keep them circulating within and contributing to the economy – thus, use replaces consumption. The ultimate goal of the CE is to enable continued global economic development while reducing dependence on the consumption of finite natural resources (Ellen MacArthur Foundation, 2015).

Similarly, Geissdoerfer et al. (2017) define CE as “*a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops.*” (p. 759). This is supported by strategies such as long-

lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. Another definition of a CE is provided by Kirchherr et al. (2017), who base their definition on an analysis of 114 existing CE definitions. They describe CE as *“an economic system that replaces the ‘end-of-life’ concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations. It is enabled by novel business models and responsible consumers.”* (p. 229).

Based on these three definitions, this thesis defines the CE as a restorative and regenerative economic system that aims to maintain products, components, and materials at their highest possible utility and value. This is achieved by replacing the ‘end-of-life’ concept with strategies such as reducing, reusing, refurbishing, recycling, and recovering materials – thereby keeping them circulating within and contributing to the economy. As a result, resource input, waste, emissions, and energy leakage are minimised.

### 2.1.2 The EU as a Driver Towards a Circular Economy

According to Boverket (2024c), the European Union (EU) is a key driver in the transition to a CE. For example, the European Commission adopted a new CE Action Plan in 2020 as part of the European Green Deal. The plan aims to accelerate the transformative change needed to achieve a sustainable economic system, building on CE principles (European Commission, 2020). Moreover, the Corporate Sustainability Reporting Directive (CSRD), which entered into force in 2023, requires all large and listed companies to disclose information on the social and environmental sustainability of their activities (European Commission, 2024). According to Boverket (2024c), the CSRD is expected to promote increased reuse and the adoption of life cycle perspectives due to its strong emphasis on considering the entire value chain.

Another relevant EU directive in this context is the Waste Framework Directive (Directive 2008/98/EC), which includes a five-step waste hierarchy that sets the priority order for waste management. The preferred option is waste prevention, meaning that measures should be taken before a product becomes waste – such as extending its lifespan. The second priority is preparation for reuse, which involves enabling products to be used again for their original

purpose. The third is recycling – reprocessing waste into materials or products, either for the same or different purposes. Fourth is recovery, where waste serves a useful function, for example through energy recovery. Finally, if none of the above options are viable, disposal should be used as a last resort. This hierarchy is illustrated in Figure 2.1.



**Figure 2.1:** *The waste hierarchy (the author’s own figure).*

### 2.1.3 Circularity in Construction

In the context of the construction industry, Benachio et al. (2020) define the CE as “*the use of practices, in all stages of the life cycle of a building, to keep the materials as long as possible in a closed loop, to reduce the use of new natural resources in a construction project*” (p. 5). Such practices include designing for adaptability and disassembly, conducting life cycle assessments, creating material stocks, developing material passports, reusing building materials, deconstructing building components, and reducing waste. Among these, Benachio et al. (2020) found that the reuse of building materials was the most frequently studied area.

Bellini et al. (2024) also note that the reuse of construction products is increasingly being explored as a strategy to achieve circularity. According to Gerhardsson et al. (2020), many stakeholders in the building sector have a positive attitude toward reuse and see potential for expanding its implementation in their work. Not least, it is viewed as an opportunity to position their organisations as leaders in sustainability and CE. Nevertheless, the actual level of reuse in current projects remains low.

Similarly, Guerra et al. (2021) observe that construction companies worldwide have started to embrace CE principles and incorporate them into their operations. However, while some circular business models are relatively easy to adopt, other models have seen a slower uptake across the industry. Moreover, a gap remains between the theoretical understanding of CE and its practical application; although many circular strategies and business models appear straightforward in theory, few have been widely implemented in practice.

#### 2.1.4 Barriers to Circularity and Reuse in Construction

Hart et al. (2019) identified four categories of barriers to implementing a CE in the built environment: cultural, regulatory, financial, and sectoral. Cultural barriers include a lack of interest, skills, and engagement; operating in a linear economy; and insufficient collaboration both between companies and across business functions. Regulatory barriers involve the absence of a consistent regulatory framework, obstructive laws and regulations, and a lack of incentives for CE. Financial barriers stem from short-term business focus, high upfront investment costs, low virgin material prices, unconvincing business cases and case studies, and limited access to funding. Sectorial barriers relate to the inherent characteristics of the construction industry, such as its conservative, uncollaborative, and risk-averse nature; the complexity of buildings; long product lifecycles; and a lack of standardisation.

More recently, similar efforts to categorise barriers to CE in construction have been made by AlJaber et al. (2023) and Ababio and Lu (2023). Based on a systematic literature review, AlJaber et al. (2023) identified six main categories: awareness, technical, economic and market, implementation, support/promotion, and social barriers. Within these, the five major barriers were the absence of comprehensive CE policies and legislation, a fragmented supply chain, high upfront investment costs, a conservative and non-collaborative mindset, and a general lack of interest in adopting CE principles. These barriers closely align with the categories proposed by Hart et al. (2019).

Similarly, Ababio and Lu (2023) identified five categories: social and cultural, political and legislative, financial and economic, technological, and framework- and theory-related barriers. At the micro-level – referring to individual firms or projects – they found that social/cultural and financial/economic barriers were the most critical. These included high upfront costs, funding issues, lack of interest, insufficient human resources, resistance to change, and lack of expertise – all of which align well with Hart et al. (2019).

In a Swedish context, both Gerhardsson et al. (2020) and Ericsson et al. (2024) have identified the lack of a professional reuse market as a key barrier to the reuse of building materials. This finding is consistent with Rakhshan et al. (2020), who note that the absence of a mature reuse market hinders the establishment of a sustainable supply of recovered building components. Similarly, Nordby (2019) argue that technical, legislative, and market-related barriers to reuse are linked to an underdeveloped market, compounded by a lack of information on used construction products and inadequate legislation governing the sale and use of reused materials. According to Rakhshan et al. (2020), overcoming barriers to reuse in the building sector requires a holistic approach. However, as many of these barriers are interrelated, they argue that priority should be given to addressing social, economic, and regulatory barriers.

### 2.1.5 Enablers for Circularity and Reuse in Construction

Using the cultural, regulatory, financial, and sectoral categories, Hart et al. (2019) also identified enablers for CE, and explored how they relate to existing barriers. While some enablers directly address barriers within the same category, others intersect across categories. For example, leadership – a cultural enabler – was proposed as a response to sectoral barriers related to the nature of the industry itself. Likewise, fostering long-term relationships and partnerships was presented as a solution to the short-term financial focus. In the regulatory domain, policy support and public procurement were proposed to address the lack of a consistent regulatory framework.

According to Ababio and Lu (2023), enabling strategies for increased CE implementation in the construction industry include promoting stakeholder awareness, creating roles within firms to champion the transition, developing collaborative tools for information transfer, enforcing strict CE policies and guidelines, using innovative procurement and financing methods, and funding CE-related research projects. Additionally, both Nordby (2019) and AlJaber et al. (2023) identify economic incentives as enablers for reuse.

Benachio et al. (2020) emphasise the importance of integrating CE practices during the early design stages of a project. Similarly, Ericsson et al. (2024) highlight the early introduction of reuse as a key enabler. At this stage, Bellini et al. (2024) argue that establishing strong collaboration among project participants and adopting a systemic approach is essential. They also stress the importance of involving architects and consultants early on to support the

successful implementation of reuse and circularity. In addition, Ericsson et al. (2024) suggest that the early involvement of manufacturers – by connecting them with architects to facilitate the integration of reused products into the design – can help reduce waste, simplify logistics, and create new business opportunities. These perspectives align with AlJaber et al. (2023), who identify stakeholder collaboration and engagement as important enablers for implementing CE practices in the building sector.

Moreover, Bellini et al. (2024) state that a clear goal for reuse and CE should be defined in the early phases of the project. This is further supported by Gerhardsson et al. (2020), who emphasise the importance of setting specific targets for reuse and regularly following up on them. If needed, they recommend adjusting these targets throughout the process to ensure they meet the criteria of being specific, measurable, attainable, realistic, and time bound (SMART).

In addition, Benachio et al. (2020) highlight the role of Building Information Modelling (BIM) as a key enabler, emphasising its ability to store material information within digital models and support the analysis of reuse potential across different material choices. Similarly, AlJaber et al. (2023) identify the use of BIM as one of the most critical enablers for facilitating the transition to a CE, as it has the potential to support the planning, management, and supervision of the entire building lifecycle. According to Charef and Emmitt (2021), developing and enhancing the use of BIM in the construction sector can help overcome economic, political, sociological, technical, environmental, and organisational barriers to the adoption of CE practices.

Bellini et al. (2024) also identify the lack of information and data about existing products as a barrier to reuse. One way to address this challenge is through reuse mapping, also referred to as a reuse inventory. This aligns with Gerhardsson et al. (2020), who recommend conducting a materials inventory at an early stage to support decision-making related to reuse and circularity. Similarly, Ericsson et al. (2024) note that early inventories help lower the threshold for initiating reuse. They suggest that such inventories can provide a basis for contractor procurement – for instance, by being included in tender documents and contracts.

Furthermore, enabling reuse requires new design methods that are adapted to circularity and reuse, distributing project resources with reuse in mind, and creating incentives for reuse in procurement (Gerhardsson et al., 2020). It also involves allocating more time, establishing new roles and responsibilities, and developing new working methods (Ericsson et al., 2024).

Overall, Ericsson et al. (2024) highlight that organisational factors are among the most frequently cited when discussing both enablers and barriers to reuse. While one of the most significant barriers identified was organisational challenges related to project management and leadership, the main enablers included new and improved methods for project management as well as enhanced competence and learning within and across organisations.

## 2.2 Organisation and Contract Relationships in Construction

According to Ericsson et al. (2024), certain contract and procurement forms may act as barriers to reuse in construction, while others are highlighted as creating favourable conditions for it. Therefore, the choice of contract type and procurement strategy is an important consideration when implementing reuse in construction. These topics are explored further in this section.

### 2.2.1 Contract Types and Project Delivery Methods

In Sweden, construction projects typically follow one of two main contract types: design-build contracts (also known as turnkey contracts) or traditional construction contracts, in which the client is responsible for the design (also referred to as execution contracts) (Boverket, 2024b). These contract types correspond to different project delivery methods: design-build and design-bid-build. The project delivery method defines the relationship between the contracting parties and the timing of their involvement (Ibrahim et al., 2020).

According to Hale et al. (2009), the design-build delivery method involves the client awarding a single contract to a company responsible for both the design and construction, based on the client's project requirements. In contrast, under the design-bid-build method, the client first enters into a contract with an architect or engineering firm that provides design services and produces design documents. These documents then serve as the basis for a separate contract with a construction company, which executes the construction without assuming responsibility for the design. A third delivery method is construction management (CM), described by Ibrahim et al. (2020) as a system in which a construction manager is engaged early in the process to support the client during both the design and construction phases.

Kereri (2017) suggests that design-build projects generally foster stronger relationships between parties compared to design-bid-build projects. For instance, design-build contracts

tend to involve greater trust and more balanced risk allocation. According to Kereri (2017), this is due to the contractual dynamics of the two methods; while design-bid-build parties typically focus on fulfilling contractual obligations, design-build parties often aim to secure future contracts with each other. Additionally, Hale et al. (2009) found that the design-build project delivery method outperformed design-bid-build in terms of both cost and time.

Lingegård et al. (2021) note that for experienced clients, a design-bid-build setup with a traditional construction contract offers greater control over quality, as it allows them to specify materials and technical solutions in detail. However, this approach limits the contractor's opportunities to contribute to innovation. As a result, the responsibility for driving innovation rests more heavily with the client organisation. Nonetheless, the overall potential for innovation is considered equally high in both traditional construction contracts and design-build contracts; the key difference lies in which party is primarily responsible for generating innovative solutions (Göteborgs Stad, 2020).

If the client seeks to leverage the contractor's expertise – such as in material selection or ensuring constructability – Lingegård et al. (2021) argue that the earlier involvement of the contractor enabled by a design-build contract can be advantageous. However, to realise innovation through this approach, it is essential that the contractor is procured with incentives to invest time and resources in development activities, rather than through traditional price-based competitive tendering.

### 2.2.2 Procurement Strategies

Boverket (2024b) identifies two main types of procurement in Sweden: divided contracts and general contracts. These approaches determine how many contractors the client procures and how the contractual relationships are structured. In a divided contract, the client directly procures and contracts all necessary contractors for the project, treating them as parallel actors. In contrast, in a general contract, the client hires a general contractor, who then procures and manages the required subcontractors. In a CM project, however, the construction manager assumes the responsibilities of a general contractor, managing all contractors throughout the project (Ibrahim et al., 2020).

In the transition to a CE, the concept of circular procurement has emerged. According to the United Nations Environment Programme (2018), this involves both promoting circular business

models and procuring more circular products, materials, and services. Such procurement can be achieved by developing and applying circular procurement criteria and encouraging product lifetime extension.

Xu et al. (2022) outline that the circular procurement process includes defining goals and objectives, deciding how to design the procurement, and selecting an appropriate evaluation model with relevant CE criteria. Since circular procurement remains relatively new and uncertain for many companies, it often requires internal collaboration across departments. However, the specific design of the circular procurement process varies.

Ahmed et al. (2024) stress that the procurement strategy is crucial for enabling CE in construction projects. Yet, contracts are typically awarded based on the lowest tender, focusing primarily on time, cost, and quality. Because current procurement strategies often lack CE objectives, little attention is given to sustainability and CE in procurement. This aligns with both Sajid et al. (2024), who note that literature on circular procurement in construction is still limited, and Ababio et al. (2025), who argue that few studies have evaluated circular procurement within a construction setting.

To accelerate circular procurement in construction, Sajid et al. (2024) recommend incentivising stakeholders to adopt circular practices and using pilot projects to bridge the gap between theory and practice. Similarly, Ababio et al. (2025) note that pilot projects can help demonstrate the quantifiable benefits of circular procurement. They also advocate for aligning procurement strategies with CE principles and developing circularity metrics to guide the procurement. Ahmed et al. (2024) further argue that CE objectives should be clearly defined and integrated across the entire procurement process. From early project stages, procurement criteria can be used to establish CE requirements. For example, the reuse of building materials can be encouraged through specifications in tender documents during the procurement phase.

A more detailed guideline to circular procurement in construction is provided by Göteborgs Stad (2020). They suggest that procurement documents should offer contractors the necessary information to submit circular tenders. In renovation and demolition projects, a well-documented material inventory plays a key role in the procurement documentation. Additionally, it may be relevant to specify how the documentation of installed products and materials should be conducted. Tender documents should also clearly state how bids will be evaluated and followed up, what methods will be used, and what information and documentation the contractor must provide during these phases.

Gerhardsson et al. (2019) argue that for reuse to be implemented in practice, the client must offer appropriate incentives. This can be achieved by integrating reuse into procurement documents through financial incentives, setting specific targets for reuse levels, or providing separate guidelines for product guarantees and quality assurance of reused materials. Similarly, Göteborgs Stad (2020) emphasises that bonuses and penalties linked to clear circular goals or requirements can effectively steer contractors toward increased circularity. Additionally, Ericsson et al. (2024) note that it may be necessary to redefine responsibilities in reuse projects, as obtaining material warranties for reused products is often difficult – creating uncertainty regarding performance and responsibility allocation.

### 2.2.3 Partnering

According to Bresnen and Marshall (2000), partnering refers to a form of inter-organisational collaboration, typically between clients and contractors, in which the parties agree to cooperate and resolve problems jointly and informally. Thereby, it aims to address issues associated with the fragmentation of the construction industry. When implemented successfully, partnering can reduce costs and project durations, improve quality and safety, and increase client satisfaction. Additionally, Black et al. (2000) found that partnering can foster less adversarial relationships and greater understanding between parties. However, its success depends on mutual trust, effective communication, commitment, a clear understanding of roles, consistency, and a flexible attitude. Furthermore, Bresnen et al. (2025) argue that partnering requires greater sharing of risk, rewards, resources, and knowledge – enabling more open communication and trusting relationships.

Byggherrarna (n.d.) note that in recent decades, partnering has become relatively common in the Swedish construction industry. However, it is important to clarify that partnering is not a contract type, but rather a business model that can be applied to both design-build and traditional construction contracts. It is typically combined with procurement methods and compensation models that promote cooperation between the parties. The model is generally well-suited for complex projects with a high degree of uncertainty – for example, projects where it is difficult to produce detailed documentation in advance, or where flexibility is required to adapt the work to changing conditions. Such projects may include renovation and extension works with tenants remaining in place, or refurbishments involving heritage conservation.

Similarly, several studies have identified partnering as a suitable approach to support circularity and reuse. For example, Ahmed et al. (2024) argue that collaborative and partnering-based procurement methods are essential for the effective implementation of CE in construction. Ericsson et al. (2024) highlight that partnering enhances collaboration, fosters shared goals, and enables trade-offs between costs and benefits, all of which facilitate reuse. It also helps address responsibility issues and supports ongoing dialogue with contractors, making it particularly effective in large-scale reuse projects. When combined with cost-plus compensation models and target pricing, partnering creates favourable conditions and incentives for contractors to prioritise disassembly and reuse over purchasing new materials. Furthermore, Perzon et al. (2022) note that partnering is especially effective in reuse projects where not all goals or parameters are defined from the outset, as it allows for late-stage changes or substitutions with reused materials, provided that all parties understand this from the beginning.

However, according to Bresnen et al. (2025), a clear and widely accepted definition of partnering is still lacking. As a result, partners may hold differing views on what partnering entails, which can hinder its successful implementation. The lack of a clear definition also complicates comparisons between partnering projects, as the metrics used to evaluate their outcomes tend to be highly context specific. Another barrier to partnering is the tension between competition and collaboration. While some clients prefer to test the market and minimise upfront costs through competitive tendering, enabling greater collaboration through a negotiated partnering agreement often requires giving up the benefits of competition in procurement. For contractors, the opportunity to secure future work through partnering comes with the downside of assuming greater risk and potentially reduced profit margins – particularly in markets where clients hold more power.

In addition, Oliveira and Lumineau (2017) note that the use of a partnering contract alone is insufficient to improve project performance, and that the benefits of partnering can be achieved without explicitly committing to it. Similarly, Black et al. (2000) argue that partnering can be effective, but only if all project participants adopt new mindsets and actively contribute to enhancing efficiency, success, and reducing conflicts. Trigunaryyah (2017) also suggests that the client's level of involvement largely depends on organisational culture, and that adopting a team-oriented approach can help increase client involvement and improve performance.

## 2.3 The Design and Construction Process

Kagioglou et al. (2000) divide the design and construction process into ten phases, grouped into four broader stages: pre-project, pre-construction, construction, and post-construction. During the pre-project phases, the client's needs are gradually clarified and assessed to determine whether a construction project is necessary and to obtain initial financial approval to proceed. In the pre-construction stage, these needs are developed into a design solution. The design is successively developed with the ultimate aim of producing approved production documents. By the end of this stage, full financial authority must be secured for the project to move forward. The construction phase then begins, involving the actual realisation of the design. At this point, any changes in the client's requirements should be minimal, as the cost of changes increases significantly as the project progresses. Finally, the post-construction stage includes the operation and maintenance of the completed facility. However, this final stage lies outside the scope of this thesis.

Building on the process protocol introduced by Kagioglou et al. (2000), Cooper et al. (2008) similarly describe the design and construction process in terms of pre-project, pre-construction, construction, and post-completion phases. The pre-project phases involve identifying needs, exploring potential solutions, evaluating project feasibility, and obtaining financial approval to proceed. The pre-construction stage includes both conceptual design phases, where key design elements are identified and a system concept design is developed, and a coordinated design phase, which should be detailed enough to ensure predictability regarding cost, design, and production. As noted by Kagioglou et al. (2000), full financial approval is required before construction begins. The construction phases involve preparing detailed production documentation, including coordinated construction drawings, as well as executing the actual construction works. The post-completion phases correspond to the post-construction phases defined by Kagioglou et al. (2000), which are, again, outside the scope of this thesis.

Mitchell et al. (2011) focus specifically on the interface between the pre-construction and construction stages – namely, the transition from detailed design to construction. With the increasing use of design-build contracts, responsibility for detailed design is often transferred to the main contractor. However, these phases differ in character and must be managed accordingly. While the design process is iterative, involving multiple cycles of development and revision, the construction process is more linear in nature. To explore this interface, Mitchell et al. (2011) conceptualise the design process as a spiral in which uncertainty is

gradually reduced and ultimately eliminated as the design matures. By the time construction is completed, all uncertainty should have been resolved.

Based on the descriptions and discussions above, this thesis groups the design and construction process into five main phases: a pre-study, a program phase, a system design phase, a detailed design phase, and a production phase. These stages are illustrated in Figure 2.2.



**Figure 2.2:** *The standard design and construction process (the author’s own figure).*

The pre-study phase involves defining the project needs, assessing feasibility, and obtaining initial financial approval to proceed. The program phase focuses on developing the project brief and producing a preliminary conceptual design. The system design phase includes the development of the design from a system-level concept to coordination across disciplines. The detailed design phase entails producing comprehensive production documentation, including construction drawings. Finally, the production phase involves the execution of the actual construction works. This model does not account for the potential overlap between phases, although such overlaps may occur in practice.

According to Konstantinou et al. (2021), the same main project phases apply to renovation projects. However, in renovation projects, the pre-study phase also includes analysing and diagnosing the existing building. If tenants remain in the building during construction, this affects the production phase – for instance, in terms of time planning. Similarly, Shiue et al. (2019) note that the concurrent use of the building by both workers and occupants makes scheduling more difficult in renovation projects than in new construction.

### 2.3.1 Integrating Reuse in the Design and Construction Process

Reusing building products and components in construction projects significantly impacts the traditional design and construction process (Støre-Valen, 2024). According to Göteborgs Stad (2020), the clear separation between stages in a conventional process presents challenges for integrating reused materials. Consequently, adopting a more integrated approach to planning

and construction may be beneficial. Reuse also affects the project timeline, as some activities may require more time, others less, and entirely new tasks may be introduced. For example, additional time is often needed during the design and construction phases to accommodate disassembly, along with increased demands on planning and logistics. In renovation and demolition projects, an important step is to inventory existing components and make relevant information about these products accessible. Furthermore, a more flexible design process is required – one that can accommodate uncertainty, as it is not always clear from the outset which products will be available for reuse.

Similarly, Gerhardsson et al. (2019) mention disassembly, reconditioning, storage, and increased working time to identify reuse opportunities as new project phases that emerge with reuse. They emphasise the importance of planning for reuse and the associated new phases as early as possible. For instance, conducting a reuse inventory in the early stages of a project can support more informed decision-making and planning. This point is reinforced by Støre-Valen (2024), who argues that collaboration and the involvement of relevant expertise are essential in the early stages. In particular, Støre-Valen (2024) suggests that reuse consultants should be involved early on to assist with the inventory process. Moreover, it is crucial to incorporate reuse considerations into the budgeting process (Gerhardsson et al., 2019).

Although the reuse process is generally treated as separate from the design and construction process, some attempts have been made to integrate them. For example, Lindborg et al. (2024), propose conducting a brief reuse inventory during the pre-study phase, formulating reuse goals during the program phase, and carrying out a more detailed inventory during the system design phase. In later phases, these activities are typically followed by steps such as disassembly, transport and storage, possible quality control and classification, potential reconditioning, and finally, reassembly. However, Lindborg et al. (2024) also note that no single, standardised reuse process exists. As a result, both the activities involved and the order in which they are carried out can vary between reuse projects.

## 3. Methodology

In this chapter, the chosen methodology for the thesis is described. The sections cover the research approach, research design, data collection, data analysis, data quality and trustworthiness, and ethical considerations.

### 3.1 Research Approach

For this thesis, an abductive research approach was adopted, allowing the theoretical framework, empirical data collection, and analysis to evolve simultaneously. As the research questions were confronted with the empirical world, they were continuously refined and reoriented. This process is described by Dubois and Gadde (2002) as ‘systematic combining’. By moving iteratively between theory and empirical observations, the understanding of both was gradually deepened. The central idea of this approach is that “*theory cannot be understood without empirical observation and vice versa*” (Dubois & Gadde, 2002, p. 555).

The flexibility of the abductive approach enabled the exploration of new concepts and ideas as they emerged during the research process. Since this thesis employed a qualitative research strategy, data collection and analysis focused on words rather than quantification (Bell et al., 2019), which supported a deeper exploration of real-world problems (Tenny et al., 2022).

### 3.2 Research Design

The research was designed as a multiple case study, including three Swedish redevelopment projects: Lumi, Werket, and Triåkåfabriken. According to Dubois and Gadde (2002), “*case studies provide unique means of developing theory by utilizing in-depth insights of empirical phenomena and their contexts*” (p. 555). By conducting a multiple case study, it was possible to gain a deeper understanding of these specific projects while also enabling comparisons between them. The projects were selected because they all had high ambitions regarding reuse and were completed within the past three years. The study was limited to completed projects in order to examine the entire design and construction process and to allow for conclusions to be drawn about the outcomes. At the same time, it was important to study recent projects, as the development of reuse practices is progressing rapidly. To enable more general conclusions

within a Swedish context, projects were selected from three different property owners in three different large to mid-sized Swedish cities.

### 3.3 Data Collection

The empirical data was collected through interviews with representatives from the three case projects. This method was selected because the aim was to explore the individual experiences of professionals involved in reuse projects, which made qualitative interviews an appropriate choice (Kvale & Brinkmann, 2014).

For each project, 3–4 semi-structured interviews were conducted with project stakeholders such as the client, project manager, architect, and contractor. The interviewees are presented in Figure 3.1. In total, 11 interviews were conducted. This number falls within the range suggested by Kvale and Brinkmann (2014), who note that interview studies commonly involve between 5 and 25 interviews, although the ideal number depends on the purpose of the study. While a larger number of interviewees can offer a broader range of perspectives, a smaller sample allows for more in-depth analysis. This balance was carefully considered when determining the number of interviewees. The interviewees' individual experiences collectively contributed to a holistic understanding of the design and construction process, as well as the influence of contract types and organisational structures, in each project.

The use of a semi-structured approach allowed for flexible interviews with minor adjustments to the wording and order of questions depending on the interviewees' responses, which further supported the explorative nature of the study. All interviews were conducted in Swedish to ensure that interviewees could express themselves in a language they felt comfortable using. As the case projects were situated in different parts of Sweden, all interviews were conducted online using Microsoft Teams.

The interviews followed a guideline consisting mainly of open-ended questions (see Appendix), allowing the respondents to describe their experiences from the specific case project in their own words. The interviewees were asked to briefly describe their own role in the project, how reuse was addressed in their work, the organisational structure and the type of contract used, the process during different project phases, and to reflect on challenges and success factors related to reuse. Each interview concluded with an open question, giving the interviewee the

opportunity to add any additional thoughts if they wished. The interviews lasted between 30 and 60 minutes, with most of them lasting around 45 minutes.

<b>Label</b>	<b>Role</b>	<b>Date</b>
<b><i>Lumi</i></b>		
A1	Project Director	2025-03-10
A2	Architectural Project Manager	2025-03-11
A3	BIM Manager and Assistant Project Manager	2025-03-12
A4	Site Manager	2025-04-11
<b><i>Werket</i></b>		
B1	Project Development Manager	2025-03-20
B2	Architect (and Interdisciplinary Design Coordinator)	2025-03-07
B3	Site Manager	2025-03-18
B4	External Project Manager and Construction Manager	2025-04-14
<b><i>Trikåfabriken</i></b>		
C1	Project Director	2025-03-24
C2	Project Architect	2025-04-10
C3	Senior Construction Manager	2025-04-24

**Figure 3.1:** *List of interviewees.*

To provide a clear idea of the interview’s focus and to allow time for reflection, the main interview questions were sent to the interviewees a few days in advance. However, sub-questions were not shared in advance, leaving room for flexibility and helping to maintain the semi-structured character of the interviews. In some cases, complementary information was provided by the interviewees via email, either before or after the interview.

The interviews were recorded and transcribed automatically in Microsoft Teams, with the interviewees’ consent. The transcriptions were then proofread and corrected by the author to ensure they accurately reflected the interviewees’ oral responses. The intention was to reproduce the answers verbatim, but where necessary for the sake of readability, minor adjustments were made to facilitate the subsequent analysis process. For example, repetitions and filler words were removed. Pauses, intonation, and voice level were not reflected in the transcription. Since the author was solely responsible for conducting the interviews,

transcribing them, and carrying out the analysis, the primary aim was to ensure that the transcriptions were clear and understandable to the author. Furthermore, the content of the responses was considered more relevant for the purpose of this study than their exact phrasing.

### 3.4 Data Analysis

As all interview transcripts were originally in Swedish, the data analysis and coding process was conducted in Swedish to minimize the loss of information. Only direct quotes were translated to English.

The data was analysed using a thematic approach. First, four main categories were defined based on an initial analysis of the interview transcripts, and then the sub-categories were successively developed while reading and analysing the interview transcripts (see themes in Figure 3.2). The sub-categories related to “Reuse activities” were also coded based on when in the design and construction process each activity took place.

<b>Project organisation</b>	<b>Procurement</b>	<b>Reuse activities</b>	<b>Challenges and success factors</b>
Partnering	Selection of consultants and contractors	Reuse goal formulation	Culture and collaboration
Other contracts	Clear requirements	Inventory	Economic hinders
Project roles	Financial incentives	Disassembly	Regulatory hinders
	Warranties	Quality control and test assembly	
		Reconditioning	
		Design and planning for reuse	
		Storage and logistics	
		Reassembly	

**Figure 3.2:** *List of themes.*

### 3.5 Data Quality and Trustworthiness

According to Bell et al. (2019), trustworthiness in qualitative research can be achieved by fulfilling four main quality criteria. These are credibility, transferability, dependability, and confirmability.

Credibility entails *“both ensuring that research is carried out according to the canons of good practice and submitting research findings to the members of the social world who were studied, for confirmation that the investigator has correctly understood that social world”* (Bell et al., 2019, p. 363). The latter technique can be referred to as respondent validation. In this study, all interviewees were given the opportunity to review a first draft of the case studies and results chapters. This helped ensure that the findings aligned with the views of the respondents. Another method used for ensuring the credibility of the findings was triangulation, which involves using multiple sources of data and cross-checking the findings against each other. This was achieved by conducting multiple interviews on the same project. The respondents represented at least three different companies involved in each project, offering diverse perspectives on the topics discussed.

Transferability refers to the degree to which the findings can be generalised to other settings. According to Bell et al. (2019), this can be a problem in qualitative research as it typically involves case studies and small samples, tending to be oriented to a specific context. In this thesis, the aim is for the results to be transferable to other redevelopment projects in Sweden, but not necessarily beyond that context. However, the thesis also aims to be detailed and transparent enough for the reader to be able to judge whether the findings are applicable to other contexts.

Dependability is concerned with the consistency of the results, and whether they are repeatable (Bell et al., 2019). To ensure the dependability of the study, the same interview guideline was used for all interviews, and all steps of the research process were carefully documented.

Confirmability involves ensuring that the researcher has conducted the study in good faith, without letting personal values influence the research process or its findings (Bell et al., 2019). While complete objectivity is ultimately unattainable, the author of this study made a conscious effort to remain critical and impartial, striving to approach an accurate understanding of reality.

### 3.6 Ethical Considerations

In conducting the interview study, ethical principles related to informed consent, confidentiality, and data protection were carefully followed. Prior to the interviews, participants received an information email along with the Microsoft Teams invitation, outlining the study's purpose and their rights as participants. They were informed that the interviews would be recorded and transcribed with their consent and that all collected data would be securely stored. The recordings and transcripts would be deleted upon the completion of the thesis, or no later than December 31, 2025.

To ensure confidentiality, any information that could directly or indirectly identify participants or their respective companies would be excluded from the final thesis unless explicit permission was granted. Participation in the study was entirely voluntary, and interviewees had the right to withdraw at any time without providing a reason. Additionally, they were informed of their right to access, correct, or request the deletion of their data in accordance with GDPR. These ethical measures were implemented to protect participants' privacy and ensure transparency and integrity in the research process.

During the interviews, all interviewees gave their verbal consent for the thesis to mention the name of the project they had been involved in, as well as their professional role. This information is presented in Figure 3.1, with an individual label assigned to each respondent to ensure their anonymity. The interviewees also had the chance to review a draft of the findings to ensure they approved of how the collected data was used and interpreted.

As part of the writing process, the author used the AI tool ChatGPT to support the translation of the interview findings and the proofreading of the thesis. The tool was employed solely for language-related feedback, such as identifying grammatical errors and suggesting clearer formulations. No sensitive or personal information about the interviewees was shared with the tool, and the author takes full responsibility for the final content of the thesis.

## 4. Case studies

This chapter presents and briefly describes the three case projects to provide background for the subsequent Results chapter. For each project, the description focuses on the type of products that were reused and the organisational structure, including the contract types and procurement strategies used.

### 4.1 Lumi

Lumi is part of a larger redevelopment of a 1970s government agency block in Uppsala, Sweden, which has served – and continues to serve – as office and laboratory space. The initial plan was to demolish the entire block and replace it with new, modern facilities. However, when it became clear that the proposed construction closely resembled the existing volumes, it was concluded that retaining the building would be more cost-effective, time-efficient, and sustainable than demolition. Consequently, the decision was made to preserve the structure. A covered atrium was added to connect the different sections of the building, and three new floors were constructed on top of the original structure, making the project a combination of renovation and extension. Images of the building before and after the redevelopment are shown in Figure 4.1.



**Figure 4.1:** *To the left, a picture of Lumi before the renovation. To the right, a picture of Lumi after the renovation. Photographs by White Arkitekter, republished with permission.*

The renovation and extension work took place between 2022 and 2024 and covered a total of 22,000 square meters of gross floor area (GFA). In the project, the structural frame and foundations were preserved. This was possible, despite the addition of three new floors, because the original façade was removed and replaced by a lighter one, thereby reducing the building's

overall weight. Since larger parts of the block were demolished, there was a much bigger structure to source materials from, creating favourable conditions for large-scale internal reuse. Gypsum boards and suspended ceiling tiles account for a large portion of the reused building components, coming both from the project itself and from another property owned by the client. Other examples of reused products within the project include doors, glass partitions, built-in furniture, installation products, bricks, and lightweight concrete. The only reused products purchased from an external supplier were carpet tiles. Otherwise, all reused materials came from client's own property portfolio.

#### 4.1.1 Project Organisation and Procurement in Lumi

In the Lumi project, a divided contract structure was used, and a construction management (CM) consultancy firm was engaged to oversee the construction process. Approximately 50 contractors were involved, all directly contracted by the client, with the majority operating under AB 04 – the standard agreement for traditional construction contracts, in which the client retains responsibility for the design. Although some contractors participated during the pre-construction phases, including inventory, disassembly, and test assembly, they were generally not the same parties responsible for reassembly during the production phase. The architect was procured through an existing framework agreement and was involved from the pre-study phase until project completion.

While the CM consultants did not hold contractual relationships with the contractors, they were responsible for contractor procurement in collaboration with the client. The CM consultants issued request documents, evaluated tenders, and then submitted a procurement evaluation report to the client, comparing the tenders and recommending which contractors should be awarded contracts. In most cases, the client followed these recommendations, as the CM consultants ultimately bore responsibility for managing the project and working directly with the contractors.

In the procurement process, the Revit model was used to extract quantity take-offs for the request documents. Contractors were then procured based on unit prices, with a distinction made between the price for assembling reused materials, where the client provided the materials, and the price for assembling and purchasing new materials. Quantities were continuously extracted from the 3D model, and a structure was in place for estimating the

amount of material as well as determining what proportion could be supplied and what needed to be purchased. No financial incentives were included in the contracts.

## 4.2 Werket

Werket is another office building previously occupied by Swedish government agencies, originally constructed in 1975 and located in Jönköping, Sweden. When the property owner suddenly faced a complete lease termination, leaving 25,000 square meters of office space vacant, the need arose to renovate the building to make the premises rentable again. It was a structure with low floor-to-ceiling heights, small windows, and heavy brick walls – features that made it appear highly outdated. Although demolition was considered, the decision was ultimately made to work with the existing structure and transform it into something new and attractive.

The renovation was carried out between 2021 and 2023. The project primarily involved refurbishment of the existing premises but also included the construction of a covered courtyard using an ETFE roof spanning between the building volumes. Images of the building before and after the redevelopment are shown in Figure 4.2. Within the project, stairwells were preserved, and a range of building products were reused, including bricks, tiles, porcelain fixtures, electrical and ventilation ducts, cable trays, as well as selected doors and glass partitions.



**Figure 4.2:** *To the left, a picture of Werket before the renovation. To the right, a picture of Werket after the renovation. Photographs by Castellum, republished with permission.*

Two office spaces were also constructed using 100% reused materials, with only a few electrical cables being newly installed. In these spaces, items such as kitchens, frames, doors, wall tiles, floor tiles, carpets, and suspended ceilings with grid systems were reused. To achieve full reuse

in these areas, materials were sourced both from within the building and from other properties owned by the client. No reused materials were purchased from external suppliers, except for furniture. However, a number of components were sold off from the project.

#### 4.2.1 Project Organisation and Procurement in Werket

Since Werket differed significantly from other projects at the time, the client chose to divide the project rather than consolidate everything under a single large contract with a general contractor. The project was partially run as a partnering project, in which a design-build contractor was procured to renovate the courtyard, stairwells, industrial kitchen, and restaurant. This contract was a cost-plus agreement with a ceiling price, meaning the contractor was reimbursed for actual costs up to a maximum agreed amount. For the tenant adaptations, however, contractors were engaged through existing framework agreements and operated under traditional construction contracts. These contractors were not procured at a fixed price either; instead, the work was carried out within a predetermined budget. No financial incentives were included in any of the contracts.

The various construction firms were procured entirely separately, each under different contracts. However, an external construction manager was hired directly by the client and worked across both contract types, with a more prominent role in the traditional construction contracts, where they oversaw the entire project. The architect was also involved throughout the process, collaborating with both the client and the various contractors. When the design-build contractor was procured, it was a requirement that the same architect from the early stages continue with the project. As a result, the architect was involved from the concept phase through to final inspection.

### 4.3 Triåfabriken

The third case project examined in this thesis is Triåfabriken, a former knitwear factory building from the early 1900s located in Malmö, Sweden. Over the years, the building had undergone several extensions, with the most recent addition dating back to the mid-20th century. Since the factory's closure in the 1980s, the building had become rather worn and was occupied by various types of cultural workers. Previous adaptations had been carried out in a highly localised manner, resulting in a fragmented structure. At the same time, there were strict

requirements from the Malmö Museum regarding the preservation of the building's cultural and historical values as it was redeveloped and upgraded into modern office spaces. Images of the building before and after the redevelopment are shown in Figure 4.3.



**Figure 4.3:** *To the left, a picture of Trikåfabriken before the renovation. To the right, a picture of Trikåfabriken after the renovation. Photographs by Sofia Lagerblad, republished with permission.*

The project was part of a pilot initiative and among the first renovation projects in Sweden to include climate calculations. It began with a non-compliant planning status, meaning that essentially no changes were allowed. The team also had to work within the constraints of an existing detailed development plan, as there was no time to revise it.

The renovation encompassed approximately 5,500 square meters and took place between 2021 and 2022. One of the main tenants is the architectural firm that was also responsible for the project's design. The project placed strong emphasis on preservation and restoration. As the premises were largely empty, there were limited amounts of materials available for reuse. The primary elements reused within the project included wooden flooring, bricks, and windows. Rosette vents, mouldings, and a few individual doors were also reused where possible. In addition to internal reuse, a significant amount of material was sent to reuse depots, although no reused materials were purchased from external suppliers.

#### 4.3.1 Project Organisation and Procurement in Trikåfabriken

In the Trikåfabriken project, the client collaborated with a design-build contractor under a partnering agreement with incentives. This general contractor was responsible for contracting most of the project team, including the architect, other design consultants, and various

subcontractors. In total, the organisation comprised approximately 20 subcontractors. Additionally, a few side contractors were procured separately, directly by the client.

The architect was involved from the early stages, initially working directly for the client. When the design-build contractor was brought on board, the client required that the same design consultants, including the architect, continue with the project. As the architect was also a tenant, it was particularly important for them to remain engaged throughout the entire process. The client also maintained a direct agreement with the architect in parallel with the design-build contract, enabling them to influence certain aspects of the design throughout the project.

Overall, the client organisation remained highly involved, actively participating in decision-making and follow-up. The procurement documents clearly stated that the design-build contractor was expected to promote reuse and that certain decisions required client approval. Contractors were awarded extra points in the tender evaluation for proposing creative solutions for reuse from a production perspective. They were also eligible for a percentage share of a negotiated profit margin if they met three main criteria – one of which was reuse. Furthermore, they were given clear instructions to procure their subcontractors with incentives for reuse.

## 5. Results

In this chapter, the main findings from the interviews are presented. The results are organised thematically and address all three case projects collectively. The first two sections focus on the project organisation and the procurement strategies used. The third section identifies and describes eight main types of reuse activities. Finally, the fourth section highlights general challenges and success factors that emerged from the interviews.

### 5.1 Project Organisation

Two projects (Werket and Trikåfabriken) were carried out through partnering with a design-build contractor, with some side contractors procured separately, while one project (Lumi) used a divided contract setup, in which most contractors were procured through traditional construction contracts.

**Partnering:** Several interviewees with experience in partnering mentioned that it can create favourable conditions for reuse. For instance, C1 viewed it as an advantage that the client organisation became more actively involved and was able to provide clear direction throughout the project. According to B4, partnering enabled a different kind of dialogue and a joint focus on achieving the best outcomes for the project. It also allowed certain aspects to evolve during the process, as not everything had to be defined from the start.

However, neither of the partnering projects were entirely free of challenges. According to B3, it would have been better to allow more time during phase one, so that more aspects could have been resolved during the design stage, reducing the need for changes later. Instead, B3 felt that things were rushed, and the focus was on moving forward quickly. The construction side had clear incentives to keep to the schedule, as the setup included penalties for exceeding the budget. B3 believed it could have been a better partnering project if risks, opportunities, and profits had been shared more equally – enabling the team to dedicate more time to design development.

B1 agreed that there were certain challenges associated with working in a partnering setup with a cost-plus agreement and a ceiling price, as neither the client nor the contractor were particularly accustomed to this way of working. It became difficult for the contractor to operate with such a high level of ambiguity, and in some cases, the client and the contractor had

differing views on what constituted a variation order and what did not. C2 also noted some drawbacks of bringing in a design-build contractor to take over responsibility, as this gave the contractor considerable influence over how things were to be executed, which not necessarily aligned with the architect's priorities.

Moreover, the advantages of partnering also appear to be achievable under other contract and procurement models. Both B1 and B4 described strong collaboration and the ability to implement changes and make quick decisions, even when working with the framework agreement contractors involved in Werket. This flexibility was largely attributed to the fact that these contractors were working to a budget rather than a fixed price. B1 further highlighted that success depends on having the right company or organisation in the appropriate role. While the larger design-build contractor was well-suited for managing the more complex aspects of the project, the framework agreement contractors proved more effective for handling tenant adaptations.

**Other contracts:** The Lumi project, however, used a quite different project setup with a divided contract structure and a CM consultancy firm managing the construction process. According to A1, this was advantageous as it gave the client more control and provided greater flexibility throughout the process compared to working with a general contractor.

*“I don't believe this would have worked well with a large contractor – they tend to focus more on risks, and since this project was essentially all about risk, it would have been a bit more difficult.”*

– Quote by A1

A3 also believed that the contract setup with a divided contract worked significantly better than a traditional setup with a design-build contractor, as it made it easier to have direct discussions with the client. Since there were some sudden changes regarding which elements would be reused, the flexibility and close collaboration between the client and the CM consultants leading the process proved beneficial. According to A3, such changes would likely have been much more complicated under a different procurement model.

Although the overall process worked very well, A4 identified some potential for improvement in the organisational setup of the Lumi project. Specifically, there was no dedicated reuse coordinator, which A4 believed would have facilitated the process. Instead, five to six construction managers each handled reuse within their respective areas, but no one held

overarching responsibility for reuse-related matters. In hindsight, A4 felt that such a role should have been established from day one. A general lesson from the project was therefore the importance of organising effectively around reuse and conducting thorough planning, especially in large-scale reuse projects.

In all three projects, the same architect was involved from start to finish – something that B1 described as a major advantage. According to B1, architects are often considered expensive and therefore involved for as short a time as possible. However, to succeed with reuse, it is necessary to keep them engaged further into the process.

**Project roles:** It is also worth noting that many interviewees had broader and more extensive responsibilities than their official roles on paper, indicating that the scope of traditional project roles is somewhat changed when working with large-scale reuse. For example, A3 described their formal role as digitalisation lead and assistant project manager, but in practice, they were also responsible for procurement and contracting. A4 also noted that the organisation had a flat structure where formal roles were less emphasised:

*“I would not say that it is merely a name on paper, because that is not the case – there is a function, and one is expected to fulfil it. However, since the company and the organisation are mine, I simply take action where I see that it is needed.”*

– Quote by A4

Similarly, B2 explained that although they did not formally hold a project management role, they ended up acting as a kind of coordinator across disciplines, ensuring cohesion throughout the process. When other consultants were less experienced in designing for preservation or reuse, the architects had to support them as well – without being patronising. As a result, the architects became involved in most aspects of the project, driven by a strong desire to do what was best for the project.

## 5.2 Procurement

**Selection of consultants and contractors:** Several interviewees mentioned that more careful procurement work was required when selecting consultants and contractors for a reuse project. In all three case projects, consultants were handpicked, and in two of the projects (Lumi and Werket), a similar approach was taken for selecting contractors.

In the Lumi project, it was described as essential that both contractors and consultants shared the client's vision – otherwise, the collaboration would not proceed. As a result, the procurement process required greater attention and care. From A1's perspective, the procurement of contractors was more similar to hiring individual consultants – with a greater focus on personal engagement, interviews, and a more individual approach. Thus, they ensured the formation of an engaged and motivated project team.

Similarly, in the Werket project, both contractors and consultants were handpicked for each assignment, resulting in a procurement process that was less strictly followed than usual (B1). In the Trikäfabriken project, consultants were also handpicked and involved throughout the entire process (C1), whereas contractors were procured more traditionally, based on the lowest tender (C2).

**Clear requirements:** In both Lumi and Trikäfabriken, great emphasis was placed on clear requirements and thoroughly developed request documents – particularly in Lumi, where traditional construction contracts were used.

According to A2, the extent of what was requested and how requirements were specified varied, but regardless, the architect was expected to provide the necessary documentation for the contractors to be able to prepare their tenders. By having the architects spend more time compiling a detailed list of the requested materials, the contractors were spared from doing manual calculations, allowing more of them to take the time to submit a tender. In addition, the tenders became more comparable, as they were based on the same figures rather than on each contractor's individual assessment of the documents (A2). For example, it was explicitly stated that contractors installing reused gypsum boards had to price with two workers per board, considering that the reused boards provided by the client were very heavy (A4).

From C2's perspective, the tender documentation could have been slightly more detailed, but that would have resulted in a different price.

*“The tenders were quite competitive. We generally prefer not to select the cheapest option, because it is often not the best; instead, you should select the one that is most realistic. However, for the client, there were probably no alternatives – the lowest price ultimately determined the outcome.”*

– Quote by C2

Instead, the project team had to focus on establishing certain fundamental conditions and articulating these requirements as clearly as possible. For instance, the contractor was prohibited from using cement mortar and was instead required to use lime mortar (C2).

According to B4, such detailed requirements are less important in a partnering contract. However, it is crucial to include reuse in the initial project scope to ensure that the team can rely on the fact that the contractor was procured with that condition in mind. To the extent possible, B4 also noted that it is beneficial to carry out preparatory work and investigations to define in the documentation which products should be prioritised for reuse. When working with partnering, this does not necessarily need to be as concrete, but it is helpful if, for instance, the project's terms and conditions outline that the team will collaboratively identify how to approach reuse. In this case, it was not entirely clear how reuse would be implemented when the procurement documents were drafted, so the client instead stated more generally that reuse would be pursued to the extent possible (B4).

**Financial incentives:** Only one of the projects, Trikäfabriken, implemented financial incentives for reuse in the contractual agreements (C1). In the other two projects, the client did not consider such incentives necessary. Instead, alternative strategies were employed to ensure that reuse remained a central focus throughout the project.

*“You can offer financial incentives or impose penalties – there are many possible approaches – but I genuinely believe that the most important thing is to establish a shared vision.”*

– Quote by B1

This meant that in Werket, there were no direct financial incentives for the design-build contractor to engage in reuse if it led to additional costs – at least not from a purely economic perspective. Nonetheless, there was a mutual interest on both sides in identifying reuse opportunities, as the project was carried out in partnering form and the contractor had been procured with the expectation of incorporating reuse (B3).

In the Lumi project, the client organisation explicitly specified which products were to be reused. In this way, the contractors were clearly directed to incorporate reuse, even without the use of financial incentives.

**Warranties:** Warranties also became a topic of discussion during the procurement phase in all three projects, given that the contractors were expected to work with reused products. As these

products were provided by the client, the client in the Lumi project assumed responsibility for the warranties on the reused items (A1). This arrangement meant that the contractors only provided warranties for the installation, not the products themselves (A4).

A similar approach was adopted in the Werket project. According to the client, it was difficult to determine the scope of warranties when certain components were reused (B1), and the contractor was unwilling to provide warranties for reused products (B3). As a result, the client received a warranty for the execution but not for the product when requesting the contractor to use a reused item (B4). However, since the client was prepared for this outcome, it did not become a significant issue; rather than receiving a product warranty, they benefited from a lower purchase price (B3). From the client's perspective, the reasoning was that for every additional year a reused product remains functional, it adds one more year of value that would have been lost if it had simply been discarded (B4).

Unlike the contractors in the other two projects, the design-build contractor in Trikåfabriken did not perceive any difficulties in providing warranties for reused products:

*“We provide the usual warranties as we would for any floor, because the products used are of such high quality. Actually, the floors that were already there were better than most of the new ones you can buy today. So it was not difficult to provide warranties. We offer our standard five- and ten-year warranties on all materials, and we applied the same to the reused materials as well.”*

– Quote by C3

### 5.3 Reuse Activities

During the interviews, eight types of activities related to reuse were identified, which were implemented to varying degrees across all three case projects. These activities were: reuse goal formulation, inventory, quality control and test assembly, disassembly, reconditioning, design and planning for reuse, storage and logistics, and reassembly.

### 5.3.1 Reuse Goal Formulation

In all case projects, ambitious goals for reuse were set. However, these were often either relatively vague or deliberately unattainable – typically framed in terms of reusing “as much as possible”, or even “everything”. While such goals were generally introduced in the early stages, it was common for them to evolve and become more clearly defined as the project progressed.

For example, the intention to incorporate reuse in the Lumi project emerged already during the pre-study phase, when the decision was made not to demolish the building. The subsequent step involved identifying additional materials that could be reused, with the aim of transforming the project into a large-scale circular initiative. The goal was essentially to reuse “almost everything”, though it was acknowledged that full reuse was not a realistic expectation. Nevertheless, a wide range of items – both large and small – were identified, and a preliminary list of potentially reusable products was compiled based on an initial assessment.

*“The client and the production team entered with the mindset that 100% was a reasonable vision. We knew we would not reach 100%, but if we did not try, we would never reach 75%. (...) So, the starting point was everything, and then we filtered from there.”*

– Quote by A2

From the production side, there were differing interpretations of what constituted a high degree of reuse. Some considered the goal achieved simply by preserving the structural frame. However, within the context of this project, a high level of reuse was understood to include components down to the screw-and-bolt level. When the client communicated a target of 100% reuse, the production management team interpreted this as a mandate to make every possible effort to maximise the extent of reuse (A4).

In the Trikäfabriken project, the client aimed to establish clear reuse targets, but no measurable figure was ultimately defined (C1). Instead, components were identified through an early inventory process, and priorities were assigned accordingly. Certain elements were mandated for reuse, while others were to be reused if they met requirements concerning safety, fire resistance, and acoustics. While the major elements were determined early on, several decisions still had to be made as the project progressed. The project was guided by a broader vision of adopting circular business models, and the approach was therefore aligned with the waste

hierarchy: prioritising preservation, followed by product reuse, and finally material recycling. (C1).

In the Werket project, the reuse goal was not concretely formulated in numerical terms either. However, it was clear from an early stage that the intention was to work with reuse and to base the design on what was already available in the building. The specific objectives related to reuse evolved gradually over the course of the project (B4). One clearly stated target, however, was for Werket to have 20% lower climate impact compared to a standard reference project, although no specific reuse percentage was linked to this target (B1). Beyond that, the overarching aim was simply to push reuse to the greatest extent possible (B2). As a result, the default approach became to prioritise reused products unless otherwise specified (B4).

The project goals in Werket were jointly developed by the client and architect during the programme phase and were communicated both in written form and through visual mood boards. According to B2, this early articulation of goals was crucial for the project's success. B1 added that visual aids also played an important role in establishing a shared vision and served as guidance in decision-making processes. Moreover, it was decided that two spaces would be built using 100% reused materials, as this was considered more impactful for branding purposes than applying a uniform reuse percentage – such as 20% – across all tenant adaptations (B1). While this was an ambitious target, it proved achievable – ultimately, only a few electrical cables had to be purchased new for those particular spaces.

Interviewees from the Werket project reflected on both the benefits and drawbacks of having relatively vague reuse targets. According to B3, it would have been significantly easier to define from the beginning which materials should be reused and where efforts should be concentrated, rather than allowing these decisions to emerge over time. B4 similarly noted that a more concrete goal could have been formulated but also argued that the absence of strict definitions allowed the team to remain flexible and take advantage of opportunities as they arose. Had specific products been pre-identified for reuse, the team might have limited their ambitions to those items rather than seeking to push the boundaries further wherever feasible.

### 5.3.2 Inventory Process

A common feature across all three projects was that inventories were conducted in multiple stages – typically beginning with a more general assessment in an early phase, such as during

the pre-study or system design stage, followed by a more detailed inventory at a later stage, often in connection with disassembly.

In the Lumi project, all design consultants, the client, and the CM consultants initially walked through the site together to identify which building components might be suitable for reuse. This preliminary, high-level inventory was carried out during the system design stage to gain an overview of available resources in the building and determine reuse priorities based on existing conditions (A2). At the same time, inspection consultants with experience in system calibration were brought in to assist. Certain contractors also contributed by identifying products with reuse potential. Early in the inventory process, it became apparent that a dedicated platform was needed. This led to a collaboration with a startup company that provided a digital inventory tool, allowing all identified products to be tagged and collected in a database (A3).

The more detailed inventory was then led by the CM consultants in collaboration with the startup company (A1). All reusable products were tagged with an ID chip and a physical QR code, and the information was uploaded to a database. In the database, product attributes – such as fire rating, acoustic rating, and dimensions – were assigned. A connection was then established between the database and the Revit model, allowing the inventoried products to be directly integrated into the design process. Part of the project's vision was also to make all products traceable – similar to IKEA's self-service warehouse system (A3).

In the Werket project, an external reuse consultant was initially engaged to carry out a comprehensive inventory using a tool that enabled the project team to access and review the documented materials. However, this material was later perceived as difficult to manage (B1), prompting the client to conduct a supplementary internal inventory for which the architect assumed primary responsibility (B3). The team began with a relatively thorough inventory and continued to document materials as needed throughout the project. This was a largely analogue process, involving extensive photography and note-taking (B2). The client also conducted separate inventories of specific items, such as code locks, while the architects focused on construction materials (B2). The contractor was not significantly involved in the inventory process, but during disassembly, additional materials were collected and stored on site, allowing the architects to inspect and select items as needed (B1, B3). According to B3, this approach had some advantages, but it also led to some redundant work.

In the Trikäfabriken project, the initial inventories were carried out already during the pre-study phase. An internal inventory was first conducted, followed by an assessment by a reuse consultant. However, the outcome indicated that there was very little material suitable for reuse and virtually nothing that was in demand on the reuse market (C1). As a result, the decision was made to instead focus on identifying and reclaiming usable materials incrementally as they progressed through the building. The architects then conducted a design-driven inventory based on the belief that reuse should be integrated with architectural expression. Consultants from other design disciplines also conducted walkthroughs but found it difficult to identify reusable components. The architects, however, identified and listed several elements, although without knowing at the time how they might be repurposed. This inventory served as input to the programme document.

At the beginning of the system design stage, a more detailed inventory was conducted, in which the architects documented components using BSAB classification codes. This is a common Swedish classification system used to organise and manage information throughout the construction process. Items were photographed, labelled, and described in terms of their characteristics and potential for reuse. This inventory formed the basis for the continued design process (C1). Once the contractor was onboarded, they conducted a parallel inventory to determine what they considered reasonable to reuse based on their observations. As disassembly progressed, additional reusable items were discovered. All recovered products were stored in a designated room on site, where project participants could inspect them during the construction phase to determine whether anything could be incorporated.

Several interviewees across the three projects stressed the importance of thorough inventorying for the successful implementation of reuse practices. According to A2, it is particularly important to be meticulous when inventorying doors and glass partitions and ensure all parameters are listed correctly. A3 also highlighted the significance of the person conducting the inventory having a solid understanding of what needs to be matched, as the Lumi project experienced issues with inaccurate measurements in the inventory. For this reason, A3 argued that the client side could have taken greater control over the inventory process by establishing clearer requirements. Moreover, the matching process could have been initiated earlier.

B4 also mentioned that it is important to include reuse inventories from the beginning, partly to ensure compliance with waste legislation and similar regulations. B3 also highlighted the importance of conducting a thorough inventory from the start – and preferably anchoring it with a contractor at an early stage – as a key lesson learned from the project.

According to A1, the Lumi project would not have been feasible without the digital workflow that underpinned the inventory and design integration. The challenges encountered were mainly due to shortcomings in the inventory process itself – specifically, the steps between physically tagging products with QR codes and correctly inputting their attributes into the database. Errors at this stage resulted in considerable additional manual work for the consultants, highlighting an area for improvement. A1 further noted that especially for large-scale reuse, the integration of digital systems is crucial.

### 5.3.3 Quality Control and Test Assembly

Quality control and test assemblies were a major part of the process in the Lumi project. In both Werket and Trikåfabriken, however, quality control was carried out continuously over the course of the project.

Since no critical load-bearing components were reused in the Werket project, B4 explained that the assessment could generally be made visually to determine whether products were of sufficient quality. As a result, quality control was carried out visually and on an ongoing basis. For installations and similar systems, the contractors were responsible for quality assessment, as they were involved in both disassembly and reassembly. However, there was ongoing dialogue and coordination with the client (B4).

*“The process relied on everything passing the final inspection, which would not have been possible if things had not functioned properly, so quality control was performed continuously. At times, something may have been installed and later removed, but it was never a major issue.”*

– Quote by B3

Prototyping and testing were also part of the process in the Werket project. For instance, a carpenter experimented with a dismantled glulam beam, cutting it into sections to test the feasibility of constructing a low wall. He presented the resulting prototype, which ultimately led to all the atrium walls of this kind being built from reused timber based on his design (B1).

In the Trikåfabriken project, quality assessments were conducted both during the initial inventory phase and in connection with disassembly. For example, in the case of steel doors, the fire consultants were initially optimistic and believed that the doors could be reclassified to meet current standards. However, at a later stage, difficulties arose when attempting to install

modern locking systems, ultimately preventing the reuse of the doors (C2). To ensure the quality of the flooring, a specialist was brought in to take various samples, after which the client had to assess whether the results could be considered reliable (C1). Additionally, an inspection organization was engaged to carry out ongoing inspections during the final six months of the project. This allowed for supplementary quality checks to be performed as needed, thereby providing the contractor with confidence in fulfilling their warranty obligations (C1).

The Lumi project employed a somewhat different approach compared to the other two cases. To ensure that the reuse of building components would be feasible, full-scale 1:1 mock-up rooms were constructed using the reclaimed products that had been identified for reuse. This allowed the team to test, for example, whether reused doors, glass partitions, and walls met the required acoustic standards. In cases where they did not, further investigations were conducted to determine what measures would be necessary to bring them up to standard. This work was carried out while the basic building design was still in progress, before an investment decision had been made.

From A3's perspective, one major advantage was having access to large spaces for quality testing; the vacated premises were essentially used as a workshop where, among other things, radiators were pressure-tested and electrical boxes repainted. Contractors also tested the disassembly and reassembly of suspended ceilings and gypsum walls at an early stage. It then turned out that dismantling gypsum took not significantly longer than traditional demolition, while also providing a better working environment (A2). According to A1, involving contractors at this stage is essential in order to develop viable working methods for reuse.

By constructing mock-up rooms at an early stage, the project team developed a clearer understanding of what the final result might look like and were better equipped to find workable solutions. Already at this stage, the idea began to take root within the project that it was necessary to challenge long-standing assumptions by testing them in practice.

*“Already at that stage, it began to settle into most people's mindset: now we have built mock-up rooms, we have tested it, and it works. Few had actually believed it would. So when the next bold idea emerged, the approach was no longer to dismiss it outright, but rather to ask: how can we test it?”*

– Quote by A4

For example, the project involved brick walls that the acoustic consultant initially assessed as unsuitable for reuse. However, the team decided to challenge this by commissioning an acoustic measurement to obtain definitive data. The results exceeded expectations, and the consultant was genuinely surprised. According to A4, this was one of those “aha moments” that demonstrated the importance of daring to question conventional wisdom.

### 5.3.4 Disassembly

In both Triåfabriken and Werket, the contractor responsible for disassembly also carried out the reassembly, whereas in Lumi, separate contractors were procured for these two stages. The original intention had been for the disassembly contractors to also handle the reassembly, but this did not materialise as the scope of the assignment proved too extensive for these contractors. However, the same suspended ceiling contractor was involved in both the disassembly and reassembly phases in Lumi.

According to B4, in small-scale projects it can be beneficial to have the same contractor handle both disassembly and reassembly, but in large-scale projects this becomes less important. Nonetheless, there is a certain incentive for the disassembly contractor to be more careful if they know they will also be responsible for reassembly. Therefore, B4 argued that either the same contractor who will carry out the reassembly should perform the disassembly, or a dedicated disassembly contractor should be engaged. B4 also added that much depends on the type of product involved. For example, the suspended ceiling contractor in Werket insisted on dismantling the ceiling support structure themselves if they were to reinstall it, so they could ensure proper handling and keep track of all components. In contrast, for the reuse of other products, such as doors, B4 stated that having different contractors is not problematic as long as the disassembly is performed correctly.

In the Lumi project, it became evident during the construction of the mock-up rooms that not just any demolition contractor could be brought in for the disassembly work:

*“That was when we had to begin evaluating – who is actually suitable for performing these tasks? And it is probably not demolition contractors who should be taking down the suspended ceilings; perhaps it should be ceiling installers. If electrical products are to be removed, then maybe it should not be a demolition contractor either, but rather an electrician. Of course, that is significantly more*

*expensive per hour. But at the same time, we wanted some form of quality assurance for the components we were dismantling and intended to reuse. And that was precisely what we felt we achieved when we engaged skilled professionals for the disassembly.”*

– Quote by A4

The contractors who carried out the disassembly in Lumi also played an important role in the inventory process. The dismantled materials were packaged on pallets, after which the workers moved around with scanners and entered the data into Excel lists (A3).

According to B1, problems were encountered in the Werket project due to the careless handling by those performing the disassembly – they were accustomed to demolition rather than careful dismantling. B3 noted that it was difficult to motivate the workers to handle materials with care if they were unaware of the intended reuse of the components. This resulted in careless handling of, for example, façade glass, some of which was damaged. To counteract this, the project team attempted to specify, to some extent, how much of each product type needed to be preserved, so that the contractors would not feel as though items were merely being saved “just in case” (B2).

In Triåfabriken, the disassembly of the wooden flooring proved particularly challenging due to it being partially glued. According to C2, it would have been beneficial to engage a specialist contractor, but this was not feasible within the project’s budget. Consequently, the general contractor was tasked with the disassembly. Despite the difficulties, a large portion of the flooring was successfully reused. However, the process was time-consuming – according to C3, there is a significant difference between careful dismantling and demolition. Additionally, the dismantled materials required handling, which further increased costs, although C3 emphasised that they have already learned how to manage this more effectively.

A4 also pointed out that dismantling in a careful and orderly fashion results in higher demolition costs, as opposed to using machinery such as a Bobcat. At the same time, A2 highlighted that part of this cost is offset by savings from not having to purchase new materials. This somewhat aligns with B2’s observation that dismantling glass panes is much more time-consuming – and therefore more costly – than demolishing them, but that it provides other forms of value in return.

### 5.3.5 Reconditioning

In all case study projects, certain products were reconditioned or restored in some way prior to being reinstalled. This became particularly important in the reuse of products such as doors and glass partitions, which were reused in both the Lumi and Werket projects. In the Lumi project, all doors and glass partitions underwent some form of treatment, either at a paint workshop or by a specialist joinery firm. According to A3, this resulted in significant cost savings, as the refurbishment measures were relatively inexpensive compared to purchasing new doors and partitions.

Similarly, in the Werket project, doors were sent for repainting – sometimes over a single weekend while the spaces were still being rented out – which led to a significant quality improvement with relatively simple means (B1). However, B1 also noted that processes such as repainting doors can be time-consuming, so it is important to plan for this and ensure a smooth workflow. B3 further emphasised the benefit of contacting the party responsible for processing the materials at an early stage and establishing what is feasible in order to understand from the outset what can be done with the products.

In the Triksåfabriken project, such products were not successfully reused within the project; however, original windows were restored to meet modern standards before being reinstalled.

### 5.3.6 Design and Planning for Reuse

Several interviewees from both the Werket and Lumi projects noted that the design process changed significantly when working with reuse.

In the Lumi project, a high degree of digitalisation was applied, with a direct connection between the database of inventoried materials and the Revit model used by the consultants. If the architect working on the model needed a door with certain properties, such an item would be selected from the database and automatically removed from the inventory. Once placed into the model, it was expected to include all relevant attributes (A1).

According to A2, the design process took considerably longer when working with reused materials, as it involved first drafting an approximate design, then checking what materials were available, and finally going back to adjust the design to fit. Since they had access to all the building components themselves, A2 likened the design process to creating a new image from

the same puzzle pieces. A significant amount of time was also spent on detailing, particularly since the project was modelled with quantities, making precise design especially important.

The architect in the Werket project also experienced challenges with traditional design methods (B2). As a result, more decisions were made on-site using hand sketches and discussions, rather than through conventional design documentation. Much of the design was shaped by the materials that were found, rather than starting from a fixed concept. This meant that design decisions extended further into the construction process than is typical (B1).

According to B4, involving the architect and maintaining an ongoing dialogue throughout the construction phase is crucial in reuse projects, as it often becomes necessary to redraw, rethink, and revise solutions as the project evolves. Without that flexibility, more extensive investigation would have been needed earlier on to ensure that reused products were identified and integrated from the beginning (B4). From the contractor's perspective, however, there was a desire for more time to finalise the design before entering production, as this phase is typically fast paced and demanding, leaving little room for creative problem-solving (B3).

In the Lumi project as well, design work was still ongoing when construction began. A2 noted that it was challenging to be designing so close to production, but it also enabled a closer collaboration between contractors and designers, as builders could return to the design team with questions and feedback. Close coordination among the various design disciplines also proved essential in the project.

### 5.3.7 Storage and Logistics

Since all three projects involved renovations of at least partly vacant buildings, there was an opportunity to store dismantled products on-site – something many interviewees emphasised as a significant advantage.

In the Trikafabriken project, a dedicated space was established early on to manage products with reuse potential. It was deemed necessary to consolidate all products in one location, as tenants still occupied parts of the building and were gradually relocated within it as the project progressed (C1). This space, located in the basement, was referred to as the “reuse museum.” There were no external storage facilities; all dismantled products intended for reuse within the project were stored on-site (C3).

In the Werket project, finding adequate storage space was challenging, as the goal was to avoid transporting materials back and forth between multiple locations (B2). Fortunately, because the entire building was to be vacated, many dismantled items could be stored in the basement, where a 600 m<sup>2</sup> reuse room was eventually established. However, this space was not available at the start of the project; it emerged later in response to growing needs. Until then, storage was difficult, so securing on-site storage became an important enabler for reuse (B2, B3).

An off-site storage area was also used for items like bricks and other heavy products that could withstand outdoor conditions. This solution, too, was not in place from the beginning. Initially, such materials were stored in the courtyard, but as the volume increased, this became unmanageable, and the decision was made to relocate them off-site. While this led to additional transportation, it had the benefit of keeping the construction site clear (B3).

B1 saw it as an advantage to have a decent amount of space available for stockpiling materials but also pointed out that stacked materials were prone to damage. According to B3, handling the reused materials was the most challenging part of the project. A suggested improvement was to have had intermediate storage areas on each floor under construction, thereby avoiding repeated elevator transport, which increased the risk of damage. Nevertheless, the ability to store reused materials on-site was widely seen as a major benefit (B3).

In the Lumi project, an entirely vacant block was available for storage, allowing dismantled materials to be stored in an adjacent building until they were ready for reinstallation. When that time came, pallets of materials could simply be rolled over. As there was uncertainty about whether the same premises would be available throughout the entire project, the tagging system was introduced to allow easy relocation of materials while maintaining inventory control. According to A3, this system ultimately worked very well.

A logistics hub was also established within the Lumi project, using loop vehicles that came two or three times a week to deliver goods and collect waste in the same trip. Since both new and reused materials were transported in the same vehicles, working with supplied reused materials posed little difference for contractors – aside from being subject to separate pricing lists. Other than the logistics hub, no external storage facilities were used.

The main logistical challenges experienced in the Lumi project related to the order of deliveries (A3). For example, it was expected that items would return to the site in the same sequence they were removed, but in practice, items were sometimes placed on the wrong pallet or pallets

were returned in the wrong order. Such human errors also need to be anticipated and managed, according to A3.

### 5.3.8 Reassembly

In both the Werket and Trikåfabriken projects, the same contractor who disassembled the products also carried out the reassembly, whereas in the Lumi project, new contractors were brought in for the reassembly. According to A3, it was important that contractors who had not been involved in the disassembly were fully aware of what working with reused products would entail.

In Lumi, the digital process – from inventory and design to construction – was maintained all the way through the production phase. Workers used phones and iPads on-site, building according to the digital 3D model. It was a live model accessible to both production teams and designers, allowing designers to stay involved in discussions and coordination around the materials even during construction (A2). This was a new way of working for many on the construction site – not only were they dealing with reused materials, but they were also building entirely without paper drawings. According to A4, few contractors were enthusiastic at the outset, so some persuasion was needed, but once the work got underway, it functioned well.

In the Werket project, the construction phase did not feel significantly different from a typical project once it was underway (B2). However, B1 noted that implementing a “just-in-time” approach proved more difficult, requiring a different kind of planning to ensure a smooth workflow.

## 5.4 Challenges and Success Factors

In addition to what was discussed in relation to organisation, procurement, and various reuse activities, the interviewees also shared more general reflections on challenges and success factors in the projects. These reflections, which cannot be directly linked to a specific activity, are presented in this section.

### 5.4.1 Culture and Collaboration

For instance, factors related to culture and collaboration were mentioned by many interviewees both when discussing the largest challenges and the most important success factors in their respective projects.

**Project culture:** This partly concerned the general attitude and willingness to work with reuse. For example, A1 felt that they initially had to push many people forward, but that the industry has since moved ahead – making it easier to start a similar reuse project today. B2 and A4 also noted that generating willingness to work with reuse was a major challenge at the beginning. However, once that willingness was established, it seems to have been a key success factor. According to A2, it was crucial for the project that both the client and production management had the mindset to truly dare to try and not retreat at the first sign of friction. Moreover, A2 argued that it makes a significant difference to have a client who also considers the management and operation of the building, rather than planning to sell it for maximum profit as soon as it is completed. On the client side, A1 described that efforts were made to work with individuals and companies who were enthusiastic about being part of a reuse project.

**Collaboration and shared vision:** Interviewees from all three projects also emphasised good collaboration and a shared vision as critical factors for successful reuse. According to B2, it is important to engage people at every level – from top decision-makers to the workers on-site. One strategy is to identify ambassadors at different levels who can champion the vision and help build a committed team working toward the same goal. B3 particularly emphasised the importance of establishing early understanding among the construction workers so that they, too, can see the end goal of the reuse effort.

**Resistance:** In some cases, there was resistance from tenants, and it was generally considered difficult to sell something that was not brand-new while still charging premium rents – according to A3, the leasing agents felt like they were trying to sell a Ferrari but delivering a Skoda. However, by creating a theme around the reuse concept, B1 felt that it became more acceptable. A1 even argued that reuse had a positive effect in attracting tenants. Nonetheless, A4 stressed the importance of communicating with future tenants early on and building an understanding of what it means to receive reused products – that they will function the same as new ones, but may have minor scratches, blemishes, or other visible signs of previous use – so that tenants are aware of this from the start.

## 5.4.2 Regulatory Hinders

In all three projects, problems arose because older products did not meet modern standards, which complicated reuse efforts. This included requirements for accessibility, fire safety, and acoustics that were difficult to satisfy. Many interviewees specifically mentioned such challenges in relation to the reuse of doors. For example, in the Lumi project, they faced issues with door opening widths that were just a few centimetres too narrow to meet new requirements introduced in 2020 – despite having installed new hinges to widen the openings and demonstrating that all types of wheelchairs and mobility scooters could pass through:

*“This door standard essentially means that everything built from the 1970s until perhaps just a few years ago would now have to be discarded, resulting in a significant amount of material waste – simply due to what could be considered an unreasonable 1.5 cm shortfall in the required clear door opening. I believe we looked at the widest mobility scooter available globally, which requires a clear width of 65 cm, yet the regulation mandates 80 cm. That leaves a very generous margin, and it seems entirely unreasonable for so much material to be discarded because of that. For this reason, the municipality ultimately informed us that they would not deny us approval, despite the fact that we did not meet the 80 cm requirement.”*

– Quote by A3

In the Werket project, it was instead new fire gas-sealing requirements that posed challenges when attempting to reuse steel doors from the 1980s. According to B1, it took a lot of effort, but eventually, they managed to get the fire consultant to inspect the door in person:

*“He concluded that yes, it was indeed an A60 door, and it had hinges on it, so it was practically impossible to remove – it was even cast into the wall. You cannot buy a door like that today, so it had to be possible to retrofit it with proper sealing. He therefore certified it on-site. We installed special sealing strips, and the door was approved – but I am only permitted to use it at Werket. I could not relocate it to another property, as it would not be considered compliant in that context”*

– Quote by B1

B1 considered this a textbook example of how you must fight a lot of battles to make progress. It could also involve acoustic requirements and similar issues. For example, when dealing with

major tenants, their specifications for acoustic classes were hard to prove compliance with, according to B1. In the Lumi project, that challenge was one reason for building mock-up rooms – to test whether the reused materials met tenant requirements for aspects like sound class.

In the Trikåfabriken project, they managed to improve the energy coefficient of original early 1900s windows by installing new inner sashes, which enabled them to meet the BBR energy requirement. Moreover, they had to fight for approval of stairwell railings based on safety standards:

*“If you also have to meet every requirement in accordance with modern office standards, then the stair railings do not comply with safety regulations, and we had to fight quite hard on that point. From our perspective, child safety is not necessary in this context, but the final inspector thought otherwise – they assume children could be present and always apply the strictest possible interpretation to protect themselves legally. Accessibility is also one of those issues. Naturally, accessibility must be ensured, but that becomes challenging in a 120-year-old building. So, some degree of adaptation is necessary.”*

– Quote by C2

However, none of the projects reported any issues with obtaining building permits due to working with reused materials.

### 5.4.3 Economic Hinders

Finally, interviewees from both Werket and Trikåfabriken mentioned financial factors as barriers to reuse. According to B1, reuse can be economically viable on a smaller scale, but when scaling up, it becomes difficult to access enough materials, making the process increasingly complex and costly. Even though Trikåfabriken was a somewhat smaller project, both C1 and C3 expressed that the project’s financial viability was challenged by working with reused materials. At the same time, the economic impact appears to depend heavily on the type of products being reused. B1, for example, stated that reusing ceiling tiles was roughly twice as expensive as purchasing new ones, whereas B3 noted significant savings from reusing door closers:

*“If you take a door closer as an example, the purchase price is around 5,000 SEK. Dismantling one does not take long, maybe half an hour, so the reused product ends up costing about 250 SEK instead of 5,000. And it might last another 20 years. Eventually, you will have to buy a new one, but by then, you have saved that money for 20 years. So of course it is justified.”*

– Quote by B3

In the Lumi project, A2 described that it was estimated that by retaining the structural frame and foundation, the construction time could be reduced by two years, resulting in two additional years of rental income. Similarly, B2 argued that it would have been significantly more expensive to demolish the entire Werket building and construct something new, compared to working with preservation and reuse. Thus, the perceived cost of reuse depends largely on the reference point. At the same time, A2 emphasised that reuse is primarily a matter of sustainability, and that as long as the overall financial outcome at least breaks even, working with reuse is worthwhile.

## 6. Discussion

In this chapter, the interview findings presented in the previous chapters are discussed in relation to the theoretical framework. The first section addresses contract types and procurement strategies for reuse. The second section examines the design and construction process for reuse. The third section discusses barriers to reuse, with a focus on how these can be overcome.

### 6.1 Contract Types and Procurement Strategies for Reuse

The case projects included in this study used different contract types and procurement strategies. In the Lumi project, traditional construction contracts were used, and a CM firm was engaged to oversee the design and construction process. According to Lingegård et al. (2021), traditional construction contracts give the client greater control over quality and detailed solutions, which also places the responsibility for finding innovative solutions on the client organisation. Similarly, the CM consultants in Lumi carried significant responsibility for driving innovation within the project. In the procurement process, clear requirements for reuse were established: the client organisation specified which products were to be new and which reused, and provided all reused products. This enabled full control over the reuse level.

The CM approach with traditional construction contracts was highlighted by interviewees from the Lumi project as particularly well-suited for reuse. However, it may not be appropriate in all reuse projects, as it relied on the involvement of experienced and committed consultants to support the client. It also required significant effort from the client and their consultants.

A different approach was taken in the Trikäfabriken and Werket projects, both of which involved partnering agreements between the client and a design-build contractor. This arrangement allowed contractors to participate in identifying reuse opportunities, which was actively encouraged in both projects. Lingegård et al. (2021) similarly note that design-build contracts allow contractors to develop innovative solutions, which can help ensure feasibility. This is especially suitable for clients lacking the expertise or resources to lead innovation themselves. However, for this approach to effectively support reuse, contractors must be procured with the right incentives.

Incentives are crucial as it is more difficult to define specific reuse requirements for a design-build contractor procured before the design is finalised; at that point, the extent of reuse and the applicable requirements may still be unclear. Therefore, it is important to ensure that the contractor will actively contribute to reuse efforts, rather than doing the bare minimum. Several previous studies recommend using financial incentives to promote reuse (Gerhardsson et al., 2019; Göteborgs Stad, 2020; Nordby, 2019; AlJaber et al., 2023). However, the case studies suggest that financial incentives are not always necessary in practice. Of the three projects, only Trikäfabriken used financial incentives, while Werket found other ways of encouraging the design-build contractor to implement reuse, and Lumi used a model where such incentives were less relevant. This indicates that there are multiple ways to ensure contractors engage with reuse. What matters most is that the contractor is given the opportunity – and encouragement – to prioritise reuse. If the client signals that cost and speed are the top priorities, reuse is unlikely to be prioritised.

In addition, the choice between a divided contract and a general contract structure determines whether the client engages directly with individual contractors or delegates that responsibility to a general contractor (Boverket, 2024b). This choice influences the client's ability to set specific requirements for contractors and subcontractors. All three case projects employed multiple parallel contractors to some extent. Trikäfabriken consolidated most of the work under a general contractor, with only a few additional side contractors. Lumi used a divided contract setup in which all contractors became parallel actors. Werket divided the contract between a design-build contractor and contractors from the client's framework agreements. Since the general contractor in Trikäfabriken procured their own subcontractors, the client had less control over those contracts. However, the general contractor was required to procure subcontractors with reuse incentives, helping to align priorities across all levels of the project.

Overall, interviewees described the procurement process as requiring more attention and care – especially when selecting consultants, but also when choosing contractors. This was essential both to enable strong collaboration and to ensure motivation to work with reused products. As a result, most contracts were awarded based on criteria beyond just lowest price, and many organisations were handpicked for their assignments. In Trikäfabriken, however, the contractor was procured through a traditional competitive tender focused on price, though additional points were awarded for innovative ideas regarding circularity and reuse.

As previous research has noted, warranties must also be addressed during procurement to avoid uncertainty (Gerhardsson et al., 2019; Ericsson et al., 2024). Gerhardsson et al. (2019)

recommend providing separate guidelines for warranties and quality assurance of reused materials. Similarly, Ericsson et al. (2024) suggest that responsibilities may need to be redefined in reuse projects, since obtaining warranties for reused products is often difficult – creating uncertainty around performance and liability. According to the interviewees, warranties were discussed in all three projects, but it did not lead to any major conflicts. Most interviewees felt it was natural for the client to take on that responsibility, and most clients only expected warranties for the installation of reused products – not the products themselves. However, in Triåkåfabriken, the contractor did agree to provide standard warranties on the reused wooden floor. This may be due to the product's simplicity and low risk; if more complex or load-bearing components had been reused, the discussion would likely have been more difficult.

**Partnering:** Another strategy to address uncertainties related to reuse is the use of partnering. This approach is widely recommended in previous research, for instance by Ahmed et al. (2024) and Ericsson et al. (2024), but the experiences from the case projects were not entirely positive. According to Black et al. (2000), the success of partnering depends on mutual trust, effective communication, commitment, a clear understanding of roles, consistency, and a flexible attitude. It also requires greater sharing of risk, rewards, resources, and knowledge (Bresnen et al., 2025). However, the interview findings suggest that these conditions may not have been fully present in either of the two partnering projects. For instance, a contractor in the Werket project described a setup involving penalties for exceeding the budget, indicating that risks and rewards were not equally shared between the client and the contractor. Thus, although several interviewees argued that partnering can create favourable conditions for reuse, there appears to be room for improvement in how it was implemented in the case projects.

As Bresnen et al. (2025) note, there is no clear and universally accepted definition of partnering, which means that project stakeholders may hold different understandings of what it entails. This ambiguity can hinder both its practical implementation and the evaluation or comparison of partnering projects. Therefore, it is difficult to assess the overall suitability of partnering for reuse projects based on these case studies alone. Additionally, there seemed to be a conflict in the Triåkåfabriken project between the clients' desire for close collaboration with the contractor and the fact that procurement was based on the lowest price – a tension also highlighted by Bresnen et al. (2025). For partnering to be more successful, less emphasis may need to be placed on price alone during procurement.

Moreover, the benefits typically associated with partnering also appear to be achievable under other contract and procurement models. This suggests that a collaborative mindset and open

communication are what matter most – not the partnering contract structure itself. It is also possible that the success of collaboration depends more on soft factors, such as organisational culture, than on hard factors like contract type. Therefore, it can be concluded that simply choosing a partnering setup does not automatically create favourable conditions for reuse; successful partnering requires deliberate effort from both parties to foster a collaborative environment. This aligns with the findings of Oliveira and Lumineau (2017) who suggest that the use of a partnering contract alone is insufficient to improve project performance, and that the benefits of partnering can be achieved without explicitly committing to partnering. Black et al. (2000) also note that partnering will not succeed unless all project participants adopt new mindsets and actively contribute to enhancing efficiency, success, and reducing conflicts.

**Project roles:** According to Ericsson et al. (2024), implementing reuse requires the establishment of new roles and responsibilities. Similarly, several interviewees indicated that traditional project roles shifted with the introduction of reuse. For example, interviewees from both the Werket and Lumi projects described how they assumed responsibilities beyond their formal roles. This shift may be partly due to strong personal commitment, but it also reflects the emergence of new tasks and areas of responsibility related to reuse – tasks that do not clearly fall under any existing role, particularly when no dedicated reuse coordinator is appointed, as was the case in all three projects. While this topic was not the main focus of the study, one interviewee suggested that a dedicated reuse coordinator should have been appointed early on to better support the process. However, since none of the other interviewees raised this point, it remains unclear whether it is more appropriate to create new, dedicated reuse roles or to integrate these responsibilities into existing ones. Regardless of the chosen approach, a clearer division of responsibilities is likely to be beneficial.

Another common feature across all three case projects was the extended involvement of the architect, who remained active further into the process than is typical. This appears to be necessary, as reuse often demands a more flexible design process. Additionally, involving the same actors from the early stages through to project completion helps ensure consistency and continuity. The findings also suggest that clients tend to take a more active role in reuse projects, becoming more involved throughout the process to ensure that the responsibility for enabling reuse does not rest solely with the contractor. In the case projects, this increased client involvement was facilitated either through a partnering arrangement or through a divided contract structure. The collaborative organisational culture present in the projects likely contributed further to client involvement, as noted by Trigunaryah (2017).

## 6.2 The Design and Construction Process for Reuse

When reuse is integrated into construction projects, several new activities are introduced. The reuse-related activities identified in the case studies included reuse goal formulation, inventory, quality control and test assembly, disassembly, reconditioning, design and planning for reuse, storage and logistics, and reassembly. These align well with the reuse process suggested by Lindborg et al. (2024), which includes the formulation of reuse goals, inventory, quality control and classification (when applicable), disassembly, potential reconditioning, transport and storage, and reassembly.

However, the reuse process may differ slightly depending on the choice of contract type and procurement strategy. For example, traditional construction contracts typically require a more extensive preparatory phase, as demonstrated in the Lumi project. In contrast, design-build contracts allow reuse solutions to be identified progressively during the construction phase – though this may result in a longer production period. Based on this study, it is not possible to determine which approach is generally preferable. The most suitable method likely depends on the specific project context, including whether there is greater flexibility to allocate time before or after contractor procurement. On one hand, a project may aim to begin construction quickly, making it less desirable to delay the start for full reuse planning. On the other hand, if reuse solutions are not fully developed in advance, delays during production may occur, potentially leading to higher costs.

Regardless of the approach, the interview findings suggest that the overall project timeline is affected when reuse is integrated. Therefore, allocating more time and distributing project resources with reuse in mind, as recommended by Gerhardsson et al. (2020) and Ericsson et al. (2024), is likely necessary. Moreover, previous studies emphasise the importance of introducing reuse in the early stages (Benachio et al., 2020; Ericsson et al., 2024). This allows more time for planning, which is especially important when new activities are introduced.

In addition, the use of BIM has been highlighted in previous research as a key enabler for reuse and circularity in construction (Benachio et al., 2020; AlJaber et al., 2023; Charef & Emmitt, 2021). Similarly, the Lumi project adopted a highly digital approach, and many project participants saw the digital workflow and BIM integration as major advantages. While it is possible to succeed with reuse without such tools, BIM has the potential to make the process more structured and efficient, as demonstrated in the Lumi project. Nonetheless, several interviewees noted that the digital workflow used in Lumi still has room for improvement.

**Reuse goal formulation:** It is clear from both previous research and the interview findings that reuse goal formulation is important. However, it is less clear how specific these goals need to be. According to Bellini et al. (2024), clear reuse goals should be in place from the early stages of the project. Gerhardsson et al. (2020) further emphasise the importance of setting specific, measurable, attainable, realistic, and time-bound (SMART) reuse targets that are regularly followed up throughout the process. None of the case projects had reuse goals that fulfilled these criteria, and in general, the goals were not clearly defined from the beginning. Nevertheless, most interviewees did not perceive this as a problem, and some even saw advantages in having vague or unattainable goals. For instance, a project manager from Werket argued that the absence of specific goals allowed them to push the boundaries and take advantage of reuse opportunities as they arose. Similarly, interviewees from Lumi described how the goal of 100% reuse helped them maximise their reuse level, even though they knew from the beginning that the goal was unrealistic.

However, the approach adopted in these projects likely requires a highly motivated project team to be successful, as not all project participants will actively strive to go beyond what is required of them. For more typical projects, it is probably more appropriate to follow the recommendations of Gerhardsson et al. (2020) and use the SMART criteria when formulating reuse goals. It may not be necessary to define exact reuse percentages or metrics, but in that case, it is important to specify how reuse will be promoted, and which activities will be carried out. What is essential is a shared vision; the goal must at least be clear enough for all project participants to understand it.

**Inventory process:** The inventory process was also highlighted both in previous studies (Bellini et al., 2024; Gerhardsson et al., 2020; Ericsson et al., 2024) and by several interviewees as crucial for successful reuse. Interviewees from the Lumi project emphasised the importance of conducting the inventory carefully and ensuring that all properties are correctly documented. Despite their highly digital workflow, the Lumi project faced problems with incorrect measurements in the inventory, which caused a lot of additional manual work. Still, the interviewees stressed that digital tools were essential to support the inventory process. Among the case projects, Lumi achieved the highest reuse level, suggesting that this approach is well-suited for large-scale reuse. Nevertheless, both Werket and Trikäfabriken managed to integrate reuse through more analogue processes – showing that it is possible, but perhaps less efficient, especially when scaling up.

Overall, there seems to be consensus that the inventory should be conducted as early as possible. However, in none of the case projects was the inventory performed in a single, unified session. Instead, it was typically divided into an early, more general inventory and a later, more detailed one. This approach makes it possible to get an overview of which products may be available for reuse in early stages – even before the resources are in place to conduct a more detailed inventory, which often must wait until at least some building components can be disassembled.

Furthermore, it does not seem necessary to involve a reuse consultant in the inventory process. In fact, the inventories conducted by reuse consultants in Werket and Trikåfabriken were not considered particularly useful. Instead, those carried out by the project teams were more valuable. These inventories were typically performed by design consultants from several disciplines, sometimes involving contractors, to help identify reuse opportunities.

**Design and planning for reuse:** As noted by Gerhardsson et al. (2020), new and adapted design methods are required to support reuse. This became evident in both the Werket and Lumi projects, where traditional design methods had to be challenged. Architects from these projects described that a more flexible design process was required when incorporating reused products. This is consistent with the findings of Göteborgs Stad (2020), which emphasise that the design process must accommodate uncertainty regarding which products will be available for reuse.

Due to this uncertainty, it is often not possible to complete the design before construction begins – at least not until the inventory, quality control, and disassembly are completed. Even then, changes may occur if a reused product is damaged and needs to be replaced. Thus, it may be necessary to adopt a more integrated approach to planning and construction, as suggested by Göteborgs Stad (2020). This requires the architect to remain involved throughout the production phase, taking on an important role in the reuse process.

Another enabler identified in previous studies is the early involvement and collaboration between stakeholders, including manufacturers and various design consultants, to identify reuse opportunities and integrate them into the design (Bellini et al., 2024; Ericsson et al., 2024). While manufacturers were not particularly involved in the case projects, several interviewees emphasised the importance of close collaboration between design consultants. In the Lumi project, this collaboration was supported by the digital workflow, where all designers worked within the same digital 3D model.

**Quality control and test assembly:** The quality assessment of reused products is a crucial consideration, highlighted by both Ericsson et al. (2024) and Gerhardsson et al. (2019).

However, the interview results indicated that there are various ways to approach it. According to the interviewees, quality assurance becomes more critical when reusing load-bearing components or other safety-sensitive products. In contrast, for smaller or less critical items, visual inspections by contractors or other individuals with expertise in building materials are often sufficient.

In the Lumi project, products that might otherwise have been discarded were successfully reused by constructing mock-up rooms for testing. This allowed the team to verify that the reused components met acoustic and other performance standards, enabling the reuse of a wider range of products than in the other two case projects. While this method proved effective for quality assurance, it required additional time, effort, and access to vacant space. Depending on the project scale and available resources, test assemblies can likely be adapted to fit the specific context. Nevertheless, the Lumi project demonstrated that physically testing reused products can be a highly successful approach.

**Disassembly and reassembly:** The interviewees generally agreed that disassembly is more time and resource consuming than demolition. However, if done properly it can lead to significant cost savings by eliminating the need to purchase new materials. Several interviewees therefore stressed the importance of having qualified contractors conduct the disassembly to ensure it is performed correctly. One approach was to involve the same contractor who would also carry out the reassembly. This provided the contractor with an incentive to exercise additional care during disassembly, while also facilitating reassembly, as the contractor was already familiar with the process. However, one interviewee suggested that the priority should be to engage skilled professionals for the disassembly who can also conduct an initial quality control of the products. Moreover, the findings indicate that it may be beneficial to integrate the disassembly and inventory processes, as demonstrated in the Lumi project.

**Storage and logistics:** While the storage and logistics could have been a significant hinder to reuse, this was largely facilitated in all three case projects by having access to internal storage on-site. However, it is important that materials are stored in a way that does not complicate the construction works, while also avoiding damage – so reused products cannot be stored just anywhere on site. For instance, the decision was made in the Werket project to relocate some dismantled products off-site to keep the construction site clear. In cases when external storage is required, a combined logistics hub for new and reused products can facilitate the logistics, as seen in the Lumi project.

### 6.3 Overcoming Barriers to Reuse

The interviewees in this study described barriers and enablers for reuse that were largely consistent with those identified in previous research. For example, Hart et al. (2019) identified cultural, regulatory, financial, and sectoral factors affecting the transition to a CE, while this study found similar cultural, regulatory, and economic factors. Likewise, Rakhshan et al. (2020) highlighted social, economic, and regulatory barriers as particularly important to address.

Among the cultural barriers, earlier studies have pointed out a lack of interest (Hart et al., 2019; AlJaber et al., 2023; Ababio & Lu, 2023), limited skills or expertise (Hart et al., 2019; Ababio & Lu, 2023), and insufficient collaboration (Hart et al., 2019; AlJaber et al., 2023). Similarly, the interviewees mentioned a lack of interest as an initial challenge. Several noted that the general willingness to work with reuse was low at the beginning of the project. However, once a positive attitude and motivation for reuse were established within the project team, these became significant success factors. This shift was often driven by the personal commitment and enthusiasm of individuals in the project organisation, which helped inspire and engage others. One client suggested that this barrier can be effectively addressed by involving only people and organisations with a genuine interest in reuse. While such individuals or companies may not always be available, the interview results also showed that it is possible to create interest even among initially sceptical contractors – though this may require some effort.

While some interviewees encountered scepticism towards reuse from tenants, others found that implementing reuse actually helped attract tenants. Thus, tenant resistance should not be considered a significant barrier. However, communicating the reuse concept effectively from the early stages will likely help increase interest among tenants and prevent conflicts.

Furthermore, close collaboration between project participants was highlighted as a key success factor by several interviewees – aligning with findings from Hart et al. (2019) and AlJaber et al. (2023), who noted that a lack of collaboration can be a barrier to reuse. This collaboration was often supported by establishing a shared vision within the project team. One interviewee particularly emphasised the importance of engaging individuals at all levels, from top management to on-site workers, suggesting that this can be achieved by having ambassadors at different levels who share the vision and motivate others.

In contrast to the findings of Hart et al. (2019) and Ababio and Lu (2023), the lack of skills or expertise was not mentioned as a major barrier by the interviewees – even though reuse was a new practice for many participants in all three case projects. This indicates that, with the right

attitude and strong collaboration, prior experience may not be necessary. Therefore, the threshold for starting to work with reuse does not need to be particularly high, provided there is a willingness to adopt new working methods.

The regulatory barriers encountered in the case projects were mainly related to reused products not fulfilling modern requirements. In particular, regulations regarding accessibility, acoustics, and fire safety were difficult to prove compliance with when using reused products. For instance, the Lumi project had to invest considerable effort in proving that its door openings were accessible to wheelchairs and mobility scooters, as they were 1.5 cm too narrow to meet current standards. This is consistent with the regulatory obstacles identified by Hart et al. (2019), suggesting that the regulatory framework may need to be simplified to better support reuse. At the same time, examples from the case studies show that it is often possible to work around such regulations if one is persistent and can demonstrate that reused products meet acceptable standards. However, it is not ideal that so many resources must be spent on doing so.

Financial barriers to reuse were also discussed by some interviewees. While certain participants highlighted economic viability as a major challenge, others noted that reuse was sometimes less expensive than purchasing new products. Thus, the profitability of reuse seems to depend largely on the type of product. The main costs associated with reuse relate to disassembly and the careful handling of materials. However, once reuse practices become more established and stakeholders gain more experience, these activities may become less time consuming and less expensive. Similarly, the high upfront investment costs emphasised in previous research (Hart et al., 2019; AlJaber et al., 2023; Ababio & Lu, 2023) are likely to decrease as reuse becomes more common. While low virgin material prices, identified by Hart et al. (2019) as a barrier to circularity, continue to make certain new building products cheaper than reused products, many interviewees noted that reuse offers other forms of value that are not easily measured in economic terms.

In addition to cultural, regulatory, and financial barriers, previous research has identified the lack of a mature reuse market as a major hinder. For instance, both Gerhardsson et al. (2020) and Ericsson et al. (2024) highlighted this issue in the Swedish context. However, the interviewees in this study did not describe the underdeveloped reuse market as a significant barrier. This can be explained by the fact that the case projects focused on internal reuse and generally did not involve the purchase of reused materials. Thus, the absence of a professional reuse market becomes a barrier primarily in projects where reused materials cannot be sourced

internally. Nevertheless, had a mature reuse market been available at the time these case projects were carried out, they might have achieved even higher reuse levels by supplementing internal reuse with externally sourced materials. It can therefore be assumed that a professional reuse market has the potential to accelerate reuse across all types of construction projects, including transformation and redevelopment, and is particularly crucial in new construction, where no reusable materials are available within the project.

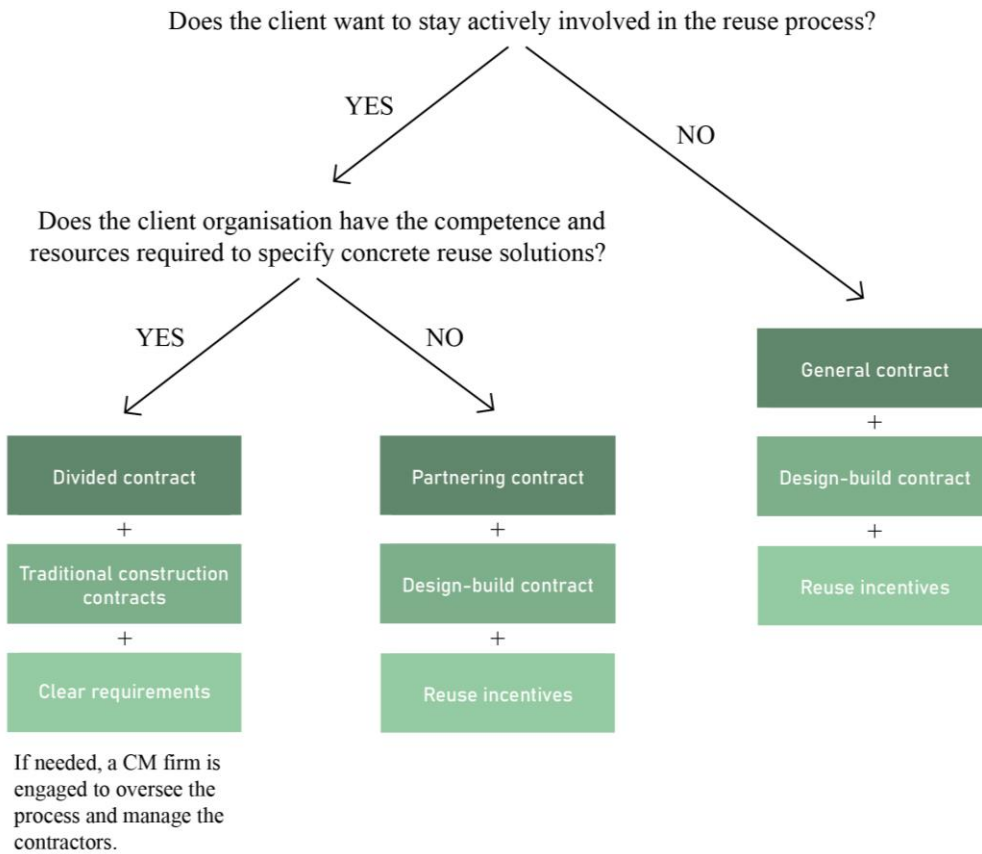


## 7. Recommendations

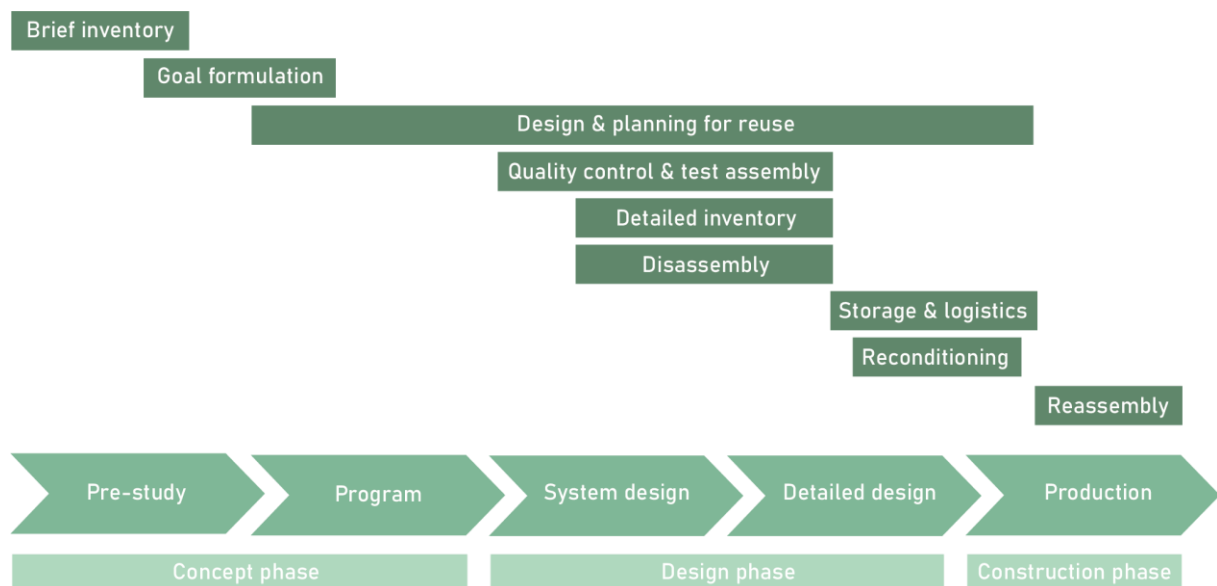
Based on the main findings of the thesis, this chapter provides general recommendations for enabling large-scale reuse in building transformation and redevelopment projects. These include recommendations regarding the choice of contract types and procurement strategies, as well as the organisation of the reuse process.

In Figure 7.1, a guideline for selecting contract types and procurement strategies is illustrated. It suggests that the client should first decide whether they wish to remain actively involved throughout the reuse process. If not, procuring a general contractor through a design-build contract with reuse incentives may be the best option, as it encourages the contractor to take responsibility for driving reuse efforts independently. If the client does wish to be involved, they should consider whether they have the necessary competence and resources to specify concrete reuse solutions during procurement. In that case, using a divided contract setup with traditional construction contracts and clear reuse requirements is likely the most suitable approach. This approach may benefit from involving a CM firm that takes responsibility for overseeing the process and managing the contractors. However, if the client organisation lacks sufficient competence or resources to specify reuse solutions in detail before contractor procurement, entering a partnering contract with a design-build contractor, combined with reuse incentives, may be more appropriate. This approach supports reuse efforts by encouraging collaboration between the client and the contractor, enabling them to identify reuse opportunities collectively.

Figure 7.2 illustrates the recommended reuse process, including the eight main reuse activities identified in the thesis. The inventory process is divided into two parts, where a brief inventory is preferably conducted during the pre-study phase, and a detailed inventory is carried out during the system design and detailed design phases. Reuse goals are formulated during the pre-study and program phases. Design and planning for reuse is required from the program phase through to the production phase. Quality control and test assembly are performed during the system design and detailed design phases, partly in parallel with disassembly and the detailed inventory. From disassembly until reassembly, storage and logistics are required. If needed, the phase between disassembly and reassembly may also involve reconditioning of the products to be reused. Finally, the products are reassembled during the production phase.



**Figure 7.1:** Suggested guideline for selecting contract types and procurement strategies to support large-scale reuse in building transformation and redevelopment projects (the author's own figure).



**Figure 7.2:** Suggested process for reuse in building transformation and redevelopment projects (the author's own figure).

## 8. Conclusion

This thesis explored the organisation of reuse in Swedish redevelopment projects, with the aim of identifying success factors and providing practical examples of methods and solutions. It focused particularly on the types of contracts and procurement strategies used, how the design and construction process is structured and adapted for reuse, and how challenges related to reuse implementation are addressed. The research was designed as a multiple case study, and an abductive approach was adopted to allow for an iterative research process, moving back and forth between literature and empirical findings. The data was collected through 11 semi-structured interviews with participants from the three case projects. In this concluding chapter, the three research questions presented in section 1.3 are answered based on the findings of the thesis.

**RQ1: How have building transformation and redevelopment projects involving the reuse of building products and components been organised in terms of contract types and procurement strategies?**

The case projects included in this study either involved a partnering agreement with a design-build contractor or used a divided contact structure with traditional construction contracts, overseen by a CM firm. Both approaches were considered suitable for reuse, but roles and responsibilities shifted significantly depending on the chosen approach. The findings also highlighted that “partnering” can be interpreted differently by different parties, and its effectiveness depends on factors such as risk-sharing, trust, and collaboration – conditions that were not always fully achieved in the case projects.

Procurement strategies were closely tied to the chosen contract model. Traditional construction contracts required detailed and clearly defined reuse requirements from the outset, while design-build partnering arrangements instead relied on contractor incentives – either financial or otherwise – to promote reuse efforts. The importance of selecting motivated consultants and contractors was emphasised across all cases.

As reuse introduced new tasks and areas of responsibility, traditional project roles changed. None of the projects appointed a dedicated reuse coordinator; instead, reuse responsibilities were distributed among several project members, often driven by personal engagement. However, it was noted that having a dedicated coordinator may facilitate the reuse process. Architects also took on broader roles and remained involved later in the process than usual.

Additionally, client organisations – including their directly engaged consultants – took on more active roles to ensure that reuse was prioritised and implemented effectively, particularly in the absence of strong reuse mandates for contractors.

**RQ2: How does the reuse of building products and components influence the design and construction process in building transformation and redevelopment projects?**

The reuse of building products and components introduces new activities that significantly influence the design and construction process. Key reuse-related tasks include reuse goal formulation, inventory, disassembly, quality control and test assembly, reconditioning, design and planning for reuse, storage and logistics, and reassembly. These tasks require greater coordination across project stages and introduce complexity that challenges traditional linear workflows.

The reuse process is also affected by the contract type and procurement strategy used. Traditional construction contracts often require more planning in advance, while design-build contracts allow reuse opportunities to be identified progressively during construction. Regardless of the approach, resources should be distributed with reuse in mind, and additional time often needs to be scheduled. If possible, reuse should be introduced at early stages to allow sufficient time for planning. The reuse process can also be facilitated by the use of BIM.

**RQ3: How can the barriers associated with reuse be addressed in future transformation and redevelopment projects?**

To overcome barriers to reuse in transformation and redevelopment projects, several strategies can be adopted based on insights from both empirical and theoretical findings. The strategies particularly address cultural, regulatory, and financial barriers.

Cultural barriers – such as initial scepticism, lack of interest, or resistance to change – can be mitigated by fostering a strong, shared vision for reuse within the project team. The enthusiasm and commitment of individuals often proved crucial in motivating others. Involving team members who are genuinely interested in reuse or appointing “reuse ambassadors” at various levels of the organisation, can help shift attitudes. Effective early communication with tenants and stakeholders also helps generate acceptance and avoid conflicts. In general, a collaborative project culture with close cooperation among project participants effectively supports reuse efforts.

Regulatory barriers – particularly those relating to modern requirements for accessibility, fire safety, and acoustics – remain a major challenge. Though workarounds appear to be possible, these often demand substantial resources. Simplifying regulations or developing clearer standards for reused products would greatly facilitate compliance.

Financial barriers, such as high upfront costs and time-intensive processes like disassembly, remain a challenge for some products, while the reuse of others is already economically viable. These costs will likely decrease as reuse becomes more common and stakeholders gain experience. Moreover, while reused products may not always be cheaper, they often provide added value in terms of sustainability.

Lastly, although the studied projects mainly focused on internal reuse, the absence of a professional reuse market limits the broader applicability of reuse. Establishing a mature, accessible reuse market would allow more projects to source materials externally and scale reuse more effectively.

## 8.1 Future Research and Development

The research conducted in this thesis has also identified several areas that could be explored in future studies. First, the process for internal reuse in redevelopment projects differs significantly from the reuse process in new construction, where no building products are available internally. Therefore, further research is needed to better understand the reuse process in new construction projects, including the procurement of reused products. In such projects, the absence of a professional reuse market is likely to present a greater barrier, while storage and logistics may also become more complex.

In future studies, it would also be valuable to include less successful projects. Examining projects that have failed to incorporate reuse, despite genuine efforts to do so, could help increase the understanding of the barriers to reuse that need to be addressed. Moreover, since this study focused on large-scale reuse in highly ambitious projects, studying more typical projects that have implemented reuse to a limited extent would provide a different and complementary perspective.

Finally, some interviewees indicated that certain building products may be more suitable for reuse than others. This would be an interesting area for further investigation. For example, future research could map the reuse process for specific products, assess the economic viability

of each product type, and compare their climate impact. Such research could result in recommendations regarding the reuse potential of different building products and components, helping to establish an order of priority for reuse in future construction projects.

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# Appendix: Interview Guideline

The following questions served as the basis for the interviews. Since the interviews were semi-structured, the questions were sometimes slightly adjusted. Follow-up questions varied for each interview and were often added spontaneously depending on the interviewee's responses. Therefore, they are not included in this guideline.

## **Formal questions:**

- May I record and transcribe this interview?
- Is it okay to mention your professional role and the name of the project in the thesis?
- Do you have any questions before we begin?

## **Background:**

- Could you briefly describe your background and your current role at the company?

## **Case-specific questions:**

- What was your role in the project?
- Can you describe how reuse was handled in the project?
- What type of contracts were used in the project, and what did the organisational structure look like?
- Can you describe the process during the phases you were involved in?
- What were the biggest challenges related to reuse, and how did you address them?
- What do you see as the main success factors in your project regarding process and organisation?

## **Concluding questions:**

- Is there anything you would like to add that we have not discussed?
- Is there anyone else involved in the project whom you would recommend I interview?
- Would you like to receive a copy of the final thesis before it is published?





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